Attachment 2

LaSalle Unit 1 Cycle 9

Reload Analysis

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Revision 1

LaSalle Unit 1 Cycle 9 Reload Analysis

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Siemens Power Corporation
Nuclear Division

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Revision 1

LaSalle Unit 1 Cycle 9
Reload Analysis

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Nature of Changes

Item	Page	Description and Justification
1.	5-1	Discussion added to indicate $MCPR_f$ limits and $LHGRFAC_f$ multipliers are provided for maximum core flows of 102.5% and 105% of rated.
2.	5-10	Revised Figure 5.1 to include $MCPR_f$ limits for both 102.5% and 105% maximum core flows.
3.	9-1	Updated references to revised plant transient analysis and fuel design reports.

The changed items are further identified by a vertical line (|) in the right-hand margin.

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Nomenclature

AOO	abnormal operational occurrence
BOC	beginning of cycle
CPR	critical power ratio
EFPH	effective full power hour
EOC	end of cycle
EOD	extended operating domain
EOOS	equipment out of service
FHOOS	feedwater heater out of service
FWCF	feedwater controller failure
ICF	increased core flow
LFWH	loss of feedwater heater
LHGR	linear heat generation rate
LHGRFAC	LHGR multiplier
LPRM	local power range monitor
LRNB	load rejection no bypass
MAPLHGR	maximum average planar linear heat generation rate
MCPR	minimum critical power ratio
MELLLA	maximum extended load line limit area
MSIV	main steam isolation valve
NSS	nominal scram speed
PAPT	protection against power transient
PCT	peak clad temperature
RPT	recirculation pump trip
SLMCPR	safety limit minimum critical power ratio
SLO	single-loop operation
SPC	Siemens Power Corporation
SRVOOS	safety/relief valve out of service
TBVOOS	turbine bypass valves out of service
TCV	turbine control valve
TIP	traversing in-core probe
TIPOOS	traversing in-core probe out of service
TSSS	technical specification scram speed
UFSAR	updated final safety analysis report
ΔCPR	change in critical power ratio

1.0 Introduction

This report provides the results of the analysis performed by Siemens Power Corporation (SPC) as part of the reload analysis in support of the Cycle 9 reload for LaSalle Unit 1. This report is intended to be used in conjunction with the SPC topical Report XN-NF-80-19(P)(A), Volume 4, Revision 1, *Application of the ENC Methodology to BWR Reloads*, which describes the analyses performed in support of this reload, identifies the methodology used for those analyses, and provides a generic reference list. Section numbers in this report are the same as corresponding section numbers in XN-NF-80-19(P)(A), Volume 4, Revision 1. Methodology used in this report which supersedes XN-NF-80-19(P)(A), Volume 4, Revision 1, is referenced in Section 8.0. The NRC Technical Limitations presented in the methodology documents, including the documents referenced in Section 8.0, have been satisfied by these analyses.

Analyses performed by Commonwealth Edison Company (ComEd) are described elsewhere. This document alone does not necessarily identify the limiting events or the appropriate operating limits for Cycle 9. The limiting events and operating limits must be determined in conjunction with results from ComEd analyses.

The Cycle 9 core consists of a total of 764 fuel assemblies, including 372 unirradiated ATRIUM™-9B* assemblies and 392 irradiated GE9 assemblies. The reference core configuration is described in Section 4.2.

The design and safety analyses reported in this document were based on the design and operational assumptions in effect for LaSalle Unit 1 during the previous operating cycle. The effects of channel bow are explicitly accounted for in the safety limit analysis. The extended operating domain (EOD) and equipment out of service (EOOS) conditions presented in Table 1.1 are supported.

Analyses were performed to support end-of-cycle (EOC) operating limits. This report provides limits for both pre-power uprate (3323 MWt) and power uprate (3489 MWt) conditions. The analyses upon which the operating limits are based were performed such that both the pre-power uprate and power uprate limits are applicable for all of Cycle 9.

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* ATRIUM is a trademark of Siemens.

Table 1.1 EOD and EOOS Operating Conditions

Extended Operating Domain (EOD) Conditions

- Increased Core Flow
- Maximum Extended Load Line Limit Analysis (MELLLA)

Equipment Out of Service (EOOS) Conditions*

- Feedwater Heaters Out of Service (FHOOS)
- Single-Loop Operation (SLO) - Recirculation Loop Out of Service
- Turbine Bypass Valves Out of Service (TBVOOS)
- Recirculation Pump Trip Out of Service (No RPT)
- Turbine Control Valve (TCV) Slow Closure and/or No RPT
- Safety Relief Valve Out of Service (SRVOOS)
- Up to 2 TIP Machine(s) Out of Service (or the equivalent number of TIP channels)
- Up to 50% of the LPRMs Out of Service
- TCV Slow Closure, FHOOS and/or No RPT

* EOOS conditions are supported for EOD conditions as well as the standard operating domain. Each EOOS condition combined with 1 SRVOOS, up to 2 TIPOOS (or the equivalent number of TIP channels) and/or up to 50% of the LPRMs out of service is supported.

2.0 Fuel Mechanical Design Analysis

Applicable SPC Fuel Design Reports — References 9.1 & 9.2

To assure that the power history for the ATRIUM-9B fuel to be irradiated during Cycle 9 of LaSalle Unit 1 is bounded by the assumed power history in the fuel mechanical design analysis, LHGR operating limits have been specified in Section 7.2.3. In addition, LHGR limits for Anticipated Operational Occurrences have been specified in Reference 9.1 and are presented in Section 7.2.3 as Figure 7.1.

3.0 Thermal-Hydraulic Design Analysis

3.2 *Hydraulic Characterization*

3.2.1 Hydraulic Compatibility

Component hydraulic resistances for the fuel types in the LaSalle Unit 1 Cycle 9 core have been determined in single-phase flow tests of full-scale assemblies. The hydraulic demand curves for SPC ATRIUM-9B and GE9 fuel in the LaSalle Unit 1 core are provided in Reference 9.1, Figure 4.2.

3.2.3 Fuel Centerline Temperature

Applicable Report ATRIUM-9B		Reference 9.1, Figure 3.3

3.2.5 Bypass Flow

Calculated Bypass Flow at 100%P/100%F (includes water channel flow)	14.7 Mlb/hr	Reference 9.3

3.3 *MCPR Fuel Cladding Integrity Safety Limit (SLMCPR)*

Two-Loop Operation*	1.11	Reference 9.3
Single-Loop Operation*	1.12	

3.3.1 Coolant Thermodynamic Condition

Thermal Power (at SLMCPR)	5232.35 MWt
Feedwater Flow Rate (at SLMCPR)	22.7 Mlbm/hr
Core Exit Pressure (at Rated Conditions)	1031.35 psia
Feedwater Temperature	426.5°F

* Includes the effects of channel bow, up to 2 TIPOOS (or the equivalent number of TIP channels), a 2000 EFPH LPRM calibration interval, and up to 50% of the LPRMs out of service.

3.3.2 Design Basis Radial Power Distribution

Figure 3.1 shows the radial power distribution used in the MCPR Fuel Cladding Integrity Safety Limit analysis.

3.3.3 Design Basis Local Power Distribution

Figures 3.2, 3.3 and 3.4 show the local power peaking factors used in the MCPR Fuel Cladding Integrity Safety Limit analysis.

SPCA9-393B-16GZ-100M	Figure 3.2
SPCA9-396B-12GZB-100M and SPCA9-396B-12GZC-100M	Figure 3.3
SPCA9-384B-11GZ-80M	Figure 3.4

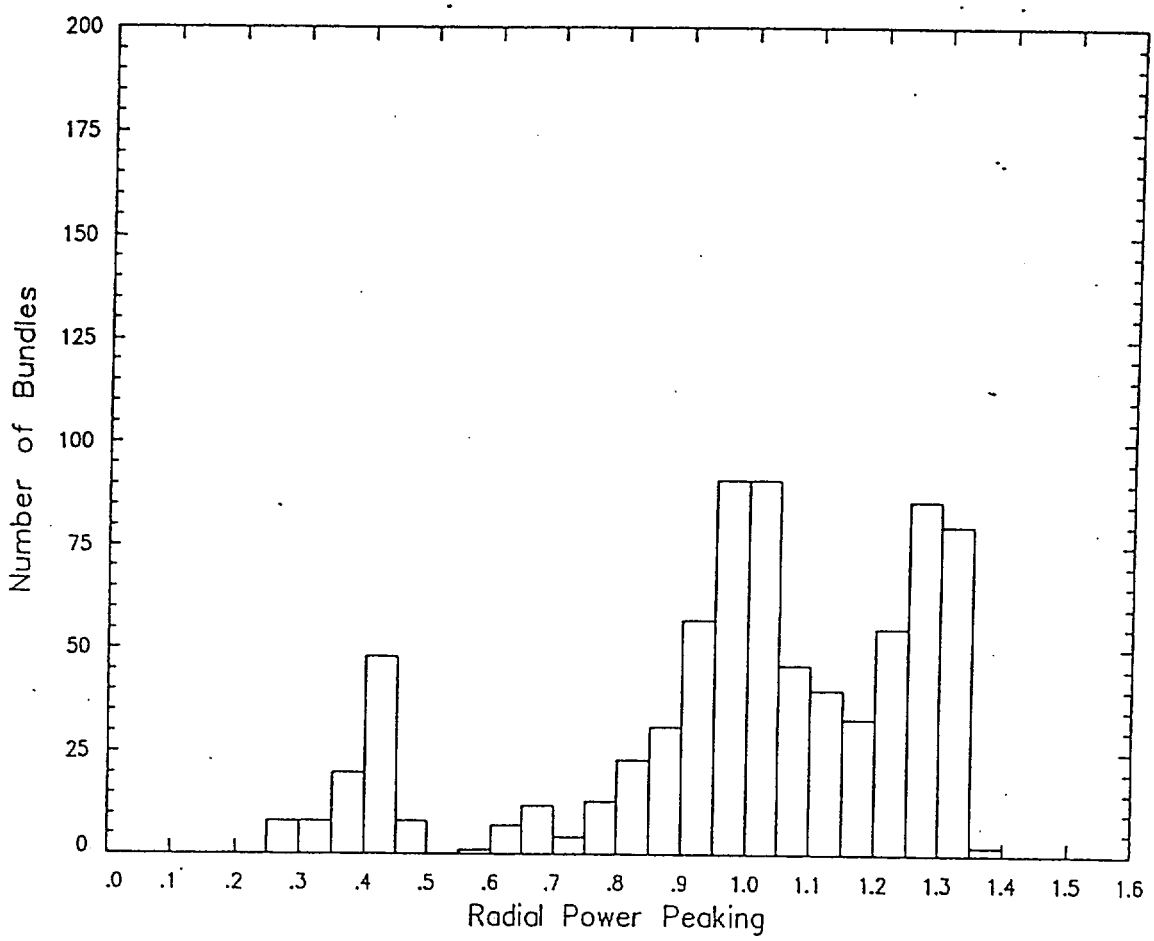


Figure 3.1 Radial Power Distribution for SLMCPR Determination

Control Rod Corner

Control Rod Corner

1.023	1.055	1.068	1.112	1.099	1.102	1.049	1.023	.977
1.055	.958	.894	1.016	.894	1.007	.877	.927	1.002
1.068	.894	1.031	1.065	1.084	1.056	1.010	.863	1.011
1.112	1.016	1.065	Internal			1.044	.980	1.051
1.099	.894	1.084	Water			1.063	.863	1.038
1.102	1.007	1.056	Channel			1.035	.971	1.041
1.049	.877	1.010	1.044	1.063	1.035	.990	.846	.992
1.023	.927	.863	.980	.863	.971	.846	.895	.970
.977	1.002	1.011	1.051	1.038	1.041	.992	.970	.931

Figure 3.2 LaSalle Unit 1 Cycle 9 Safety Limit Local Peaking Factors
SPCA9-393B-16GZ-100M With Channel Bow

Control Rod Corner

Control Rod Corner

1.013	1.042	1.056	1.110	1.098	1.100	1.037	1.010	.967
1.042	.944	1.025	.879	1.014	.871	1.005	.912	.989
1.056	1.025	1.018	1.064	1.081	1.055	.997	.989	.999
1.110	.879	1.064	Internal			1.043	.848	1.047
1.098	1.014	1.081	Water			1.059	.978	1.035
1.100	.871	1.055	Channel			1.034	.840	1.037
1.037	1.005	.997	1.043	1.059	1.034	.977	.968	.979
1.010	.912	.989	.848	.978	.840	.968	.881	.956
.967	.989	.999	1.047	1.035	1.037	.979	.956	.921

Figure 3.3 LaSalle Unit 1 Cycle 9 Safety Limit Local Peaking Factors SPCA9-396B-12GZB-100M and SPCA9-396B-12GZC-100M With Channel Bow

Control Rod Corner

Control Rod Corner

1.022	1.056	1.061	1.035	1.102	1.028	1.045	1.029	.982
1.056	.947	1.018	1.003	.879	.997	1.004	.919	1.011
1.061	1.018	1.001	1.050	1.081	1.048	.996	.992	1.012
1.035	1.003	1.050	Internal			.926	.983	.987
1.102	.879	1.081	Water			1.077	.853	1.049
1.028	.997	1.048	Channel			1.040	.970	.979
1.045	1.004	.996	.926	1.077	1.040	.859	.980	.996
1.029	.919	.992	.983	.853	.970	.980	.891	.983
.982	1.011	1.012	.987	1.049	.979	.996	.983	.941

Figure 3.4 LaSalle Unit 1 Cycle 9 Safety Limit Local Peaking Factors
SPCA9-384B-11GZ-80M With Channel Bow

4.0 Nuclear Design Analysis

4.1 *Fuel Bundle Nuclear Design Analysis*

Assembly Average Enrichment (ATRIUM-9B fuel)

SPCA9-393B-16GZ-100M	3.93 wt%
SPCA9-396B-12GZB-100M	3.96 wt%
SPCA9-384B-11GZ-80M	3.84 wt%
SPCA9-396B-12GZC-100M	3.96 wt%

Radial Enrichment Distribution

SPCA9-4.56L-12G8.0/4G3.0-100M	Figure 4.1
SPCA9-4.56L-12G8.0-100M	Figure 4.2
SPCA9-3.91L-12G8.0-100M	Figure 4.3
SPCA9-3.90L-8G5.0-100M	Figure 4.4
SPCA9-4.59L-12G8.0-100M	Figure 4.5
SPCA9-4.59L-12G7.0-100M	Figure 4.6
SPCA9-3.96L-8G7.0/4G8.0-100M	Figure 4.7
SPCA9-3.96L-8G5.0-100M	Figure 4.8
SPCA9-4.58L-8G6.0/4G3.0-100M	Figure 4.9
SPCA9-4.58L-8G6.0-100M	Figure 4.10
SPCA9-4.06L-11G6.0-80M	Figures 4.11
SPCA9-4.34L-10G6.0-80M	Figures 4.12

Axial Enrichment Distribution	Figures 4.13–4.16
Burnable Absorber Distribution	Figures 4.13–4.16
Non-Fueled Rods	Figures 4.1–4.12
Neutronic Design Parameters	Table 4.1

Fuel Storage

LaSalle New Fuel Storage Vault — Reference 9.4

The LSA-1 Reload Batch fuel designs meet the fuel design limitations defined in Table 2.1 of Reference 9.4 and therefore can be safely stored in the vault.

LaSalle Unit 1 Spent Fuel Storage Pool (BORAL Racks) — Reference 9.5

The LSA-1 Reload Batch fuel designs meet the fuel design limitations defined in Table 2.1 of Reference 9.5 and therefore can be safely stored in the pool.

LaSalle Unit 2 Spent Fuel Storage Pool — Reference 9.6

The LSA-1 Reload Batch fuel designs can be safely stored as long as the fuel assembly reactivity limitations defined in Reference 9.6 are met.

< ComEd has responsibility to confirm that fuel meets reactivity limitations. >

4.2 *Core Nuclear Design Analysis*

4.2.1 Core Configuration — Figure 4.17

Core Exposure at EOC8, MWd/MTU (nominal value)	27,957
Core Exposure at BOC9, MWd/MTU (from nominal EOC8)	10,962
Core Exposure at EOC9, MWd/MTU (licensing basis)	29,439

NOTE: Analyses in this report are applicable to a core exposure of 29,439 MWd/MTU.

< Cycle 9 short window exposure to be determined by ComEd. >

4.2.2 Core Reactivity Characteristics

< This data is to be furnished by ComEd. >

4.2.4 Core Hydrodynamic Stability — Reference 8.7

LaSalle Unit 1 utilizes the BWROG Interim Corrective Actions (ICAs) to address thermal hydraulic instability issues. This is in response to Generic Letter 94-02. When the long term solution OPRM is fully implemented, the ICAs will remain as a backup to the OPRM system.

In order to support the ICAs and remain cognizant of the relative stability of one cycle compared with previous cycles, decay ratios are calculated at various points on the power to flow map and at various points in the cycle. This satisfies the following functions.

1. Provides trending information to qualitatively compare the stability from cycle to cycle.
2. Provides decay ratio sensitivities to rod line and flow changes near the ICA regions.

3. Allows ComEd to review this information to determine if any administrative conservatisms are appropriate beyond the existing requirements.

The NRC approved STAIF computer code was used in the core hydrodynamic stability analysis performed in support of LaSalle Unit 1 Cycle 9. The power/flow state points used for this analysis were chosen to assist ComEd in performing the three functions described above. The Cycle 9 licensing basis control rod step-through projection was used to establish expected core depletion conditions. For each power/flow point, decay ratios were calculated at multiple cycle exposures to determine the highest expected decay ratio throughout the cycle. The results from this analysis are shown below.

Power/Flow (%)*	Maximum Global†	Maximum Regional†
29.6/26.6	0.73	0.61
30.3/29.2	0.48	0.53
51.9/26.6	>1.1	>1.1
54.4/29.2	>1.1	>1.1
61.9/50.0	0.46	0.69
73.6/50.0	0.67	1.04
78.1/55.0	0.57	0.90
82.4/60.0	0.49	0.79
70.0/55.0	0.44	0.69

For reactor operation under conditions of power coastdown, single-loop operation, final feedwater temperature reduction (FFTR) and/or operation with feedwater heaters out of service, it is possible that higher decay ratios could be achieved than are shown for normal operation.

* NOTE: % power is based on 3489 MWt as rated. % flow is based on 108.5 Mlb/hr as rated.

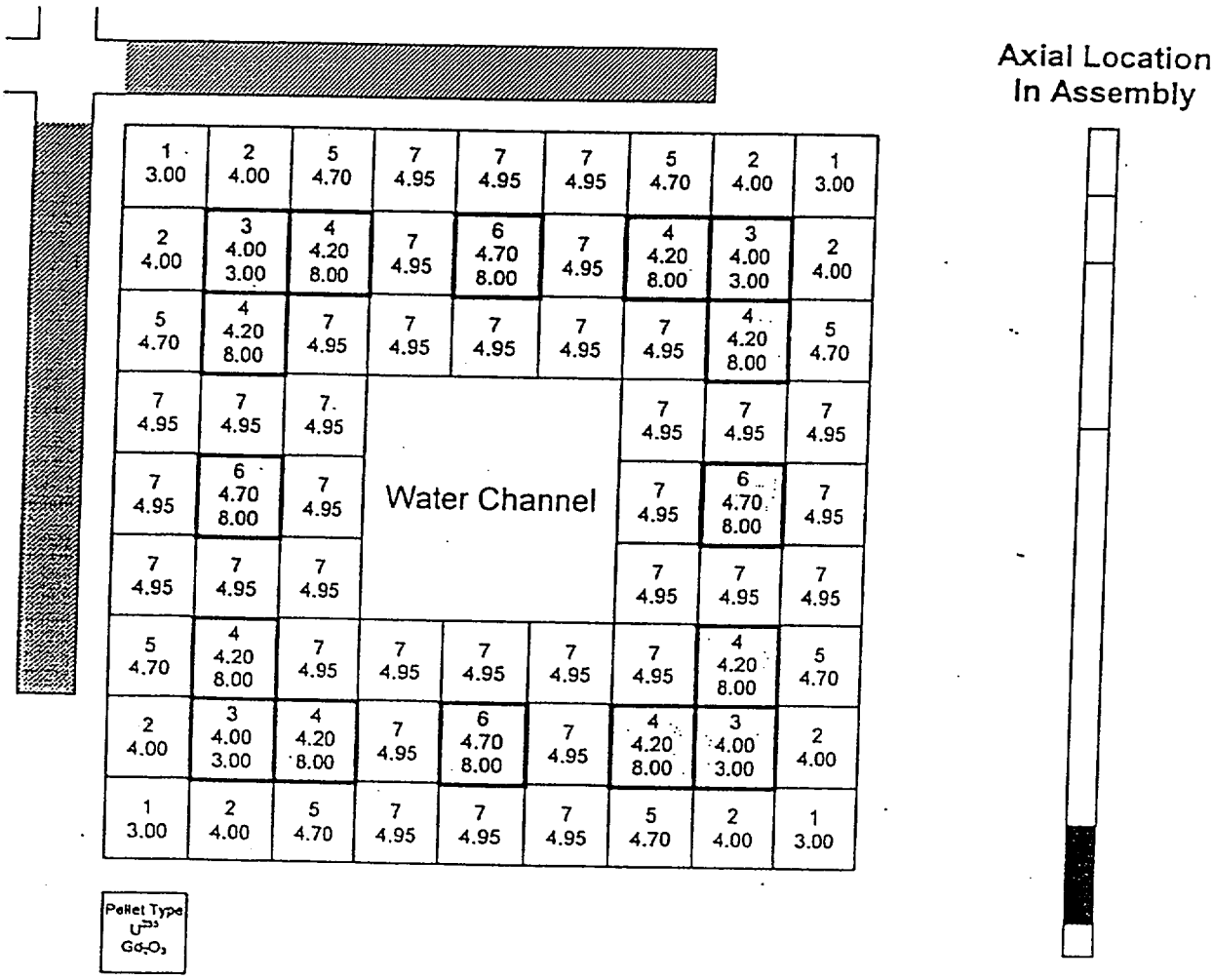
† NOTE: Decay ratios greater than 1.1 are outside the range of the STAIF methodology applicability. These points should be considered unstable without quantitative comparison.

Table 4.1 Neutronic Design Values

Number of Fuel Assemblies	764
Rated Thermal Power, MWt	3489
Rated Core Flow, Mlbm/hr	108.5
Core Inlet Subcooling, Btu/lbm	18.1
Moderator Temperature, °F	548.8
Channel Thickness, inch	0.080 & 0.100
Fuel Assembly Pitch, inch	6.0
Wide Water Gap Thickness, inch*	0.281/0.261
Narrow Water Gap Thickness, inch*	0.281/02.61
Control Rod Data†	
Absorber Material	B_4C
Total Blade Support Span, inch	1.580
Blade Thickness, inch	0.260
Blade Face-to-Face Internal Dimension, inch	0.200
Absorber Rod OD, inch	0.188
Absorber Rod ID, inch	0.138
Percentage B_4C, %TD	70

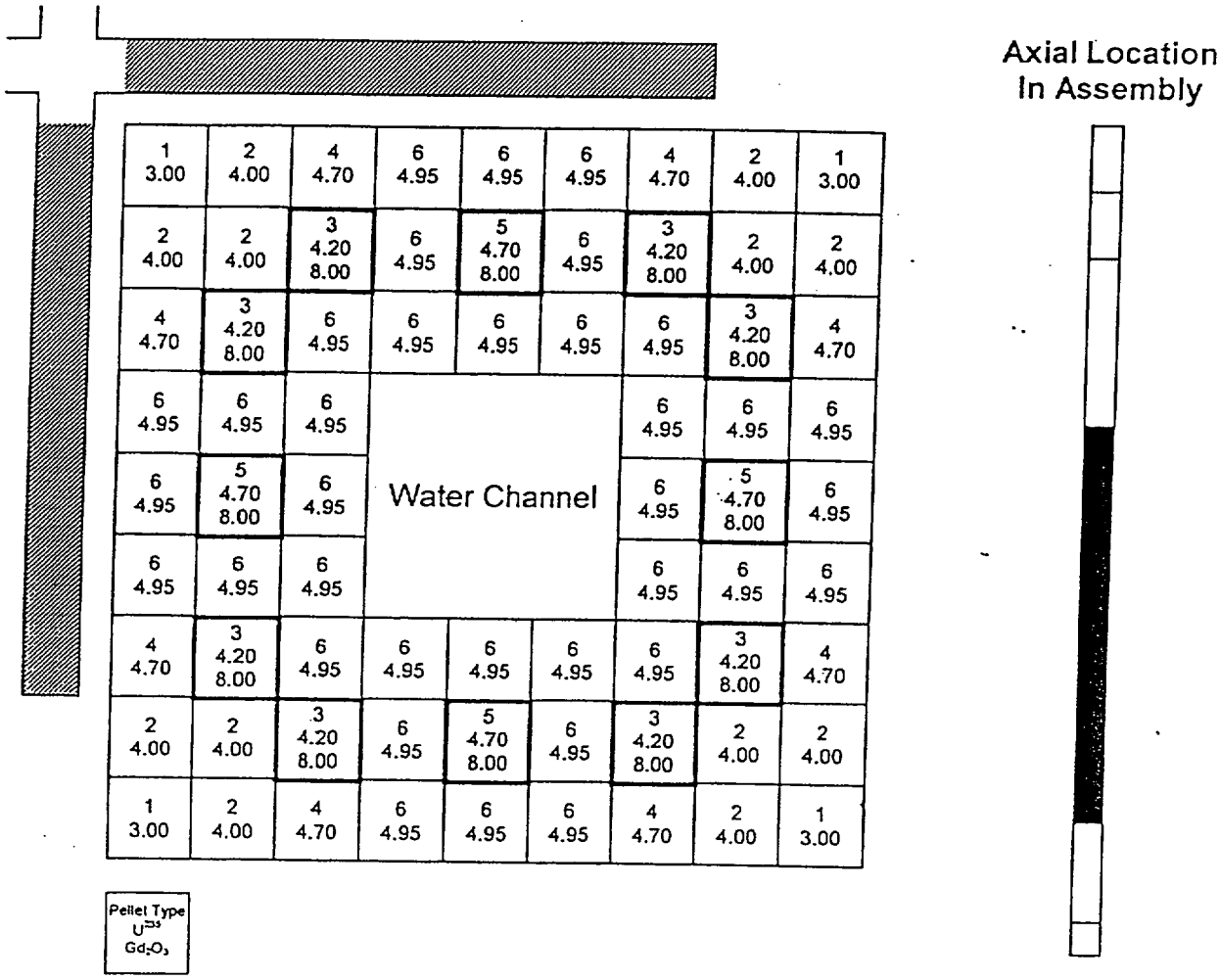
* The water gap thicknesses presented are based on 80/100-mil channels for ATRIUM-9B fuel.

† The control rod data represents original equipment control blades at LaSalle and were used in the neutronic calculations.



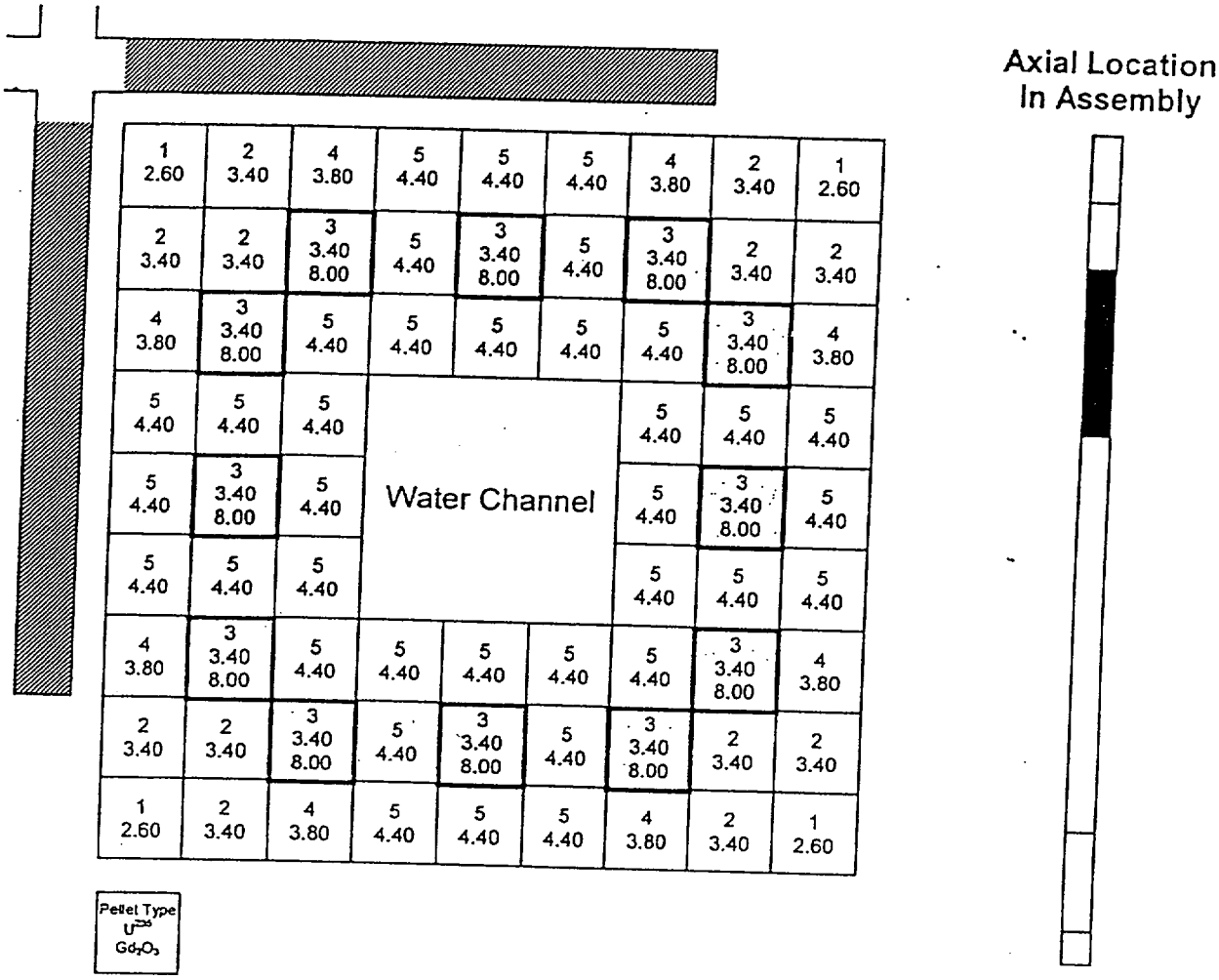
Pellet Type	Quantity	U^{235} + Gd_2O_3 Concentration (wt%)
1	4	3.00
2	8	4.00
3	4	4.00 + 3.00
4	8	4.20 + 8.00
5	8	4.70
6	4	4.70 + 8.00
7	36	4.95

Figure 4.1 SPCA9-4.56L-12G8.0/4G3.0-100M
Enrichment Distribution



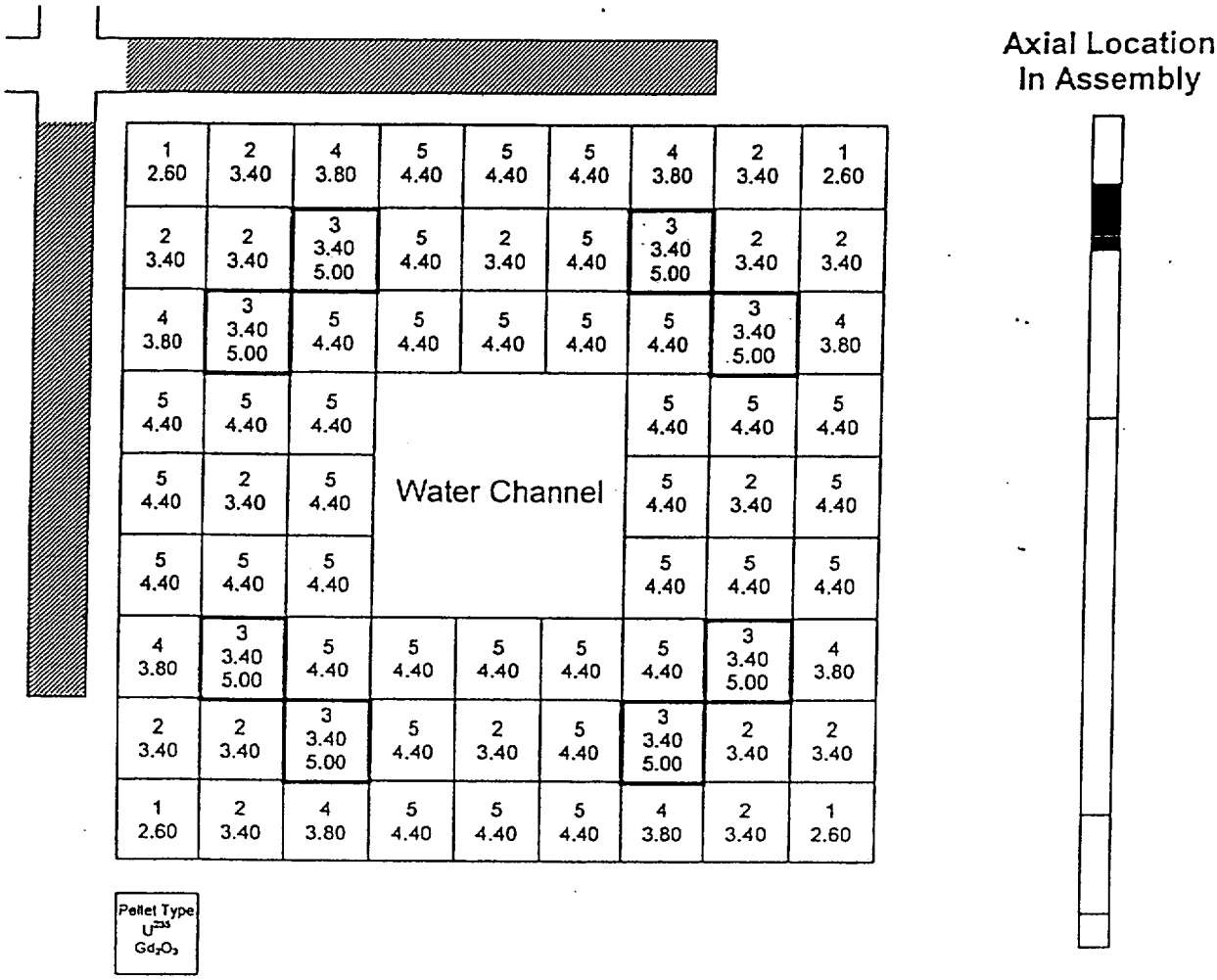
Pellet Type	Quantity	U^{235} + Gd_2O_3 Concentration (wt%)
1	4	3.00
2	12	4.00
3	8	4.20 + 8.00
4	8	4.70
5	4	4.70 + 8.00
6	36	4.95

Figure 4.2 SPCA9-4.56L-12G8.0-100M
Enrichment Distribution



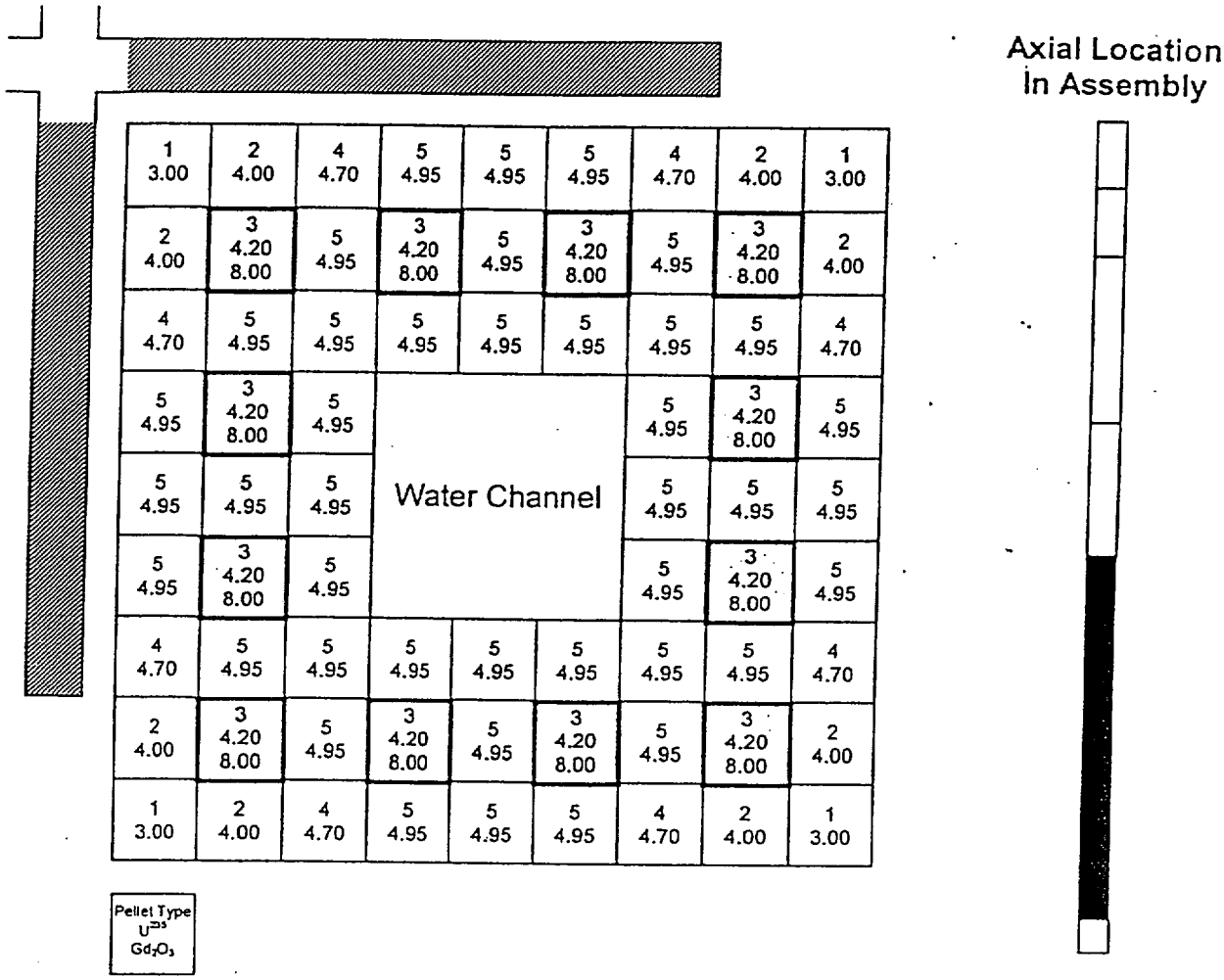
Pellet Type	Quantity	U^{235} + Gd_2O_3 Concentration (wt%)
1	4	2.60
2	12	3.40
3	12	3.40 + 8.00
4	8	3.80
5	36	4.40

