Attachment 2

LaSalle Unit 2 Cycle 9

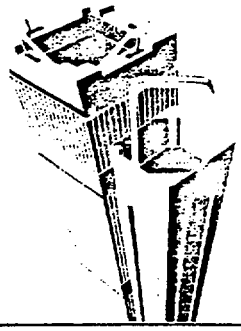
Reload Analysis Report

SIEMENS

EMF-2437
Revision 0

LaSalle Unit 2 Cycle 9 Reload Analysis

October 2000



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Nuclear Division

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Revision 0

LaSalle Unit 2 Cycle 9
Reload Analysis

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Nature of Changes

Item	Page	Description and Justification
1.	All	This is a new document.

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Nomenclature

AOO	abnormal operational occurrence
BOC	beginning of cycle
EFPH	effective full power hours
EOC	end of cycle
EOD	extended operating domain
EOFP	end of full power
EOOS	equipment out of service
FFTR	final feedwater temperature reduction
FHOOS	feedwater heater out of service
FWCF	feedwater controller failure
ICA	interim corrective actions
ICF	increased core flow
LFWH	loss of feedwater heating
LHGR	linear heat generation rate
LHGRFAC	LHGR multiplier
LOCA	loss of coolant accident
LPRM	local power range monitor
LRNB	load rejection no bypass
MAPFAC	MAPLHGR multiplier
MAPLHGR	maximum average planar linear heat generation rate
MCPR	minimum critical power ratio
MELLLA	maximum extended load line limit analysis
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 2. 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 348 unirradiated and 256 irradiated ATRIUM™-9B* assemblies and 160 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 2 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.

* 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)
- Coastdown
- Final Feedwater Temperature Reduction (FFTR)
- FFTR/Coastdown

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 (100% available at startup)
- 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 2 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 2 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 2 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)	14.8 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)	5167.29 MWt
Feedwater Flow Rate (at SLMCPR)	22.4 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 2500 EFPH LPRM calibration interval, cycle startup with uncalibrated LPRMs (BOC to 500 MWd/MTU), 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, 3.4 and 3.5 show the local power peaking factors used in the MCPR Fuel Cladding Integrity Safety Limit analysis.

SPCA9-391B-14G8.0-100M	Figure 3.2
SPCA9-410B-19G8.0-100M	Figure 3.3
SPCA9-383B-16G8.0-100M	Figure 3.4
SPCA9-396B-12GZ-100M	Figure 3.5

3.4 *Licensing Power and Exposure Shape*

The licensing axial power profile used by SPC for the plant transient analyses bounds the projected end of full power (EOFP) axial power profile. The conservative licensing axial power profile as well as the corresponding axial exposure ratio are given in Table 3.1. Future projected Cycle 9 power profiles are considered to be in compliance when the EOFP normalized power generated in the bottom of the core is greater than the licensing axial power profile at the given state conditions when the comparison is made over the bottom third of the core height.

Table 3.1 Licensing Basis Core Average Axial Power Profile and Licensing Axial Exposure Ratio

State Conditions for Power Shape Evaluation

Power, MWt	3489.00
Core Pressure, psia	1020.00
Inlet Subcooling, Btu/lbm	18.20
Flow, Mlb/hr	108.50

Licensing Axial Power Profile

Node	Power
Top 25	0.211
24	0.417
23	0.967
22	1.207
21	1.371
20	1.445
19	1.454
18	1.428
17	1.384
16	1.346
15	1.299
14	1.248
13	1.199
12	1.151
11	1.102
10	1.053
9	1.002
8	0.944
7	0.887
6	0.835
5	0.796
4	0.770
3	0.726
2	0.583
Bottom 1	0.177

