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Exelon℠
Nuclear

August 31, 2001

10 CFR 50.4

United States Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555

LaSalle County Station, Unit 2
Facility Operating License No. NPF-18
NRC Docket No. 50-374

Subject: Unit 2 Cycle 9 Core Operating Limits Report (COLR)

Due to a change in control rod pattern implementation for LaSalle Unit 2 Cycle 9 operations, a COLR change is necessary. The COLR revision incorporates new MCPR limits for certain fuel types that support the proposed control rod pattern implementation. Other administrative changes have also been incorporated.

In accordance with Improved Technical Specification Section 5.6.5, "Core Operating Limits Report," and 10 CFR 50.4, "Written Communications," Exelon Generating Company, (EGC), LLC, LaSalle County Station is submitting this COLR to the NRC.

Should you have any questions concerning this letter, please contact Mr. William Riffer, Regulatory Assurance Manager, at (815) 415-2800.

Respectfully,

Charles G. Pardee
Site Vice President
LaSalle County Station

Attachment

cc: Regional Administrator - NRC Region III
NRC Senior Resident Inspector - LaSalle County Station

A001

APPENDIX J

LASALLE UNIT 2

RELOAD LICENSING SUBMITTAL / CORE OPERATING LIMITS REPORT

Technical Requirements Manual

Appendix J

(Amendment 47)

LaSalle Unit 2 Cycle 9

Core Operating Limits Report

and

Reload Transient Analysis Results

August 2001

Section 1

LaSalle Unit 2 Cycle 9

Core Operating Limits Report

August 2001

Issuance of Changes Summary

Affected Section	**Affected Pages**	**Summary of Changes**	**Date**
All	All	Original Issue (Cycle 9)	11/00
References; 6	iii; 6-1	Revised Requirements for Use of SUBTIP Methodology	12/00
All	All	ITS changes, RBM trip setpoint and allowable value changes, TIP symmetry Chi-Squared testing, incorporated results of revised thermal limits with correct thermal conductivities, and other necessary administrative changes	5/01
Table of Contents, References, 2	ii, v, 2-3	Incorporate revised MCPR operating limits for ATRIUM-9B fuel due to schedule changes and changes in the target rod patterns.	8/01

Technical Requirements Manual - Appendix J
L2C9 Core Operating Limits Report

Table of Contents

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1. Average Planar Linear Heat Generation Rate (APLHGR) (3.2.1)

1.1 Tech Spec Reference:

Tech Spec 3.2.1

1.2 Description:

For operation without a full TIP set from BOC to 500 MWd/MT a penalty of 11.01% must be applied to all APLHGR limits.

1.2.1 GE Fuel

The MAPLHGR Limit is determined using the applicable Lattice-Type MAPLHGR limits from Tables 1.2-1 and 1.2-2. For Single Reactor Recirculation Loop Operation, the MAPLHGR limits in Tables 1.2-1 and 1.2-2 are multiplied by the MAPFAC multipliers provided in Figures 1.2-1 and 1.2-2.

1.2.2 SPC Fuel

The MAPLHGR Limit is the Lattice-Type MAPLHGR Limit. The Lattice-Type MAPLHGR limits are determined from the table given below:

Fuel Type	Cycle First Inserted
SPCA9-381B-13GZ7-80M	8
SPCA9-384B-11GZ6-80M	8
SPC-A9-391B-14G8.0-100M	9
SPC-A9-410B-19G8.0-100M	9
SPC-A9-383B-16G8.0-100M	9
SPC-A9-396B-12GZ-100M	9

(References 2 and 3)

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

(References 3 and 6)

For single loop operation, the MAPLHGR limits from the table above are multiplied by the MAPLHGR multiplier. The MAPLHGR multiplier for SPC fuel is 0.90. (References 3, 5 and 6)

Table 1.2-1

Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) vs. Average Planar Exposure for Fuel Type GE9B-P8CWB322-11GZ-100M-150-CECO

(Reference 9 and 19)