Figure 4.3 SPCA9-3.91L-12G8.0-100M
Enrichment Distribution



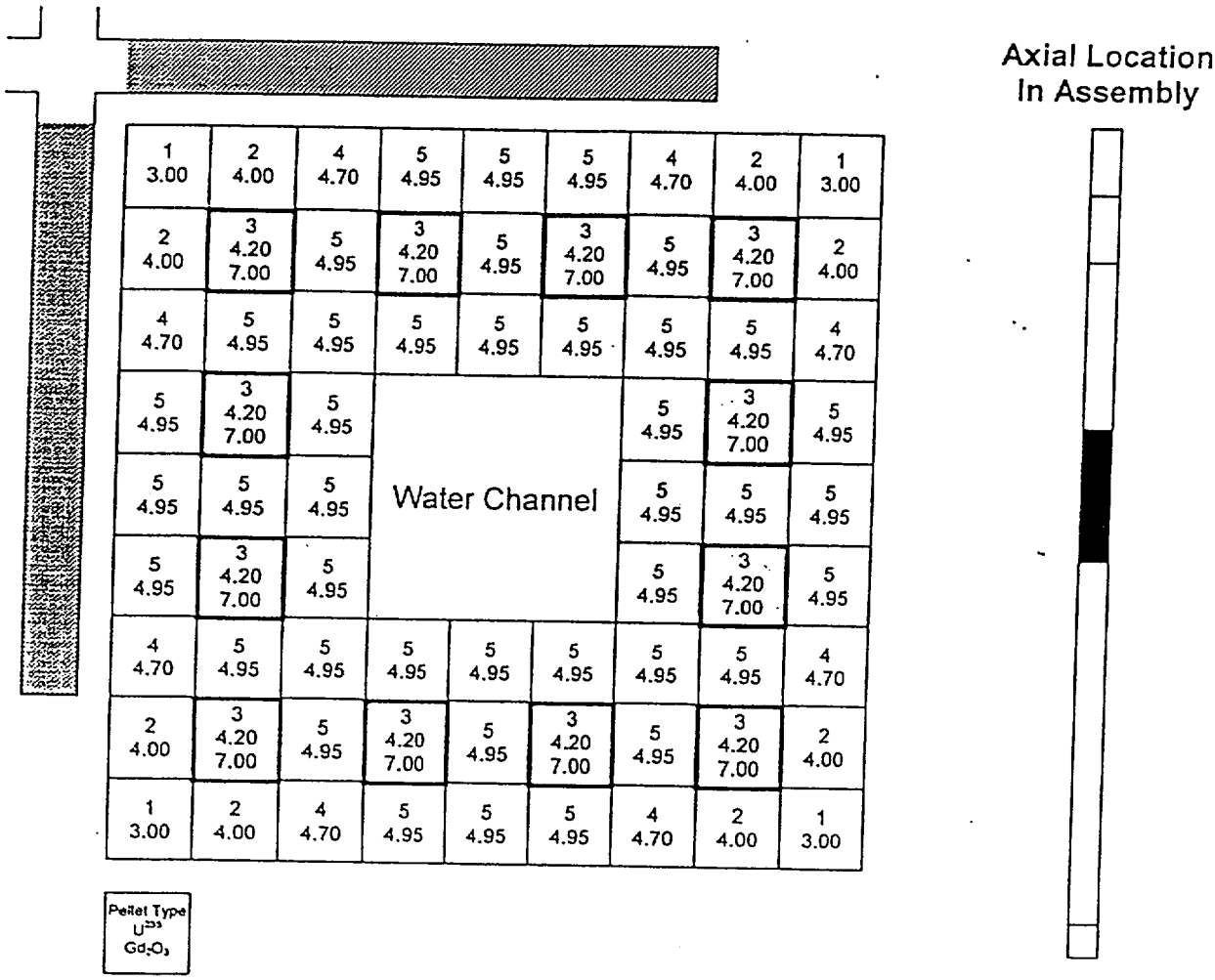
Pellet Type	Quantity	$U^{235} + Gd_2O_3$ Concentration (wt%)
1	4	2.60
2	16	3.40
3	8	3.40 + 5.00
4	8	3.80
5	36	4.40

Figure 4.4 SPCA9-3.90L-8G5.0-100M
Enrichment Distribution



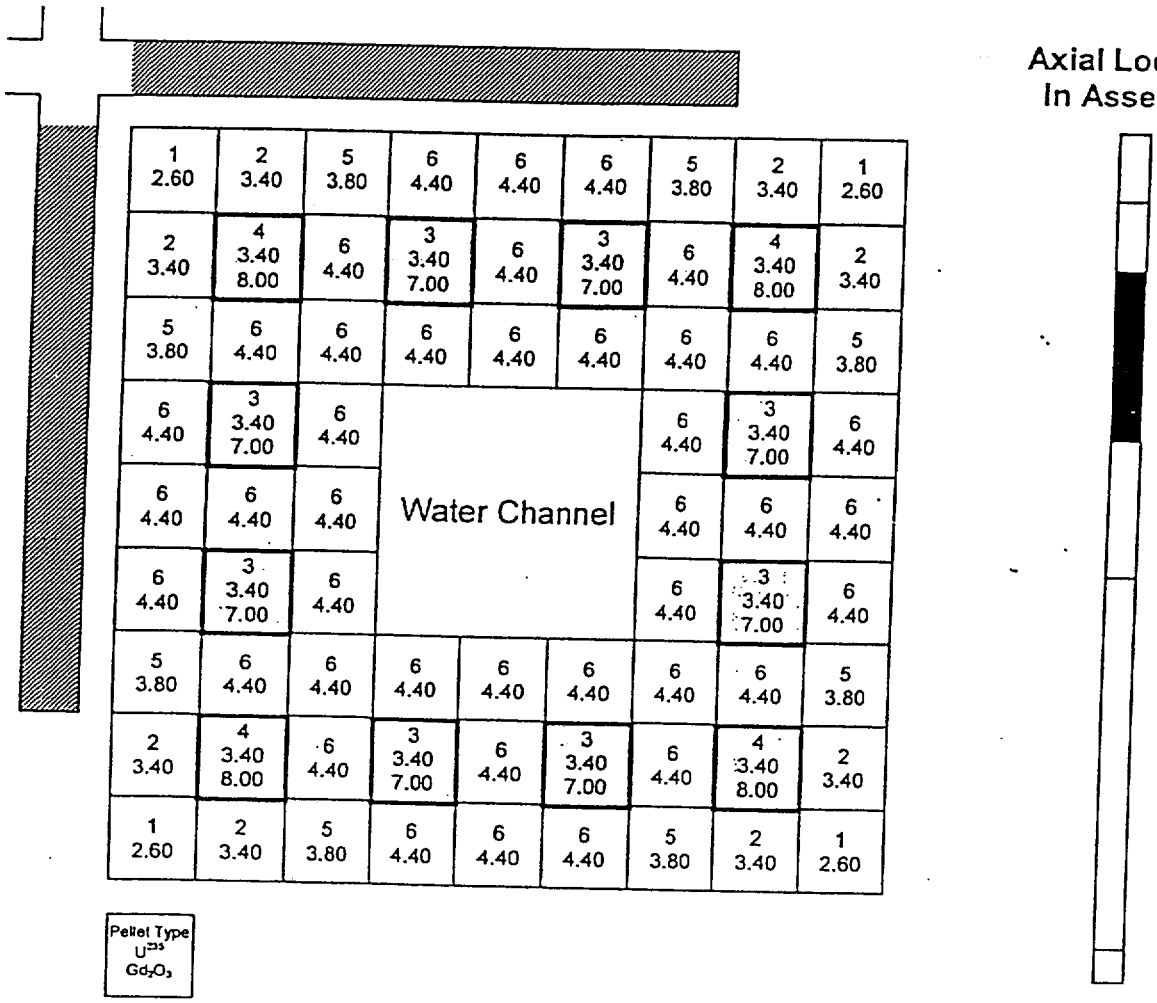
Pellet Type	Quantity	U^{235} + Gd_2O_3 Concentration (wt%)
1	4	3.00
2	8	4.00
3	12	4.20 + 8.00
4	8	4.70
5	40	4.95

Figure 4.5 SPCA9-4.59L-12G8.0-100M
Enrichment Distribution



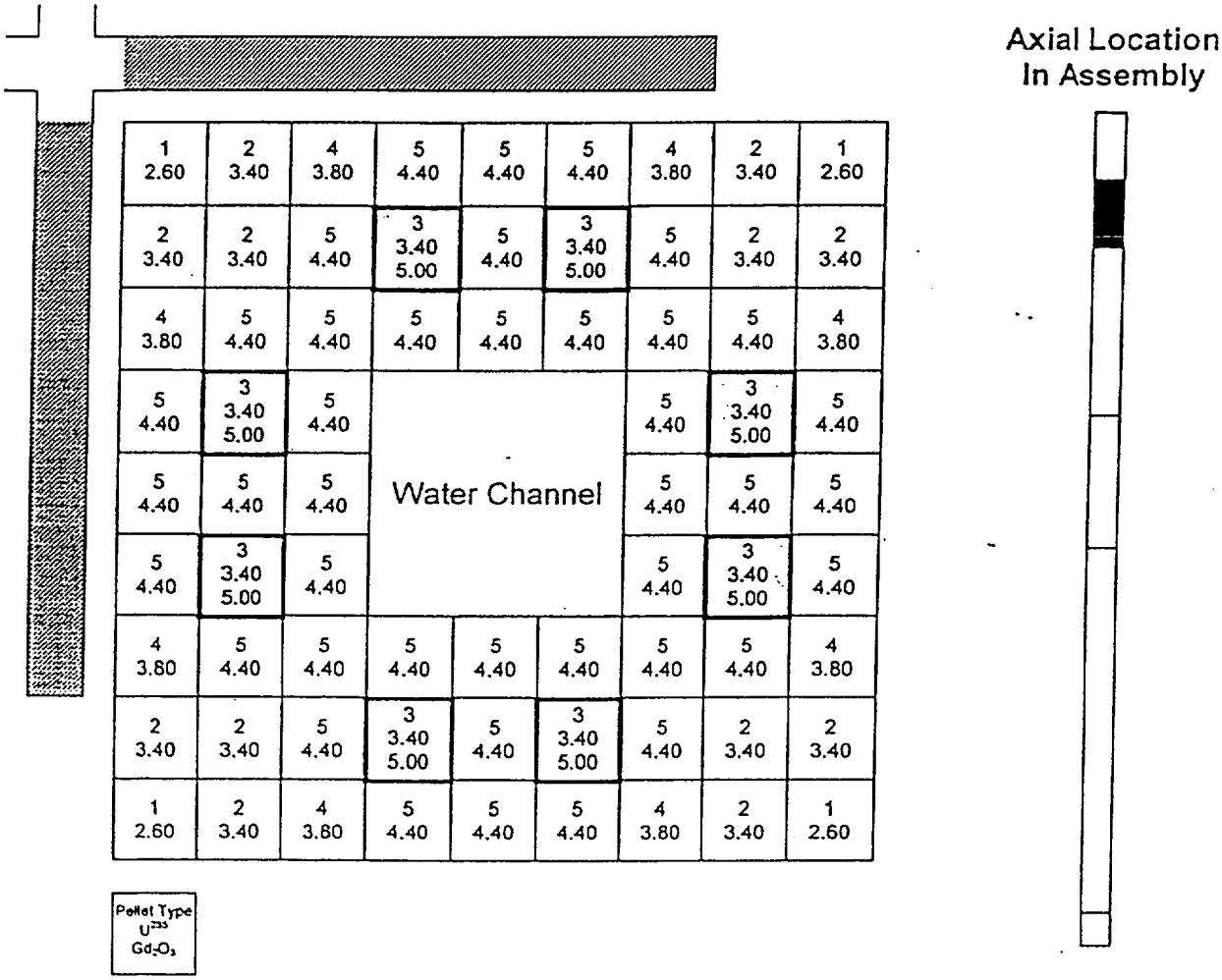
Pellet Type	Quantity	U^{235} + Gd_2O_3 Concentration (wt%)
1	4	3.00
2	8	4.00
3	12	4.20 + 7.00
4	8	4.70
5	40	4.95

Figure 4.6 SPCA9-4.59L-12G7.0-100M
Enrichment Distribution



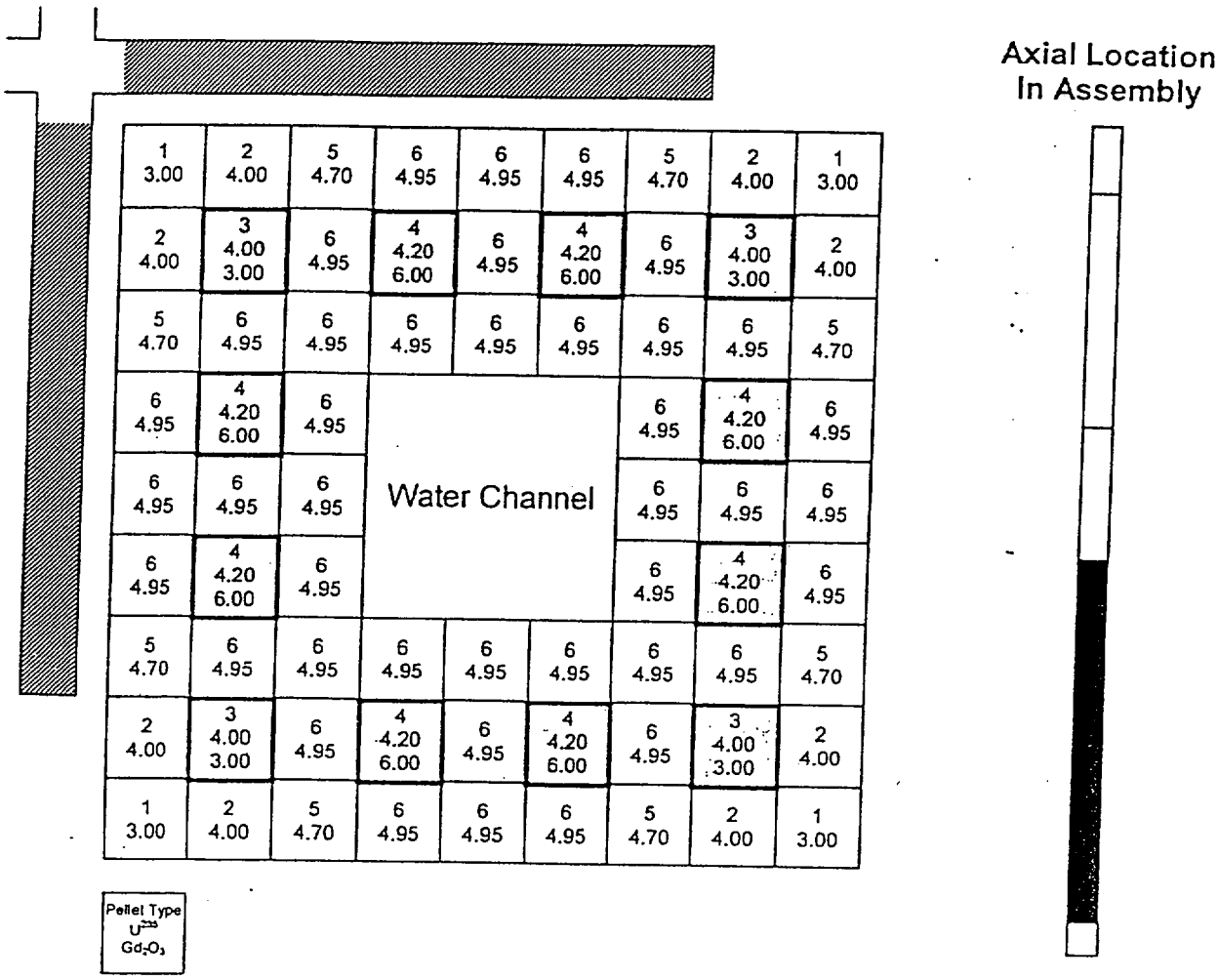
Pellet Type	Quantity	U^{235} + Gd_2O_3 Concentration (wt%)
1	4	2.60
2	8	3.40
3	8	3.40 + 7.00
4	4	3.40 + 8.00
5	8	3.80
6	40	4.40

Figure 4.7 SPCA9-3.96L-8G7.0/4G8.0-100M
Enrichment Distribution



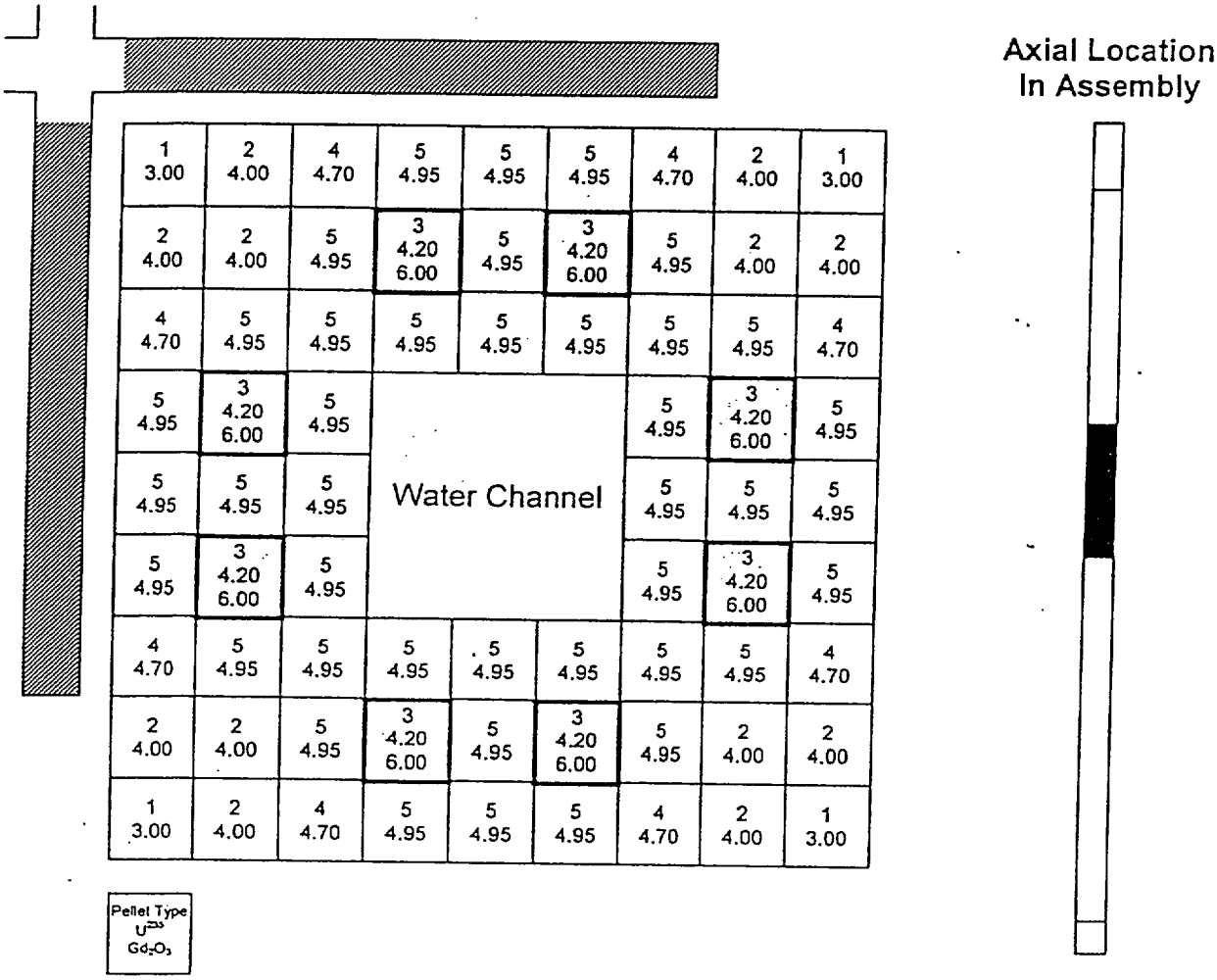
Pellet Type	Quantity	U^{235} + Gd_2O_3 Concentration (wt%)
1	4	2.60
2	12	3.40
3	8	3.40 + 5.00
4	8	3.80
5	40	4.40

Figure 4.8 SPCA9-3.96L-8G5.0-100M
Enrichment Distribution



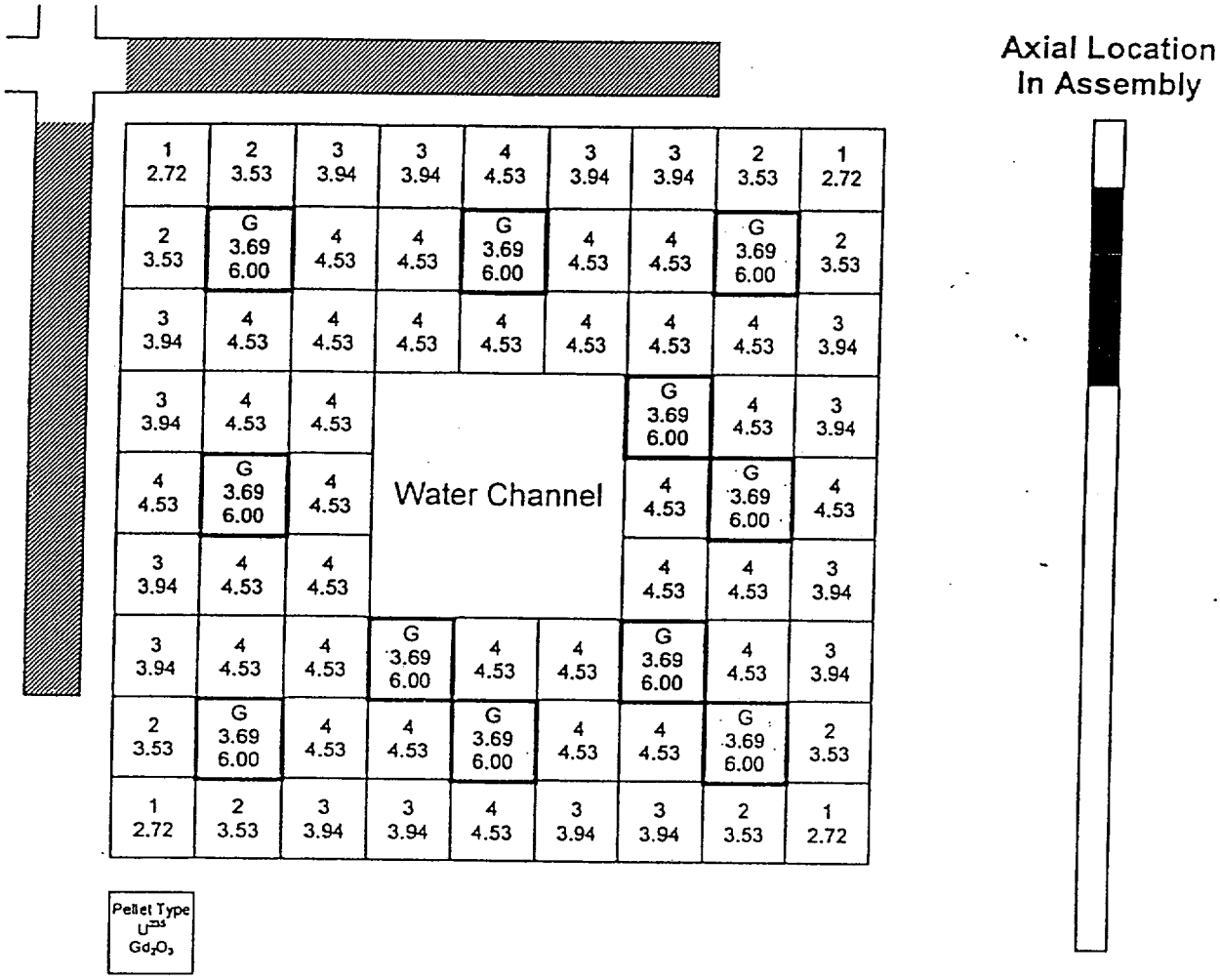
Pellet Type	Quantity	U^{235} + Gd_2O_3 Concentration (wt%)
1	4	3.00
2	8	4.00
3	4	4.00 + 3.00
4	8	4.20 + 6.00
5	8	4.70
6	40	4.95

Figure 4.9 SPCA9-4.58L-8G6.0/4G3.0-100M
Enrichment Distribution



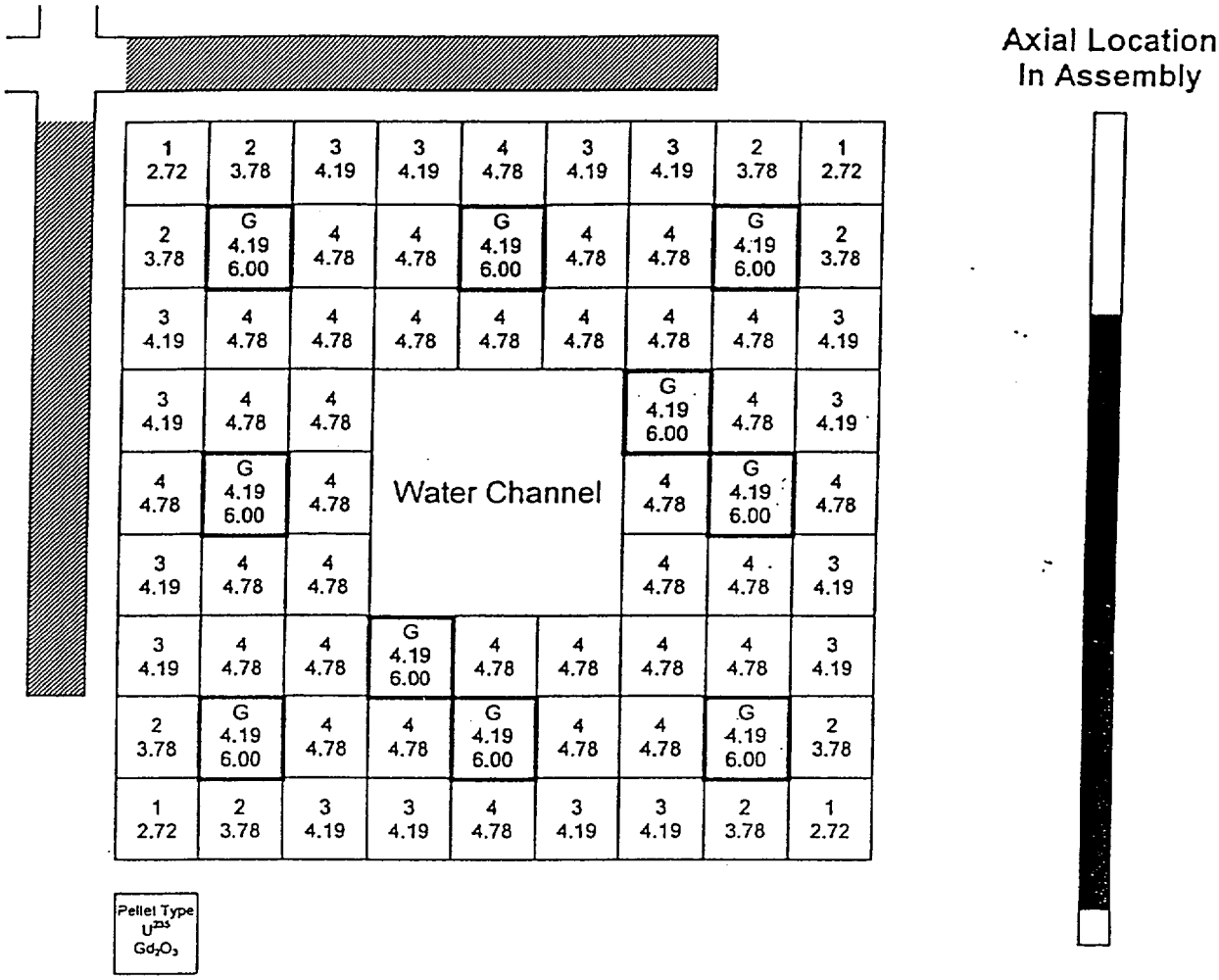
Pellet Type	Quantity	$U^{235} + Gd_2O_3$ Concentration (wt%)
1	4	3.00
2	12	4.00
3	8	4.20 + 6.00
4	8	4.70
5	40	4.95

Figure 4.10 SPCA9-4.58L-8G6.0-100M
Enrichment Distribution



Pellet Type	Quantity	U^{235} + Gd_2O_3 Concentration (wt%)
1	4	2.72
2	8	3.53
3	16	3.94
4	33	4.53
G	11	3.69 + 6.00

Figure 4.11 SPCA9-4.06L-11G6.0-80M
Enrichment Distribution



Pellet Type	Quantity	U^{235} + Gd_2O_3 Concentration (wt%)
1	4	2.72
2	8	3.78
3	16	4.19
4	34	4.78
G	10	4.19 + 6.00

Figure 4.12 SPCA9-4.34L-10G6.0-80M
Enrichment Distribution

SPCA9-393B-16GZ-100M

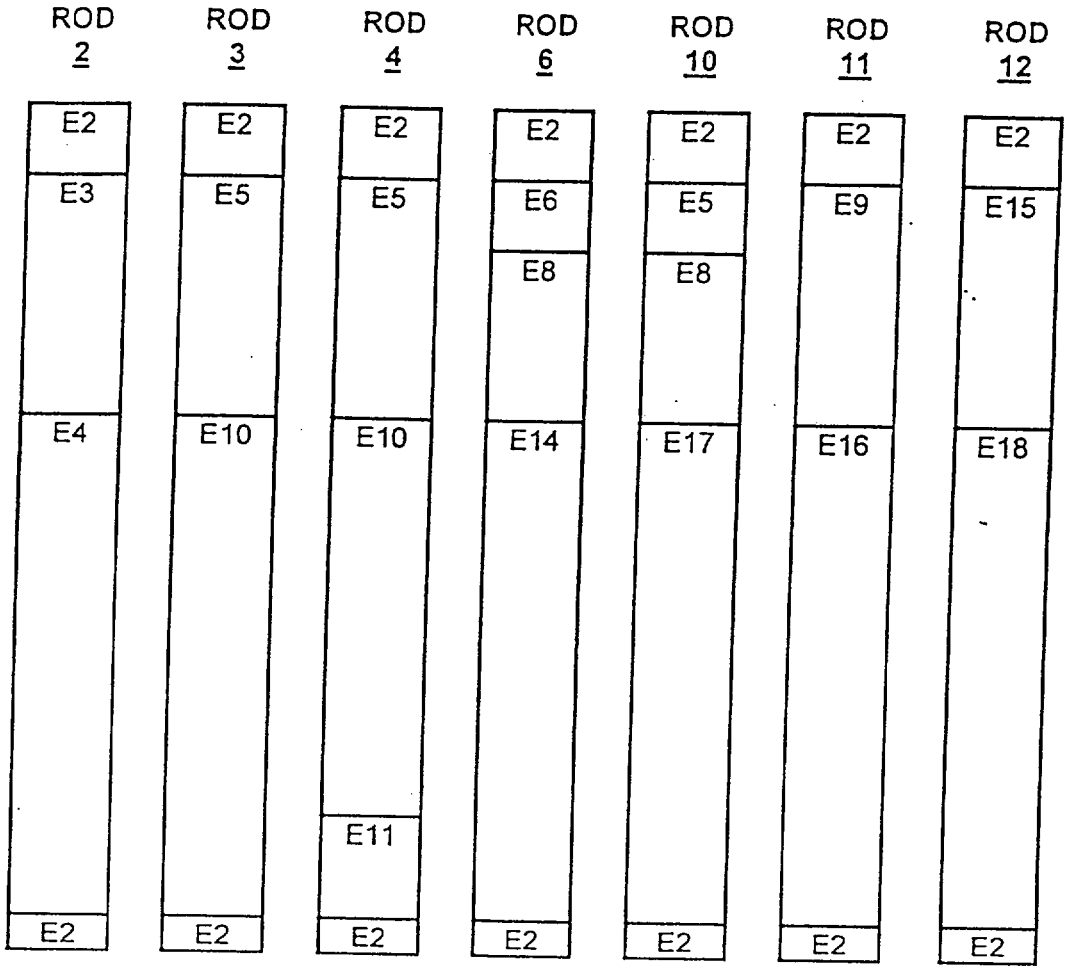
	Lattice
Natural Uranium	SPCA9-0.72L-0.G0.0-100M
3.90-8G5.0	SPCA9-3.90L-8G5.0-100M
3.91-12G8.0	SPCA9-3.91L-12G8.0-100M
4.56-12G8.0	SPCA9-4.56L-12G8.0-100M
4.56-12G8.0/4G3.0	SPCA9-4.56L-12G8.0/4G3.0-100M
Natural Uranium	SPCA9-0.72L-0.G0.0-100M

2	3	11	12	12	12	11	3	2
3	4	6	12	10	12	6	4	3
11	6	12	12	12	12	12	6	11
12	12	12	W	W	W.	12	12	12
12	10	12	W	W	W	12	10	12
12	12	12	W	W	W	12	12	12
11	6	12	12	12	12	12	6	11
3	4	6	12	10	12	6	4	3
2	3	11	12	12	12	11	3	2

Fuel Rod Type	No. Rods
2	4
3	8
4	4
6	8
10	4
11	8
12	36

Figure 4.13 ATRIUM-9B LSA-1 19A Assembly Design

SPCA9-393B-16GZ-100M



Lattice Index	Enrichment + Gd
E2	0.72 wt% U-235
E3	2.60 wt% U-235
E4	3.00 wt% U-235
E5	3.40 wt% U-235
E6	3.40 wt% U-235 + 5.0 wt% Gd_2O_3
E7	3.40 wt% U-235 + 7.0 wt% Gd_2O_3
E8	3.40 wt% U-235 + 8.0 wt% Gd_2O_3
E9	3.80 wt% U-235
E10	4.00 wt% U-235

Lattice Index	Enrichment + Gd
E11	4.00 wt% U-235 + 3.0 wt% Gd_2O_3
E12	4.20 wt% U-235 + 6.0 wt% Gd_2O_3
E13	4.20 wt% U-235 + 7.0 wt% Gd_2O_3
E14	4.20 wt% U-235 + 8.0 wt% Gd_2O_3
E15	4.40 wt% U-235
E16	4.70 wt% U-235
E17	4.70 wt% U-235 + 8.0 wt% Gd_2O_3
E18	4.95 wt% U-235

Figure 4.13 ATRIUM-9B LSA-1 19A Assembly Design (continued)

SPCA9-396B-12GZB-100M

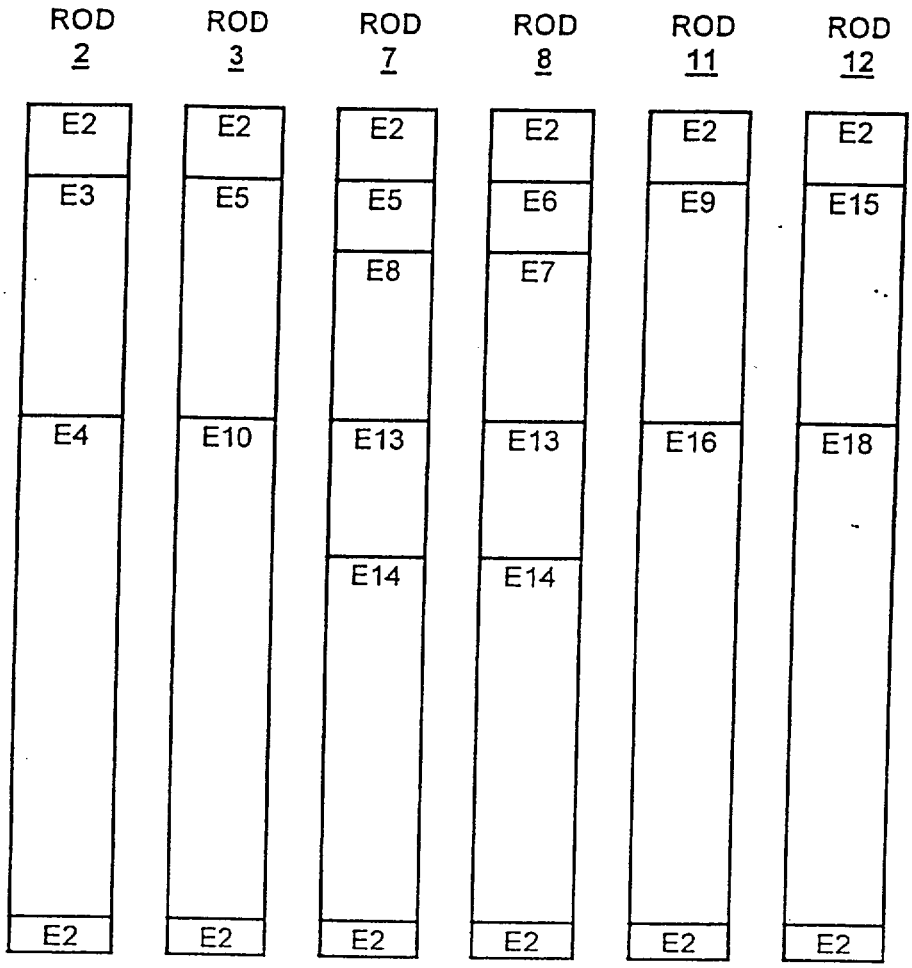
	Lattice
Natural Uranium	SPCA9-0.72L-0.G0.0-100M
3.96-8G5.0	SPCA9-3.96L-8G5.0-100M
3.96-8G7.0/4G8.0	SPCA9-3.96L-8G7.0/4G8.0-100M
4.59-12G7.0	SPCA9-4.59L-12G7.0-100M
4.59-12G8.0	SPCA9-4.59L-12G8.0-100M
Natural Uranium	SPCA9-0.72L-0.G0.0-100M

2	3	11	12	12	12	11	3	2
3	7	12	8	12	8	12	7	3
11	12	12	12	12	12	12	12	11
12	8	12	W	W	W	12	8	12
12	12	12	W	W	W	12	12	12
12	8	12	W	W	W	12	8	12
11	12	12	12	12	12	12	12	11
3	7	12	8	12	8	12	7	3
2	3	11	12	12	12	11	3	2