Licensing Axial Exposure Ratio (EOFP)
Average Bottom 8ft/12 ft = 1.098

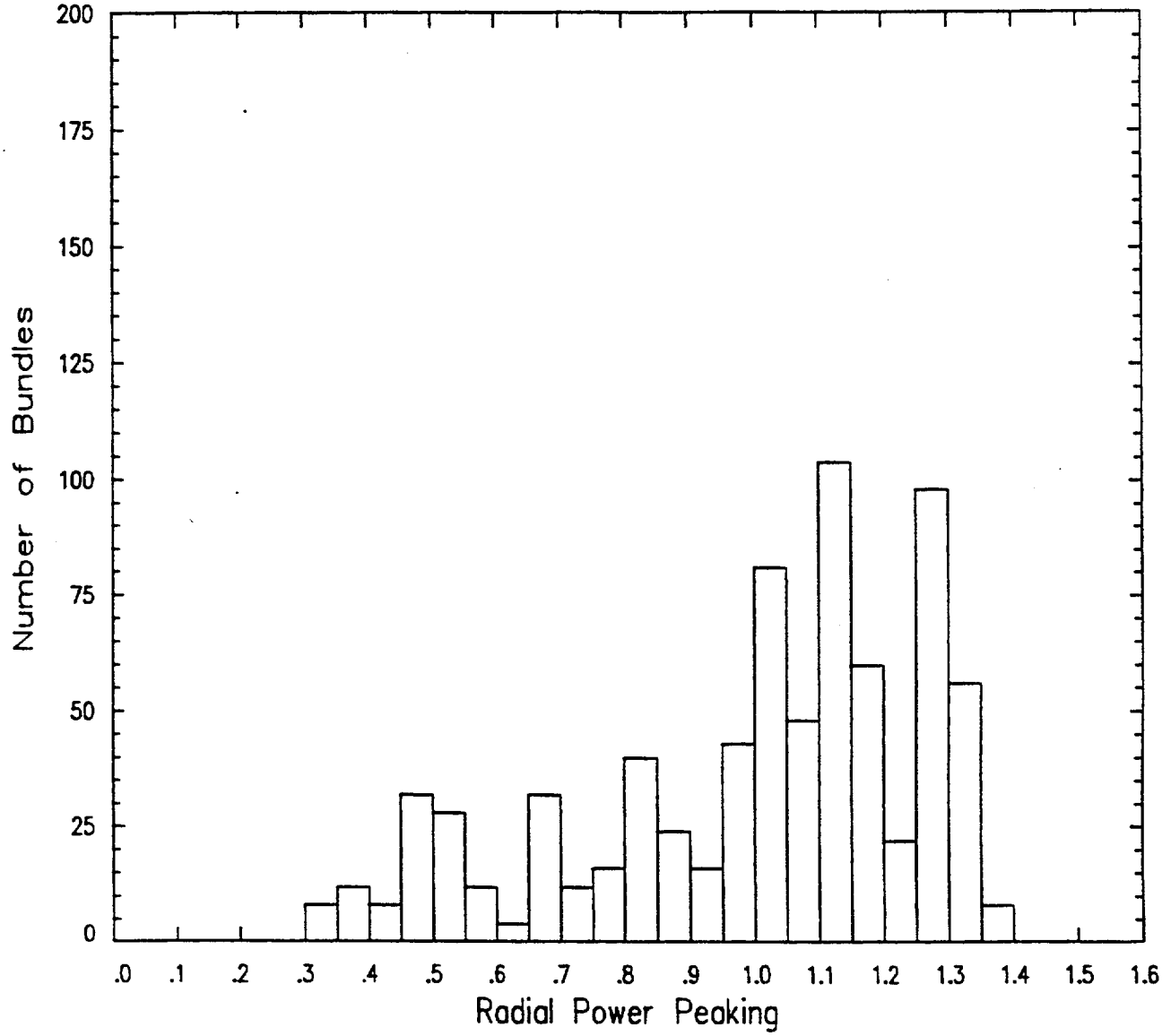


Figure 3.1 Radial Power Distribution for SLMCPR Determination

Control Rod Corner

Control Rod Corner

1.052	1.045	1.088	1.088	1.104	1.079	1.068	1.013	1.005
1.045	0.951	1.019	0.996	0.852	0.986	0.998	0.914	0.991
1.088	1.019	1.001	1.059	1.089	1.051	0.982	0.981	1.027
1.088	0.996	1.059	Internal Water Channel			0.905	0.957	1.050
1.104	0.852	1.089				1.068	0.807	1.035
1.079	0.986	1.051				1.025	0.942	1.039
1.068	0.998	0.982	0.905	1.068	1.025	0.811	0.954	1.005
1.013	0.914	0.981	0.957	0.807	0.942	0.954	0.874	0.957
1.005	0.991	1.027	1.050	1.035	1.039	1.005	0.957	0.956

Figure 3.2 LaSalle Unit 2 Cycle 9 Safety Limit Local Peaking Factors SPCA9-391B-14G8.0-100M With Channel Bow

Control Rod Corner

Control Rod Corner

1.058	1.049	1.092	1.091	1.107	1.082	1.072	1.017	1.010
1.049	0.945	1.020	0.996	0.843	0.987	0.998	0.906	0.995
1.092	1.020	1.002	1.061	1.090	1.052	0.981	0.980	1.030
1.091	0.996	1.061	Internal Water Channel			0.894	0.955	1.053
1.107	0.843	1.090				1.067	0.797	1.036
1.082	0.987	1.052				1.024	0.941	1.041
1.072	0.998	0.981	0.894	1.067	1.024	0.800	0.952	1.007
1.017	0.906	0.980	0.955	0.797	0.941	0.952	0.865	0.960
1.010	0.995	1.030	1.053	1.036	1.041	1.007	0.960	0.960

Figure 3.3 LaSalle Unit 2 Cycle 9 Safety Limit Local Peaking Factors SPCA9-410B-19G8.0-100M With Channel Bow

Control Rod Corner

Control Rod Corner

1.017	1.017	1.068	1.083	1.107	1.074	1.048	0.985	0.970
1.017	0.986	1.024	1.000	0.885	0.992	1.004	0.956	0.965
1.068	1.024	0.890	1.063	1.091	1.055	0.990	0.989	1.009
1.083	1.000	1.063	Internal Water Channel			0.944	0.966	1.055
1.107	0.885	1.091				1.074	0.846	1.040
1.074	0.992	1.055				1.032	0.951	1.043
1.048	1.004	0.990	0.944	1.074	1.032	0.850	0.964	0.988
0.985	0.956	0.989	0.966	0.846	0.951	0.964	0.916	0.932
0.970	0.965	1.009	1.055	1.040	1.043	0.988	0.932	0.924

Figure 3.4 LaSalle Unit 2 Cycle 9 Safety Limit Local Peaking Factors SPCA9-383B-16G8.0-100M With Channel Bow

Control Rod Corner

Control Rod Corner

1.025	1.058	1.062	1.117	1.100	1.108	1.043	1.026	0.979
1.058	0.934	1.018	0.852	1.003	0.845	0.999	0.903	1.005
1.062	1.018	1.003	1.067	1.092	1.058	0.984	0.983	1.006
1.117	0.852	1.067	Internal Water Channel			1.046	0.823	1.056
1.100	1.003	1.092				1.072	0.968	1.039
1.108	0.845	1.058				1.038	0.816	1.046
1.043	0.999	0.984	1.046	1.072	1.038	0.965	0.963	0.986
1.026	0.903	0.983	0.823	0.968	0.816	0.963	0.873	0.973
0.979	1.005	1.006	1.056	1.039	1.046	0.986	0.973	0.933

Figure 3.5 LaSalle Unit 2 Cycle 9 Safety Limit Local Peaking Factors SPCA9-396B-12GZ-100M With Channel Bow

4.0 Nuclear Design Analysis

4.1 *Fuel Bundle Nuclear Design Analysis*

The detailed fuel bundle design information for the fresh ATRIUM™-9B fuel to be loaded in LaSalle Unit 2 Cycle 9 is provided in References 9.1 and 9.12. The following summary provides the appropriate cross-references.

Assembly Average Enrichment (ATRIUM-9B fuel)

SPCA9-391B-14G8.0-100M	(FT16)	3.91 wt%
SPCA9-410B-19G8.0-100M	(FT17)	4.10 wt%
SPCA9-383B-16G8.0-100M	(FT18)	3.83 wt%
SPCA9-396B-12GZ-100M	(FT19)	3.96 wt%

Radial Enrichment Distribution

SPCA9-4.56L-12G8.0-100M	Ref. 9.12	Figure B.19
SPCA9-4.21L-13G8.0-100M	Ref. 9.1	Figure D.1
SPCA9-4.27L-12G8.0-100M	Ref. 9.1	Figure D.2
SPCA9-4.53L-11G8.0-100M	Ref. 9.1	Figure D.3
SPCA9-3.96L-8G5.0-100M	Ref. 9.12	Figure B.122
SPCA9-4.58L-8G6.0/4G3.0-100M	Ref. 9.12	Figure B.140
SPCA9-4.58L-8G6.0-100M	Ref. 9.12	Figure B.157

Axial Enrichment Distribution	Ref. 9.1	Figures 5.1–5.4
Burnable Absorber Distribution	Ref. 9.1	Figures 5.1–5.4
Non-Fueled Rods	Ref. 9.1	Figures 5.1-5.4
Neutronic Design Parameters		Table 4.1