Exposure (MWD/ST)	Exposure (MWD/MT)	Lattice-Type MAPLHGR (kW/ft)					
		P8CWL07 1 NOG	P8CWL345 5G5.0/4G4.0	P8CWL362 9G4.0	P8CWL362 2G5.0/9G4.0	P8CWL345 9G4.0	P8CWL071 11GE
0	0	12.74	12.09	11.65	11.25	12.11	12.74
200	220.5	12.67	12.13	11.70	11.32	12.15	12.67
1000	1102.3	12.48	12.22	11.83	11.46	12.25	12.48
2000	2204.6	12.42	12.35	12.00	11.61	12.39	12.42
3000	3306.9	12.41	12.48	12.14	11.77	12.54	12.41
4000	4409.2	12.44	12.62	12.28	11.94	12.70	12.44
5000	5511.6	12.46	12.77	12.43	12.11	12.86	12.46
6000	6613.9	12.49	12.90	12.58	12.29	13.02	12.49
7000	7716.2	12.51	13.03	12.73	12.46	13.19	12.51
8000	8818.5	12.54	13.16	12.88	12.64	13.33	12.54
9000	9920.8	12.55	13.30	13.01	12.82	13.43	12.55
10000	11023.1	12.57	13.42	13.12	12.98	13.44	12.57
12500	13778.9	12.41	13.41	13.08	13.04	13.40	12.41
15000	16534.7	12.04	13.05	12.78	12.77	13.06	12.04
20000	22046.2	11.27	12.38	12.16	12.16	12.40	11.27
25000	27557.8	10.49	11.74	11.51	11.51	11.76	10.49
27215.6	30000	12.314	12.314	12.314	12.314	12.314	12.314
48080.8	53000	10.800	10.800	10.800	10.800	10.800	10.800
58967.1	65000	6.000	6.000	6.000	6.000	6.000	6.000
Lattice No.		733	1817	1818	1819	1820	1821