Fuel Rod Type	No. Rods
2	4
3	8
7	4
8	8
11	8
12	40

Figure 4.14 ATRIUM-9B LSA-1 19B Assembly Design

SPCA9-396B-12GZB-100M



Lattice Index	Enrichment + Gd
E2	0.72 wt% U-235
E3	2.60 wt% U-235
E4	3.00 wt% U-235
E5	3.40 wt% U-235
E6	3.40 wt% U-235 + 5.0 wt% Gd_2O_3
E7	3.40 wt% U-235 + 7.0 wt% Gd_2O_3
E8	3.40 wt% U-235 + 8.0 wt% Gd_2O_3
E9	3.80 wt% U-235
E10	4.00 wt% U-235

Lattice Index	Enrichment + Gd
E11	4.00 wt% U-235 + 3.0 wt% Gd_2O_3
E12	4.20 wt% U-235 + 6.0 wt% Gd_2O_3
E13	4.20 wt% U-235 + 7.0 wt% Gd_2O_3
E14	4.20 wt% U-235 + 8.0 wt% Gd_2O_3
E15	4.40 wt% U-235
E16	4.70 wt% U-235
E17	4.70 wt% U-235 + 8.0 wt% Gd_2O_3
E18	4.95 wt% U-235

Figure 4.14 ATRIUM-9B LSA-1 19B Assembly Design (continued)

SPCA9-396B-12GZC-100M

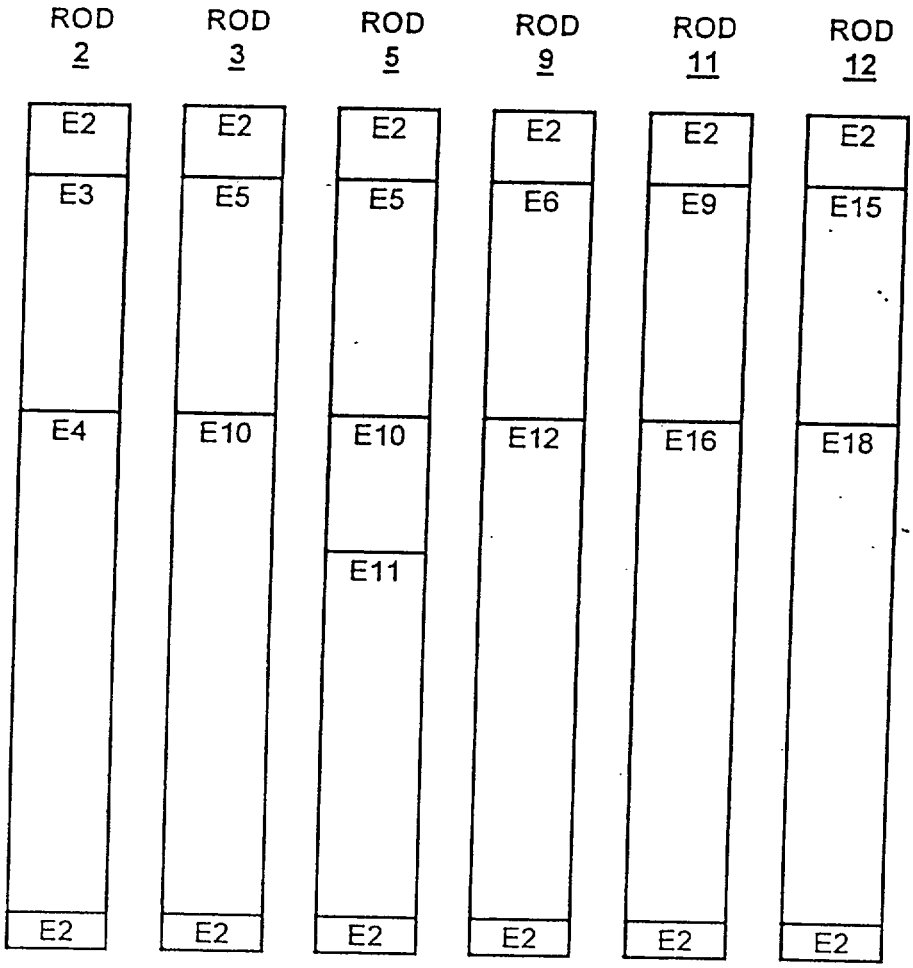
	Lattice
Natural Uranium	SPCA9-0.72L-0.G0.0-100M
3.96-8G5.0	SPCA9-3.96L-8G5.0-100M
4.58-8G6.0	SPCA9-4.58L-8G6.0-100M
4.58-8G6.0/4G3.0	SPCA9-4.58L-8G6.0/4G3.0-100M
Natural Uranium	SPCA9-0.72L-0.G0.0-100M

2	3	11	12	12	12	11	3	2
3	5	12	9	12	9	12	5	3
11	12	12	12	12	12	12	12	11
12	9	12	W	W	W	12	9	12
12	12	12	W	W	W	12	12	12
12	9	12	W	W	W	12	9	12
11	12	12	12	12	12	12	12	11
3	5	12	9	12	9	12	5	3
2	3	11	12	12	12	11	3	2

Fuel Rod Type	No. Rods
2	4
3	8
5	4
9	8
11	8
12	40

Figure 4.15 ATRIUM-9B LSA-1 19C Assembly Design

SPCA9-396B-12GZC-100M

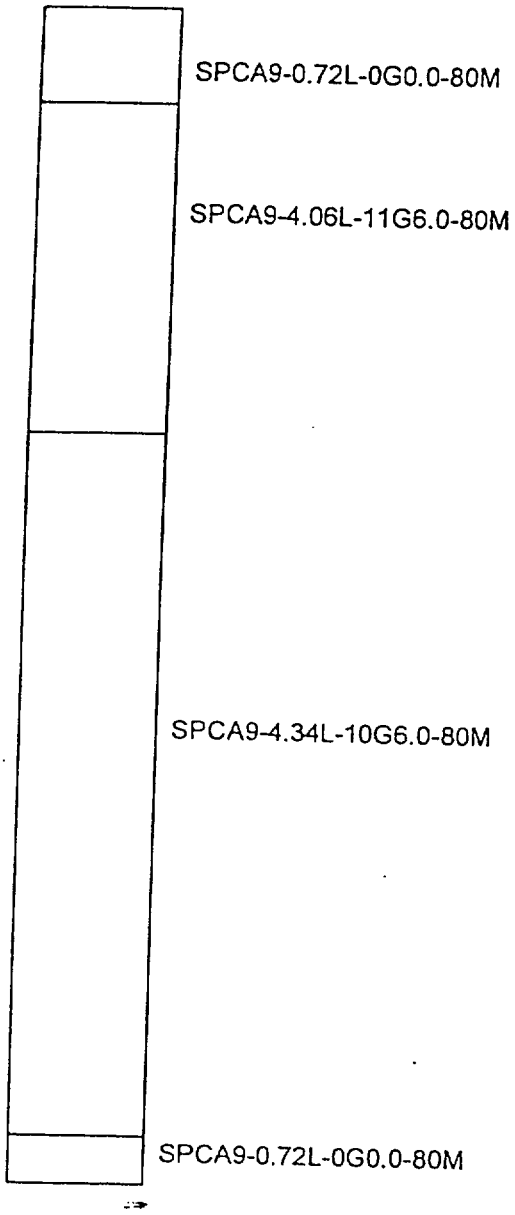


Lattice Index	Enrichment + Gd
E2	0.72 wt% U-235
E3	2.60 wt% U-235
E4	3.00 wt% U-235
E5	3.40 wt% U-235
E6	3.40 wt% U-235 + 5.0 wt% Gd_2O_3
E7	3.40 wt% U-235 + 7.0 wt% Gd_2O_3
E8	3.40 wt% U-235 + 8.0 wt% Gd_2O_3
E9	3.80 wt% U-235
E10	4.00 wt% U-235

Lattice Index	Enrichment + Gd
E11	4.00 wt% U-235 + 3.0 wt% Gd_2O_3
E12	4.20 wt% U-235 + 6.0 wt% Gd_2O_3
E13	4.20 wt% U-235 + 7.0 wt% Gd_2O_3
E14	4.20 wt% U-235 + 8.0 wt% Gd_2O_3
E15	4.40 wt% U-235
E16	4.70 wt% U-235
E17	4.70 wt% U-235 + 8.0 wt% Gd_2O_3
E18	4.95 wt% U-235

Figure 4.15 ATRIUM-9B LSA-1 19C Assembly Design (continued)

SPCA9-384B-11GZ-80M

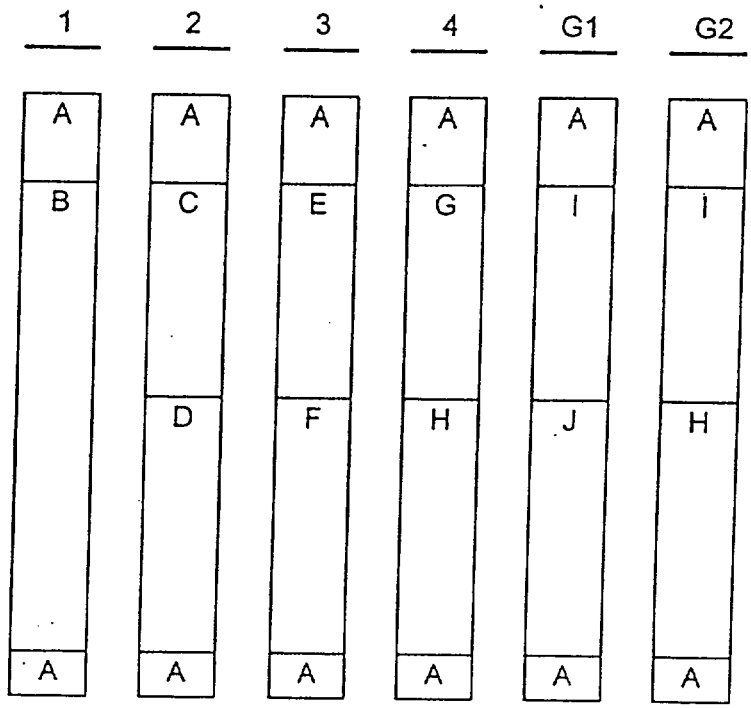


1	2	3	3	4	3	3	2	1
2	G1	4	4	G1	4	4	G1	2
3	4	4	4	4	4	4	4	3
3	4	4	W	W	W	G1	4	3
4	G1	4	W	W	W	4	G1	4
3	4	4	W	W	W	4	4	3
3	4	4	G1	4	4	G2	4	3
2	G1	4	4	G1	4	4	G1	2
1	2	3	3	4	3	3	2	1

Fuel Rod Type	No. Rods
1	4
2	8
3	16
4	33
G1	10
G2	1

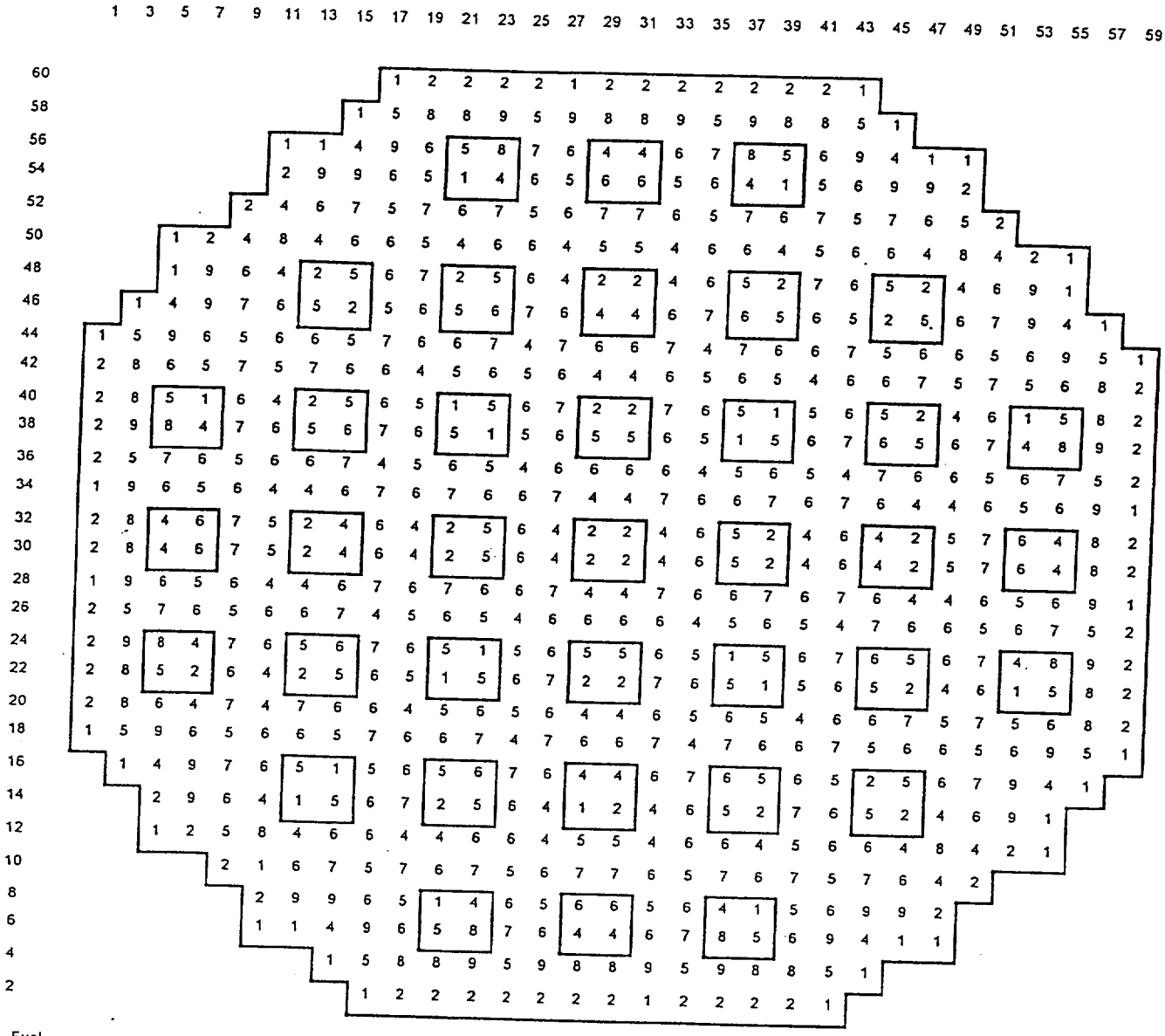
Figure 4.16 ATRIUM-9B SPCA9-384B-11GZ-80M Assembly Design

SPCA9-384B-11GZ-80M



A	0.72 wt% U-235
B	2.72 wt% U-235
C	3.53 wt% U-235
D	3.78 wt% U-235
E	3.94 wt% U-235
F	4.19 wt% U-235
G	4.53 wt% U-235
H	4.78 wt% U-235
I	3.69 wt% U-235 + 6.00 wt% Gd_2O_3
J	4.19 wt% U-235 + 6.00 wt% Gd_2O_3

Figure 4.16 ATRIUM-9B SPCA9-384B-11GZ-80M Assembly Design
(continued)



Fuel Type	Bundle Name	Number of Bundles	Load Cycle
1	GE9B-P8CWB322-11GZ-100M-150	56	7
2	GE9B-P8CWB320-9GZ-100M-150	89	7
4	GE9B-P8CWB343-12GZ-80M-150	104	8
5	GE9B-P8CWB342-10GZ-80M-150	143	8
6	SPCA9-393B-16GZ-100M	208	9
7	SPCA9-396B-12GZB-100M	88	9
8	SPCA9-384B-11GZ-80M	36	9
9	SPCA9-396B-12GZC-100M	40	9

Figure 4.17 LaSalle Unit 1 Cycle 9 Reference Loading Map

5.0 Anticipated Operational Occurrences

Applicable Disposition of Events — Reference 9.7

5.1 *Analysis of Plant Transients at Rated Conditions* — Reference 9.3

Limiting Transients: Load Rejection No Bypass (LRNB)
Feedwater Controller Failure (FWCF)
Loss of Feedwater Heating (LFWH)

Transient	Scram Speed	Peak Neutron Flux (% Rated)	Peak Heat Flux (% Rated)	Peak Lower Plenum Pressure (psig)	ΔCPR ATRIUM-9B/GE9
LRNB*	TSSS	460.2	126.5	1206	0.34 / 0.38
FWCF†	TSSS	371.3	122.6	1167	0.30 / 0.33
LRNB†	NSS	401.1	121.3	1203	0.31 / 0.34
FWCF†	NSS	342.9	120.5	1164	0.28 / 0.31
LFWH‡		‡	‡	‡	‡

5.2 *Analysis for Reduced Flow Operation* — Reference 9.3

Limiting Transient: Slow Flow Excursion

$MCPR_f$ Manual Flow Control — ATRIUM-9B and GE9 Fuel	Figure 5.1
$LHGRFAC_f$ — ATRIUM-9B Fuel	Figure 5.2
$MAPFAC_f$ — GE9 Fuel	‡

$MCPR_f$ and $LHGRFAC_f$ results are applicable at all Cycle 9 exposures and in all EOD and EOOS scenarios presented in Table 1.1. $MCPR_f$ limits are provided for maximum core flows of 102.5% and 105% of rated. The $LHGRFAC_f$ multipliers provided in Figure 5.2 are applicable for maximum core flows of 102.5% and 105% of rated.

* Based on 100%P/81%F conditions.
† Based on 100%P/105%F conditions.
‡ This data to be furnished by ComEd.

5.3	*Analysis for Reduced Power Operation*	Reference 9.3
	Limiting Transient: Load Rejection No Bypass (LRNB) Feedwater Controller Failure (FWCF)	
	$MCPR_p$ Base Case Operation	Tables 5.1–5.4 Figures 5.3–5.6
	$LHGRFAC_p$ Base Case Operation*	Tables 5.1–5.4
	$MCPR_p$, EOOS Conditions	Tables 5.1–5.4
	$LHGRFAC_p$, EOOS Conditions*	Tables 5.1–5.4
	$MAPFAC_p$ — All Operating Conditions*	<To be furnished by ComEd.>
5.4	*ASME Overpressurization Analysis*	Reference 9.3
	Limiting Event	MSIV Closure
	Worst Single Failure	Valve Position Scram
	Maximum Vessel Pressure (Lower Plenum)	1320 psig
	Maximum Steam Dome Pressure	1291 psig
5.5	*Control Rod Withdrawal Error*	
	Starting Control Pattern for Analysis	Figure 5.7

< This data is to be furnished by ComEd. >

5.6 *Fuel Loading Error*

< This data is to be furnished by ComEd. >

5.7 *Determination of Thermal Margins*

The results of the analyses presented in Sections 5.1–5.3 are used for the determination of the operating limit. Section 5.1 provides the results of analyses at rated conditions. Section 5.2 provides for the determination of the MCPR and LHGR limits at reduced flow ($MCPR_f$, Figure

* $LHGRFAC_p$ values presented are applicable to SPC fuel. GE $MAPFAC_p$ limits will continue to be applied to GE9 fuel at off-rated power.

5.1; $LHGRFAC_f$, Figure 5.2). Section 5.3 provides for the determination of the MCPR and LHGR limits at conditions of reduced power (Figures 5.3–5.6, Tables 5.1–5.4). Limits are presented for base case operation and the EOD and EOOS scenarios presented in Table 1.1. The results presented are based on the analyses performed by SPC. As indicated above, the final Cycle 9 MCPR operating limits need to be established in conjunction with the results from ComEd analyses.

Table 5.1 EOC Base Case and EOOS $MCPR_p$ Limits and $LHGRFAC_p$ Multipliers for TSSS Insertion Times for Prepower Uprate Conditions (3323 MWt Rated Power)*

EOOS Condition	Power (% Rated)	ATRIUM-9B Fuel		GE9 Fuel
		$MCPR_p$	$LHGRFAC_p$	$MCPR_p$
Base Case Operation	0	2.70	0.66	2.70
	25	2.22	0.66	2.22
	25	2.07	0.66	2.12
	63	1.56	0.94	1.57
	84	1.51	0.98	1.53
	100	1.46	0.99	1.50
Feedwater Heaters Out of Service (FHOOS)	0	2.85	0.64	2.85
	25	2.38	0.64	2.38
	25	2.38	0.64	2.38
	63	1.62	0.90	1.62
	100	1.47	0.99	1.51
Single-Loop Operation	0	2.71	0.66	2.71
	25	2.23	0.66	2.23
	25	2.08	0.66	2.13
	63	1.57	0.94	1.58
	84	1.52	0.98	1.54
	100	1.47	0.99	1.51
Turbine Bypass Valves Out of Service (TBVOOS)	0	2.70	0.66	2.70
	25	2.22	0.66	2.22
	25	2.17	0.66	2.17
	63	1.63	0.90	1.65
	100	1.49	0.94	1.53

* Limits support operation with any combination of one SRVOOS, up to 2 TIPOOS (or the equivalent number of TIP channels), up to a 20°F reduction in feedwater temperature (except for conditions with FHOOS), and up to 50% of the LPRMs out of service in the standard, ICF and MELLLA regions of the power/flow map.

Table 5.1 EOC Base Case and EOOS $MCPR_p$ Limits and $LHGRFAC_p$ Multipliers for TSSS Insertion Times for Prepower Uprate Conditions (3323 MWt Rated Power)*
(continued)

EOOS/EOD Condition	Power (% Rated)	ATRIUM-9B Fuel		GE9 Fuel
		$MCPR_p$	$LHGRFAC_p$	$MCPR_p$
Recirculation Pump Trip Out of Service (No RPT)	0	2.70	0.66	2.70
	25	2.22	0.66	2.22
	25	2.07	0.66	2.12
	63	1.60	0.86	1.63
	100	1.51	0.86	1.56
Turbine Control Valve (TCV) Slow Closure and/or No RPT	0	2.70	0.66	2.70
	25	2.22	0.66	2.22
	25	2.16	0.66	2.16
	84	1.65	0.86	1.69
	84	1.63	0.86	1.67
	100	1.56	0.86	1.60
TCV Slow Closure/ FHOOS and/or No RPT	0	2.85	0.63	2.85
	25	2.38	0.63	2.38
	25	2.38	0.63	2.38
	84	1.65	0.86	1.69
	84	1.63	0.86	1.67
	100	1.56	0.86	1.60
Idle Loop Startup	0	2.54	0.40	2.54
	25	2.54	0.40	2.54
	25	2.54	0.40	2.54
	63	2.54	0.40	2.54
	100	2.54	0.40	2.54

* Limits support operation with any combination of one SRVOOS, up to 2 TIPOOS (or the equivalent number of TIP channels), up to a 20°F reduction in feedwater temperature (except for conditions with FHOOS), and up to 50% of the LPRMs out of service in the standard, ICF and MELLLA regions of the power/flow map.

Table 5.2 Base Case $MCPR_p$ Limits and $LHGRFAC_p$ Multipliers for NSS Insertion Times for Prepower Uprate (3323 MWt Rated Power)*

EOOS Condition	Power (% Rated)	ATRIUM-9B Fuel		GE9
		$MCPR_p$	$LHGRFAC_p$	$MCPR_p$
Base Case Operation	0	2.70	0.74	2.70
	25	2.22	0.74	2.22
	25	2.07	0.74	2.07
	63	1.54	0.95	1.56
	84	1.48	1.00	1.51
	100	1.43	1.00	1.46

* Limits support operation with any combination of one SRVOOS, up to 2 TIPOOS (or the equivalent number of TIP channels), up to a 20°F reduction in feedwater temperature (except for conditions with FHOOS), and up to 50% of the LPRMs out of service in the standard, ICF and MELLLA regions for the power/flow map.

Table 5.3 EOC Base Case and EOOS $MCPR_p$ Limits and $LHGRFAC_p$ for Multipliers for TSSS Insertion Times for Power Uprate Conditions (3489 MWt Rated Power)*

EOOS/EOD Condition	Power (% Rated)	ATRIUM-9B Fuel $MCPR_p$	ATRIUM-9B Fuel $LHGRFAC_p$	GE9 Fuel $MCPR_p$
Base Case Operation	0	2.70	0.67	2.70
	25	2.20	0.67	2.20
	25	2.05	0.67	2.10
	60	1.56	0.94	1.57
	80	1.51	0.98	1.53
	100	1.45	1.00	1.49
Feedwater Heaters Out of Service (FHOOS)	0	2.85	0.65	2.85
	25	2.35	0.65	2.35
	25	2.35	0.65	2.35
	60	1.62	0.90	1.62
	100	1.45	1.00	1.49
Single-Loop Operation	0	2.71	0.67	2.71
	25	2.21	0.67	2.21
	25	2.06	0.67	2.11
	60	1.57	0.94	1.58
	80	1.52	0.98	1.54
	100	1.46	1.00	1.50
Turbine Bypass Valves Out of Service (TBVOOS)	0	2.70	0.67	2.70
	25	2.20	0.67	2.20
	25	2.15	0.67	2.15
	60	1.63	0.90	1.65
	100	1.47	0.94	1.51

* Limits support operation with any combination of one SRVOOS, up to 2 TIPOOS (or the equivalent number of TIP channels), up to a 20°F reduction in feedwater temperature (except for conditions with FHOOS), and up to 50% of the LPRMs out of service in the standard, ICF and MELLLA regions of the power/flow map.

Table 5.3 EOC Base Case and EOOS $MCPR_p$ Limits and $LHGRFAC_p$ Multipliers for TSSS Insertion Times for Power Uprate Conditions (3489 MWt Rated Power)*
(continued)

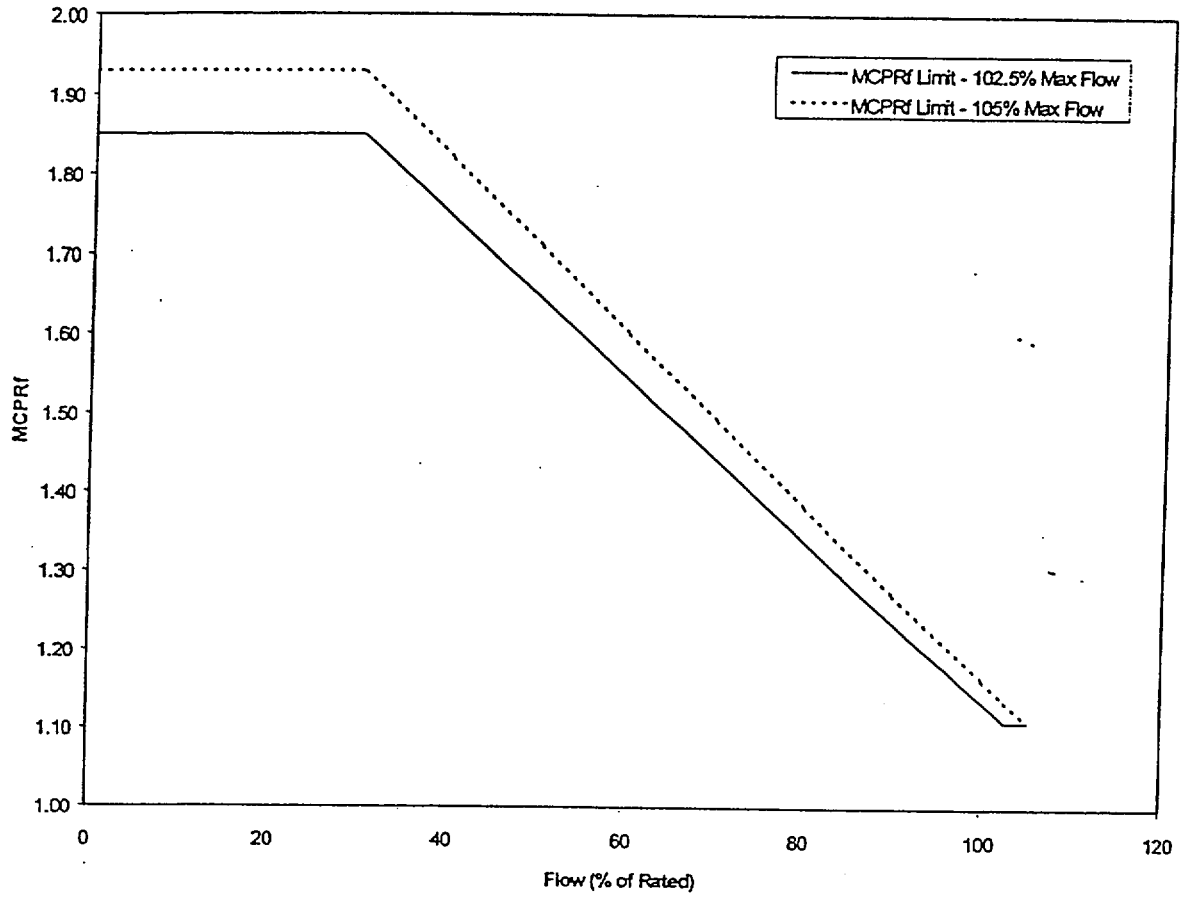
EOOS/EOD Condition	Power (% Rated)	ATRIUM-9B Fuel		GE9 Fuel
		$MCPR_p$	$LHGRFAC_p$	$MCPR_p$
Recirculation Pump Trip Out of Service (No RPT)	0	2.70	0.67	2.70
	25	2.20	0.67	2.20
	25	2.05	0.67	2.10
	60	1.60	0.86	1.63
	100	1.50	0.86	1.55
Turbine Control Valve (TCV) Slow Closure and/or No RPT	0	2.70	0.67	2.70
	25	2.20	0.67	2.20
	25	2.15	0.67	2.15
	80	1.65	0.86	1.69
	80	1.63	0.86	1.67
	100	1.54	0.86	1.58
TCV Slow Closure/ FHOOS and/or No RPT	0	2.85	0.64	2.85
	25	2.35	0.64	2.35
	25	2.35	0.64	2.35
	80	1.65	0.86	1.69
	80	1.63	0.86	1.67
	100	1.54	0.86	1.58
Idle Loop Restart	0	2.54	0.40	2.54
	25	2.54	0.40	2.54
	25	2.54	0.40	2.54
	60	2.54	0.40	2.54
	100	2.54	0.40	2.54

* Limits support operation with any combination of one SRVOOS, up to 2 TIPOOS (or the equivalent number of TIP channels), up to a 20°F reduction in feedwater temperature (except for conditions with FHOOS), and up to 50% of the LPRMs out of service in the standard, ICF and MELLLA regions of the power/flow map.

Table 5.4 EOC $MCPR_p$ Limits and $LHGRFAC_p$ Multipliers for NSS Insertion Times for Power Uprate Conditions (3489 MWt Rated Power)*

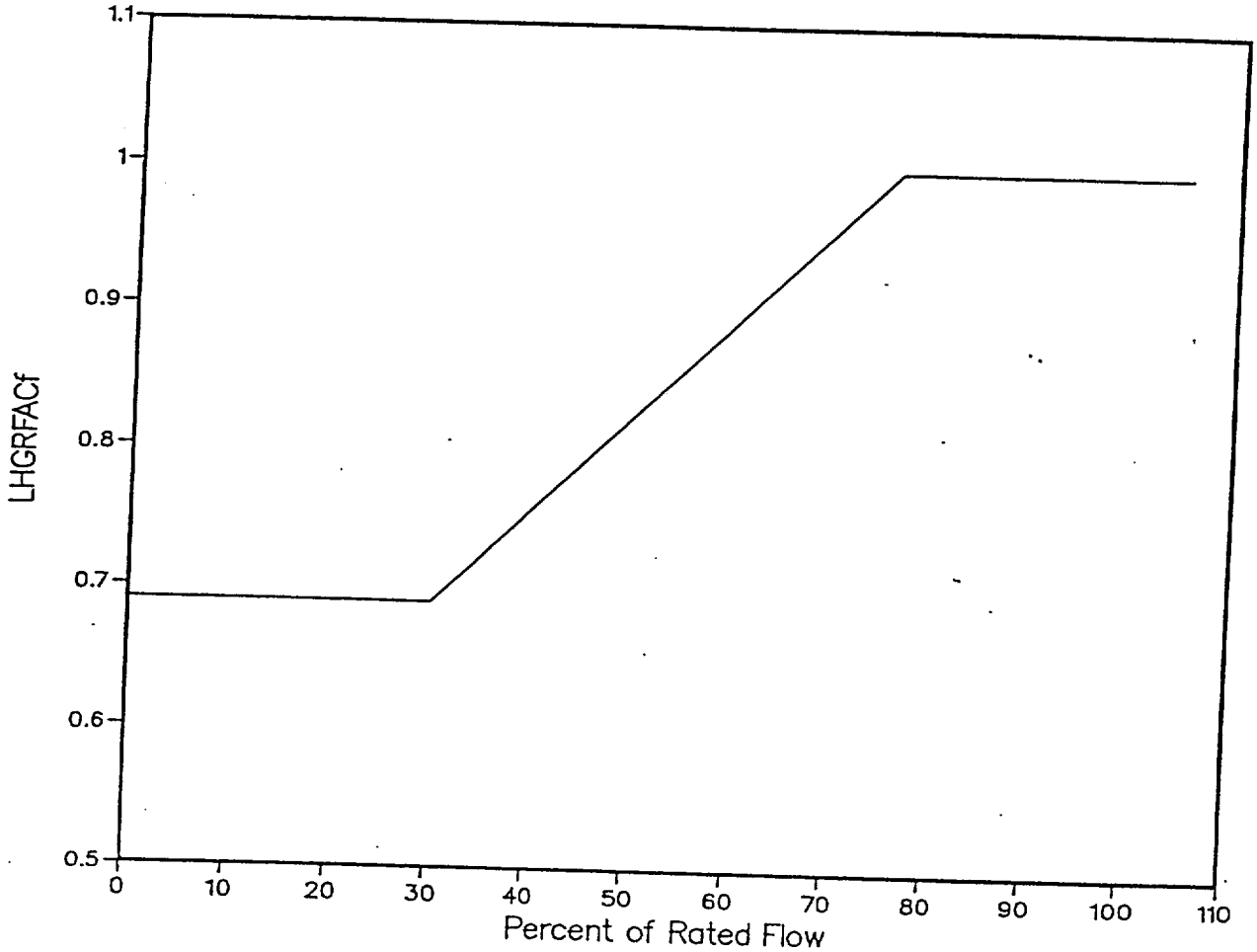
EOOS Condition	Power (% Rated)	ATRIUM-9B Fuel		GE9
		$MCPR_p$	$LHGRFAC_p$	$MCPR_p$
Base Case Operation	0	2.70	0.75	2.70
	25	2.20	0.75	2.20
	25	2.05	0.75	2.05
	60	1.54	0.95	1.56
	80	1.48	1.00	1.51
	100	1.42	1.00	1.45

* Limits support operation with any combination of one SRVOOS, up to 2 TIPOOS (or the equivalent number of TIP channels), up to a 20°F reduction in feedwater temperature (except for conditions with FHOOS), and up to 50% of the LPRMs out of service in the standard, ICF and MELLLA regions of the power/flow map.