Fuel Storage

LaSalle New Fuel Storage Vault — Reference 9.4

The LSB-2 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 LSB-2 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 (Boraflex Racks) Reference 9.6

The LSB-2 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 4.1

Core Exposure at EOC8, MWd/MTU (nominal value)	27,893.9
Core Exposure at BOC9, MWd/MTU (from nominal EOC8)	11,808.0
Core Exposure at EOC9, MWd/MTU (licensing basis to EOFP)	30,266.2

NOTE: Analyses in this report are applicable for EOFP up to a core exposure of 30,266.2 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 2 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:

- Provides trending information to qualitatively compare the stability from cycle to cycle.
- Provides decay ratio sensitivities to rod line and flow changes near the ICA regions.
- 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 2 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
30.1/26.6	0.59	0.53
31.6/29.2	0.40	0.50
61.9/45.0	0.50	0.88
73.6/50.0	0.52	0.95
78.2/60.0	0.33	0.63
82.4/60.0	0.36	0.72

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.

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	18.2
Moderator Temperature, °F	548.8
Channel Thickness, inch	0.100
Fuel Assembly Pitch, inch	6.0
Wide Water Gap Thickness, inch	0.261
Narrow Water Gap Thickness, inch	0.261
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 control rod data represents original equipment control blades at LaSalle and were used in the neutronic calculations.

I: \ J:	1	3	5	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35	37	39	41	43	45	47	49	51	53	55	57	59
60									1	2	2	1	1	1	1	1	1	1	1	2	2	1								
58								2	14	19	19	19	15	19	19	19	19	15	19	19	19	14	2							
56						2	2	15	19	17	15	17	16	17	14	14	17	16	17	15	17	19	15	2	2					
54						1	19	17	18	14	1	15	18	15	1	1	15	18	15	1	14	18	17	19	1					
52					1	14	17	17	15	15	15	18	14	17	18	18	17	14	18	15	15	15	17	17	14	1				
50			2	1	14	1	14	17	17	17	2	17	17	15	15	15	15	17	17	2	17	17	17	14	1	14	1	2		
48			2	19	17	14	1	18	17	18	1	15	18	14	2	2	14	18	15	1	18	17	18	1	14	17	19	2		
46		2	15	17	17	17	18	14	14	18	14	18	18	17	14	14	17	18	18	14	18	14	14	18	17	17	17	15	2	
44	1	14	19	18	15	17	17	14	14	18	18	18	18	14	18	18	14	18	18	18	18	14	14	17	17	15	18	19	14	1
42	2	19	17	14	15	17	18	18	18	14	14	17	15	18	14	14	18	15	17	14	14	18	18	18	17	15	14	17	19	2
40	2	19	15	1	15	2	1	14	18	14	2	14	16	15	2	2	15	16	14	2	14	18	14	1	2	15	1	15	19	2
38	1	19	17	15	18	17	15	18	18	17	14	2	15	16	15	15	16	15	2	14	17	18	18	15	17	18	15	17	19	1
36	1	15	16	18	14	17	18	18	18	15	16	15	14	16	16	16	16	14	15	16	15	18	18	18	17	14	18	16	15	1
34	1	19	17	15	17	15	14	17	14	18	15	16	16	18	15	15	18	16	16	15	18	14	17	14	15	17	15	17	19	1
32	1	19	14	1	18	15	2	14	18	14	2	15	16	15	2	2	15	16	15	2	14	18	14	2	15	18	1	14	19	1
30	1	19	14	1	18	15	2	14	18	14	2	15	16	15	2	2	15	16	15	2	14	18	14	2	15	18	1	14	19	1
28	1	19	17	15	17	15	14	17	14	18	15	16	16	18	15	15	18	16	16	15	18	14	17	14	15	17	15	17	19	1
26	1	15	16	18	14	17	18	18	18	15	16	15	14	16	16	16	16	14	15	16	15	18	18	18	17	14	18	16	15	1
24	1	19	17	15	18	17	15	18	18	17	14	2	15	16	15	15	16	15	2	14	17	18	18	15	17	18	15	17	19	1
22	2	19	15	1	15	2	1	14	18	14	2	14	16	15	2	2	15	16	14	2	14	18	14	1	2	15	1	15	19	2
20	2	19	17	14	15	17	18	18	18	14	14	17	15	18	14	14	18	15	17	14	14	18	18	18	17	15	14	17	19	2
18	1	14	19	18	15	17	17	14	14	18	18	18	18	14	18	18	14	18	18	18	18	14	14	17	17	15	18	19	14	1
16		2	15	17	17	17	18	14	14	18	14	18	18	17	14	14	17	18	18	14	18	14	14	18	17	17	17	15	2	
14			2	19	17	14	1	18	17	18	1	15	18	14	2	2	14	18	15	1	18	17	18	1	14	17	19	2		
12			2	1	14	1	14	17	17	17	2	17	17	15	15	15	15	17	17	2	17	17	17	14	1	14	1	2		
10					1	14	17	17	15	15	15	18	14	17	18	18	17	14	18	15	15	15	17	17	14	1				
8						1	19	17	18	14	1	15	18	15	1	1	15	18	15	1	14	18	17	19	1					
6						2	2	15	19	17	15	17	16	17	14	14	17	16	17	15	17	19	15	2	2					
4								2	14	19	19	19	15	19	19	19	19	15	19	19	19	14	2							
2									1	2	2	1	1	1	1	1	1	1	1	2	2	1								

Fuel Type	Bundle Name	Number of Bundles	Load Cycle
1	GE9B-P8CWB322-11GZ-100M-150	84	7
2	GE9B-P8CWB320-9GZ-100M-150	76	7
14	SPCA9-381B-13GZ7-80M	128	8
15	SPCA9-384B-11GZ6-80M	128	8
16	SPCA9-391B-14G8.0-100M	40	9
17	SPCA9-410B-19G8.0-100M	120	9
18	SPCA9-383B-16G8.0-100M	132	9
19	SPCA9-396B-12GZ-100M	56	9

Figure 4.1 LaSalle Unit 2 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	422	127	1218	0.30/0.40
FWCF*	TSSS	298	123	1176	0.25/0.31
LRNB*	NSS	380	124	1211	0.28/0.37
FWCF*	NSS	263	120	1169	0.23/0.29
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.