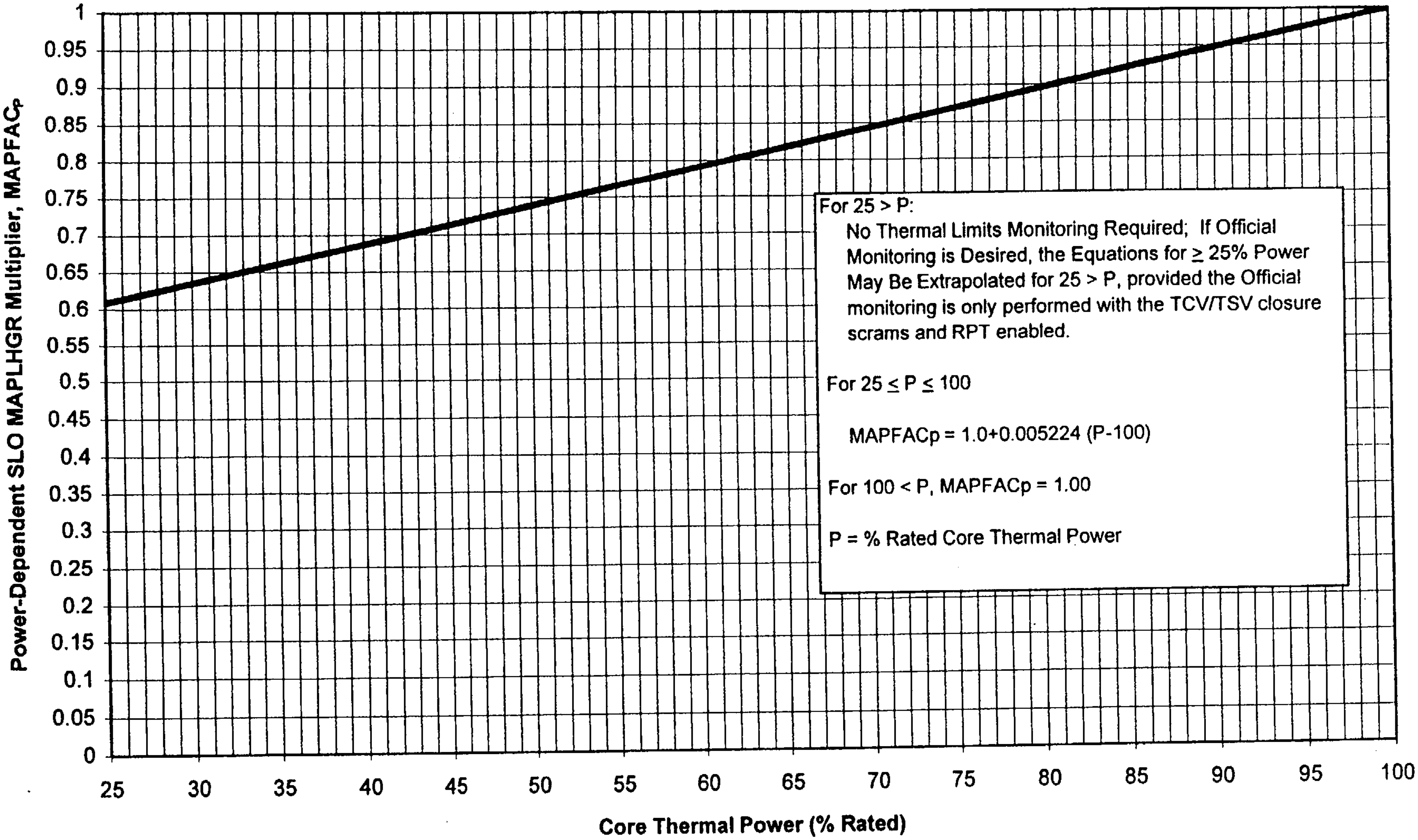
Table 1.2-2

Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) vs. Average Planar Exposure for Fuel Type GE9B-P8CWB320-9GZ3-100M-150-CECO

(Reference 9 and 19)

Exposure (MWD/ST)	Exposure (MWD/MT)	Lattice-Type MAPLHGR (kW/ft)					
		P8CWL07 1 NOG	P8CWL346 4G5.0/3G4.0	P8CWL358 7G4.0	P8CWL358 2G5.0/7G4.0	P8CWL346 7G4.0	P8CWL071 9GE2
0	0	12.74	12.05	11.62	11.10	12.09	12.74
200	220.5	12.67	12.09	11.64	11.15	12.14	12.67
1000	1102.3	12.48	12.19	11.73	11.27	12.25	12.48
2000	2204.6	12.42	12.32	11.86	11.44	12.39	12.42
3000	3306.9	12.41	12.44	11.99	11.62	12.53	12.41
4000	4409.2	12.44	12.57	12.13	11.80	12.67	12.44
5000	5511.6	12.46	12.70	12.27	11.96	12.81	12.46
6000	6613.9	12.49	12.83	12.42	12.09	12.89	12.49
7000	7716.2	12.51	12.97	12.54	12.23	12.98	12.51
8000	8818.5	12.54	13.07	12.62	12.37	13.07	12.54
9000	9920.8	12.55	13.15	12.70	12.51	13.15	12.55
10000	11023.1	12.57	13.20	12.77	12.66	13.22	12.57
12500	13778.9	12.41	13.19	12.70	12.67	13.20	12.41
15000	16534.7	12.04	12.89	12.40	12.40	12.90	12.04
20000	22046.2	11.27	12.29	11.82	11.82	12.30	11.27
25000	27557.8	10.49	11.69	11.25	11.25	11.70	10.49
27215.6	30000	12.314	12.314	12.314	12.314	12.314	12.314
48080.8	53000	10.800	10.800	10.800	10.800	10.800	10.800
58967.1	65000	6.000	6.000	6.000	6.000	6.000	6.000
Lattice No.		733	1812	1813	1814	1815	1816

Figure 1.2-1 Power-Dependent SLO MAPLHGR Multipliers for GE Fuel ($MAPFAC_P$)
(References 8 and 19)



For 25 > P:
No Thermal Limits Monitoring Required; If Official Monitoring is Desired, the Equations for ≥ 25% Power May Be Extrapolated for 25 > P, provided the Official monitoring is only performed with the TCV/TSV closure scrams and RPT enabled.