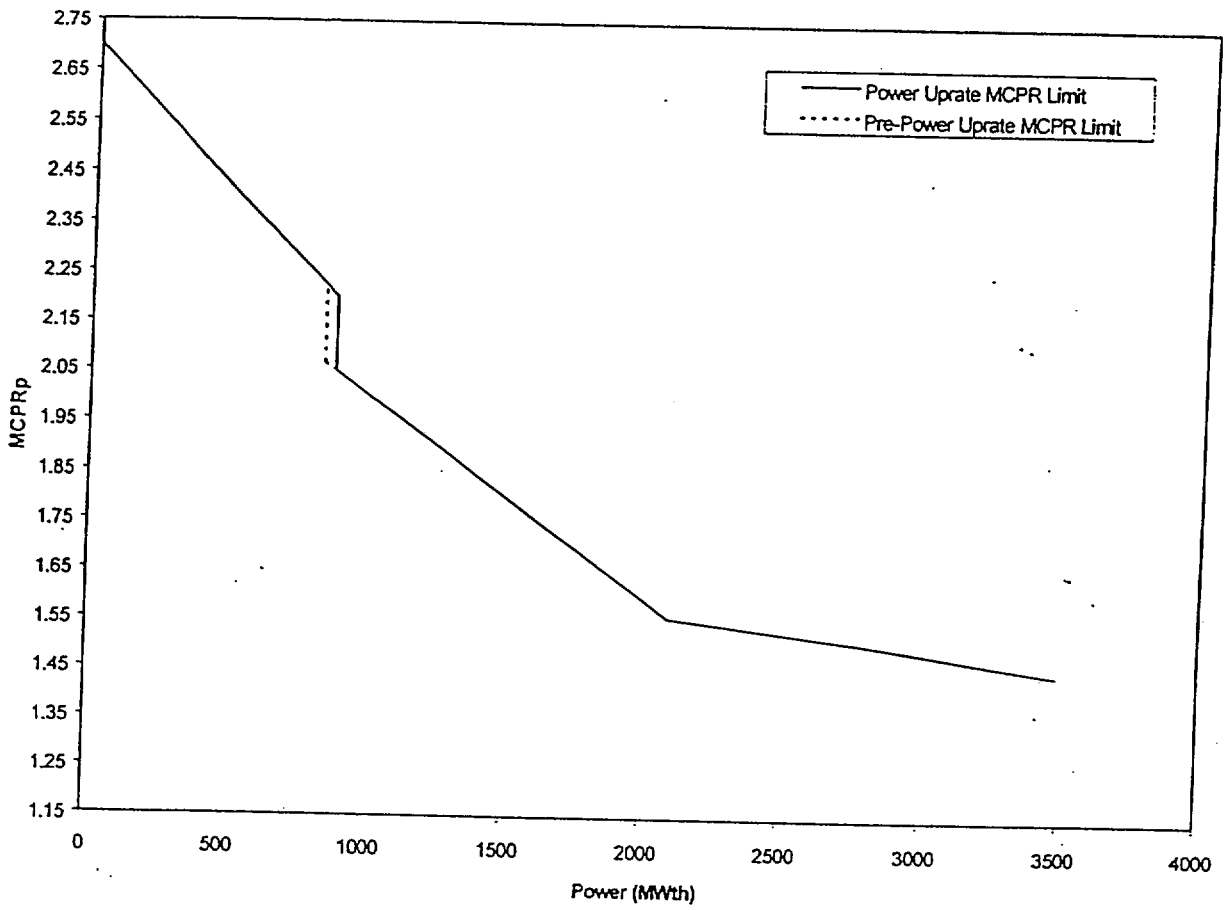
Flow (% rated)	102.5% Maximum Core Flow		105% Maximum Core Flow	
	$MCPR_f$ ATRIUM-9B	$MCPR_f$ GE9	$MCPR_f$ ATRIUM-9B	$MCPR_f$ GE9
0	1.85	1.85	1.93	1.93
30	1.85	1.85	1.93	1.93
102.5	1.11	1.11	1.14	1.14
105	1.11	1.11	1.11	1.11

Figure 5.1. Flow Dependent MCPR Limits for Manual Flow Control Mode



Flow (% rated)	$LHGRFAC_f$
0	0.69
30	0.69
76	1.00
105	1.00

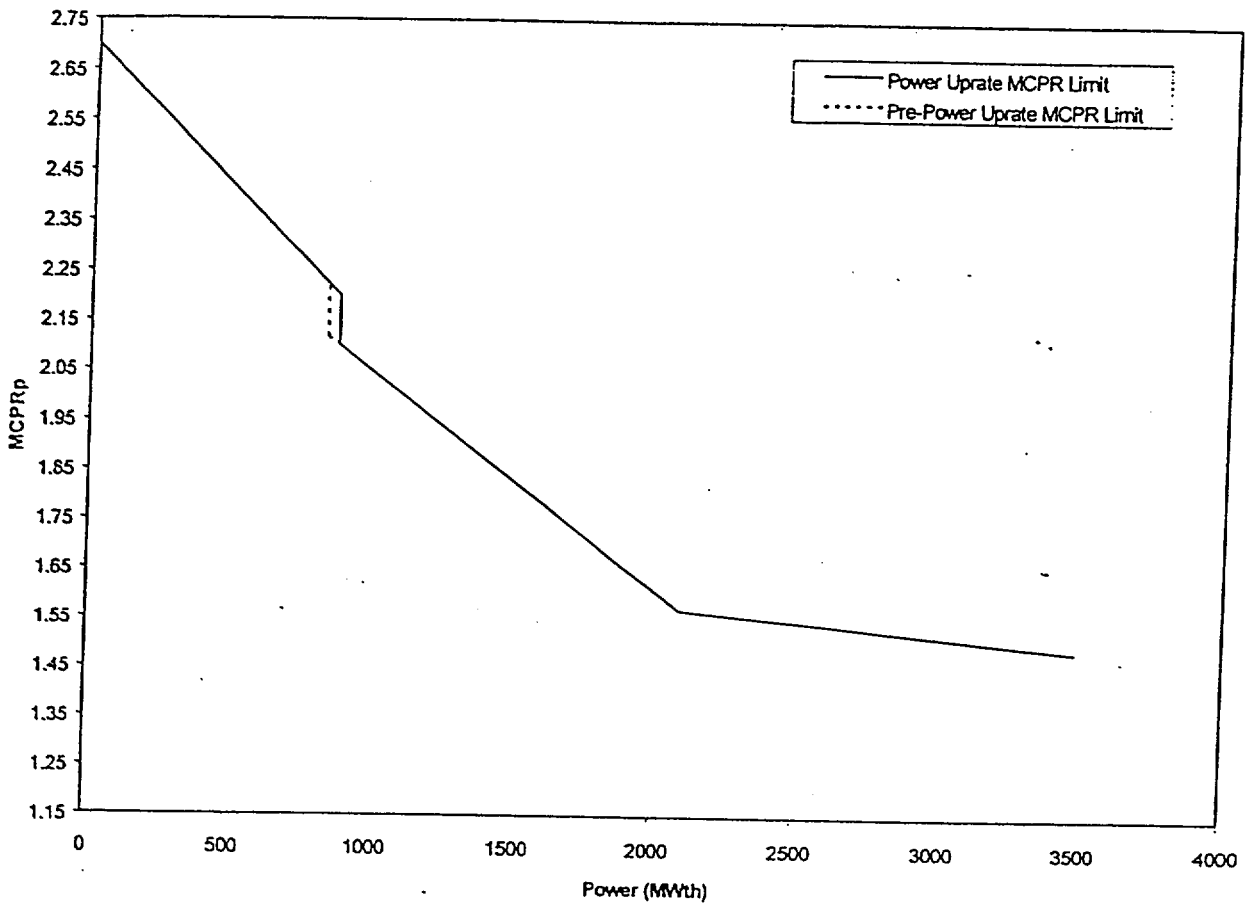
Figure 5.2 Flow Dependent LHGR Multipliers for ATRIUM-9B Fuel



3323 MWt Rated Power	
Power (%)	$MCPR_p$ Limits
100	1.46
84	1.51
63	1.56
25	2.07
25	2.22
0	2.70

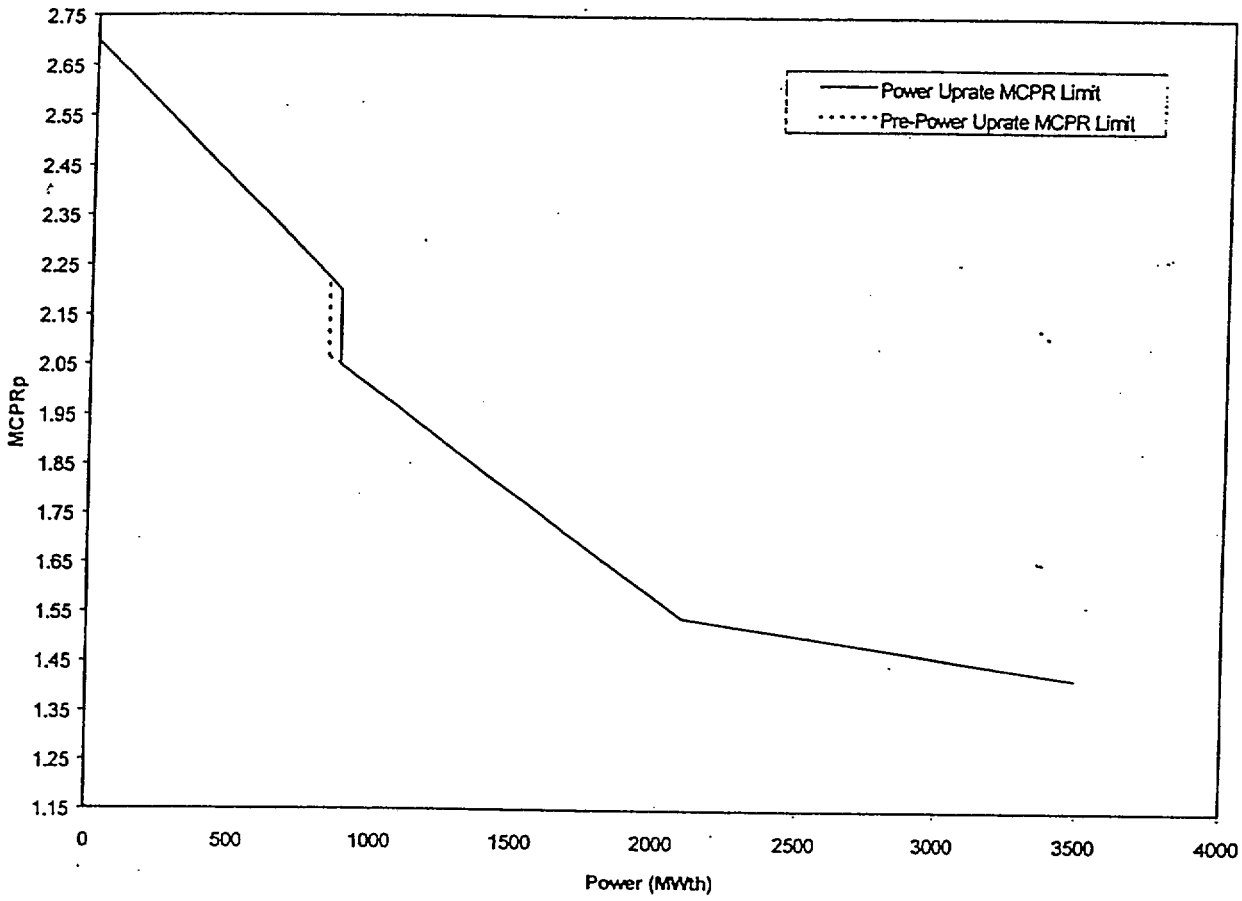
3489 MWt Rated Power	
Power (%)	$MCPR_p$ Limits
100	1.45
80	1.51
60	1.56
25	2.05
25	2.20
0	2.70

Figure 5.3 Base Case Power Dependent MCPR Limits for ATRIUM-9B Fuel - TSSS Insertion Times



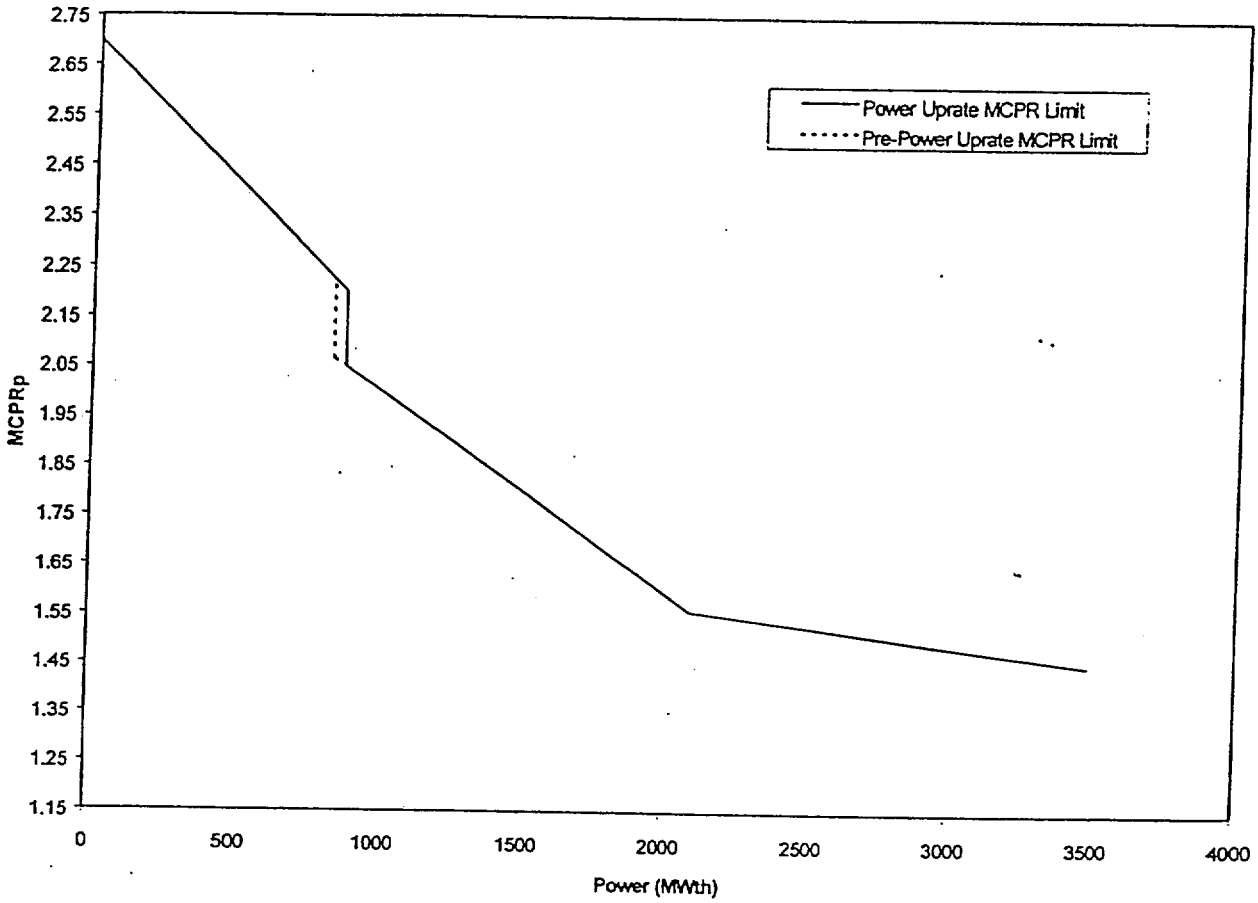
3323 MWt Rated Power		3489 MWt Rated Power	
Power (%)	$MCPR_p$ Limits	Power (%)	$MCPR_p$ Limits
100	1.50	100	1.49
84	1.53	80	1.53
63	1.57	60	1.57
25	2.12	25	2.10
25	2.22	25	2.20
0	2.70	0	2.70

Figure 5.4 Base Case Power Dependent MCPR Limits for GE9 Fuel - TSSS Insertion Times



3323 MWt Rated Power		3489 MWt Rated Power	
Power (%)	$MCPR_p$ Limits	Power (%)	$MCPR_p$ Limits
100	1.43	100	1.42
84	1.48	80	1.48
63	1.54	60	1.54
25	2.07	25	2.05
25	2.22	25	2.20
0	2.70	0	2.70

Figure 5.5 Base Case Power Dependent MCPR Limits for ATRIUM-9B Fuel - NSS Insertion Times



3323 MWt Rated Power		3489 MWt Rated Power	
Power (%)	$MCPR_p$ Limits	Power (%)	$MCPR_p$ Limits
100	1.46	100	1.45
84	1.51	80	1.51
63	1.56	60	1.56
25	2.07	25	2.05
25	2.22	25	2.20
0	2.70	0	2.70

Figure 5.6 Base Case Power Dependent MCPR Limits for GE9 Fuel - NSS Insertion Times

< This data is to be furnished by ComEd. >

Figure 5.7 Starting Control Rod Pattern
for Control Rod Withdrawal Analysis

6.0 Postulated Accidents

6.1 *Loss-of-Coolant Accident*

6.1.1 Break Location Spectrum — Reference 9.8

6.1.2 Break Size Spectrum — Reference 9.8

6.1.3 MAPLHGR Analyses

The MAPLHGR limits presented in Reference 9.9 are valid for LaSalle Unit 1 ATRIUM-9B (LSA-1) fuel for Cycle 9 operation.

Limiting Break: 1.1 ft^2 Break
Recirculation Pump Discharge Line
High Pressure Core Spray Diesel Generator Single Failure

Peak clad temperature and peak local metal water reaction results for the Cycle 9 ATRIUM-9B reload fuel are 1795°F and 0.72% respectively. These results are bounded by the results presented in Reference 9.11, which support the Reference 9.9 MAPLHGR limits. The maximum core-wide metal-water reaction for Cycle 9 remains less than 0.16%. LOCA/heatup analysis results for LaSalle ATRIUM-9B are presented below (from Reference 9.11):

	Maximum PCT (°F)	Peak Local Metal-Water Reaction (%)
ATRIUM-9B Fuel	1825	0.79*

The maximum core wide metal-water reaction is < 0.16%.

6.2 *Control Rod Drop Accident*

< This data is to be furnished by ComEd. >

6.3 *Spent Fuel Cask Drop Accident*

The radiological consequences of a spent fuel cask drop accident have been evaluated for SPC ATRIUM fuel designs in conformance with the analysis described in the LSCS UFSAR Section

* The peak local metal water reaction result is consistent with the limiting PCT analysis results reported in Reference 9.11.

15.7.5. The analysis is assumed to occur 360 days following shutdown of the reactor, and it is assumed that all 32 fuel assemblies in the cask completely fail as a result of the accident.

Because the accident is assumed not to occur sooner than 360 days following shutdown of the reactor, the source term for the accident will be very low due to fission product decay. Hence, the commensurate radiological whole-body and thyroid doses will be very low. The results of this analysis demonstrate that spent fuel cask drop accidents involving SPC ATRIUM fuel will not exceed the established radiological whole-body and thyroid dose limits which are a small fraction of the 10 CFR 100 limits for radiological exposures.

7.0 Technical Specifications

7.1 *Limiting Safety System Settings*

7.1.1 MCPR Fuel Cladding Integrity Safety Limit

MCPR Safety Limit (all fuel) — two-loop operation	1.11*
MCPR Safety Limit (all fuel) — single-loop operation	1.12*

7.1.2 Steam Dome Pressure Safety Limit

Pressure Safety Limit	1325 psig

7.2 *Limiting Conditions for Operation*

7.2.1 Average Planar Linear Heat Generation Rate

Reference 9.9

ATRIUM-9B Fuel MAPLHGR Limits

Average Planar Exposure (GWd/MTU)	MAPLHGR (kW/ft)
0.0	13.5
20.0	13.5
61.1	9.39

GE9-Fuel MAPLHGR Limits

< To be furnished by ComEd. >

Single Loop Operation MAPLHGR Multiplier for SPC Fuel is 0.90 — Reference 9.9

7.2.2 Minimum Critical Power Ratio

Rated Conditions MCPR Limit†

Flow Dependent MCPR Limits:

Manual Flow Control — Figure 5.1

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* Includes the effects of channel bow, up to 2 TIPOOS (or the equivalent number of TIP channels), a 2000 EFPH LPRM calibration interval and up to 50% of the LPRMs out of service.

† This data is to be furnished by ComEd.

Power Dependent MCPR Limits:

Base Case Operation - TSSS Insertion Times	Figures 5.3 & 5.4
Base Case Operation - NSS Insertion Times	Figures 5.5 & 5.6
EOD and EOOS Operation	Tables 5.1–5.4

7.2.3 Linear Heat Generation Rate — Reference 9.1

ATRIUM-9B Fuel Steady-State LHGR Limits		GE9 Fuel Steady-State LHGR Limits
Average Planar Exposure (GWd/MTU)	LHGR (kW/ft)	< To be furnished by ComEd. >
0.0	14.4	
15.0	14.4	
61.1	8.32	

The protection against power transient (PAPT) linear heat generation rate curve for ATRIUM-9B fuel is identified in Reference 9.1 and is presented here as Figure 7.1 for convenience. $LHGRFAC_f$ and $LHGRFAC_p$ multipliers are applied directly to the steady-state LHGR limits at reduced power, reduced flow and/or EOD/EOOS conditions to ensure the PAPT LHGR limits are not violated during an AOO. Comparison of the Cycle 9 nodal power histories for the rated power pressurization transients with the approved bounding curves to show compliance with the 1% strain criteria for GE9 fuel is discussed in Reference 9.10.

LHGRFAC Multipliers for Off-Rated Conditions - ATRIUM-9B Fuel:

$LHGRFAC_f$	Figure 5.2
$LHGRFAC_p$	Tables 5.1–5.4

MAPFAC Multipliers for Off-Rated Conditions - GE9 Fuel:

$MAPFAC_f$	< To be furnished by ComEd. >
$MAPFAC_p$	< To be furnished by ComEd. >

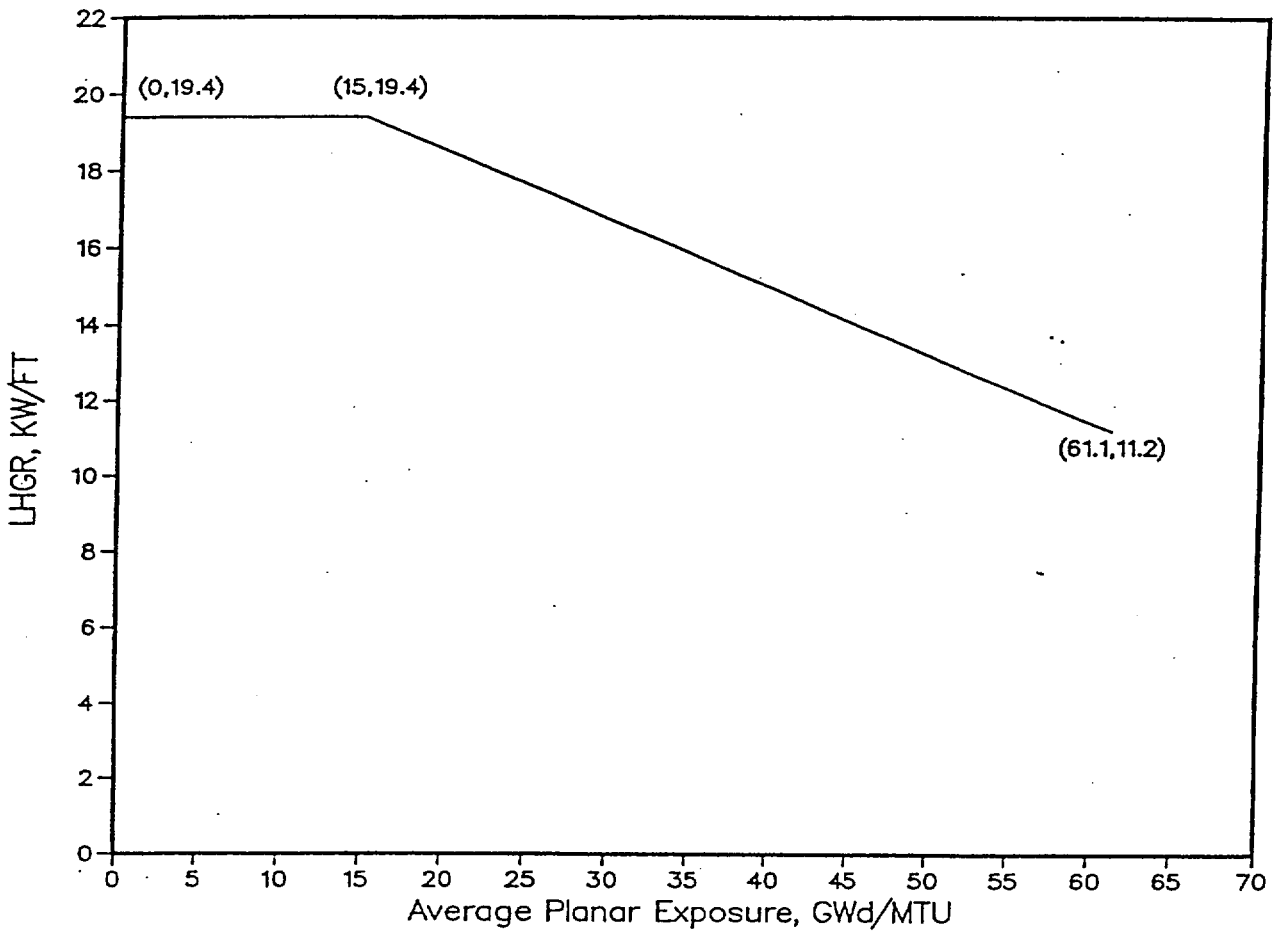


Figure 7.1 Protection Against Power Transient LHGR Limit for ATRIUM-9B Fuel

8.0 Methodology References

See XN-NF-80-19(P)(A) Volume 4 Revision 1 for a complete bibliography.

8.1 ANF-913(P)(A) Volume 1 Revision 1 and Volume 1 Supplements 2, 3 and 4, *COTRANSA2: A Computer Program for Boiling Water Reactor Transient Analyses*, Advanced Nuclear Fuels Corporation, August 1990.

8.2 ANF-524(P)(A) Revision 2 and Supplement 1 Revision 2, *ANF Critical Power Methodology for Boiling Water Reactors*, Advanced Nuclear Fuels Corporation, November 1990.

8.3 ANF-1125(P)(A) and ANF-1125(P)(A), Supplement 1, *ANFB Critical Power Correlation*, Advanced Nuclear Fuels Corporation, April 1990.

8.4 EMF-1125(P)(A), Supplement 1 Appendix C, *ANFB Critical Power Correlation Application for Co-Resident Fuel*, Siemens Power Corporation, August 1997.

8.5 ANF-1125(P)(A), Supplement 1 Appendix E Revision 0, *ANFB Critical Power Correlation Determination of ATRIUM-9B Additive Constant Uncertainties*, Siemens Power Corporation, September 1998.

8.6 XN-NF-80-19(P)(A) Volume 1 Supplement 3, Supplement 3 Appendix F, and Supplement 4, *Advanced Nuclear Fuels Methodology for Boiling Water Reactors: Benchmark Results for CASMO-3G/MICROBURN-B Calculation Methodology*, Advanced Nuclear Fuels Corporation, November 1990.

8.7 EMF-CC-074(P)(A) Volume 1, *STAIF - A Computer Program for BWR Stability Analysis in the Frequency Domain*, and Volume 2, *STAIF - A Computer Program for BWR Stability Analysis in the Frequency Domain - Code Qualification Report*, Siemens Power Corporation, July 1994.

9.0 Additional References

9.1 EMF-2249(P) Revision 1, *Fuel Design Report for LaSalle Unit 1 Cycle 9 ATRIUM™-9B Fuel Assemblies*, Siemens Power Corporation, September 1999.

9.2 ANF-89-014(P)(A) Revision 1 and Supplements 1 and 2, *Advanced Nuclear Fuels Corporation Generic Mechanical Design for Advanced Nuclear Fuels 9x9-IX and 9x9-9X BWR Reload Fuel*, Advanced Nuclear Fuels Corporation, October 1991.

9.3 EMF-2277 Revision 1, *LaSalle Unit 1 Cycle 9 Plant Transient Analysis*, Siemens Power Corporation, October 1999.

9.4 EMF-95-134(P), *Criticality Safety Analysis for ATRIUM™-9B Fuel, LaSalle Units 1 and 2 New Fuel Storage Vault*, Siemens Power Corporation, December 1995.

9.5 EMF-96-117(P), *Criticality Safety Analysis for ATRIUM™-9B Fuel, LaSalle Unit 1 Spent Fuel Storage Pool (BORAL Rack)*, Siemens Power Corporation, April 1996.

9.6 EMF-95-088(P), *Criticality Safety Analysis for ATRIUM™-9B Fuel, LaSalle Unit 2 Spent Fuel Storage Pool (Boraflex Rack)*, Siemens Power Corporation, February 1996.

9.7 EMF-95-205(P) Revision 2, *LaSalle Extended Operating Domain (EOD) and Equipment Out of Service (EOOS) Safety Analysis for ATRIUM™-9B Fuel*, Siemens Power Corporation, June 1996.

9.8 EMF-2174(P), *LOCA Break Spectrum Analysis for LaSalle Units 1 and 2*, Siemens Power Corporation, March 1999.

9.9 EMF-2175(P), *LaSalle LOCA-ECCS Analysis MAPLHGR Limits for ATRIUM™-9B Fuel*, Siemens Power Corporation, March 1999.

9.10 Letter, D. E. Garber (SPC) to R. J. Chin (ComEd), "LaSalle Unit 1 Cycle 9 Mechanical Limits for GE9 Fuel." DEG:99:213, August 4, 1999.

9.11 Letter, D. E. Garber (SPC) to R. J. Chin (ComEd), "10 CFR 50.46 Reporting for the LaSalle Units," DEG:99:129, May 6, 1999.

Attachment 3

LaSalle Unit 1 Cycle 9

Plant Transient Analysis (Excerpts)

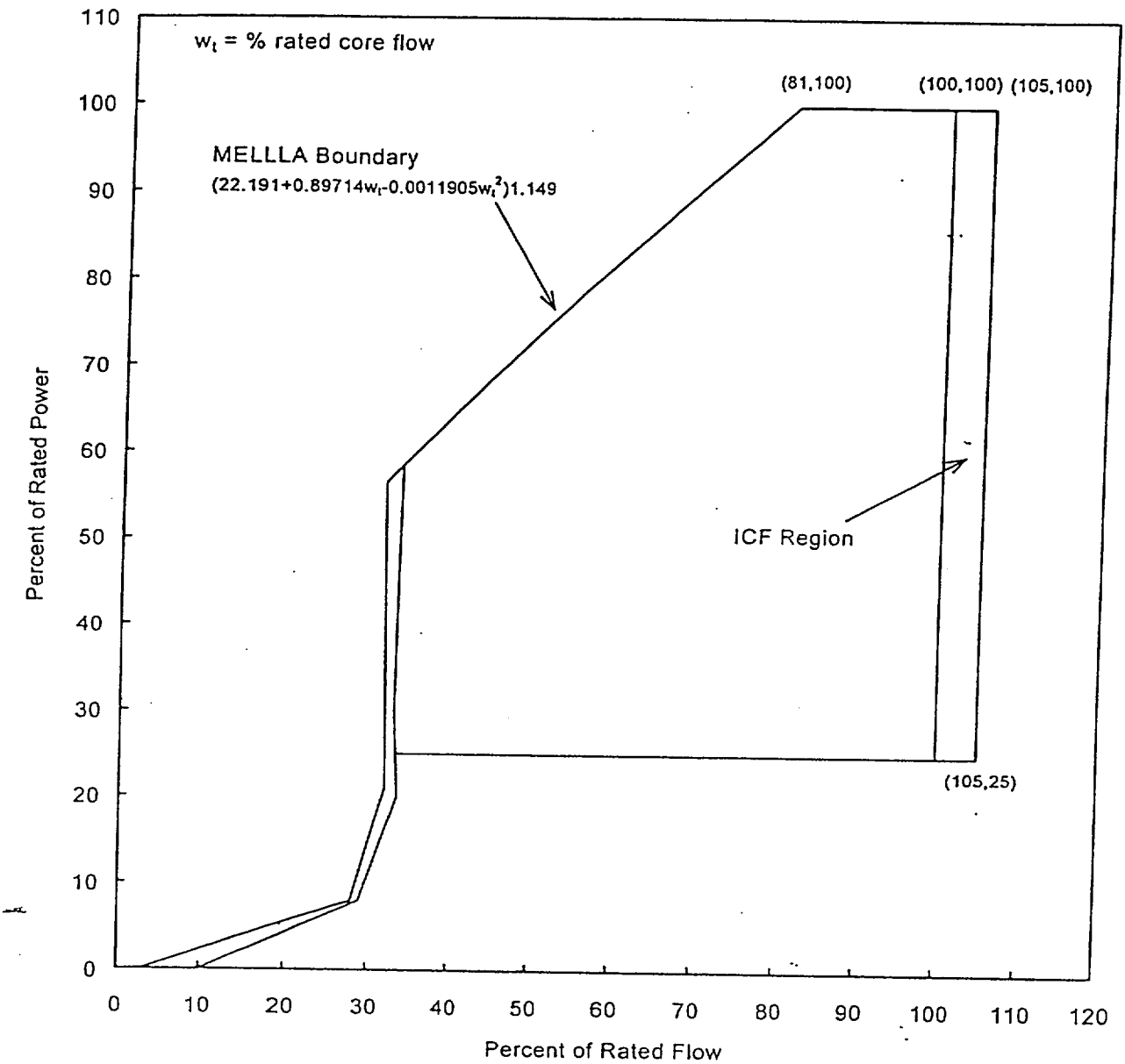
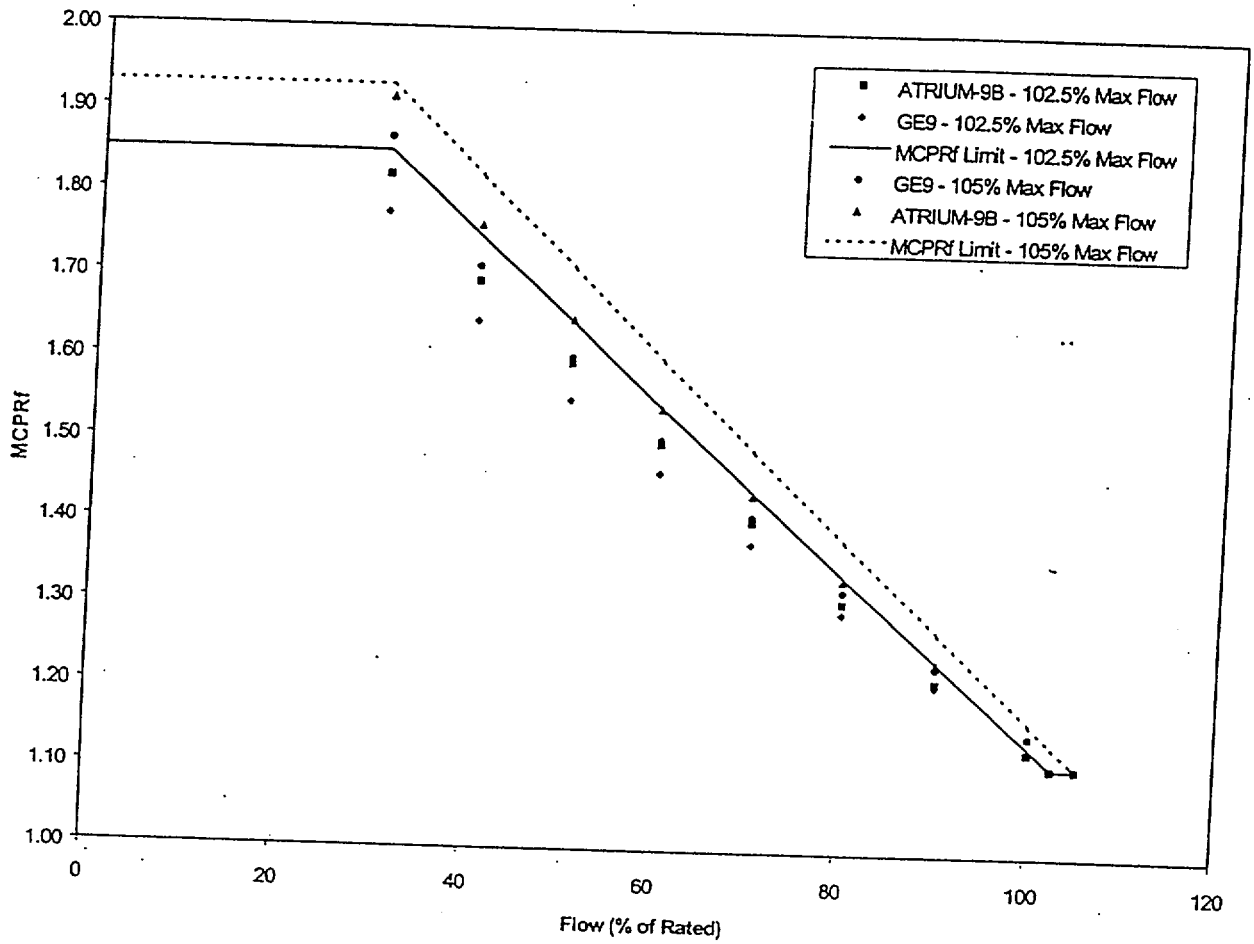
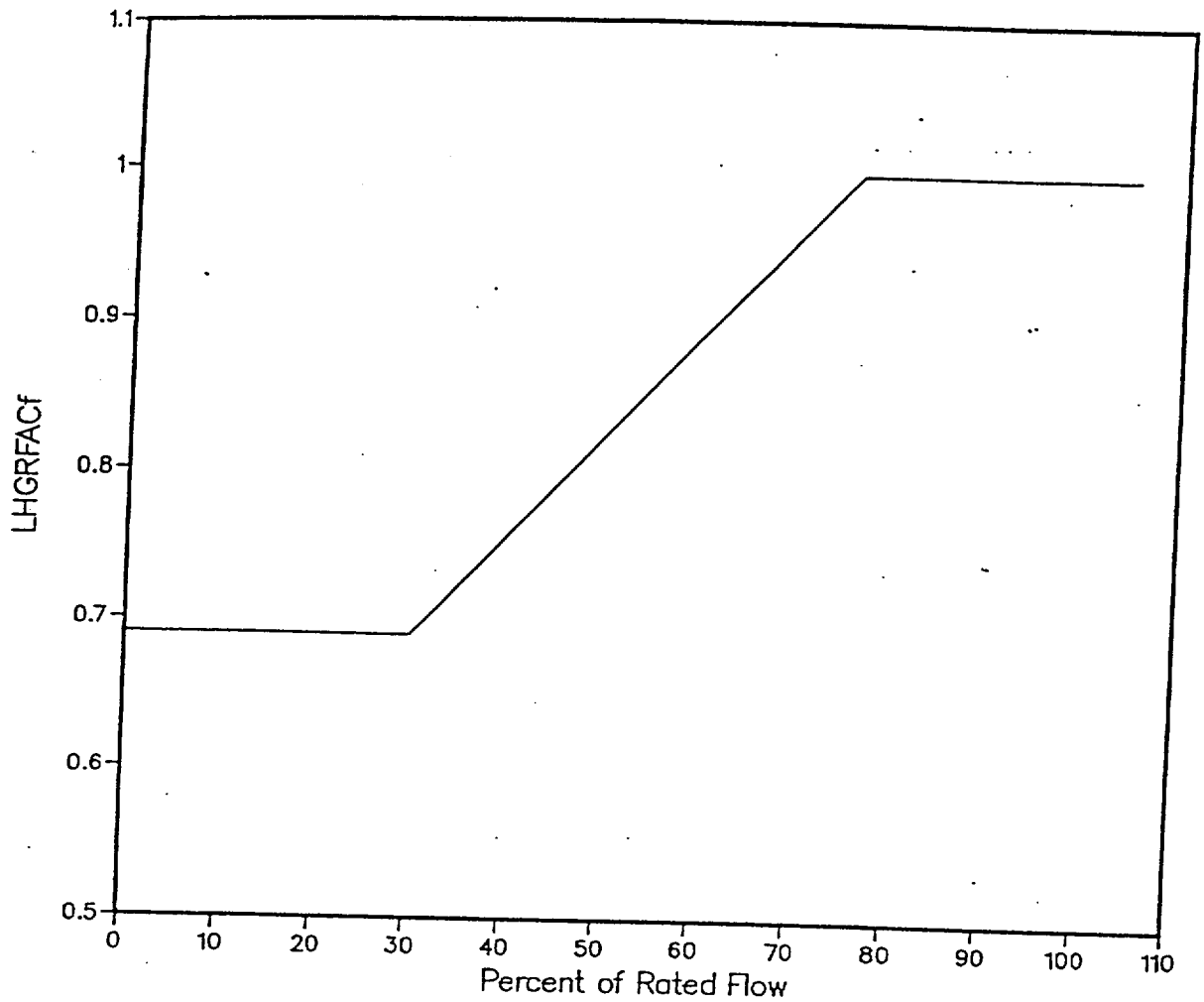


Figure 1.1 LaSalle County Nuclear Station
Power / Flow Map



Flow (% rated)	102.5% Maximum Core Flow		105% Maximum Core Flow	
	$MCPR_f$ ATRIUM-9B	$MCPR_f$ GE9 (penalty included)	$MCPR_f$ ATRIUM-9B	$MCPR_f$ GE9 (penalty included)
0	1.85	1.85	1.93	1.93
30	1.85	1.85	1.93	1.93
102.5	1.11	1.11	1.14	1.14
105	1.11	1.11	1.11	1.11

Figure 2.1 Flow-Dependent MCPR Limits for Manual Flow Control Mode



Flow (% rated)	LHGRFAC$_f$
0	0.69
30	0.69
76	1.00
105	1.00

Figure 2.2 Flow-Dependent LHGRFAC Multipliers for ATRIUM-9B Fuel

Table 3.1 LaSalle Unit 1 Plant Conditions at Rated Power and Flow

Reactor Thermal Power	3489 MWth
Total Core Flow	108.5 Mlbm/hr
Core Active Flow	93.8 Mlbm/hr
Core Bypass Flow*	14.7 Mlbm/hr
Core Inlet Enthalpy	523.9 Btu/lbm
Vessel Pressures	
Steam Dome	1001 psia
Core Exit (upper plenum)	1013 psia
Lower Plenum	1038 psia
TCV Inlet Pressure	948 psia
Feedwater/Steam Flow	15.145 Mlbm/hr
Feedwater Enthalpy	406.6 Btu/lbm
Recirculating Pump Flow (per pump)	15.83 Mlbm/hr
Core Average Gap Coefficient (EOC)	1173 Btu/hr-ft^2-°F

* Includes water channel flow.