* 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)	1346 psig
	Maximum Steam Dome Pressure	1320 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

EOOS / EOD Condition	Power (% rated)	ATRIUM-9B Fuel		GE9 Fuel
		$MCPR_p$	$LHGRFAC_p$	$MCPR_p$
Base case operation	0	2.70	0.78	2.70
	25	2.20	0.78	2.20
	25	1.91	0.78	1.99
	60	1.46	1.00	1.52
	100	1.41	1.00	1.51
Feedwater heaters out-of-service (FHOOS)	0	2.85	0.69	2.85
	25	2.35	0.69	2.35
	25	2.14	0.69	2.22
	60	1.51	0.97	1.57
	100	1.41	1.00	1.51
Single-loop operation (SLO)	0	2.71	0.78	2.71
	25	2.21	0.78	2.21
	25	1.92	0.78	2.00
	60	1.47	1.00	1.53
	100	1.42	1.00	1.52
Turbine bypass valves out-of-service (TBVOOS)	0	2.70	0.76	2.70
	25	2.20	0.76	2.20
	25	1.98	0.76	2.08
	60	1.52	0.97	1.62
	100	1.43	0.99	1.52

Table 5.1 EOC Base Case and EOOS $MCPR_p$ Limits and $LHGRFAC_p$ Multipliers for TSSS Insertion Times
(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	0.78	2.70
	25	2.20	0.78	2.20
	25	1.91	0.78	1.99
	60	1.51	0.89	1.61
	100	1.51	0.89	1.61
Turbine control valve (TCV) slow closure **AND/OR** no RPT	0	2.70	0.70	2.70
	25	2.20	0.70	2.20
	25	2.10	0.70	2.10
	80	1.69	0.86	1.95
	80	1.61	0.89	1.84
	100	1.53	0.89	1.63
TCV slow closure/ FHOOS **AND/OR** no RPT	0	2.85	0.68	2.85
	25	2.35	0.68	2.35
	25	2.14	0.68	2.22
	80	1.69	0.86	1.95
	80	1.61	0.89	1.84
	100	1.53	0.89	1.63
Idle loop startup	0	2.60	0.40	2.60
	25	2.60	0.40	2.60
	25	2.60	0.40	2.60
	60	2.60	0.40	2.60
	100	2.60	0.40	2.60

Table 5.2 EOC Base Case $MCPR_p$ Limits and $LHGRFAC_p$ Multipliers for NSS Insertion Times

EOOS / EOD Condition	Power (% rated)	ATRIUM-9B Fuel		GE9 Fuel
		$MCPR_p$	$LHGRFAC_p$	$MCPR_p$
Base case operation	0	2.70	0.79	2.70
	25	2.20	0.79	2.20
	25	1.89	0.79	1.97
	60	1.44	1.00	1.51
	100	1.39	1.00	1.48

Table 5.3 Coastdown Operation Base Case and EOOS $MCPR_p$ Limits and $LHGRFAC_p$ Multipliers for TSSS Insertion Times

EOOS / EOD Condition	Power (% rated)	ATRIUM-9B Fuel		GE9 Fuel
		$MCPR_p$	$LHGRFAC_p$	$MCPR_p$
Coastdown 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	1.48	0.99	1.54
	100	1.42	1.00	1.52
Coastdown with single-loop operation	0	2.71	0.75	2.71
	25	2.21	0.75	2.21
	25	2.06	0.75	2.06
	60	1.49	0.99	1.55
	100	1.43	1.00	1.53
Coastdown with turbine bypass valves out-of-service (TBVOOS)	0	2.70	0.73	2.70
	25	2.20	0.73	2.20
	25	2.05	0.73	2.15
	60	1.55	0.97	1.64
	100	1.44	0.99	1.53
Coastdown with recirculation pump trip out-of-service (no RPT)	0	2.70	0.75	2.70
	25	2.20	0.75	2.20
	25	2.05	0.75	2.05
	60	1.55	0.88	1.67
	100	1.55	0.88	1.67

Table 5.3 Coastdown Operation Base Case and EOOS $MCPR_p$ Limits and $LHGRFAC_p$ Multipliers for TSSS Insertion Times
(Continued)

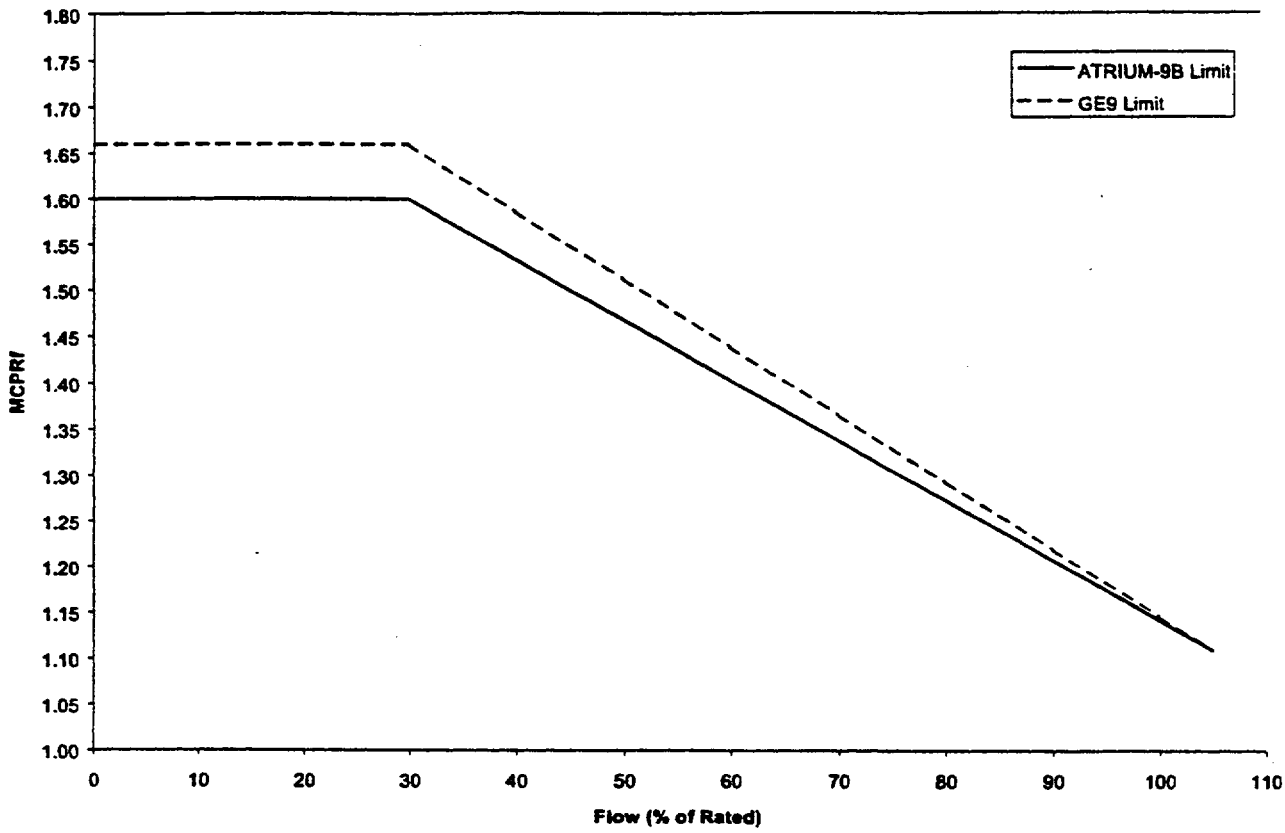
EOOS / EOD Condition	Power (% rated)	ATRIUM-9B Fuel		GE9 Fuel
		$MCPR_p$	$LHGRFAC_p$	$MCPR_p$
Coastdown with turbine control valve (TCV) slow closure **AND/OR** no RPT	0	2.70	0.68	2.70
	25	2.20	0.68	2.20
	25	2.15	0.68	2.15
	80	1.70	0.85	1.96
	80	1.62	0.88	1.85
	100	1.55	0.88	1.67
Coastdown with idle loop startup	0	2.60	0.40	2.60
	25	2.60	0.40	2.60
	25	2.60	0.40	2.60
	60	2.60	0.40	2.60
	100	2.60	0.40	2.60