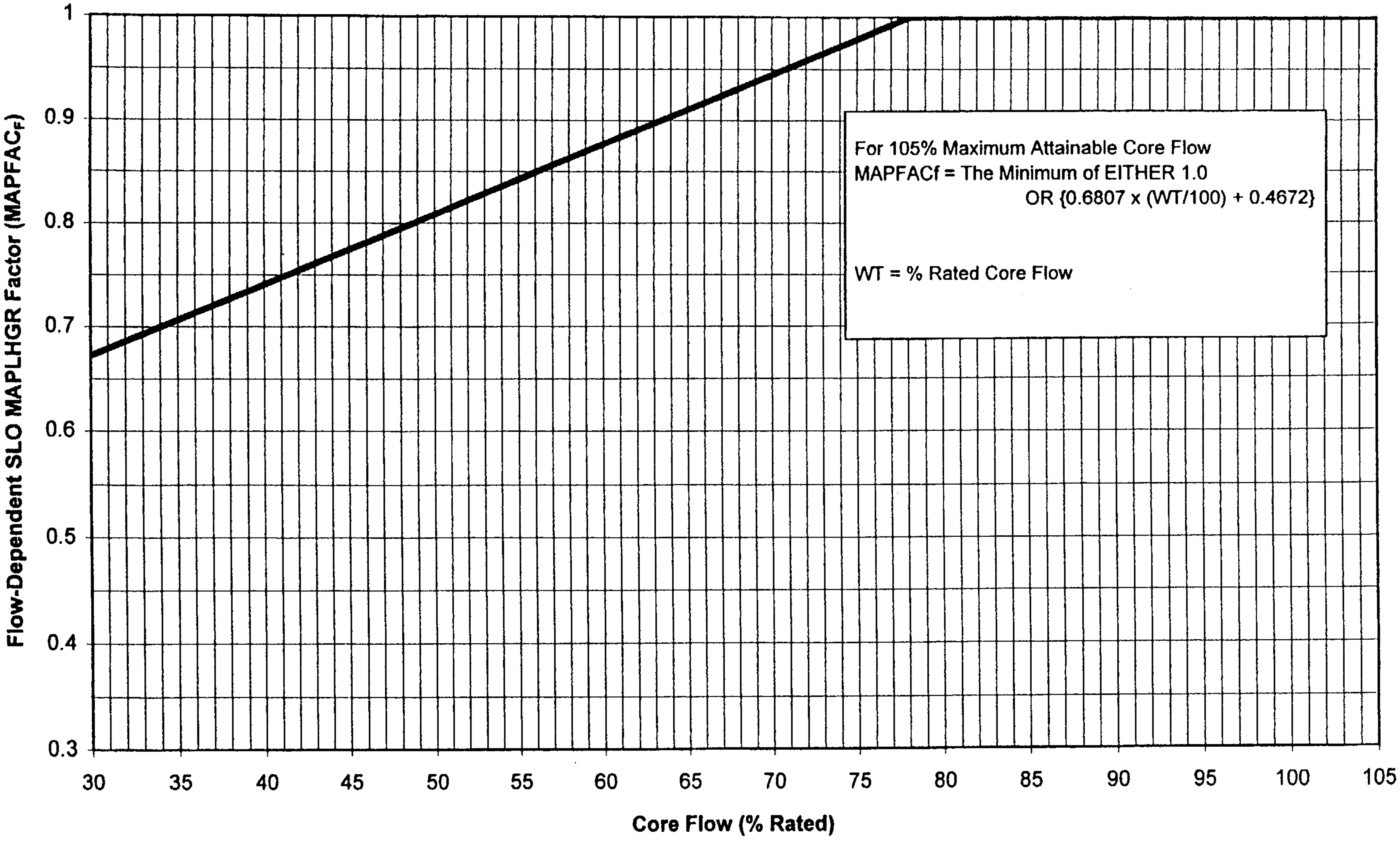
For $25 \leq P \leq 100$

$MAPFACp = 1.0+0.005224 (P-100)$

For 100 < P, MAPFACp = 1.00

P = % Rated Core Thermal Power

Figure 1.2-2 Flow-Dependent SLO MAPLHGR Multiplier ($MAPFAC_F$) for GE Fuel
(References 8, 18, and 19)



2. Minimum Critical Power Ratio (3.2.2)

2.1 Tech Spec Reference:

Tech Spec 3.2.2.