Table 3.2 Scram Speed Insertion Times

Control Rod Position (Notch)	TSSS Time (sec)	NSS Time (sec)
48 (full-out)	0.000	0.000
48*	0.200*	0.200*
45	0.430	0.380
39	0.860	0.680
25	1.930	1.680
5	3.490	2.680
0 (full-in)	3.880	2.804

* As indicated in Reference 8, the delay between scram signal and control rod motion is conservatively modeled. Sensitivity analyses indicate that using no delay provides conservative results.

Table 3.3 EOC Base Case LRNB Transient Results

Power*/ Flow	ATRIUM-9B ΔCPR	ATRIUM-9B $LHGRFAC_p$	GE9 ΔCPR	Peak Neutron Flux (% rated)	Peak Heat Flux (% rated)
TSSS Insertion Times					
100/105	0.325	1.000	0.362	438.8	123.7
100/81	0.337	1.000	0.377	460.2	126.5
80/105	0.332	1.000	0.368	367.6	98.2
80/57.2	0.377	1.000	0.410	323.7	99.3
60/105	0.319	1.033	0.349	253.1	72.3
60/35.1	0.301	1.098	0.289	135.0	67.1
40/105	0.260**	1.113	0.271	106.0**	45.6**
25/105	0.191**	1.202	0.177**	44.9**	27.0**
23.81/105	0.186**	1.211	0.171**	41.6**	25.6**
20/105 NDS	1.008	0.706	0.980	44.6	38.1
NSS Insertion Times					
100/105	0.304	1.000	0.338	401.1	121.3
100/81	0.288	1.000	0.323	409.5	122.0
80/105	0.317	1.009	0.351	347.5	96.9
80/57.2	0.278	1.014	0.306	256.1	94.2
60/105	0.309	1.038	0.338	245.9	71.6

* Power presented relative to uprated power (3489 MWth).

** The analysis results presented are from an earlier cycle exposure. The ΔCPR and $LHGRFAC_p$ results are conservatively used to establish the thermal limits.

Table 3.4 EOC Base Case FWCF Transient Results

Power*/ Flow	ATRIUM-9B ΔCPR	ATRIUM-9B $LHGRFAC_p$	GE9 ΔCPR	Peak Neutron Flux (% rated)	Peak Heat Flux (% rated)
TSSS Insertion Times					
100/105	0.299	1.019	0.322	371.3	122.6
100/81	0.280	1.032	0.301	303.1	121.8
80/105	0.355	0.986	0.376	327.2	101.9
80/57.2	0.294	1.063	0.310	203.7	96.0
60/105	0.431**	0.955	0.440	218.3**	79.3**
60/35.1	0.251	1.143	0.252	104.7	67.0
40/105	0.582**	0.891**	0.546**	128.0**	58.8**
25/105	0.884**	0.767**	0.913**	62.5**	43.2**
23.81/105	0.936**	0.750**	0.964**	61.1**	42.2**
20/105 NDS	1.119	0.688	1.029	70.2	43.9
NSS Insertion Times					
100/105	0.280	1.033	0.301	342.9	120.5
80/105	0.341	1.000	0.360	312.3	100.8
60/105	0.417	0.959	0.430	229.7.	79.9
40/105	0.570**	0.895**	0.535**	124.6**	58.5**
25/105	0.861**	0.777**	0.871**	76.7**	44.0**
23.81/105	0.901**	0.760**	0.923**	73.8**	42.9**

* Power presented relative to uprated power (3489 MWth).

** The analysis results presented are from an earlier cycle exposure. The ΔCPR and $LHGRFAC_p$ results are conservatively used to establish the thermal limits.

Table 3.5 Input for MCPR Safety Limit Analysis

Fuel Related Uncertainties

Parameter	Source Document	Statistical Treatment
ANFB Correlation*		
ATRIUM-9B	Reference 17	Convoluted
GE9	Reference 12	Convoluted
Radial Power	Reference 16	Convoluted
Local Peaking Factor	Reference 5	Convoluted
Assembly Flow Rate (mixed core)	Reference 5	Convoluted
Channel Bow Local Peaking	Function of nominal and bowed local peaking and standard deviation of bow data (see Reference 18).	Convoluted

Nominal Values and Plant Measurement Uncertainties

Parameter	Value	Uncertainty (%) (Reference 8)	Statistical Treatment
Feedwater Flow Rate** (Mlbm/hr)	22.7	1.76	Convoluted
Feedwater Temperature (°F)	426.5	0.76	Convoluted
Core Pressure (psia)	1031.35	0.50	Convoluted
Total Core Flow (Mlbm/hr)	113.9	2.50	Convoluted
Core Power** (MWth)	5232.35	---	---

* Additive constant uncertainties values are used.

** Feedwater flow rate and core power were increased above design values to attain desired core MCPR for safety limit evaluation consistent with Reference 5 methodology.

Table 3.6 Flow-Dependent MCPR Results

Core Flow (% rated)	102.5% Maximum Core Flow		105% Maximum Core Flow	
	GE9	ATRIUM-9B	GE9	ATRIUM-9B
30	1.775	1.821	1.866	1.914
40	1.645	1.693	1.711	1.761
50	1.552	1.597	1.604	1.649
60	1.464	1.501	1.505	1.543
70	1.379	1.406	1.412	1.439
80	1.295	1.308	1.322	1.336
90	1.209	1.214	1.232	1.237
100	1.129	1.129	1.149	1.149
102.5	1.110	1.110	---	---
105	1.110	1.110	1.110	1.110

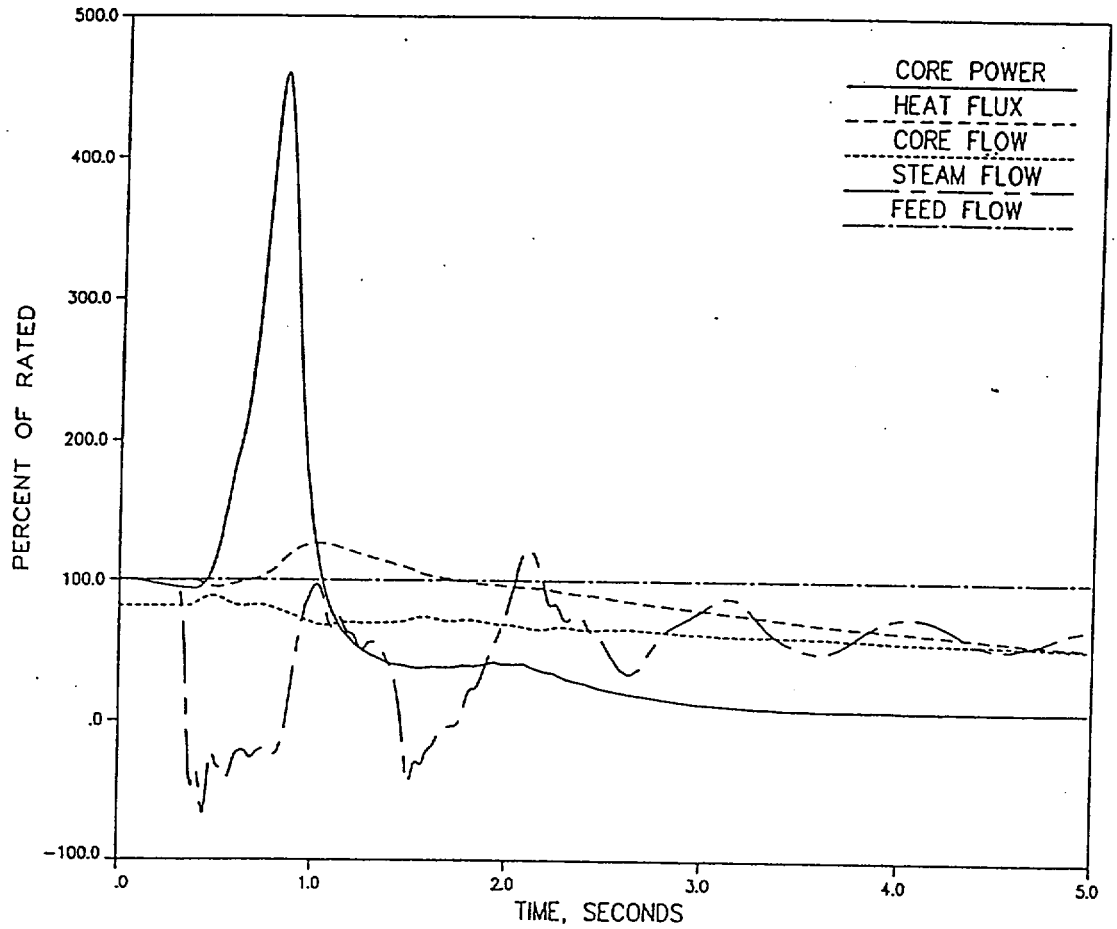


Figure 3.1 EOC Load Rejection No Bypass at 100/81 – TSSS Key Parameters

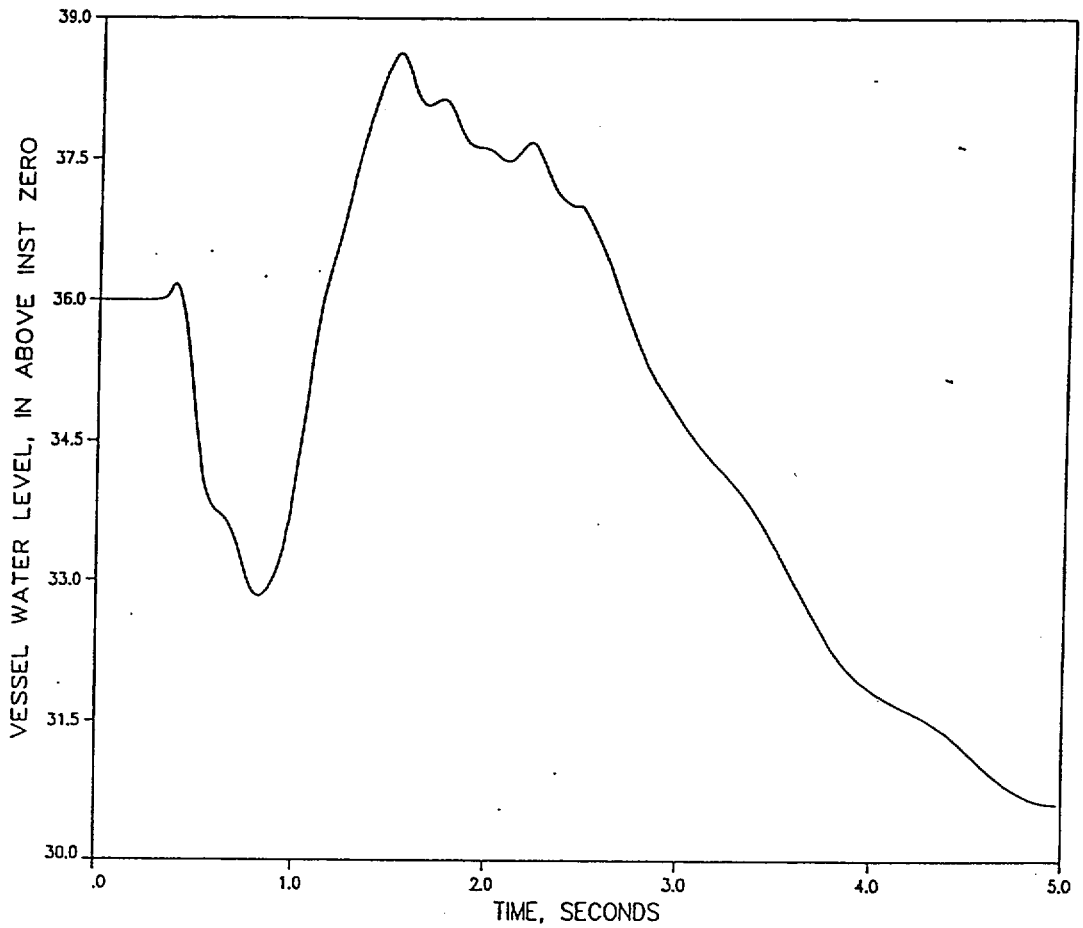


Figure 3.2 EOC Load Rejection No Bypass at 100/81 – TSSS Vessel Water Level

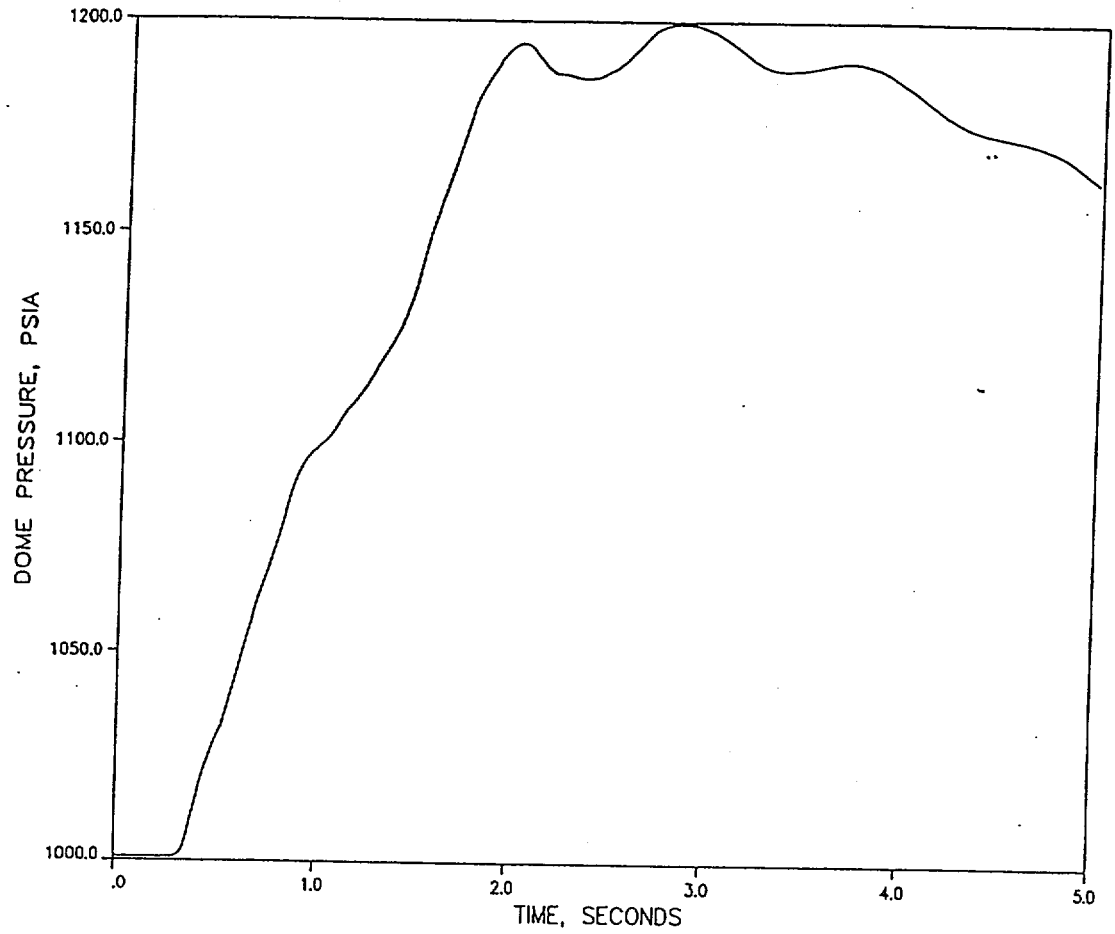


Figure 3.3 EOC Load Rejection No Bypass
at 100/81 – TSSS Dome Pressure

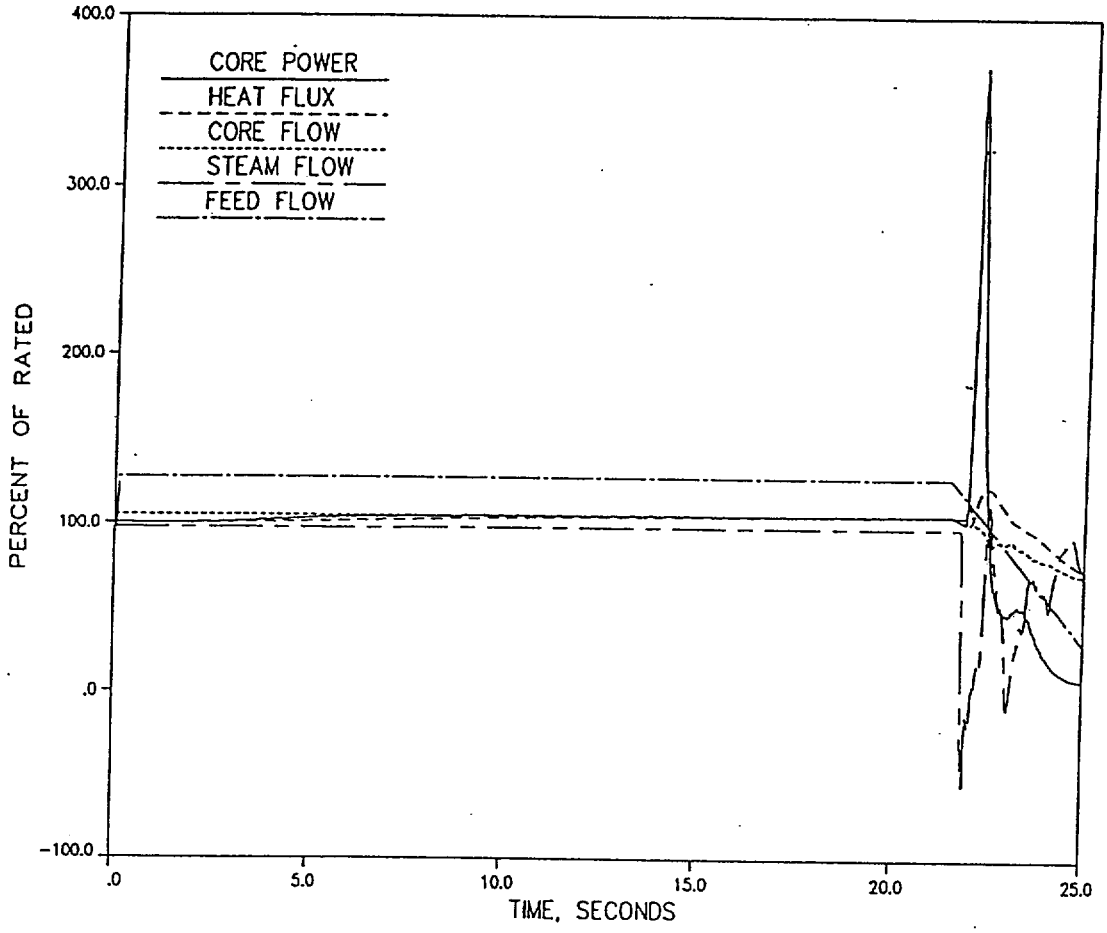


Figure 3.4 EOC Feedwater Controller Failure at 100/105 – TSSS Key Parameters

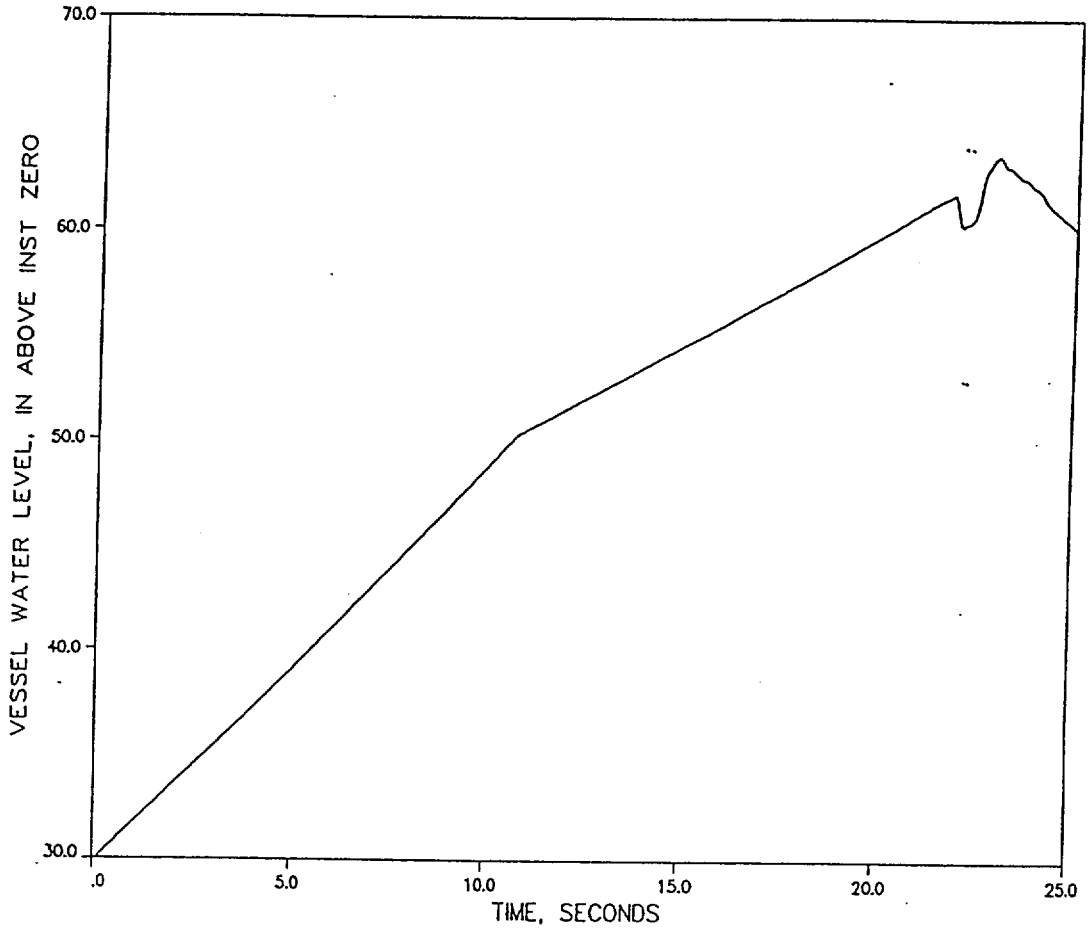


Figure 3.5 EOC Feedwater Controller Failure at 100/105 – TSSS Vessel Water Level

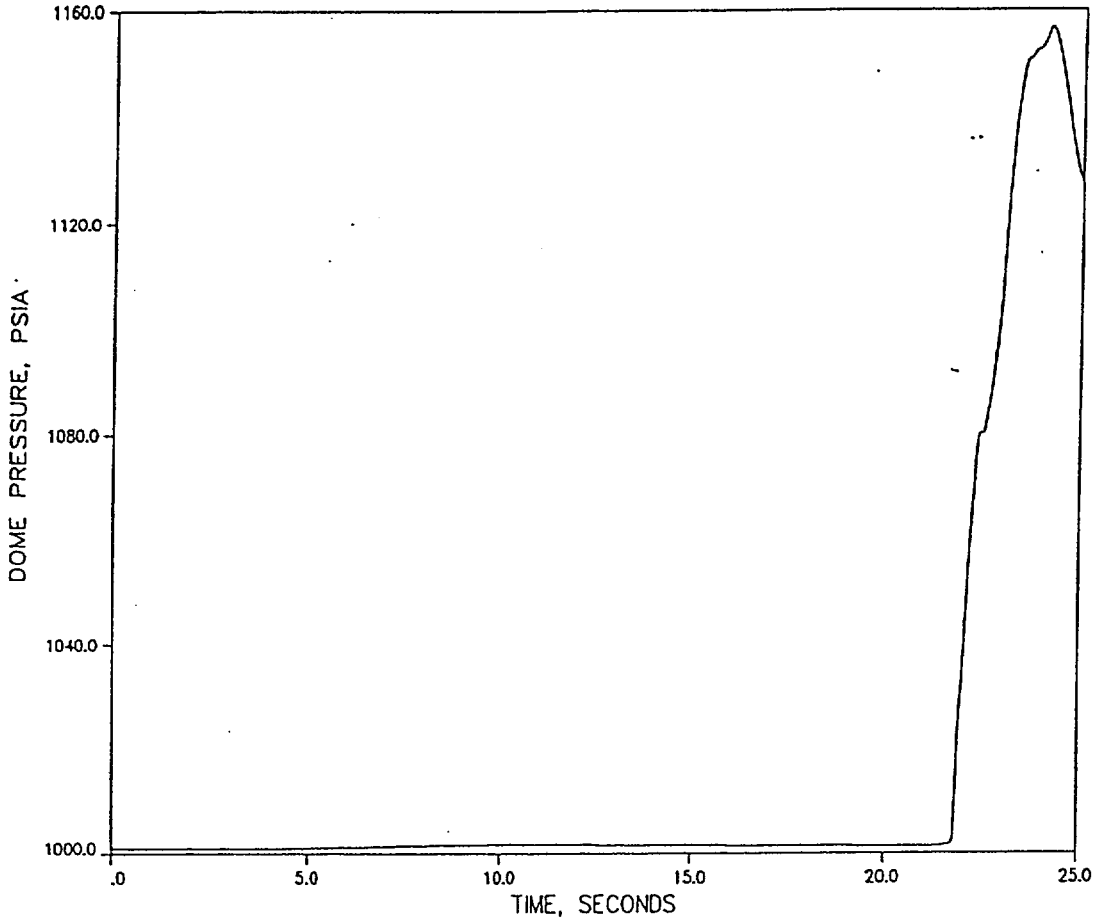


Figure 3.6 EOC Feedwater Controller Failure
at 100/105 – TSSS Dome Pressure

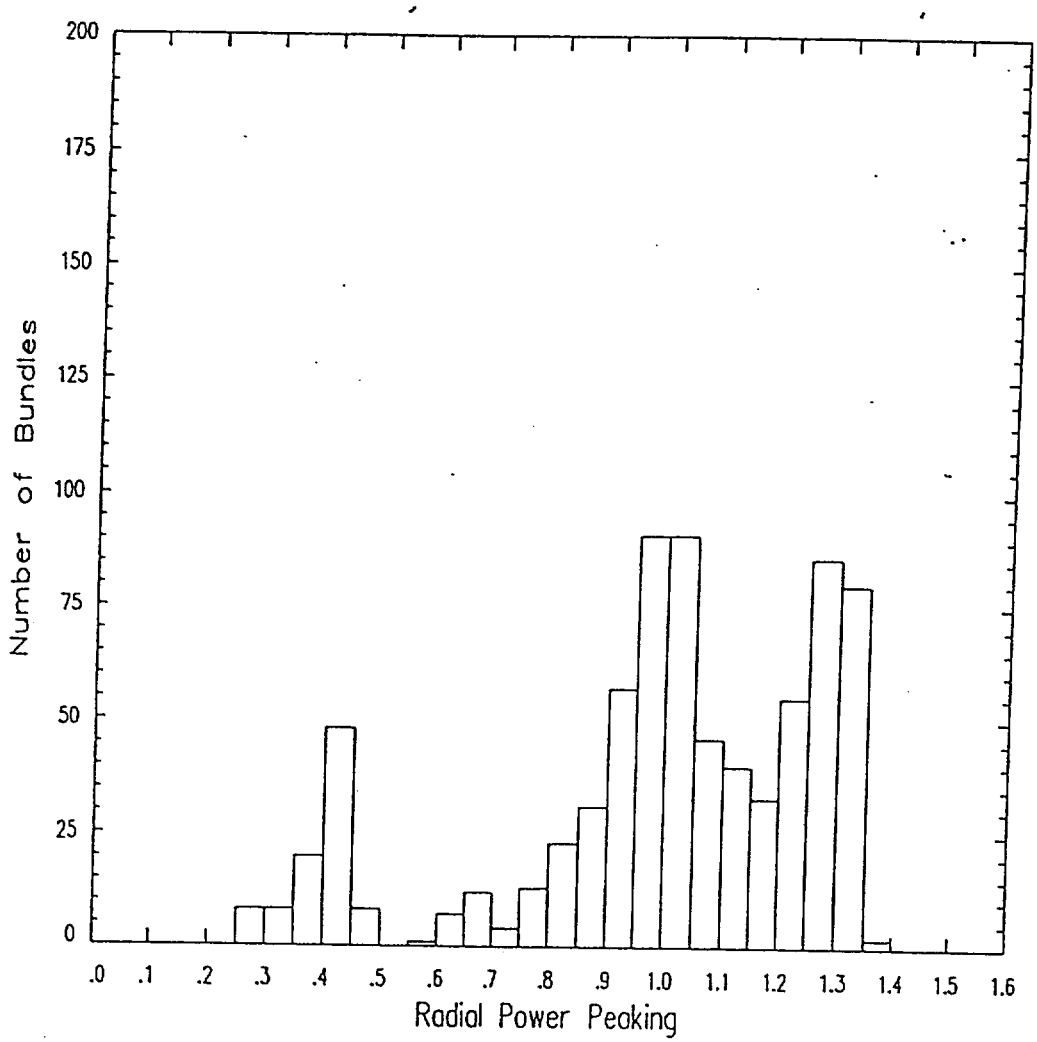


Figure 3.7 Radial Power Distribution for SLMCPR Determination

Control Rod Corner

Control Rod Corner

1.023	1.055	1.068	1.112	1.099	1.102	1.049	1.023	0.977
1.055	0.958	0.894	1.016	0.894	1.007	0.877	0.927	1.002
1.068	0.894	1.031	1.065	1.084	1.056	1.010	0.863	1.011
1.112	1.016	1.065	Internal			1.044	0.980	1.051
1.099	0.894	1.084	Water			1.063	0.863	1.038
1.102	1.007	1.056	Channel			1.035	0.971	1.041
1.049	0.877	1.010	1.044	1.063	1.035	0.990	0.846	0.992
1.023	0.927	0.863	0.980	0.863	0.971	0.846	0.895	0.970
0.977	1.002	1.011	1.051	1.038	1.041	0.992	0.970	0.931

Figure 3.8 LaSalle Unit 1 Cycle 9
Safety Limit Local Peaking Factors SPCA9-393B-16GZ-100M
With Channel Bow (Assembly Exposure of 22,500 MWd/MTU)

Control Rod Corner

Control Rod Corner

1.013	1.042	1.056	1.110	1.098	1.100	1.037	1.010	0.967
1.042	0.944	1.025	0.879	1.014	0.871	1.005	0.912	0.989
1.056	1.025	1.018	1.064	1.081	1.055	0.997	0.989	0.999
1.110	0.879	1.064	Internal			1.043	0.848	1.047
1.098	1.014	1.081	Water			1.059	0.978	1.035
1.100	0.871	1.055	Channel			1.034	0.840	1.037
1.037	1.005	0.997	1.043	1.059	1.034	0.977	0.968	0.979
1.010	0.912	0.989	0.848	0.978	0.840	0.968	0.881	0.956
0.967	0.989	0.999	1.047	1.035	1.037	0.979	0.956	0.921

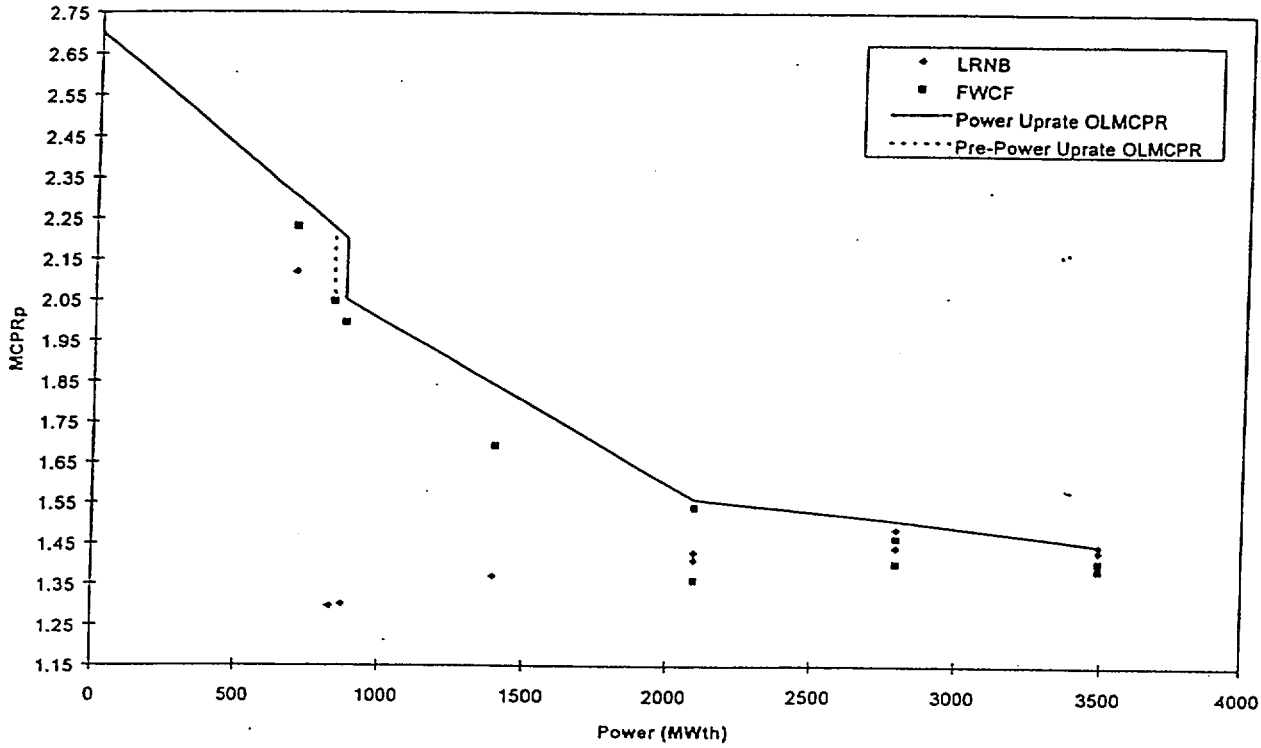
Figure 3.9 LaSalle Unit 1 Cycle 9
Safety Limit Local Peaking Factors SPCA9-396B-12GZB-100M and SPCA9-396B-12GZC-100M
With Channel Bow (Assembly Exposure of 25,000 MWd/MTU)

Control Rod Corner

Control Rod Corner

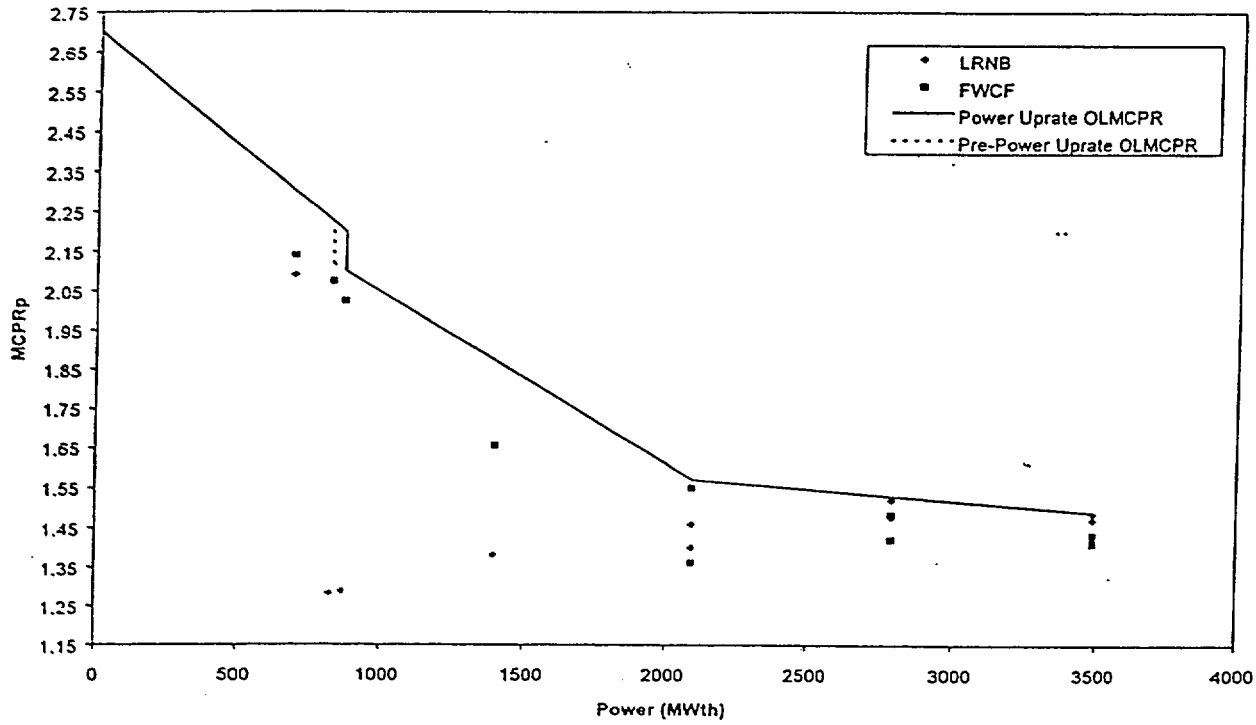
1.022	1.056	1.061	1.035	1.102	1.028	1.045	1.029	0.982
1.056	0.947	1.018	1.003	0.879	0.997	1.004	0.919	1.011
1.061	1.018	1.001	1.050	1.081	1.048	0.996	0.992	1.012
1.035	1.003	1.050	Internal			0.926	0.983	0.987
1.102	0.879	1.081	Water			1.077	0.853	1.049
1.028	0.997	1.048	Channel			1.040	0.970	0.979
1.045	1.004	0.996	0.926	1.077	1.040	0.859	0.980	0.996
1.029	0.919	0.992	0.983	0.853	0.970	0.980	0.891	0.983
0.982	1.011	1.012	0.987	1.049	0.979	0.996	0.983	0.941

Figure 3.10 LaSalle Unit 1 Cycle 9
Safety Limit Local Peaking Factors SPCA9-384B-11GZ6-80M
With Channel Bow (Assembly Exposure of 20,000 MWdMTU)