Table 5.4 FFTR/Coastdown Operation Base Case and EOOS $MCPR_p$ Limits and $LHGRFAC_p$ Multipliers for TSSS Insertion Times

EOOS / EOD Condition	Power (% rated)	ATRIUM-9B Fuel		GE9 Fuel
		$MCPR_p$	$LHGRFAC_p$	$MCPR_p$
FFTR/coastdown base case operation	0	2.85	0.65	2.85
	25	2.35	0.65	2.35
	25	2.30	0.65	2.30
	60	1.56	0.97	1.59
	100	1.42	1.00	1.52
FFTR/coastdown with single-loop operation	0	2.86	0.65	2.86
	25	2.36	0.65	2.36
	25	2.31	0.65	2.31
	60	1.57	0.97	1.60
	100	1.43	1.00	1.53
FFTR/coastdown with turbine bypass valves out-of-service (TBVOOS)	0	2.85	0.65	2.85
	25	2.35	0.65	2.35
	25	2.30	0.65	2.30
	60	1.57	0.97	1.64
	100	1.44	0.99	1.53
FFTR/coastdown with recirculation pump trip out-of-service (no RPT)	0	2.85	0.65	2.85
	25	2.35	0.65	2.35
	25	2.30	0.65	2.30
	60	1.56	0.88	1.67
	100	1.55	0.88	1.67

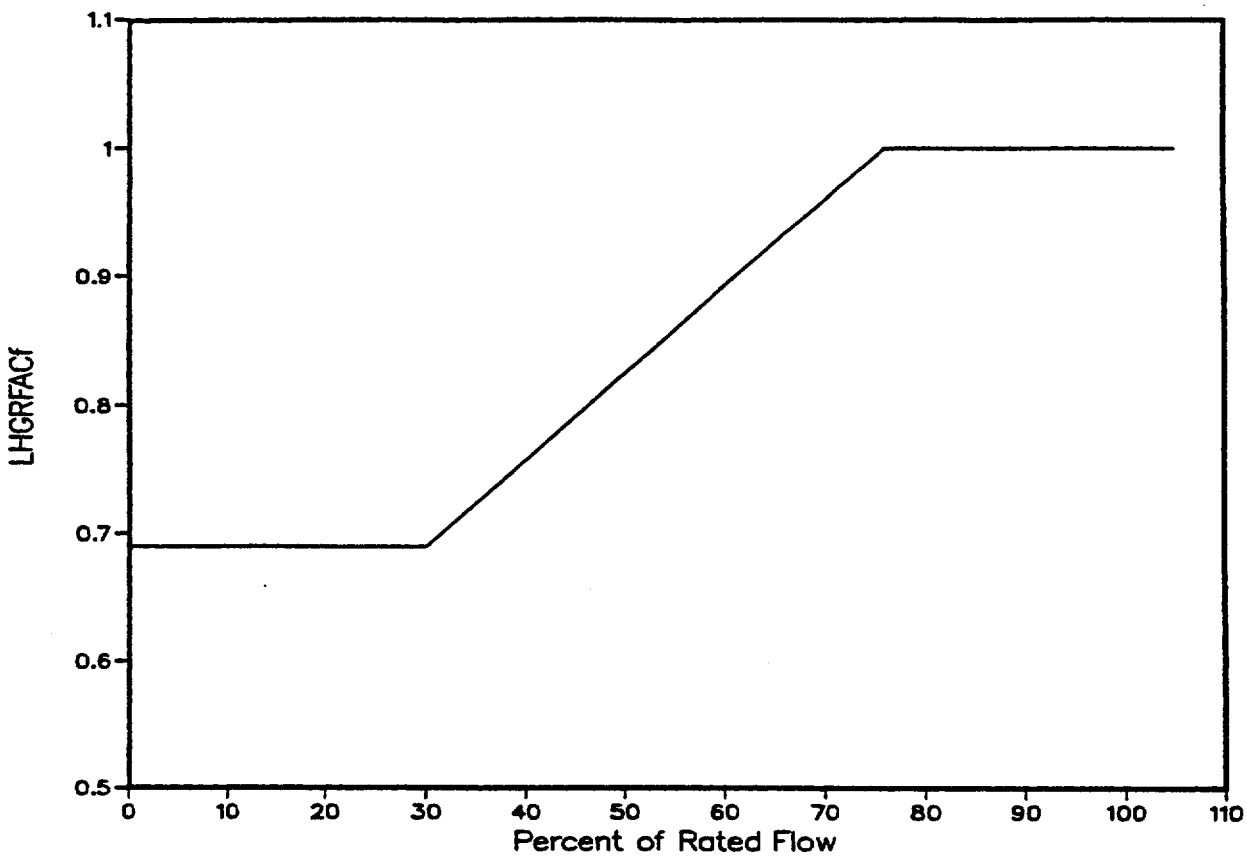
Table 5.4 FFTR/Coastdown Operation Base Case and EOOS $MCPR_p$ Limits and $LHGRFAC_p$ Multipliers for TSSS Insertion Times
(Continued)