2.2 Description:

Prior to initial scram time testing for an operating cycle, the MCPR operating limit is based on the Technical Specification Scram Times. For Technical Specification requirements refer to Technical Specification table 3.1.4-1.

TIP Symmetry Chi-squared testing shall be performed prior to reaching 500 MWd/MTU to validate the MCPR calculation.

MCPR limits from BOC to Coastdown are applicable up to a core average exposure of 30,266.2 MWd/MTU (which is the licensing basis exposure used by SPC). (Reference 3)

2.2.1 Manual Flow Control MCPR Limits

The Governing MCPR Operating Limit while in Manual Flow Control is either determined from 2.2.1.1 or 2.2.1.2, whichever is greater at any given power, flow condition.

2.2.1.1 Power-Dependent MCPR ($MCPR_P$)*

2.2.1.1.1 GE Fuel

Table 2-1 gives the $MCPR_P$ limit as a function of core thermal power for Tech Spec Scram Times.

2.2.1.1.2 Siemens Fuel

Table 2-2 gives the $MCPR_P$ limit as a function of core thermal power for Tech Spec Scram Times.

2.2.1.2 Flow-Dependent MCPR ($MCPR_F$)

Table 2-3 gives the $MCPR_F$ limit as a function of flow.

2.2.2 Automatic Flow Control MCPR Limits

Automatic Flow Control MCPR Limits are not provided for L2C9.

* For thermal limit monitoring at greater than 100%P, the 100% power MCPRp limits should be applied.

Table 2-1
MCPR$_P$ for GE Fuel

(References 2, 3, and 51)

Operation from BOC to Coastdown**

Percent Core Thermal Power*

EOOS Combination	0	25	25	60	80	80	100
No EOOS	2.70	2.20	2.01	1.53			1.51
Single RR Loop only	2.71	2.21	2.02	1.54			1.52
EOOS***	2.85	2.35	2.24		1.96	1.86	1.63
EOOS***/Single RR Loop	2.86	2.36	2.25		1.97	1.87	1.64

* Values are interpolated between relevant power levels. For operation at exactly 25% or 80% CTP, the more limiting value is used. 3489 MWt is rated power

** Coastdown thermal limits are not provided in this COLR

*** Allowable EOOS conditions are listed in Section 5.

Table 2-2
$MCPR_P$ for Siemens Fuel

(References 2, 3, 21, 51, and 53)

For all Siemens fuel <u>EXCEPT</u> Fuel Type 18 in 10B cell locations and Fuel Types 16, 17, and 18 in A1 (7A, 7B, 7C, 8A, and 8B) cell locations from BOC to Coastdown.**

	Percent Core Thermal Power*					
EOOS Combination	0	25	25	60	80	80	100
No EOOS	2.70	2.20	1.93	1.48			1.41
Single RR Loop only	2.71	2.21	1.94	1.49			1.42
EOOS***	2.85	2.35	2.17		1.70	1.62	1.53
EOOS***/Single RR Loop	2.86	2.36	2.18		1.71	1.63	1.54

For <u>ONLY</u> Siemens Fuel Type 18 in 10B cell locations for operation with rod pattern targeted from BOC to Coastdown**

	Percent Core Thermal Power*						
EOOS Combination	0	25	25	60	80	80	100
No EOOS	2.74	2.24	1.97	1.52			1.45
Single RR Loop only	2.75	2.25	1.98	1.53			1.46
EOOS***	2.89	2.39	2.21		1.74	1.66	1.57
EOOS***/Single RR Loop	2.90	2.40	2.22		1.75	1.67	1.58