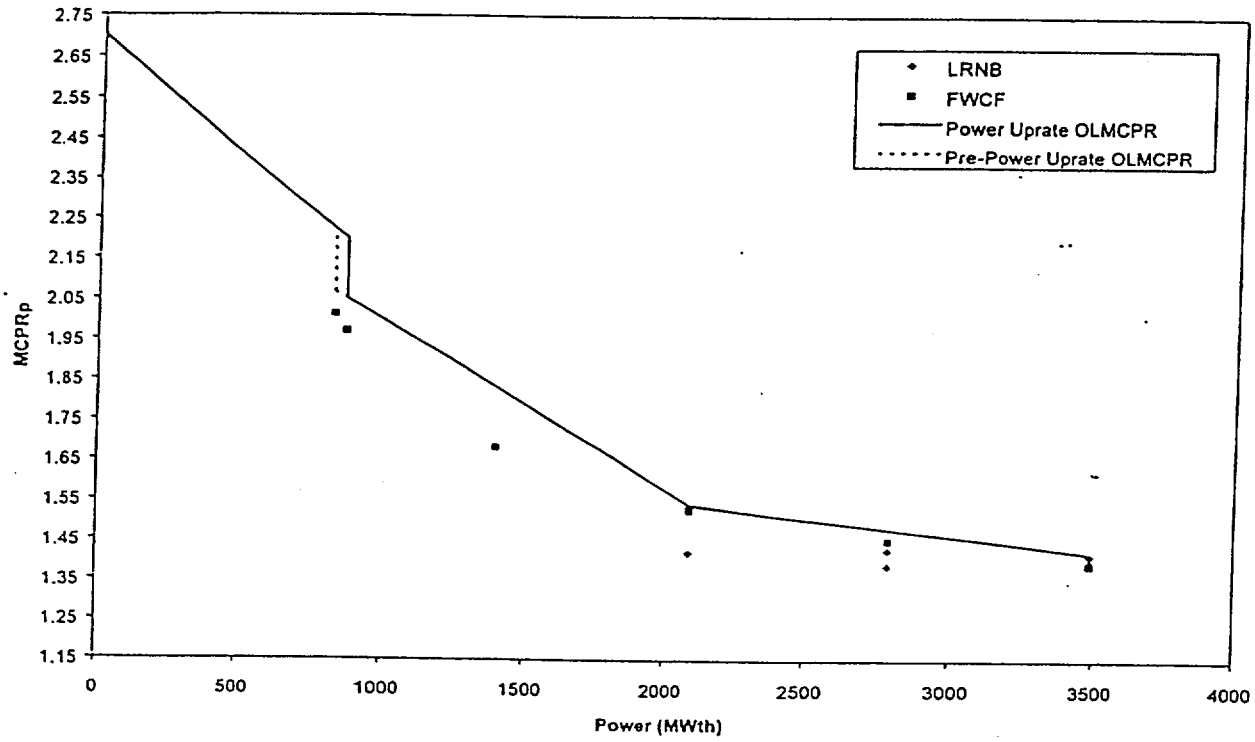
3323 MWth Rated Power		3489 MWth Rated Power	
Power (%)	$MCPR_P$ Limit	Power (%)	$MCPR_P$ Limit
100	1.46	100	1.45
84	1.51	80	1.51
63	1.56	60	1.56
25	2.07	25	2.05
25	2.22	25	2.20
0	2.70	0	2.70

Figure 3.11 EOC Base Case Power-Dependent MCPR Limits for ATRIUM-9B Fuel – TSSS Insertion Times



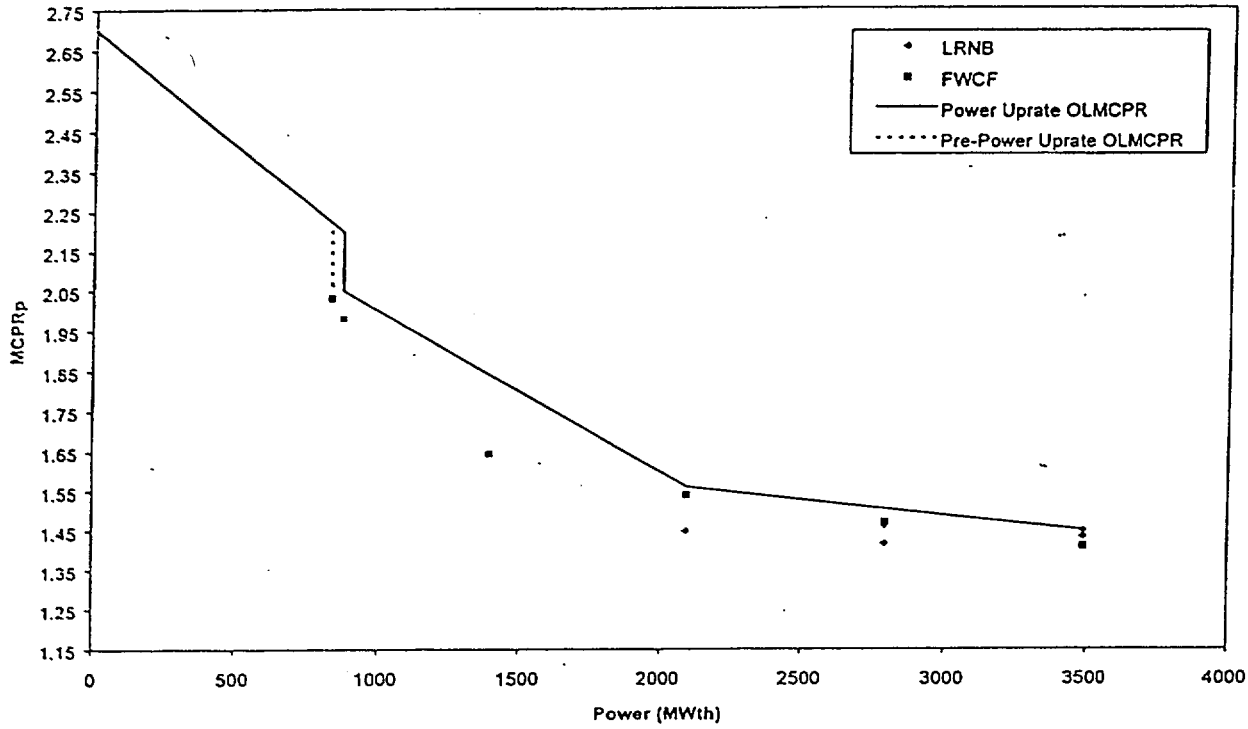
3323 MWth Rated Power		3489 MWth Rated Power	
Power (%)	$MCPR_p$ Limit	Power (%)	$MCPR_p$ Limit
100	1.50	100	1.49
84	1.53	80	1.53
63	1.57	60	1.57
25	2.12	25	2.10
25	2.22	25	2.20
0	2.70	0	2.70

Figure 3.12 EOC Base Case Power-Dependent MCPR Limits for GE9 Fuel – TSSS Insertion Times



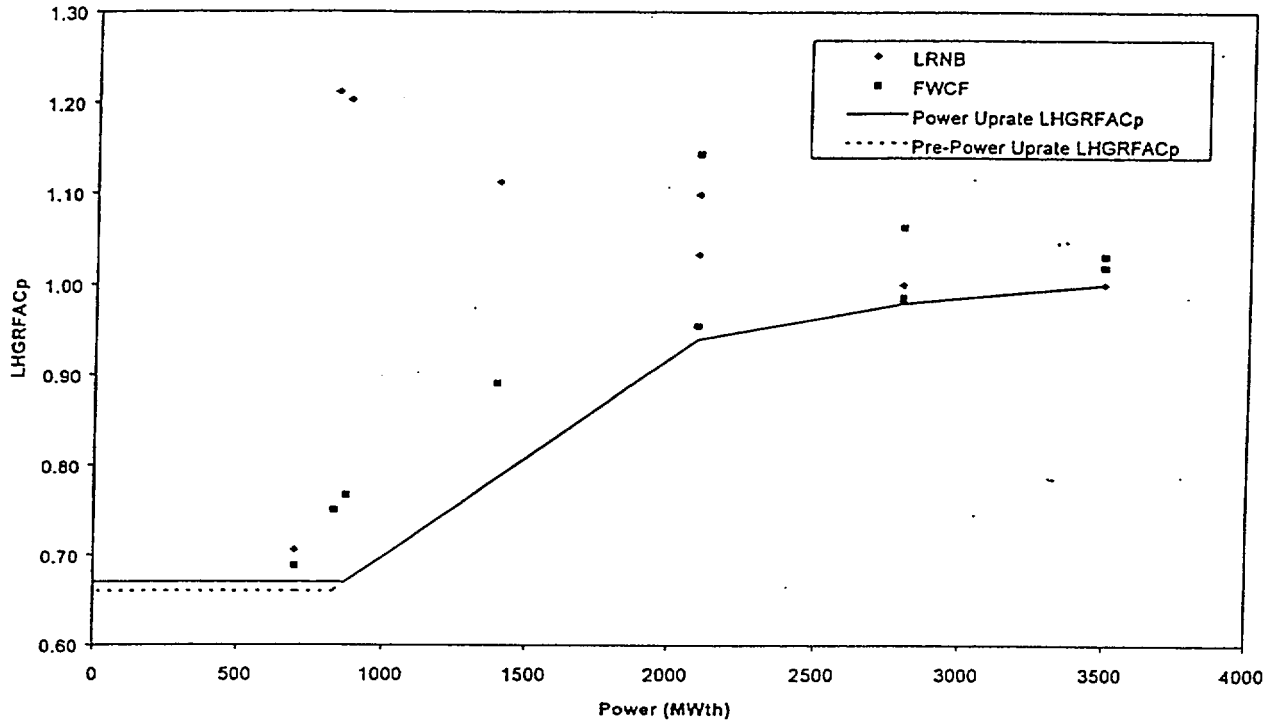
3323 MWth Rated Power		3489 MWth Rated Power	
Power (%)	$MCPR_p$ Limit	Power (%)	$MCPR_p$ Limit
100	1.43	100	1.42
84	1.48	80	1.48
63	1.54	60	1.54
25	2.07	25	2.05
25	2.22	25	2.20
0	2.70	0	2.70

Figure 3.13 EOC Base Case Power-Dependent MCPR Limits for ATRIUM-9B Fuel – NSS Insertion Times



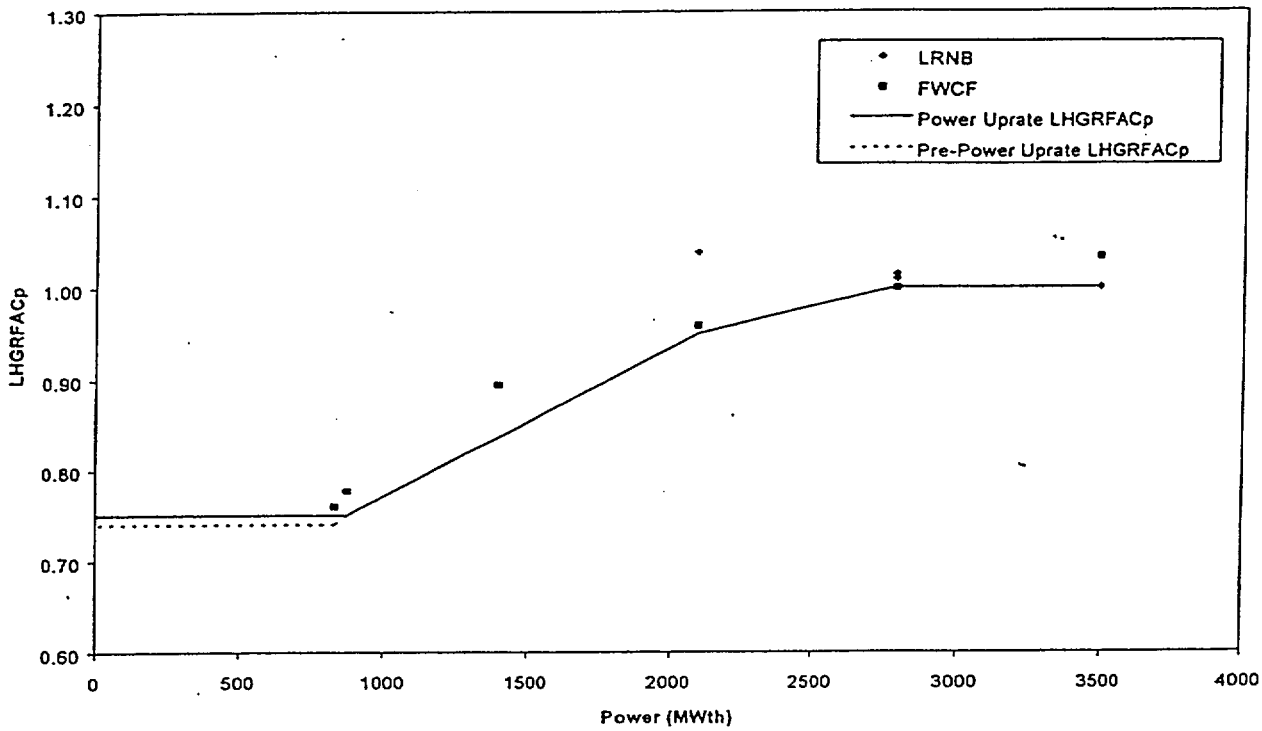
3323 MWth Rated Power		3489 MWth Rated Power	
Power (%)	$MCPR_p$ Limit	Power (%)	$MCPR_p$ Limit
100	1.46	100	1.45
84	1.51	80	1.51
63	1.56	60	1.56
25	2.07	25	2.05
25	2.22	25	2.20
0	2.70	0	2.70

Figure 3.14 EOC Base Case Power-Dependent MCPR Limits for GE9 Fuel – NSS Insertion Times



3323 MWth Rated Power		3489 MWth Rated Power	
Power (%)	$LHGRFAC_p$	Power (%)	$LHGRFAC_p$
100	0.99	100	1.00
84	0.98	80	0.98
63	0.94	60	0.94
25	0.66	25	0.67
25	0.66	25	0.67
0	0.66	0	0.67

Figure 3.15 EOC Base Case Power-Dependent LHGR Multipliers for ATRIUM-9B Fuel – TSSS Insertion Times



3323 MWth Rated Power		3489 MWth Rated Power	
Power (%)	LHGRFAC$_p$	Power (%)	LHGRFAC$_p$
100	1.00	100	1.00
84	1.00	80	1.00
63	0.95	60	0.95
25	0.74	25	0.75
25	0.74	25	0.75
0	0.74	0	0.75

Figure 3.16 EOC Base Case Power-Dependent LHGR Multipliers for ATRIUM-9B Fuel – NSS Insertion Times

Table 5.1 EOC Feedwater Heater Out-of-Service Analysis Results

Event	Power*/Flow (%rated/%rated)	ATRIUM-9B		GE9
		ΔCPR	$LHGRFAC_p$	ΔCPR
FWCF	100/105	0.311	1.000	0.329
FWCF	100/81	0.286	1.034	0.302
FWCF	80/105	0.376	0.968	0.390
FWCF	80/57.2	0.306	1.055	0.320
FWCF	60/105	0.482**	0.927**	0.472
FWCF	60/35.1	0.216	1.123	0.228
FWCF	40/105	0.698**	0.831**	0.677**
FWCF	25/105	1.142**	0.678**	1.156**
FWCF	23.81/105	1.209**	0.662**	1.216**

* Power presented relative to uprated power (3489 MWth).

** The analysis results presented are from an earlier cycle exposure. The ΔCPR and $LHGRFAC_p$ results are conservatively used to establish the thermal limits.

Table 5.2 Abnormal Recirculation Loop Startup Analysis Results

		ATRIUM-9B	
Power*/Flow (%rated/%rated)	FCV Position	ΔCPR**	$LHGRFAC_p$
33.33/47	27% open	1.40	0.425

* Power presented relative to uprated power (3489 MWth).

** ΔCPR results for ATRIUM-9B fuel are conservatively applicable for GE9 fuel.

Table 5.3 EOC Turbine Bypass Valves
Out-of-Service Analysis Results

		ATRIUM-9B		GE9
Event	Power*/Flow (%rated/%rated)	ΔCPR	$LHGRFAC_p$	ΔCPR
FWCF	100/105	0.359	0.968	0.392
FWCF	100/81	0.359	0.947	0.394
FWCF	80/105	0.418	0.942	0.449
FWCF	80/57.2	0.417	0.957	0.447
FWCF	60/105	0.499**	0.917	0.514
FWCF	60/35.1	0.327	1.032	0.332
FWCF	40/105	0.658**	0.859**	0.619
FWCF	25/105	0.962**	0.750**	0.952**
FWCF	23.81/105	1.004**	0.736**	1.002**

* Power presented relative to uprated power (3489 MWth).

** The analysis results presented are from an earlier cycle exposure. The ΔCPR and $LHGRFAC_p$ results are conservatively used to establish the thermal limits.

Table 5.4 EOC Recirculation Pump Trip
Out-of-Service Analysis Results

		ATRIUM-9B		GE9
Event	Power*/Flow (%rated/%rated)	ΔCPR	$LHGRFAC_P$	ΔCPR
LRNB	100/105	0.382	0.909	0.433
LRNB	100/81	0.371	0.868	0.430
LRNB	80/105	0.389	0.923	0.438
LRNB	80/57.2	0.391	0.899	0.439
FWCF	100/105	0.353	0.942	0.391
FWCF	100/81	0.308	0.948	0.349
FWCF	80/105	0.403	0.920	0.438
FWCF	80/57.2	0.295	1.003	0.327
FWCF	60/105	0.466	0.901	0.492
FWCF	60/35.1	0.190	1.120	0.193
FWCF	40/105	0.596**	0.857**	0.581
FWCF	25/105	0.858**	0.757**	0.861**
FWCF	23.81/105	0.896**	0.743**	0.910**

* Power presented relative to uprated power (3489 MWth)

** The analysis results presented are from an earlier cycle exposure. The ΔCPR and $LHGRFAC_P$ results are conservatively used to establish the thermal limits.

Table 5.5 EOC Turbine Control Valve
Slow Closure Analysis Results

Event	Slow Valve Characteristics	Power*/Flow (%rated/%rated)	ATRIUM-9B ΔCPR	ATRIUM-9B LHGRFAC$_p$	GE9 ΔCPR
LRNB	1 TCV closing at 2.0 sec	100/105**	0.420	0.902	0.461
LRNB	1 TCV closing at 2.7 sec	100/105**	0.419	0.899	0.461
LRNB	2 TCVs closing at 7.75 sec	100/105**	0.219	1.057	0.233
LRNB	1 TCV closing at 2.0 sec	100/81**	0.369	0.928	0.421
LRNB	2 TCVs closing at 7.75 sec	100/81**	0.199	1.107	0.223
LRNB	1 TCV closing at 2.0 sec	80/105**	0.432	0.911	0.466
LRNB	2 TCVs closing at 2.0 sec	80/105†	0.527	0.882	0.568
LRNB	2 TCVs closing at 7.75 sec	80/105**	0.293	1.014	0.314
LRNB	1 TCV closing at 2.0 sec	80/57.2**	0.504	0.911	0.548
LRNB	2 TCVs closing at 2.0 sec	80/57.2†	0.520	0.928	0.564
LRNB	2 TCVs closing at 7.75 sec, 2 TCVs closing at 2.7 sec	80/57.2**	0.277	1.115	0.305
LRNB	1 TCV closing at 2.0 sec	60/105**	0.432	0.932	0.461
LRNB	2 TCVs closing at 7.75 sec	60/105**	0.346	1.001	0.370
LRNB	1 TCV closing at 2.0 sec	60/35.1**	0.591	0.991	0.585
LRNB	1 TCV closing at 2.0 sec	40/105†	0.828‡	0.759‡	0.824
LRNB	1 TCV closing at 2.0 sec	25/105†	0.992‡	0.707‡	0.984‡
LRNB	1 TCV closing at 2.0 sec	23.81/105†	1.011‡	0.699‡	1.008‡
LRNB	2 TCVs closing at 7.75 sec	23.81/105†	0.977	0.721	0.954
LRNB w/ FHOOS	1 TCV closing at 2.0 sec	100/105**	0.363	0.944	0.396

* Power presented relative to uprated power (3489 MWth).

** Scram initiated by high neutron flux.

† Scram initiated by high dome pressure.

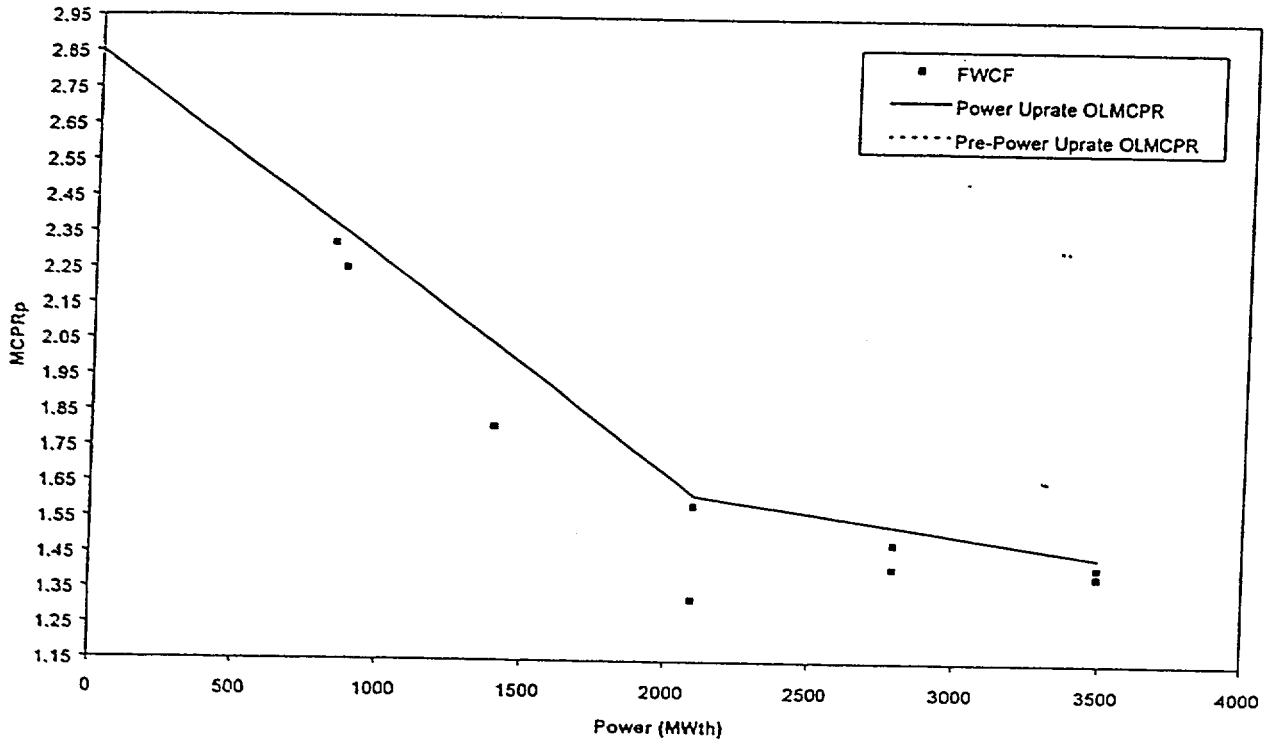
‡ The analysis results presented are from an earlier cycle exposure. The ΔCPR and LHGRFAC$_p$ results are conservatively used to establish the thermal limits.

Table 5.6 EOC Recirculation Pump Trip and Feedwater Heater Out-of-Service Analysis Results

		ATRIUM-9B		GE9
Event	Power*/Flow (%rated/%rated)	ΔCPR	$LHGRFAC_P$	ΔCPR
LRNB	100/105	0.332	0.954	0.375
LRNB	100/81	0.305	0.948	0.354
FWCF	100/105	0.358	0.933	0.391
FWCF	100/81	0.307	0.968	0.342
FWCF	80/105	0.419	0.911	0.448
FWCF	80/57.2	0.300	1.007	0.329
FWCF	60/105	0.508**	0.882	0.523
FWCF	60/35.1	0.212	1.104	0.226
FWCF	40/105	0.705**	0.804**	0.664
FWCF	25/105	1.073**	0.673**	1.092**
FWCF	23.81/105	1.125**	0.658**	1.146**

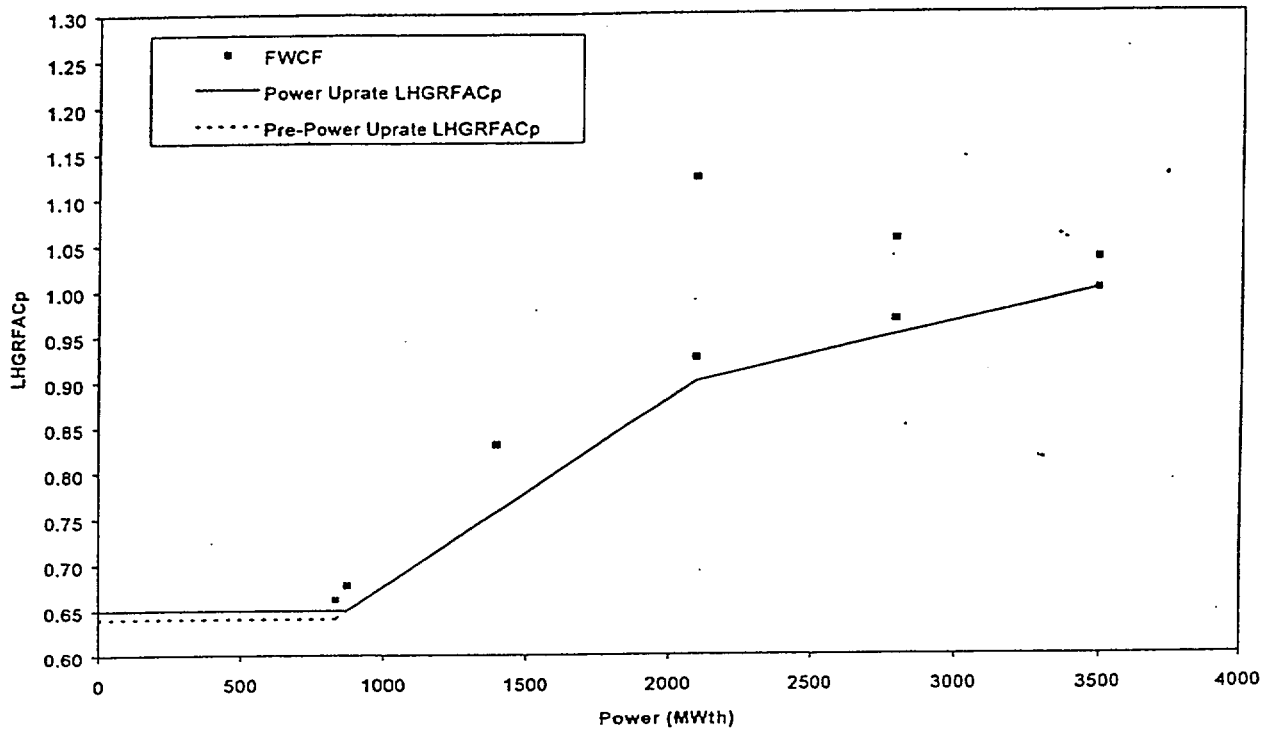
* Power presented relative to uprated power (3489 MWth).

** The analysis results presented are from an earlier cycle exposure. The ΔCPR and $LHGRFAC_P$ results are conservatively used to establish the thermal limits.



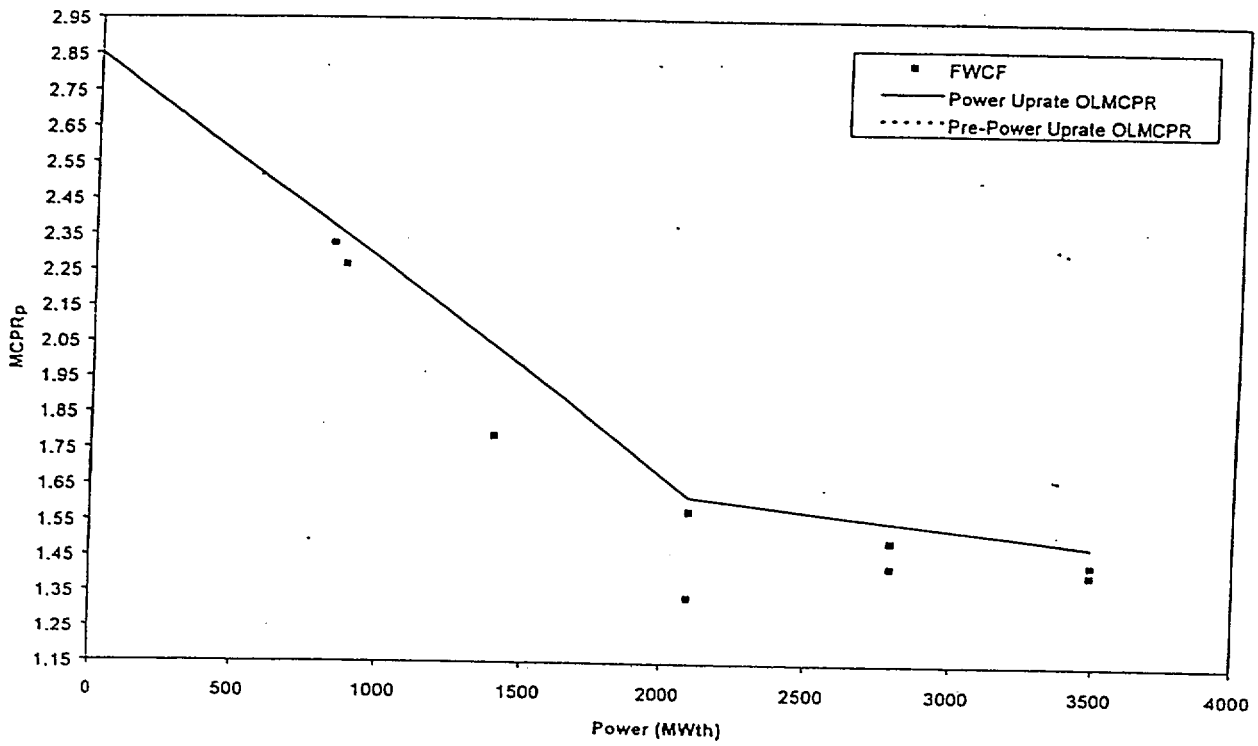
3323 MWth Rated Power		3489 MWth Rated Power	
Power (%)	$MCPR_p$ Limit	Power (%)	$MCPR_p$ Limit
100	1.47	100	1.45
63	1.62	60	1.62
25	2.38	25	2.35
25	2.38	25	2.35
0	2.85	0	2.85

Figure 5.1 EOC Feedwater Heaters Out-of-Service
Power-Dependent MCPR Limits for ATRIUM-9B Fuel



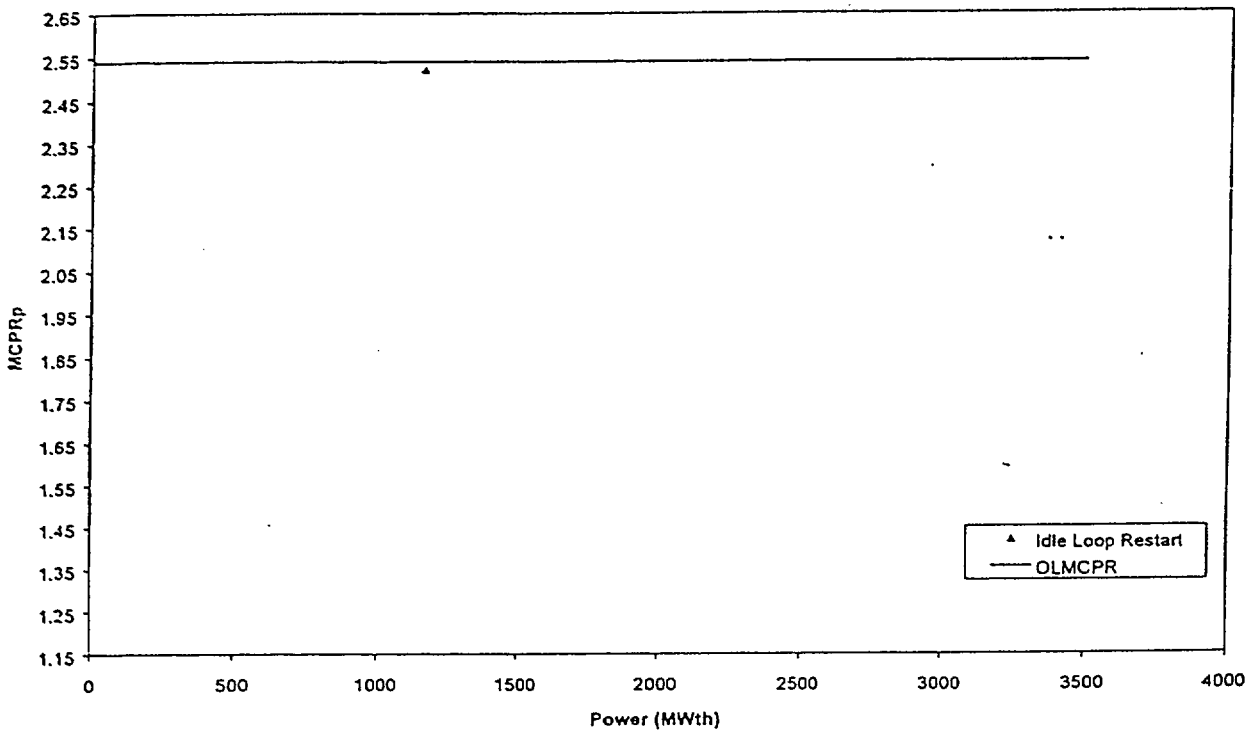
3323 MWth Rated Power		3489 MWth Rated Power	
Power (%)	LHGRFAC$_p$	Power (%)	LHGRFAC$_p$
100	0.99	100	1.00
63	0.90	60	0.90
25	0.64	25	0.65
25	0.64	25	0.65
0	0.64	0	0.65

Figure 5.2 EOC Feedwater Heaters Out-of-Service
Power-Dependent LHGR Multipliers for ATRIUM-9B Fuel



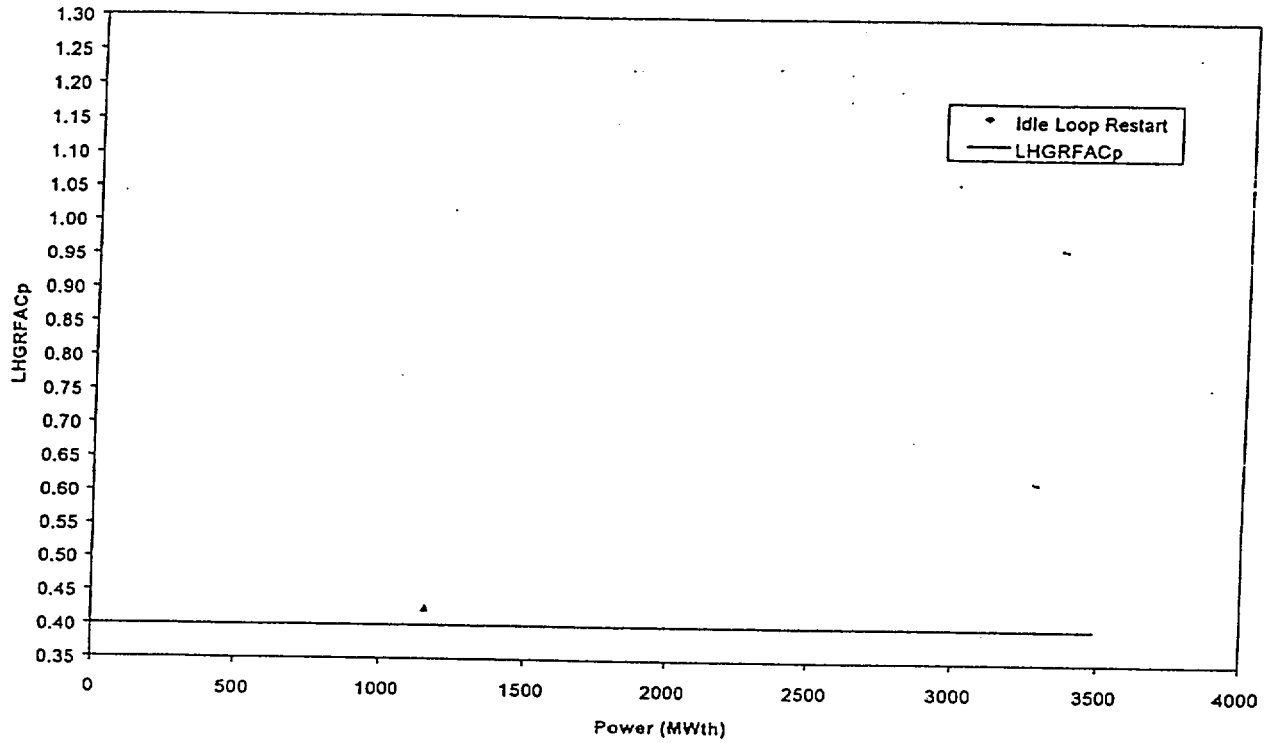
3323 MWth Rated Power		3489 MWth Rated Power	
Power (%)	$MCPR_p$ Limit	Power (%)	$MCPR_p$ Limit
100	1.51	100	1.49
63	1.62	60	1.62
25	2.38	25	2.35
25	2.38	25	2.35
0	2.85	0	2.85

Figure 5.3 EOC Feedwater Heaters Out-of-Service
Power-Dependent MCPR Limits for GE9 Fuel



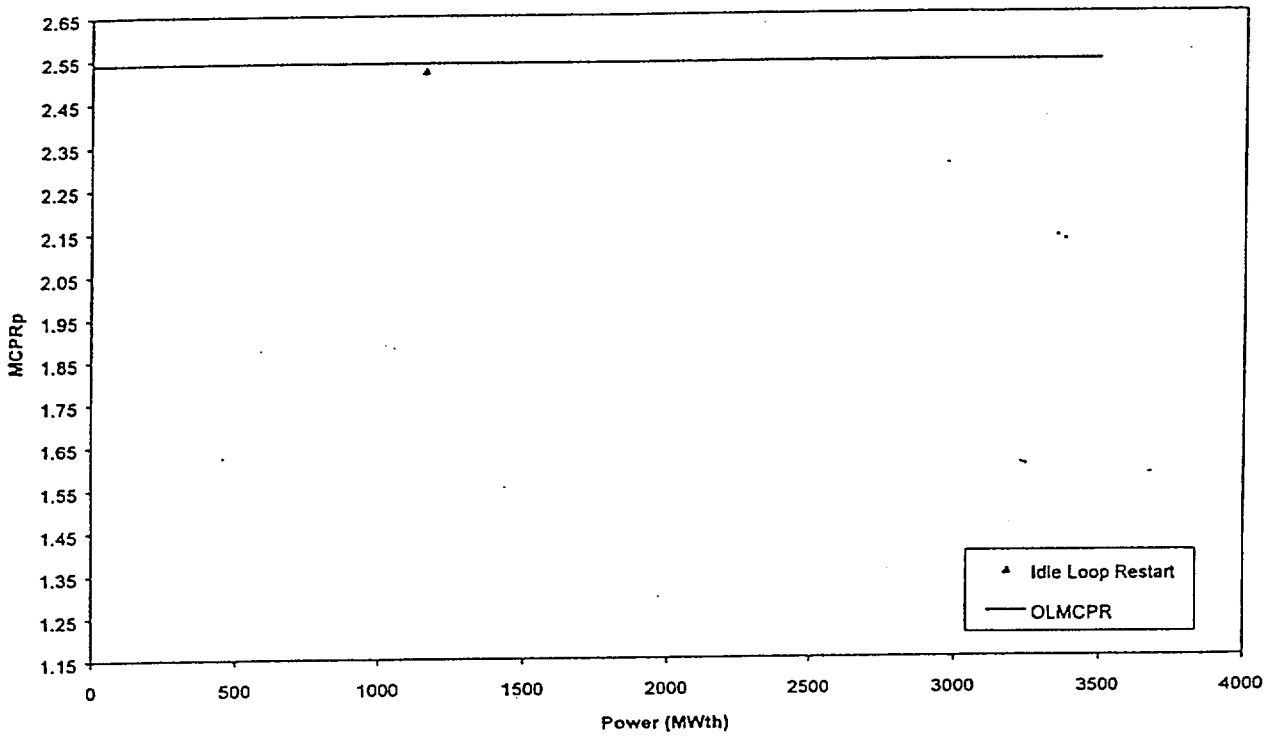
3323 MWth Rated Power		3489 MWth Rated Power	
Power (%)	$MCPR_p$ Limit	Power (%)	$MCPR_p$ Limit
100	2.54	100	2.54
63	2.54	60	2.54
25	2.54	25	2.54
25	2.54	25	2.54
0	2.54	0	2.54