EOOS / EOD Condition	Power (% rated)	ATRIUM-9B Fuel		GE9 Fuel
		$MCPR_p$	$LHGRFAC_p$	$MCPR_p$
FFTR/coastdown with turbine control valve (TCV) slow closure **AND/OR** no RPT	0	2.85	0.65	2.85
	25	2.35	0.65	2.35
	25	2.30	0.65	2.30
	80	1.70	0.85	1.96
	80	1.62	0.88	1.85
	100	1.55	0.88	1.67
FFTR/coastdown with idle loop startup	0	2.60	0.40	2.60
	25	2.60	0.40	2.60
	25	2.60	0.40	2.60
	60	2.60	0.40	2.60
	100	2.60	0.40	2.60



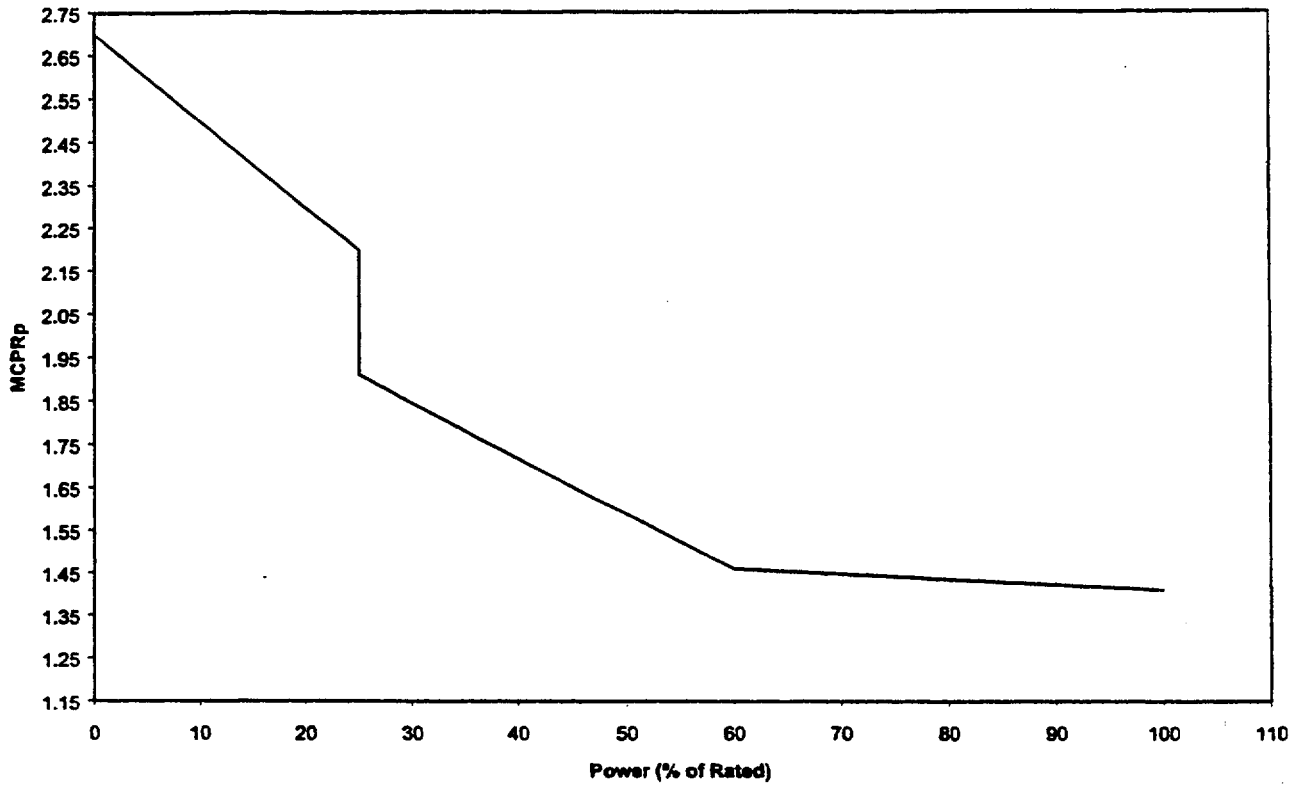
Flow (% of rated)	$MCPR_f$ ATRIUM-9B	$MCPR_f$ GE9 (penalty included)
0	1.60	1.66
30	1.60	1.66
105	1.11	1.11

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



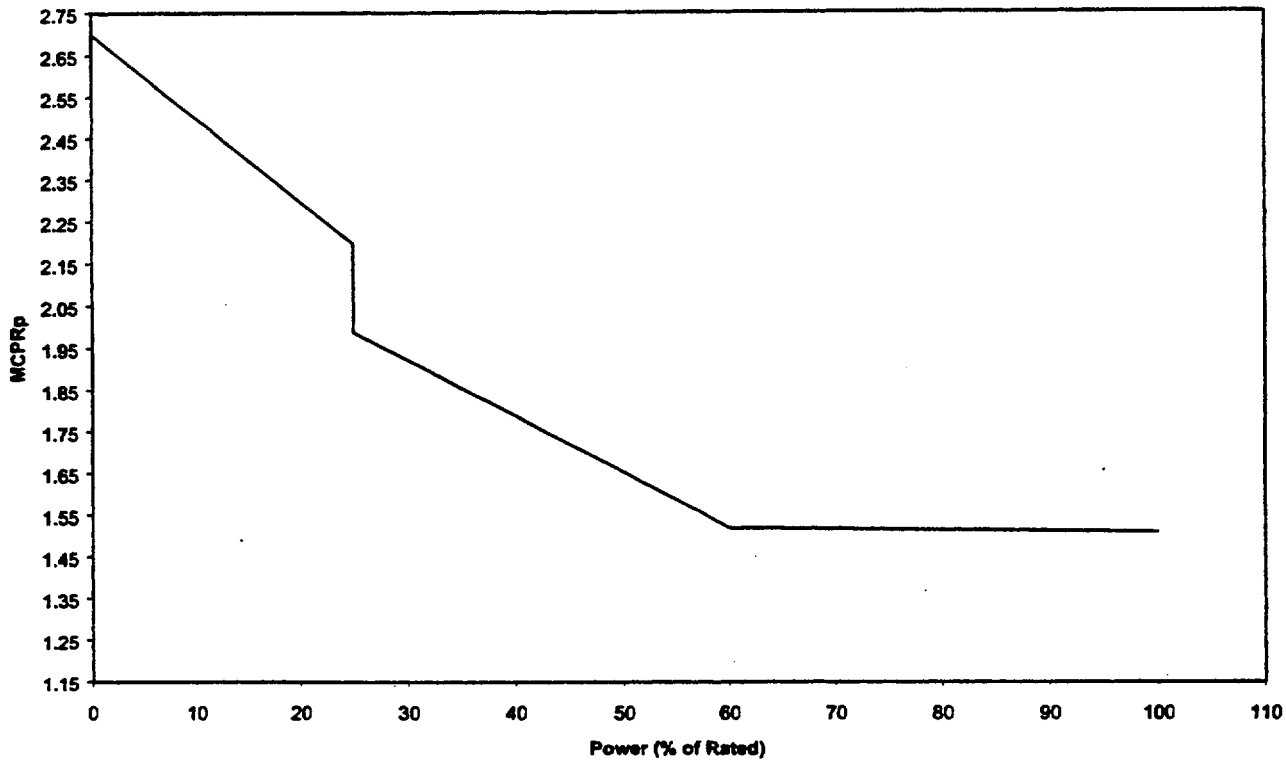
Flow (% rated)	$LHGRFAC_f$
0	0.69
30	0.69
76	1.00
105	1.00