For <u>ONLY</u> Siemens Fuel Type 16, 17, and 18 in A1 (7A, 7B, 7C, 8A, and 8B) cell locations for operation with rod pattern targeted from BOC to Coastdown**

	Percent Core Thermal Power*						
EOOS Combination	0	25	25	60	80	80	100
No EOOS	2.73	2.23	1.96	1.51			1.44
Single RR Loop only	2.74	2.24	1.97	1.52			1.45
EOOS***	2.88	2.38	2.20		1.73	1.65	1.56
EOOS***/Single RR Loop	2.89	2.39	2.21		1.74	1.66	1.57

* Values are interpolated between relevant power levels. For operation at exactly 25% or 80% CTP, the more limiting value is used. 3489 MWt is rated power.

** Coastdown thermal limits are not provided in this COLR

*** Allowable EOOS conditions are listed in Section 5.

Table 2-3
$MCPR_F$ for GE and Siemens Fuel

(Reference 3)

$MCPR_F$ limits for 105% Maximum Attainable Core Flow

Flow (% rated)	$MCPR_F$ ATRIUM-9B	$MCPR_F$ GE9
0	1.60	1.66
30	1.60	1.66
105	1.11	1.11

The $MCPR_F$ limits are applicable from BOC through coastdown and in all EOOS scenarios.

3. Linear Heat Generation Rate (3.2.3)

3.1 Tech Spec Reference:

Tech Spec 3.2.3.

3.2 Description:

For operation without a full TIP set from BOC to 500 MWd/MT a penalty of 11.01% must be applied to all LHGR limits.

3.2.1 GE Fuel

The LHGR Limit is the product of the LHGR Limit in the following tables and the minimum of either the power dependent LHGR Factor*, LHGRFAC$_P$, or the flow dependent LHGR Factor, LHGRFAC$_F$. The LHGR Factors (LHGRFAC$_P$ and LHGRFAC$_F$) for the GE fuel are determined from Figures 3.2-1 through 3.2-3. The following GE LHGR limits apply for the entire cycle exposure range: (References 2, 8, 10 and 19)

1. GE9B-P8CWB322-11GZ-100M-150-CECO (bundle 3861 in Reference 2)

Nodal Exposure (GWd/MT)	LHGR Limit (KW/ft)
0	13.75
13.06	13.75
27.80	11.75
50.31	10.31
60.89	6.00

2. GE9B-P8CWB320-9GZ-100M-150-CECO (bundle 3860 in Reference 2)

Nodal Exposure (GWd/MT)	LHGR Limit (KW/ft)
0.00	14.25
12.14	14.25
26.19	12.18
48.16	10.80
59.93	6.00