Figure 5.4 Abnormal Idle Recirculation Loop Startup
Power-Dependent MCPR Limits for ATRIUM-9B Fuel



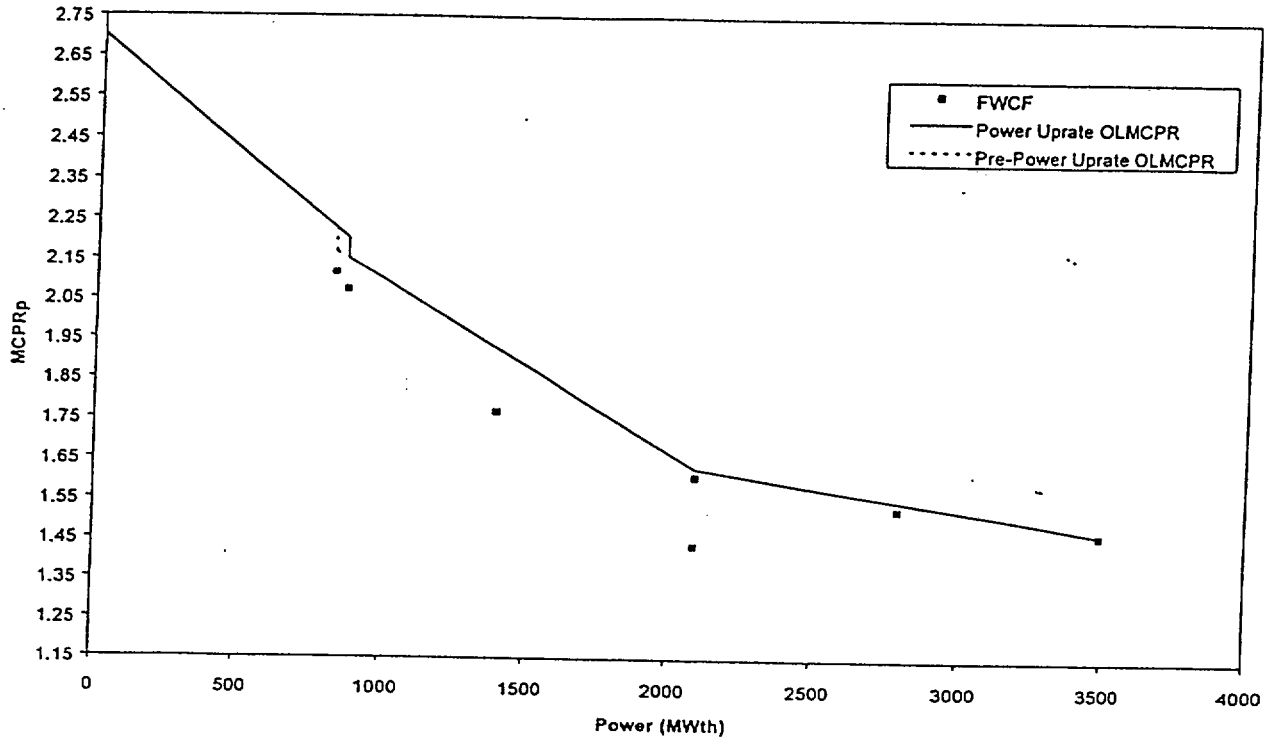
3323 MWth Rated Power		3489 MWth Rated Power	
Power (%)	LHGRFAC$_p$	Power (%)	LHGRFAC$_p$
100	0.40	100	0.40
63	0.40	60	0.40
25	0.40	25	0.40
25	0.40	25	0.40
0	0.40	0	0.40

Figure 5.5 Abnormal Idle Recirculation Loop Startup
Power-Dependent LHGR Multipliers for ATRIUM-9B Fuel



3323 MWth Rated Power		3489 MWth Rated Power	
Power (%)	$MCPR_p$ Limit	Power (%)	$MCPR_p$ Limit
100	2.54	100	2.54
63	2.54	60	2.54
25	2.54	25	2.54
25	2.54	25	2.54
0	2.54	0	2.54

Figure 5.6 Abnormal Idle Recirculation Loop Startup
Power-Dependent MCPR Limits for GE9 Fuel



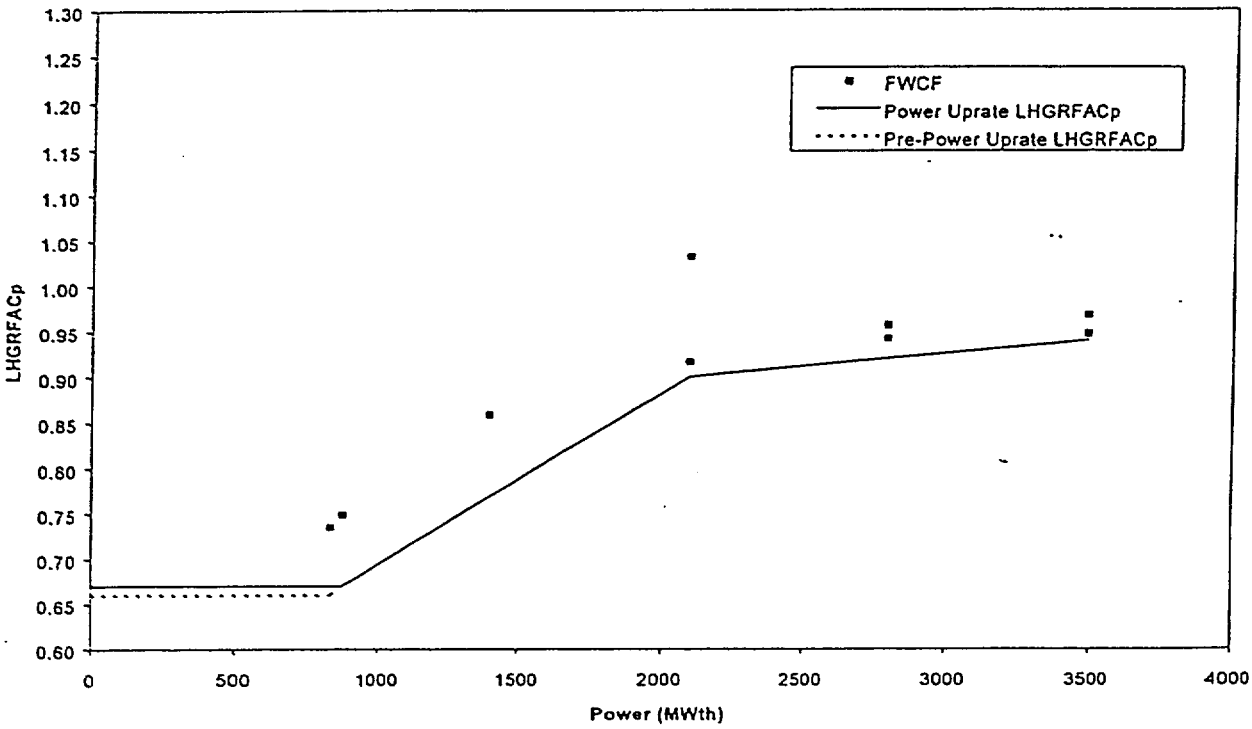
3323 MWth Rated Power

Power (%)	MCPR$_p$ Limit
100	1.49
63	1.63
25	2.17
25	2.22
0	2.70

3489 MWth Rated Power

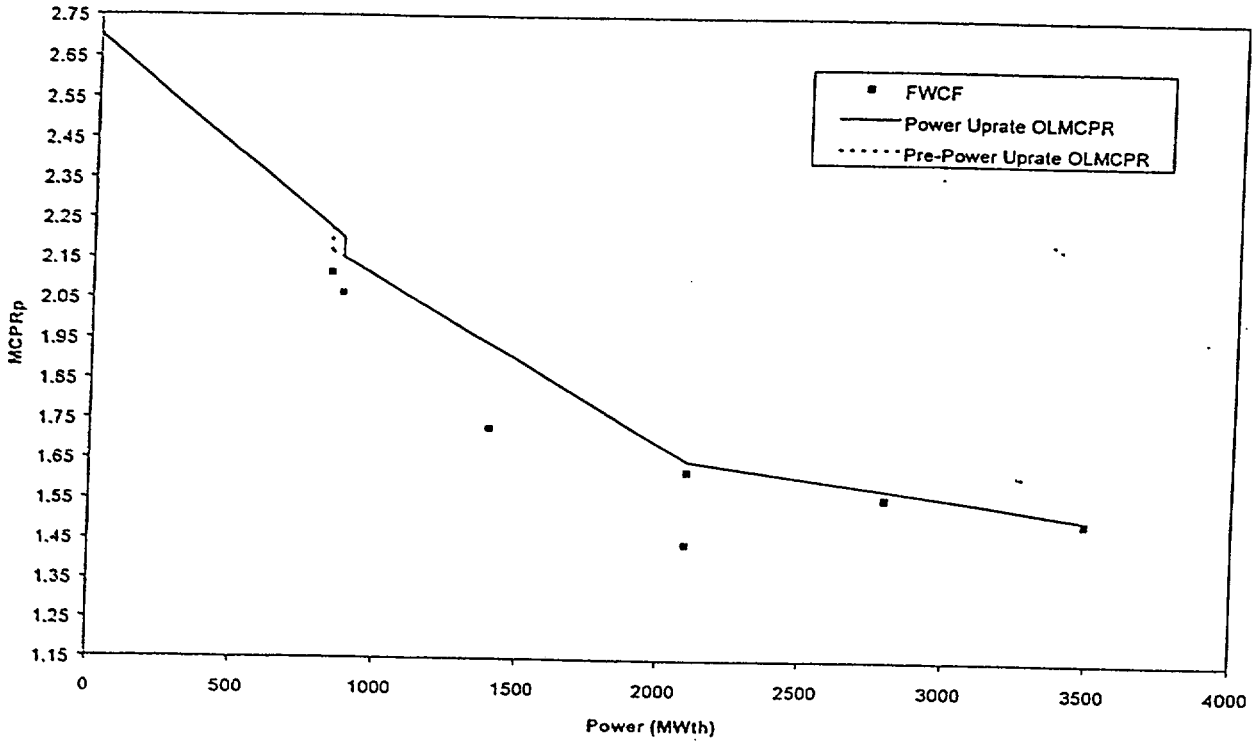
Power (%)	MCPR$_p$ Limit
100	1.47
60	1.63
25	2.15
25	2.20
0	2.70

Figure 5.7 EOC Turbine Bypass Valves Out-of-Service
Power-Dependent MCPR Limits for ATRIUM-9B Fuel



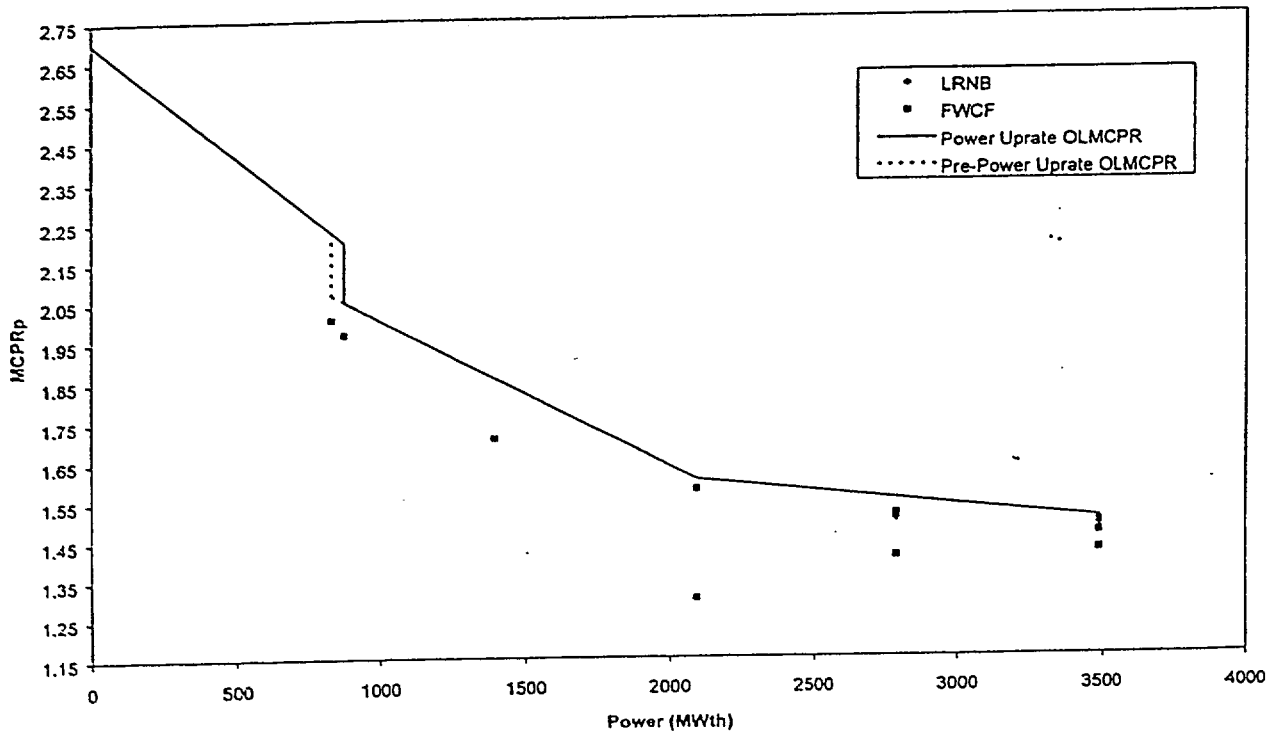
3323 MWth Rated Power		3489 MWth Rated Power	
Power (%)	LHGRFAC$_p$	Power (%)	LHGRFAC$_p$
100	0.94	100	0.94
63	0.90	60	0.90
25	0.66	25	0.67
25	0.66	25	0.67
0	0.66	0	0.67

Figure 5.8 EOC Turbine Bypass Valves Out-of-Service
Power-Dependent LHGR Multipliers for ATRIUM-9B Fuel



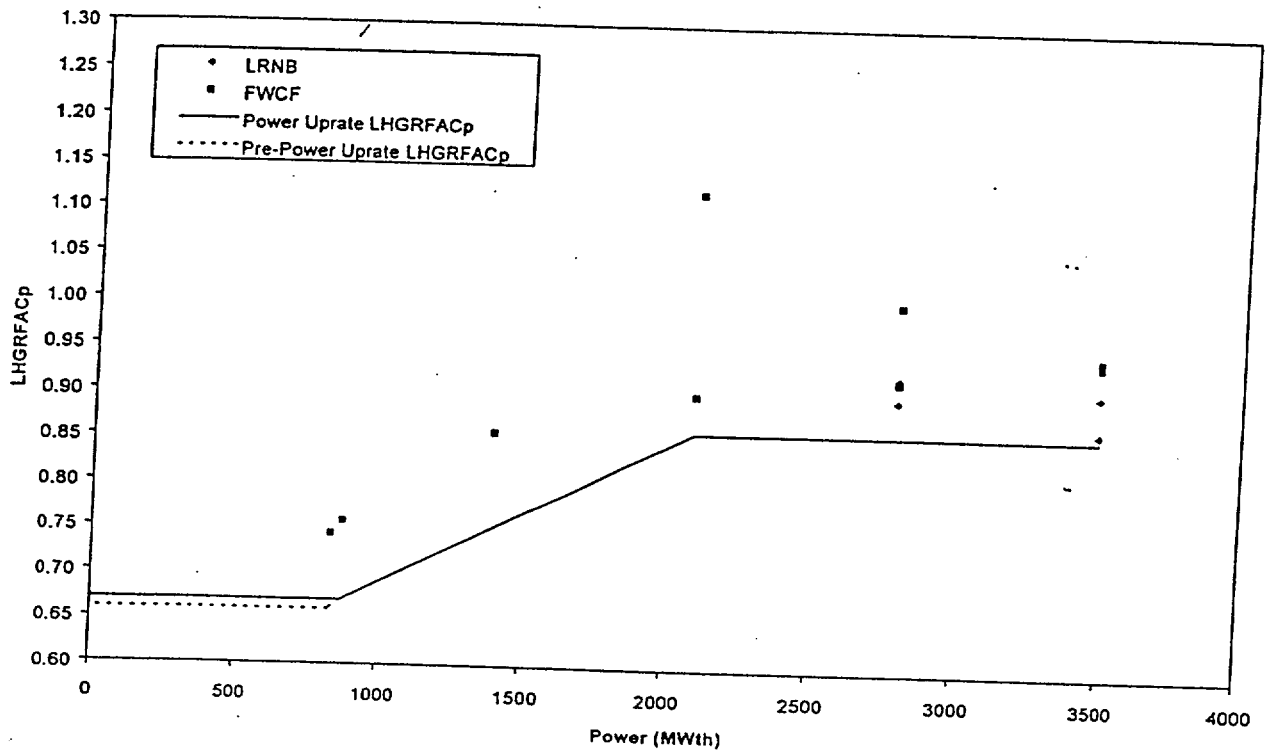
3323 MWth Rated Power		3489 MWth Rated Power	
Power (%)	$MCPR_p$ Limit	Power (%)	$MCPR_p$ Limit
100	1.53	100	1.51
63	1.65	60	1.65
25	2.17	25	2.15
25	2.22	25	2.20
0	2.70	0	2.70

Figure 5.9 EOC Turbine Bypass Valves Out-of-Service
Power-Dependent MCPR Limits for GE9 Fuel



3323 MWth Rated Power		3489 MWth Rated Power	
Power (%)	$MCPR_p$ Limit	Power (%)	$MCPR_p$ Limit
100	1.51	100	1.50
63	1.60	60	1.60
25	2.07	25	2.05
25	2.22	25	2.20
0	2.70	0	2.70

Figure 5.10 EOC Recirculation Pump Trip Out-of-Service Power-Dependent MCPR Limits for ATRIUM-9B Fuel



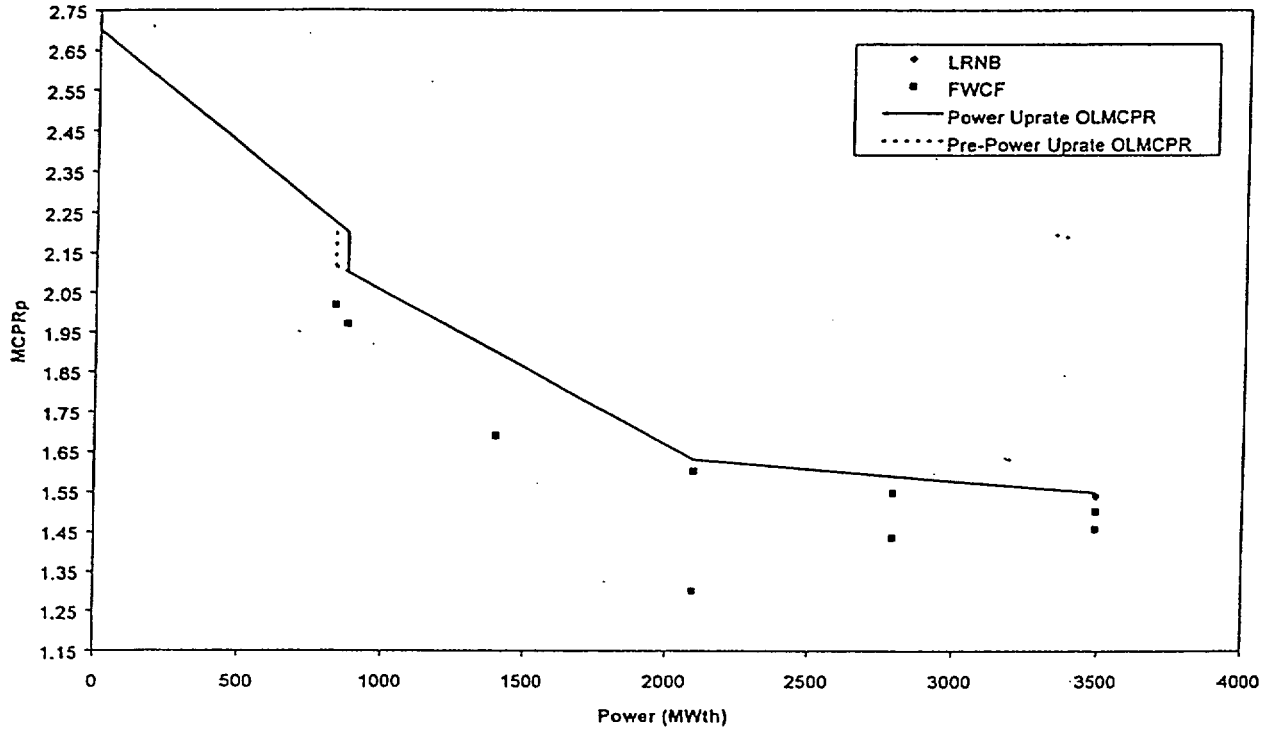
3323 MWth Rated Power

Power (%)	LHGRFAC$_p$
100	0.86
63	0.86
25	0.66
25	0.66
0	0.66

3489 MWth Rated Power

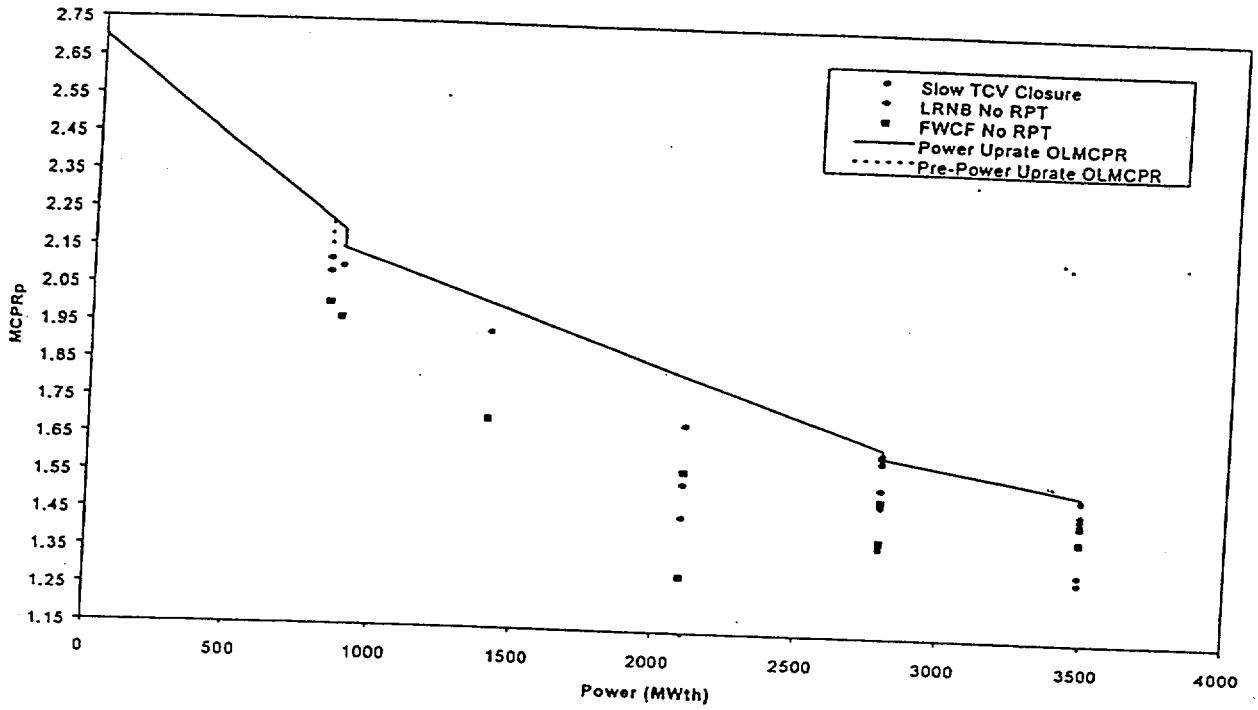
Power (%)	LHGRFAC$_p$
100	0.86
60	0.86
25	0.67
25	0.67
0	0.67

Figure 5.11 EOC Recirculation Pump Trip Out-of-Service Power-Dependent LHGR Multipliers for ATRIUM-9B Fuel



3323 MWth Rated Power		3489 MWth Rated Power	
Power (%)	$MCPR_p$ Limit	Power (%)	$MCPR_p$ Limit
100	1.56	100	1.55
63	1.63	60	1.63
25	2.12	25	2.10
25	2.22	25	2.20
0	2.70	0	2.70

Figure 5.12 EOC Recirculation Pump Trip Out-of-Service Power-Dependent MCPR Limits for GE9 Fuel



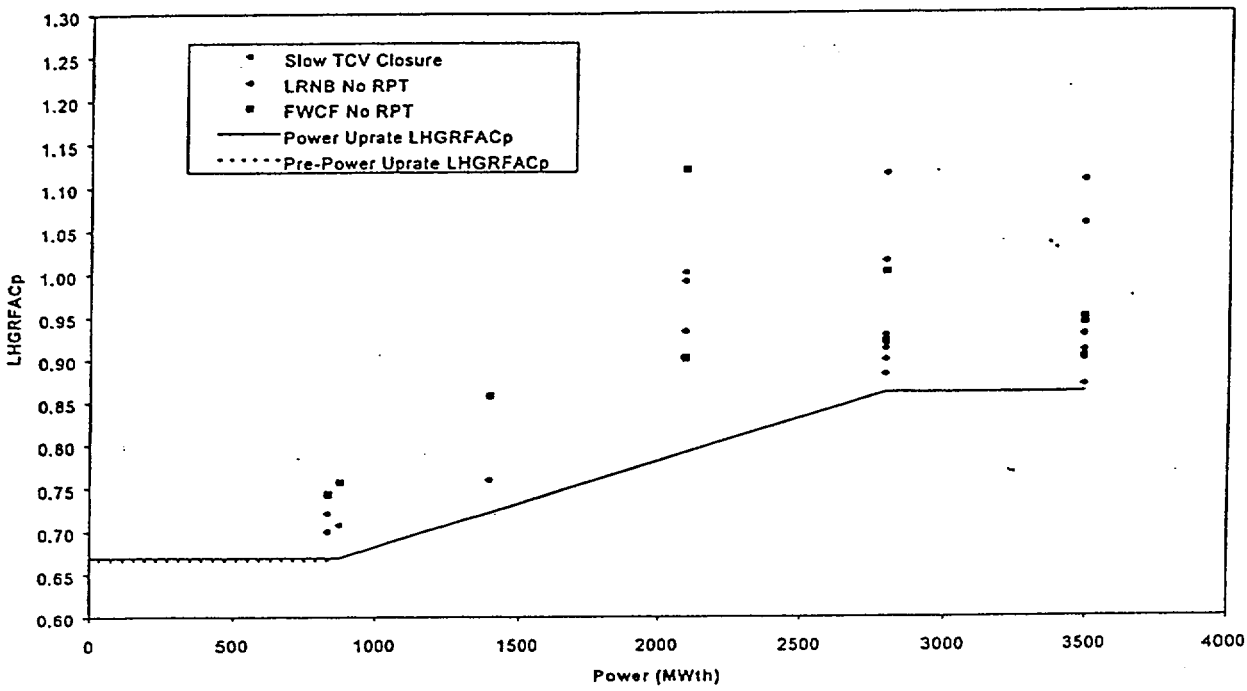
3323 MWth Rated Power

Power (%)	$MCPR_p$ Limit
100	1.56
84	1.63
84	1.65
25	2.16
25	2.22
0	2.70

3489 MWth Rated Power

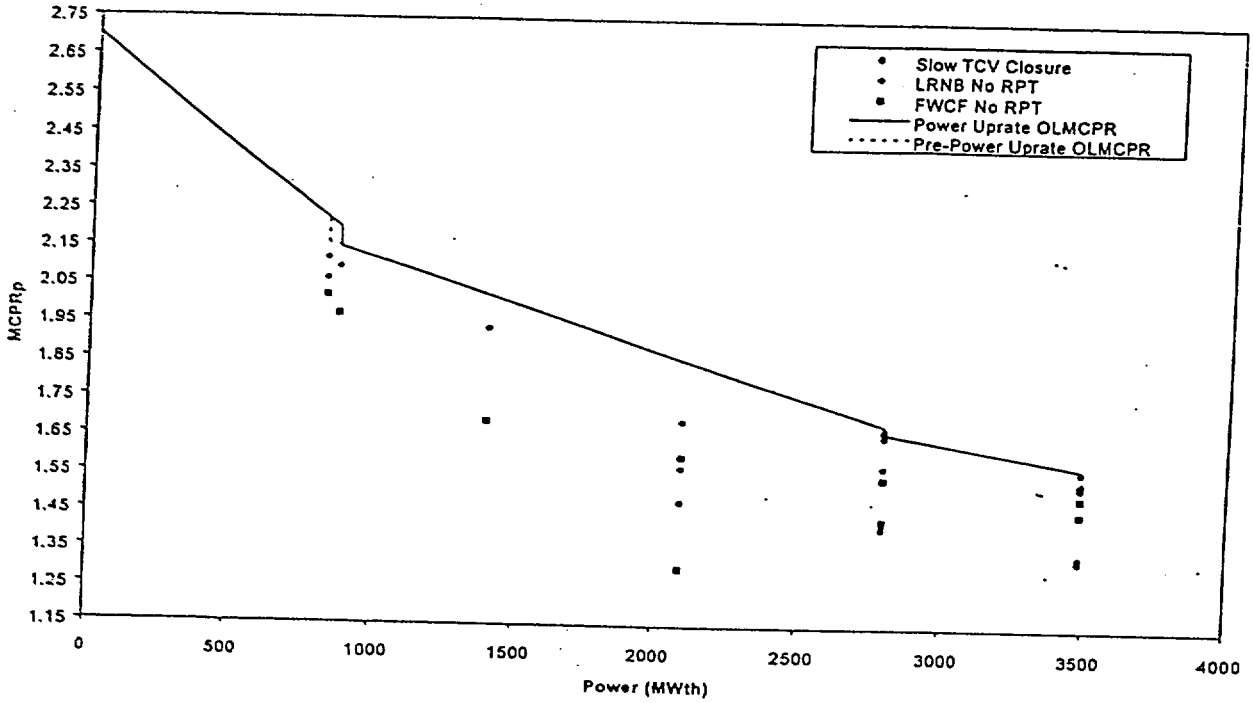
Power (%)	$MCPR_p$ Limit
100	1.54
80	1.63
80	1.65
25	2.15
25	2.20
0	2.70

Figure 5.13 EOC Turbine Control Valve Slow Closure and/or Recirculation Pump Trip Out-of-Service Power-Dependent MCPR Limits for ATRIUM-9B Fuel



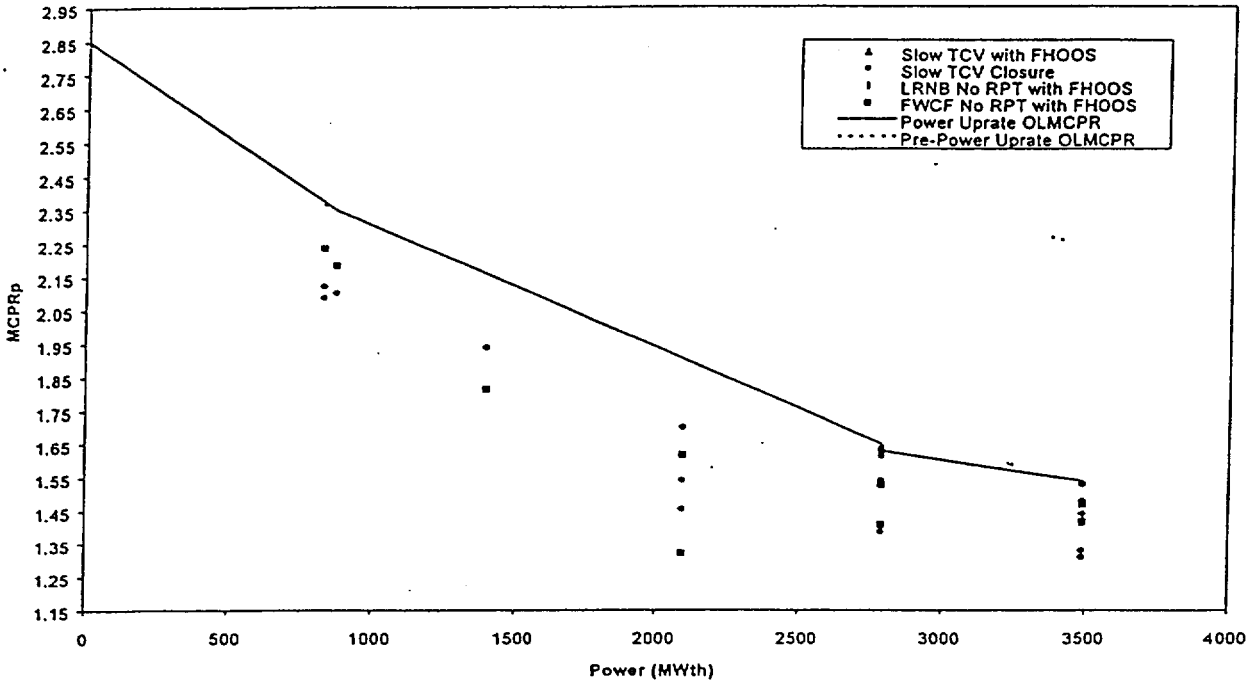
3323 MWth Rated Power		3489 MWth Rated Power	
Power (%)	LHGRFAC$_p$	Power (%)	LHGRFAC$_p$
100	0.86	100	0.86
84	0.86	80	0.86
84	0.86	80	0.86
25	0.66	25	0.67
25	0.66	25	0.67
0	0.66	0	0.67

Figure 5.14 EOC Turbine Control Valve Slow Closure and/or Recirculation Pump Trip Out-of-Service Power-Dependent LHGR Multipliers for ATRIUM-9B Fuel



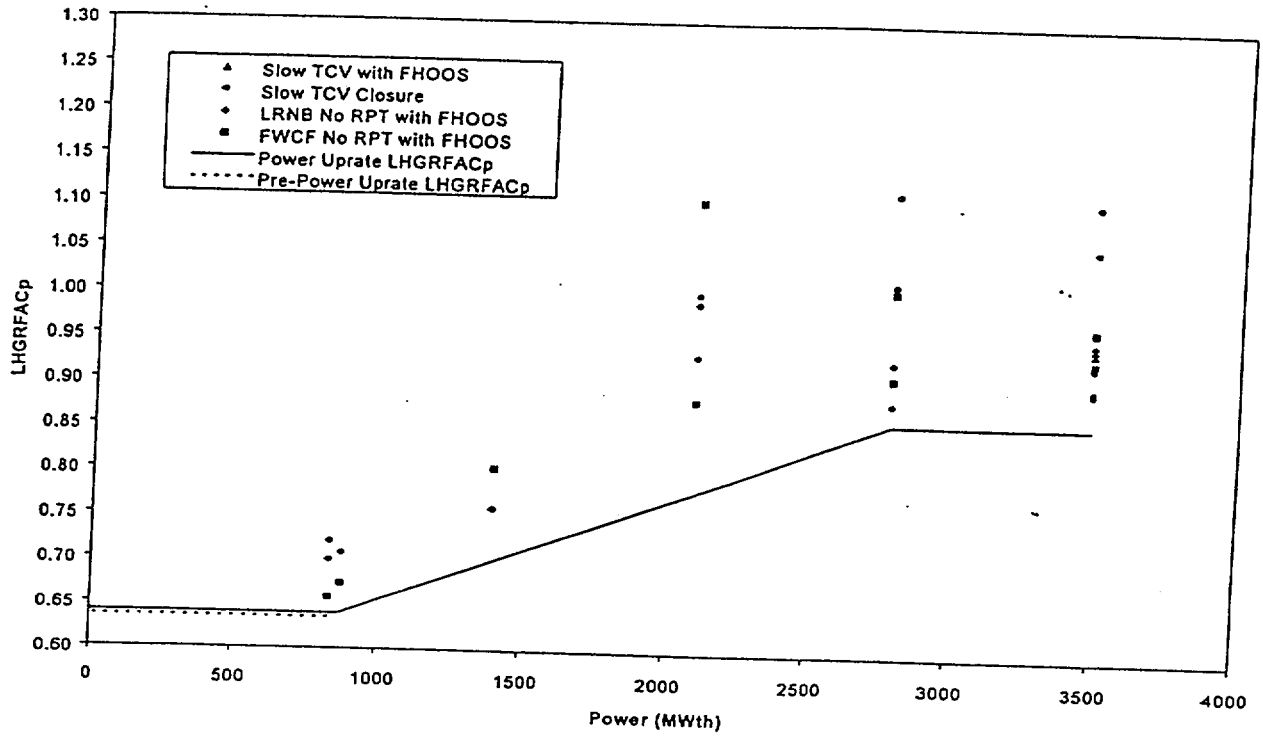
3323 MWth Rated Power		3489 MWth Rated Power	
Power (%)	$MCPR_p$ Limit	Power (%)	$MCPR_p$ Limit
100	1.60	100	1.58
84	1.67	80	1.67
84	1.69	80	1.69
25	2.16	25	2.15
25	2.22	25	2.20
0	2.70	0	2.70

Figure 5.15 EOC Turbine Control Valve Slow Closure and/or Recirculation Pump Trip Out-of-Service Power-Dependent MCPR Limits for GE9 Fuel