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



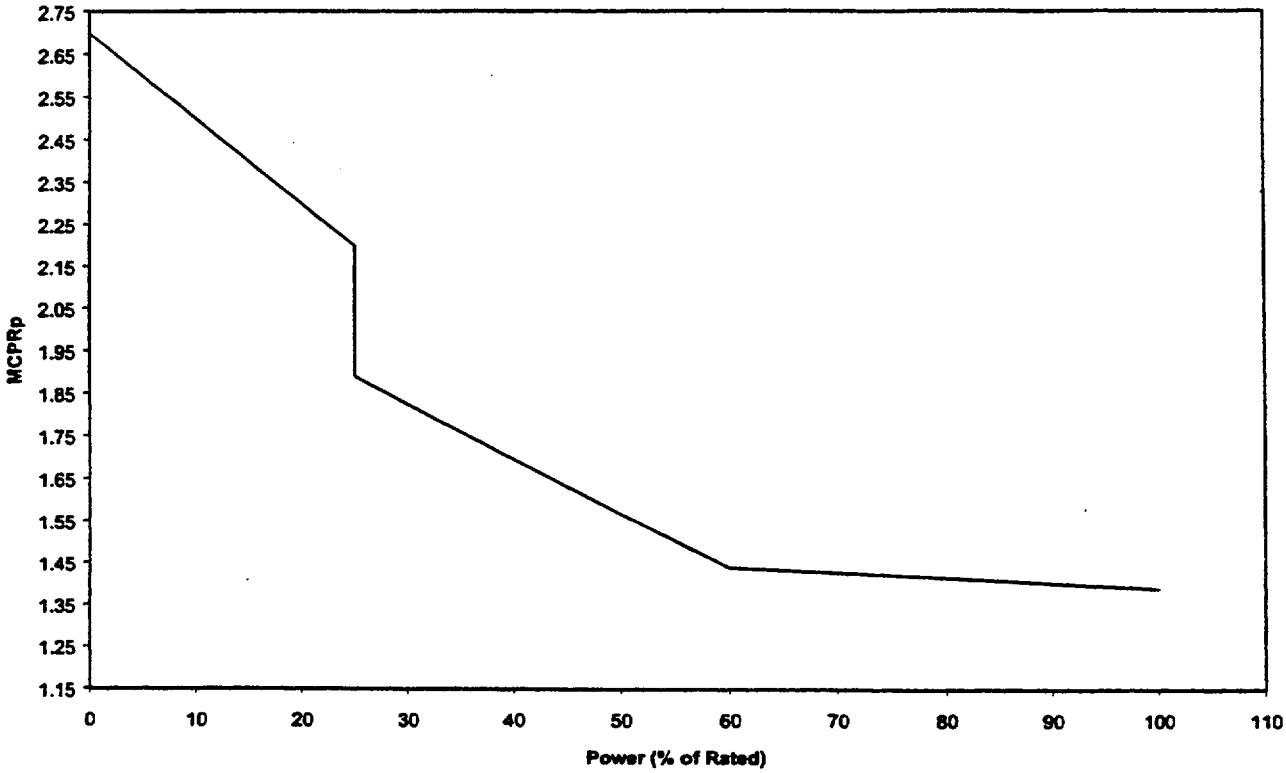
Power (%)	$MCPR_p$ Limit
100	1.41
60	1.46
25	1.91
25	2.20
0	2.70

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



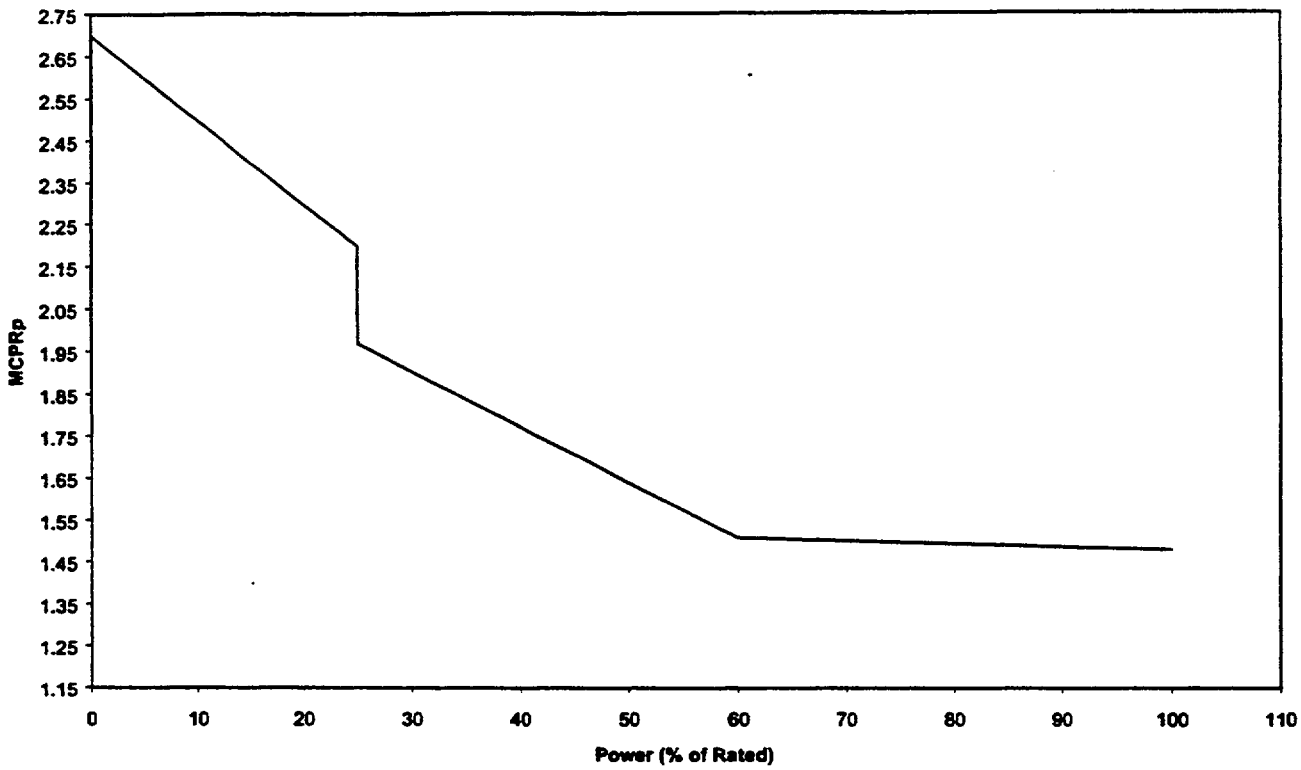
Power (%)	$MCPR_p$ Limit
100	1.51
60	1.52
25	1.99
25	2.20
0	2.70

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



Power (%)	$MCPR_p$ Limit
100	1.39
60	1.44
25	1.89
25	2.20
0	2.70

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



Power (%)	$MCPR_p$ Limit
100	1.48
60	1.51
25	1.97
25	2.20
0	2.70

Figure 5.6 EOC 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 2 ATRIUM-9B (LSB-2) 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 1810°F and 0.70% 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 (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		GE9 Fuel MAPLHGR Limits
Average Planar Exposure (GWd/MTU)	MAPLHGR (kW/ft)	< To be furnished by ComEd. >
0.0	13.5	
20.0	13.5	
61.1	9.39	

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

* Includes the effects of channel bow, up to 2 TIPOOS (or the equivalent number of TIP channels), a 2500 EFPH LPRM calibration interval, cycle startup with uncalibrated LPRMs (BOC to 500 MWd/MTU) 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. >

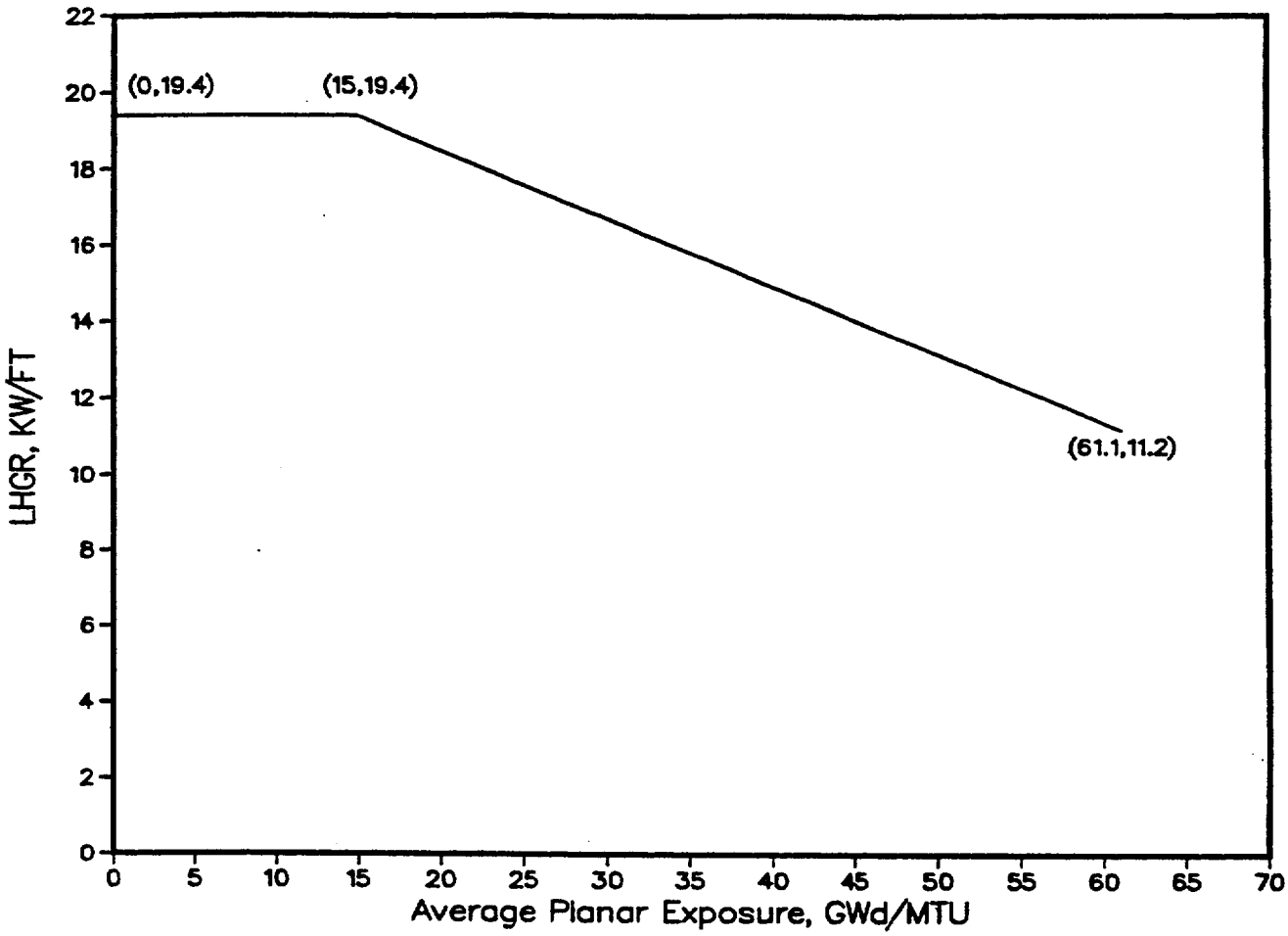


Figure 7.1 Protection Against Power Transient LHGR Limit for ATRIUM-9B Fuel

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 Supplements 1 and 2, *ANF Critical Power Methodology for Boiling Water Reactors*, Advanced Nuclear Fuels Corporation, November 1990.

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Attachment 3

LaSalle Unit 2 Cycle 9

Plant Transient Analysis