3323 MWth Rated Power		3489 MWth Rated Power	
Power (%)	$MCPR_p$ Limit	Power (%)	$MCPR_p$ Limit
100	1.56	100	1.54
84	1.63	80	1.63
84	1.65	80	1.65
25	2.38	25	2.35
25	2.38	25	2.35
0	2.85	0	2.85

Figure 5.16 EOC Turbine Control Valve Slow Closure and/or Recirculation Pump Trip and Feedwater Heaters Out-of-Service Power-Dependent MCPR Limits for ATRIUM-9B Fuel



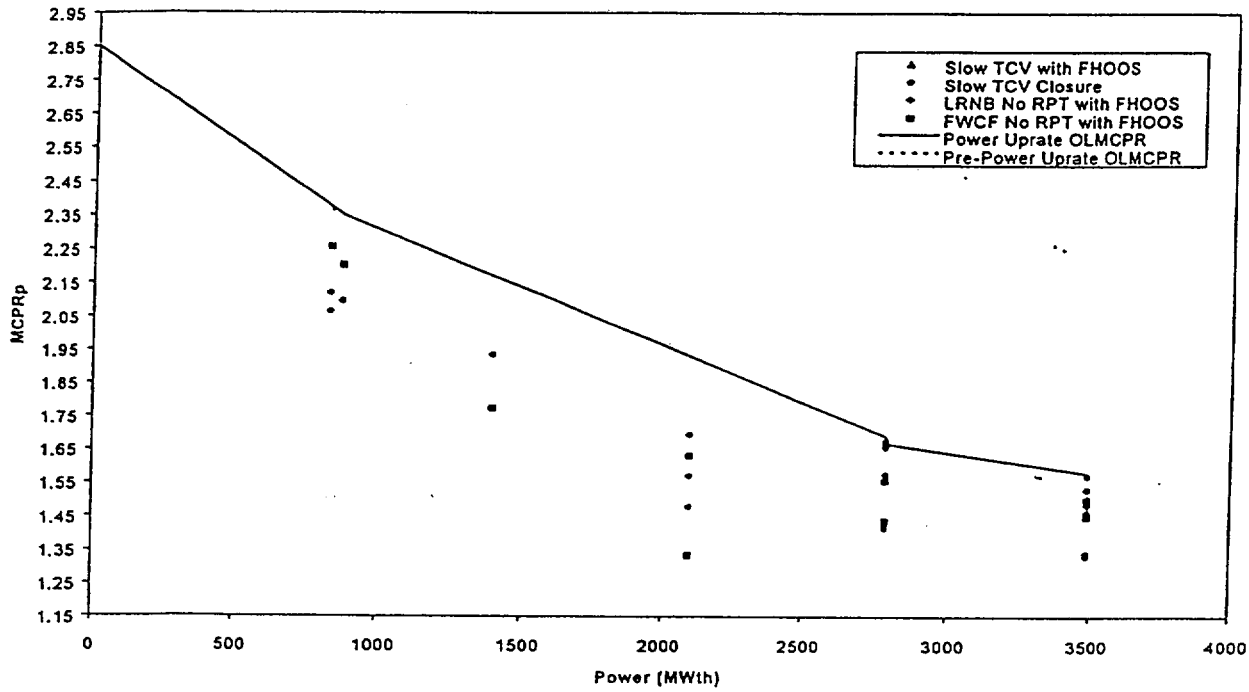
3323 MWth Rated Power

Power (%)	LHGRFAC$_p$
100	0.86
84	0.86
84	0.86
25	0.63
25	0.63
0	0.63

3489 MWth Rated Power

Power (%)	LHGRFAC$_p$
100	0.86
80	0.86
80	0.86
25	0.64
25	0.64
0	0.64

Figure 5.17 EOC Turbine Control Valve Slow Closure and/or Recirculation Pump Trip and Feedwater Heaters Out-of-Service Power-Dependent LHGR Multipliers for ATRIUM-9B Fuel



3323 MWth Rated Power		3489 MWth Rated Power	
Power (%)	$MCPR_p$ Limit	Power (%)	$MCPR_p$ Limit
100	1.60	100	1.58
84	1.67	80	1.67
84	1.69	80	1.69
25	2.38	25	2.35
25	2.38	25	2.35
0	2.85	0	2.85

Figure 5.18 EOC Turbine Control Valve Slow Closure and/or Recirculation Pump Trip and Feedwater Heaters Out-of-Service Power-Dependent MCPR Limits for GE9 Fuel

Table 7.1 ASME Overpressurization Analysis Results
102%P/105%F

Event	Peak Neutron Flux (%rated)	Peak Heat Flux (%rated)	Maximum Vessel Pressure Lower Plenum (psig)	Maximum Dome Pressure (psig)
MSIV	425.43	135.28	1320.26	1291.12
TCV	708.96	142.84	1318.41	1287.56
TSV	710.29	142.85	1318.41	1287.55

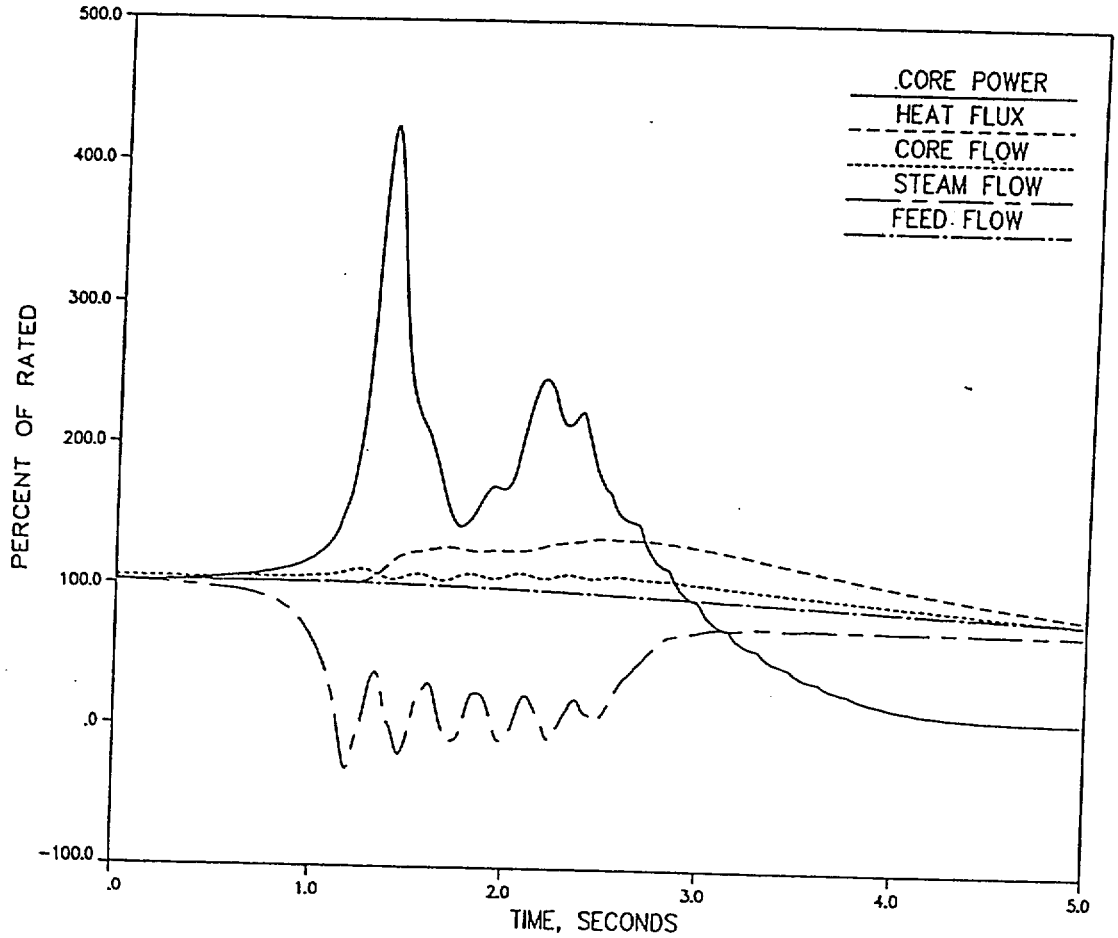


Figure 7.1 Overpressurization Event at 102/105 - MSIV Closure Key Parameters

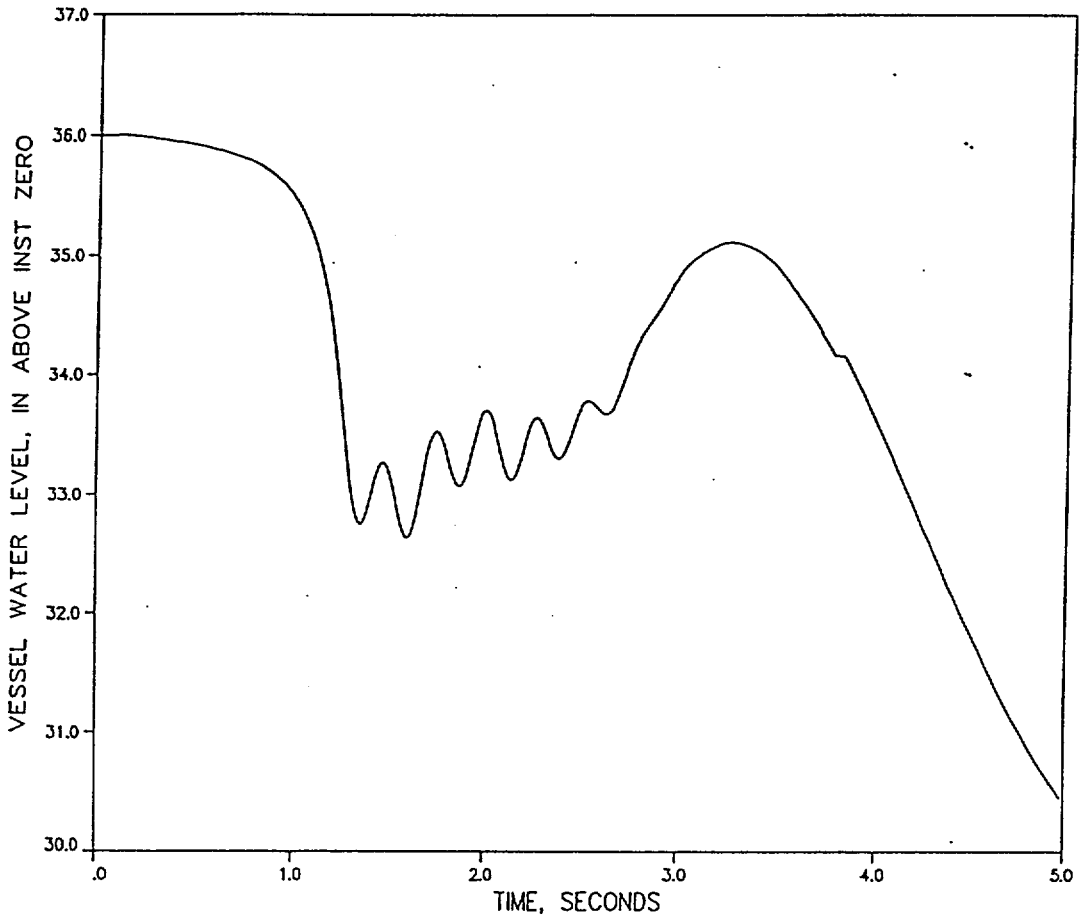


Figure 7.2 Overpressurization Event at 102/105 - MSIV Closure Vessel Water Level

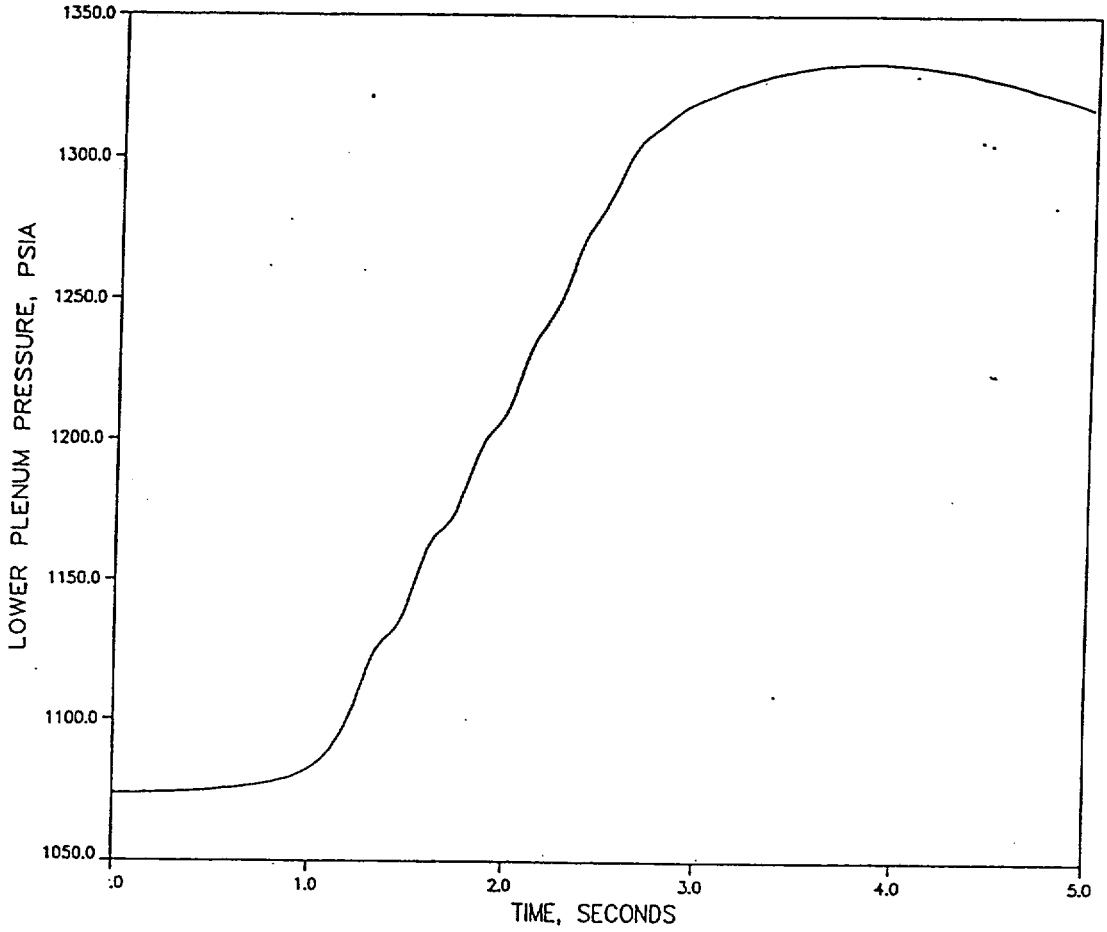


Figure 7.3 Overpressurization Event at 102/105 - MSIV Closure Lower Plenum Pressure

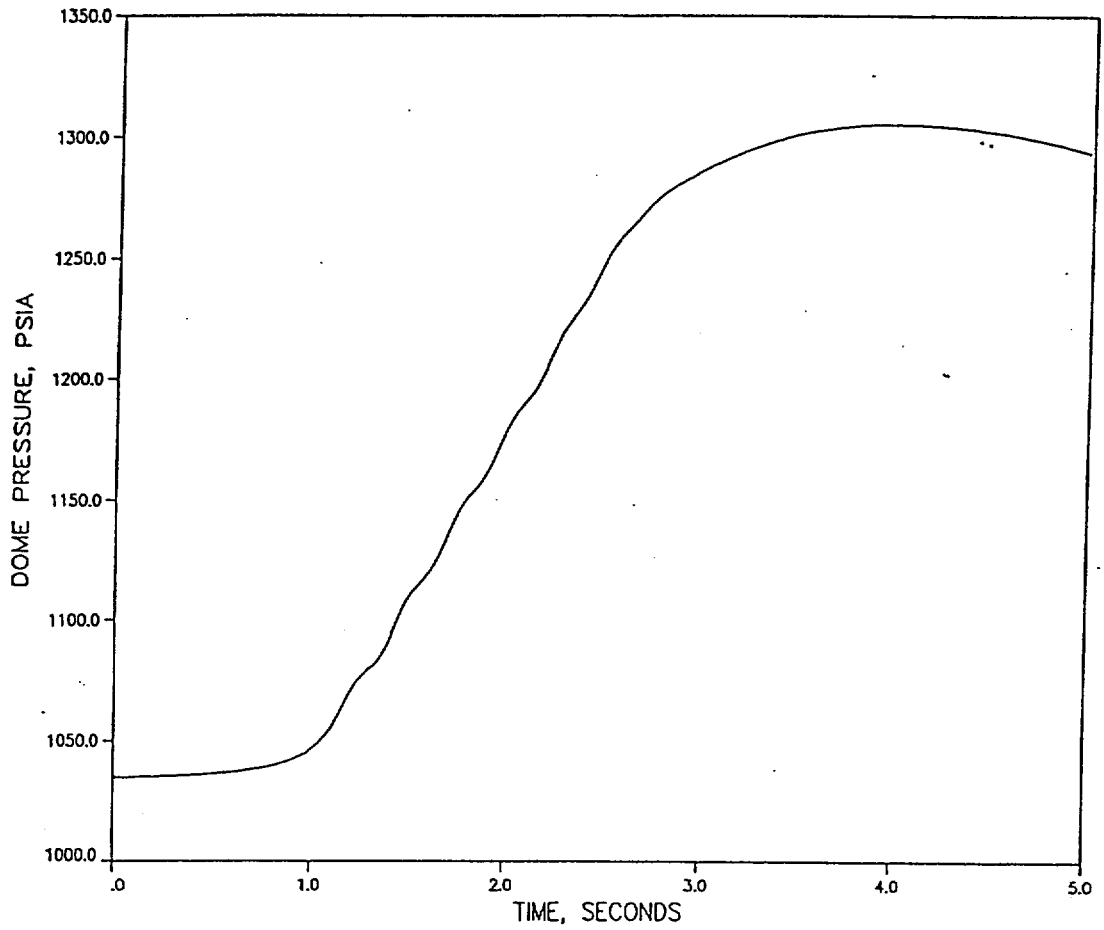


Figure 7.4 Overpressurization Event at 102/105 - MSIV Closure Dome Pressure

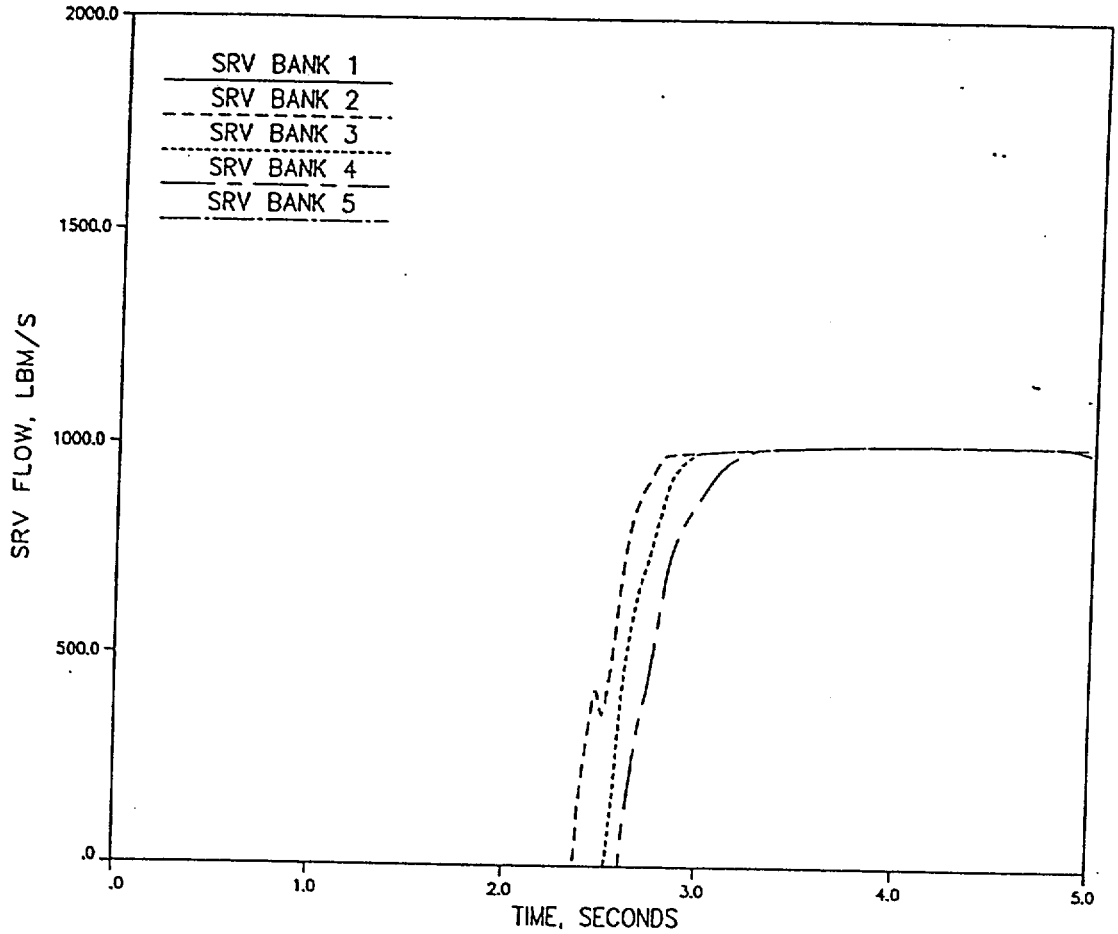


Figure 7.5 Overpressurization Event at 102/105 - MSIV Closure Safety/Relief Valve Flow Rates

Attachment 4

ARTS Improvement Program Analysis, Supplement 1 (Excerpts)

TOP/MOP and $MAPFAC_P$ Requirements

Limiting AOO	Power	Equipment Out of Service	TOP	MOP	Calculated $MAPFAC_P$	Generic $MAPFAC_P$
LRNBP	100	No EOOS	24.9	25.2	1.0	1.0
LRNBP	100	RPT OOS	30.3	30.6	1.0	1.0
FWCF	100	TBV OOS	28.7	30.0	1.0	1.0
FWCF	25	No EOOS	50.1	52.0	0.83	0.61
FWCF	25	RPT OOS	57.1	59.0	0.83	0.61
FWCF	25	TBV OOS	62.7	64.5	0.79	0.61

(a) Based on the GE9/10 LHGR Improvement Report, the MAPFACs are applied to LHGR (Reference 24)

Attachment 5

TCV Slow Closure Analysis (Excerpts)

Table 4. - TOP and MOP Values for the Off-rated Transient Events

	LRNBP, One TCV Slow Closure at 50%/s, 3 TCV Fast Closure	LRNBP, All TCV Slow Closure at 19%/s
Calculated TOP	26.17	49.27
Calculated MOP	26.17	55.30
Adjusted MOP		60.83
Required MOP		38.0
Required MAPFAC		0.62
Limiting MACFAC		0.60 (a)

Note : (a) Based on Figure 3.2-2 in COLR.

(b) Based on the GE9/10 LHGR Improvement Report, the MAPFACs are applied to LHGR (Reference 24)

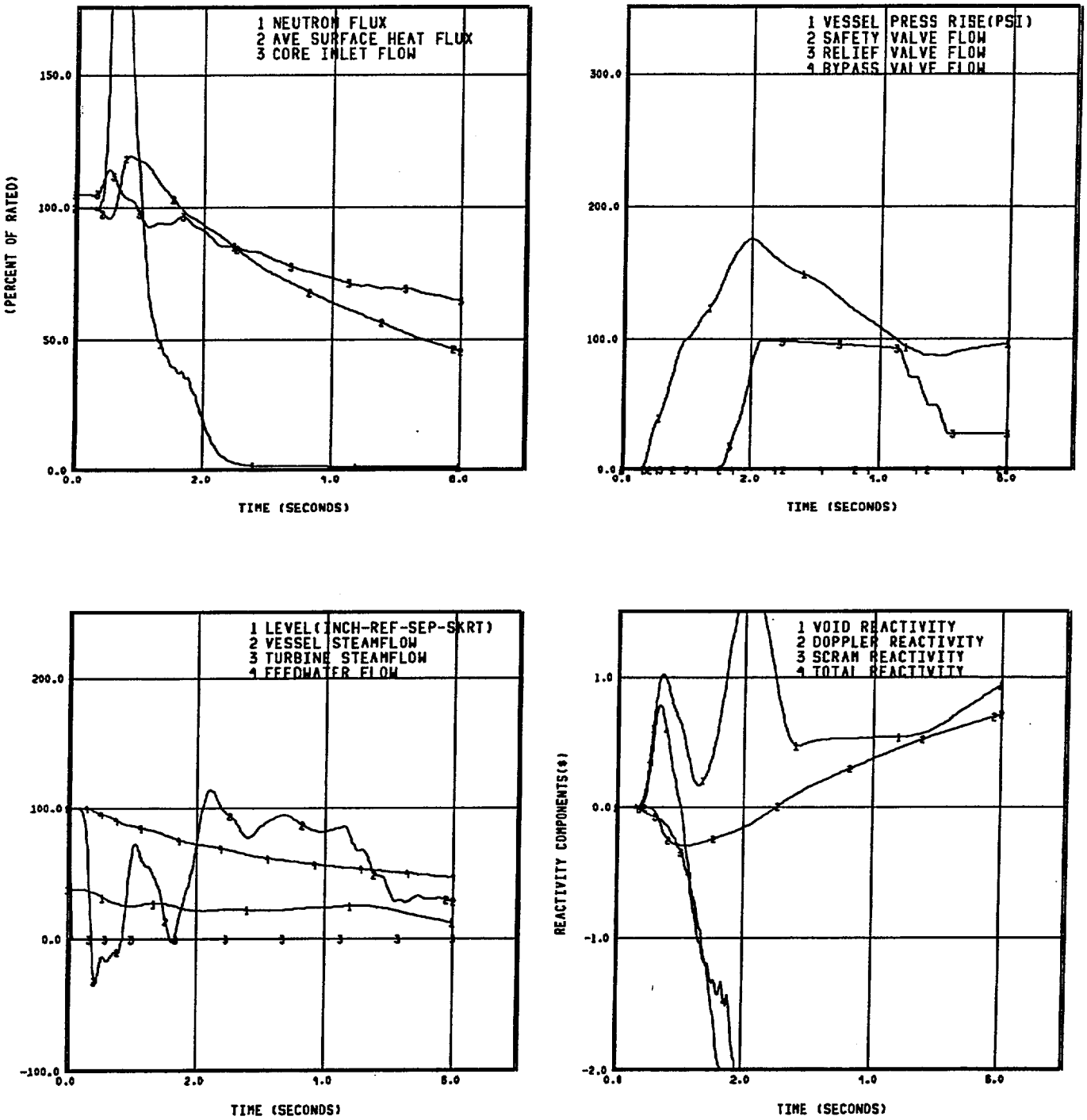


Figure 1. LRNBP from Rated Power, All TCV Fast Closure, Direct Scram, EOC-RPT

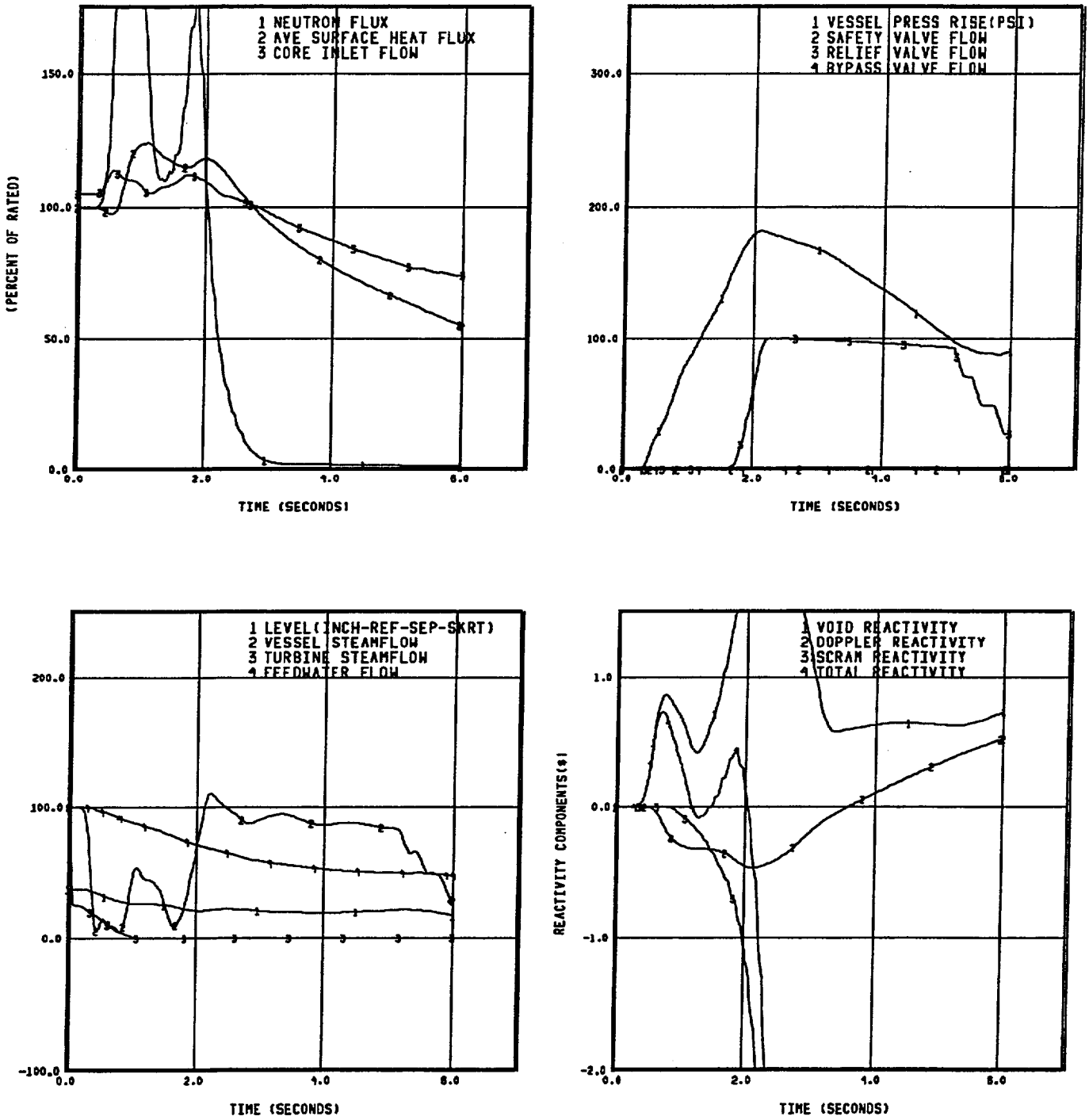


Figure 2. LRNBP from Rated Power, One TCV Slow Closure(50%/second)/Three TCV Fast Closure, Flux Scram, EOC-RPT OOS

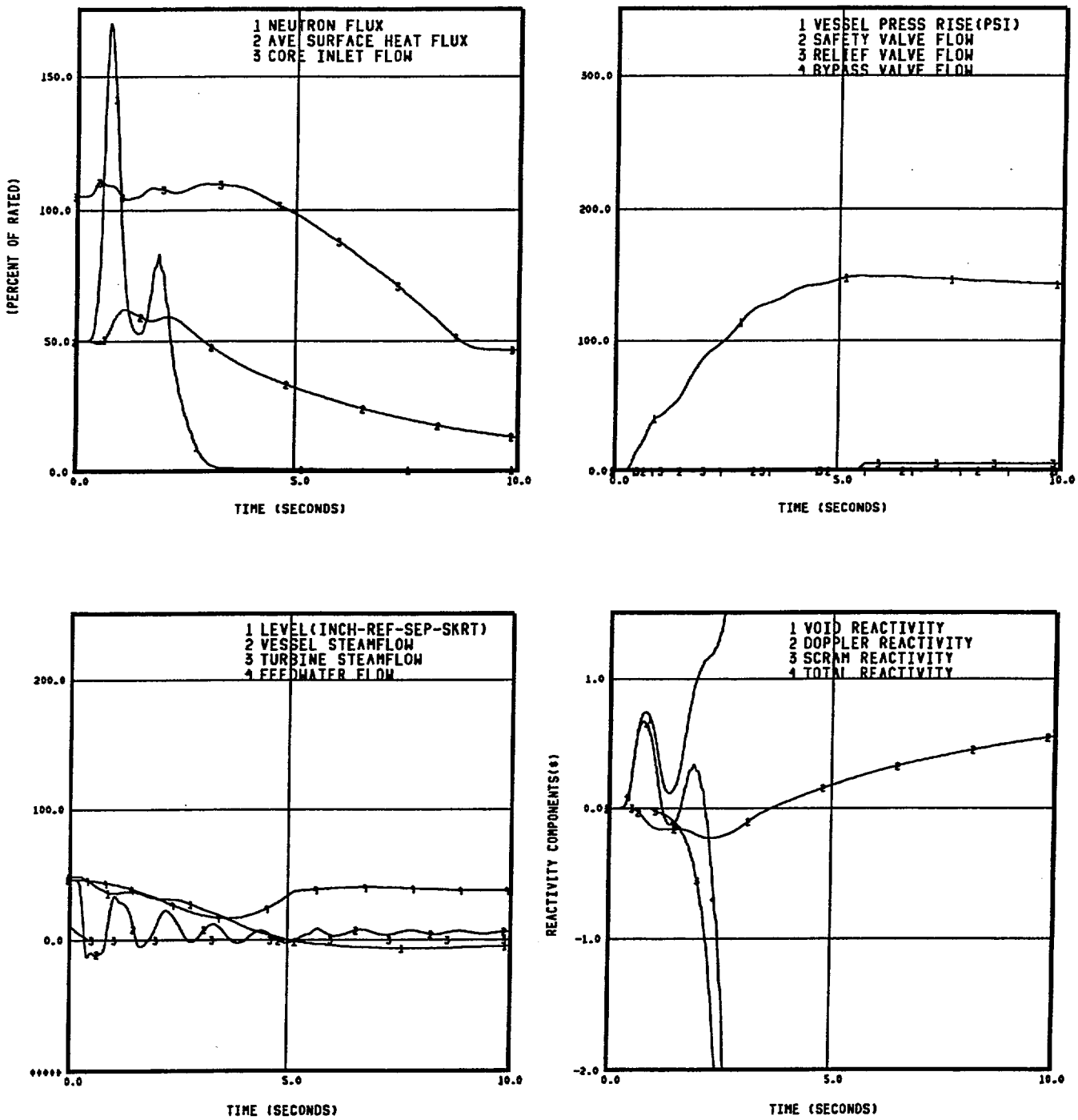


Figure 3. LRNBP from 50% Power, One TCV Slow Closure(50%/second)/Three TCV Fast Closure, Flux Scram

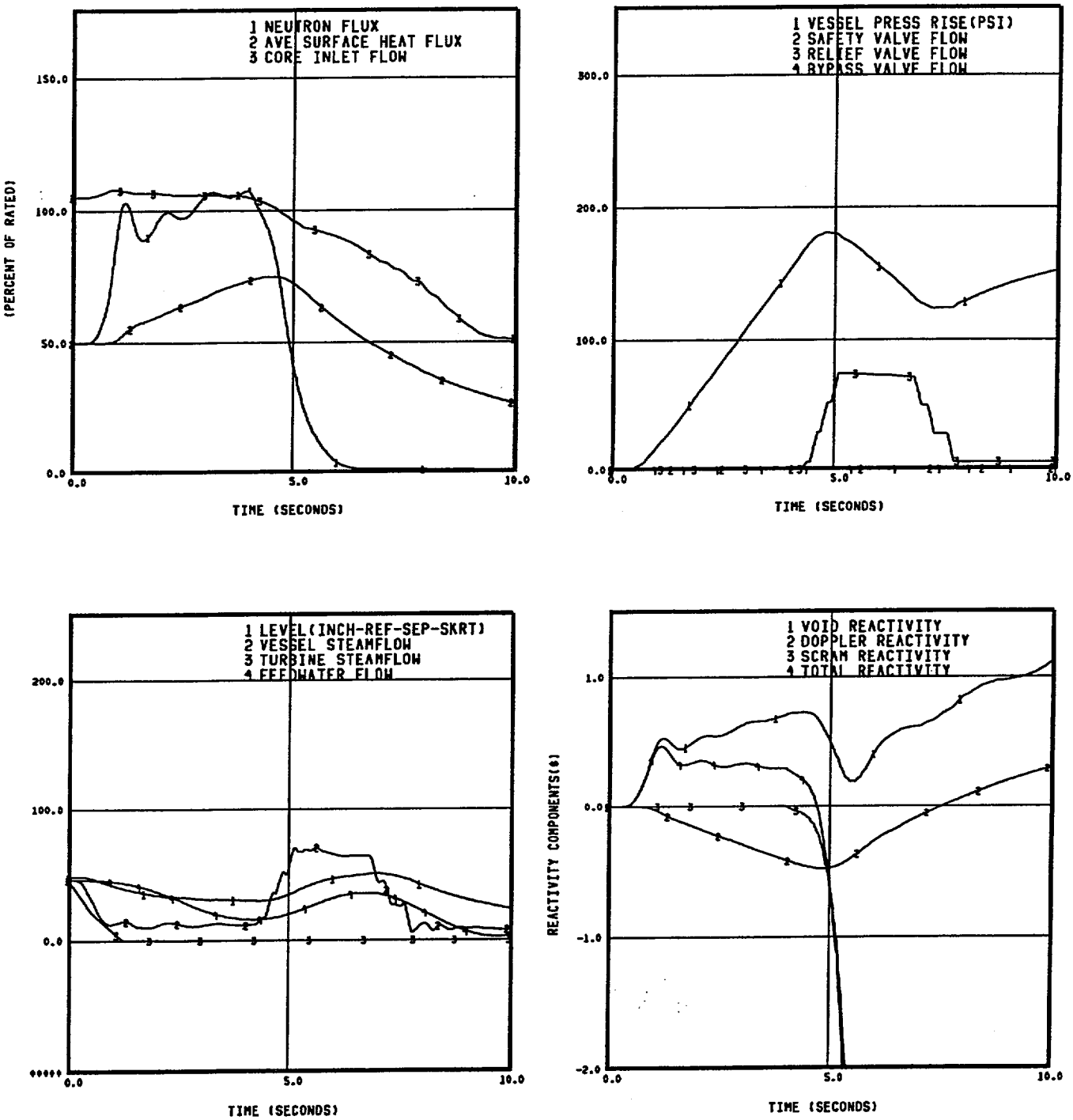


Figure 4. LRNBP from 50% Power, All TCV Closure at 19%/second, Pressure Scram