3.2.2 Siemens Fuel

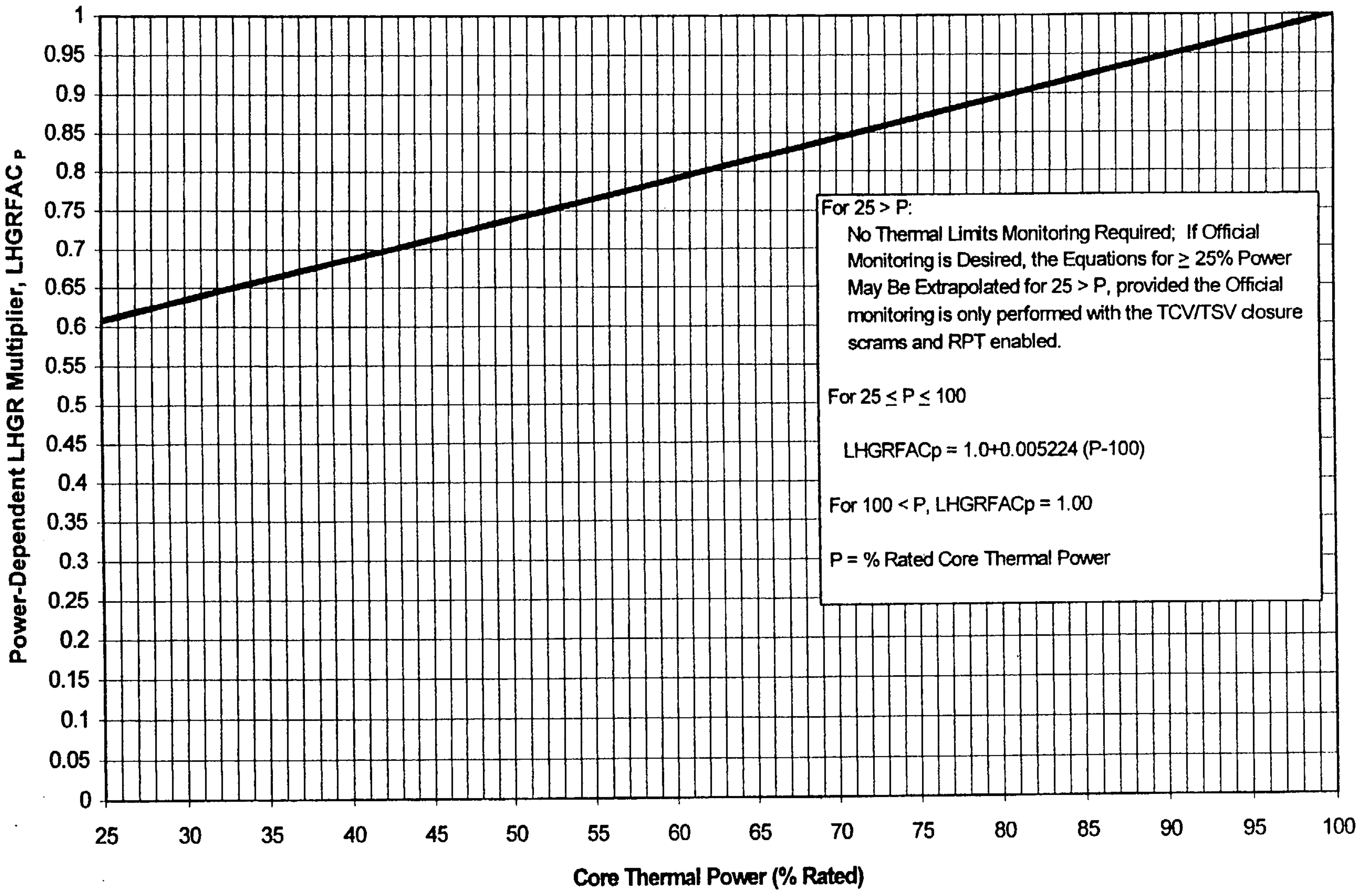
The LHGR Limit is the product of the Steady-State LHGR Limit (given below from Reference 3) and the minimum of either the power dependent LHGR Factor*, LHGRFAC$_P$, or the flow dependent LHGR Factor, LHGRFAC$_F$. LHGRFAC$_P$ is determined from Table 3-1. LHGRFAC$_F$ is determined from Table 3-2. SPC LHGRFAC multipliers from BOC to Coastdown are applicable up to a core average exposure of 30,266.2 MWd/MTU (which is the licensing basis exposure used by SPC). (Reference 3)

Planar Average Exposure (GWd/MTU)	LHGR limit (kW/ft)
0.0	14.4
15.0	14.4
61.1	8.32

* For thermal limit monitoring at greater than 100%P, the 100% power LHGRFACp limits should be applied.

Figure 3.2-1 Power-Dependent LHGR Multipliers for GE Fuel (Formerly MAPFAC$_P$)

(References 8 and 19)



For 25 > P:

No Thermal Limits Monitoring Required; If Official Monitoring is Desired, the Equations for ≥ 25% Power May Be Extrapolated for 25 > P, provided the Official monitoring is only performed with the TCV/TSV closure scrams and RPT enabled.

For 25 ≤ P ≤ 100

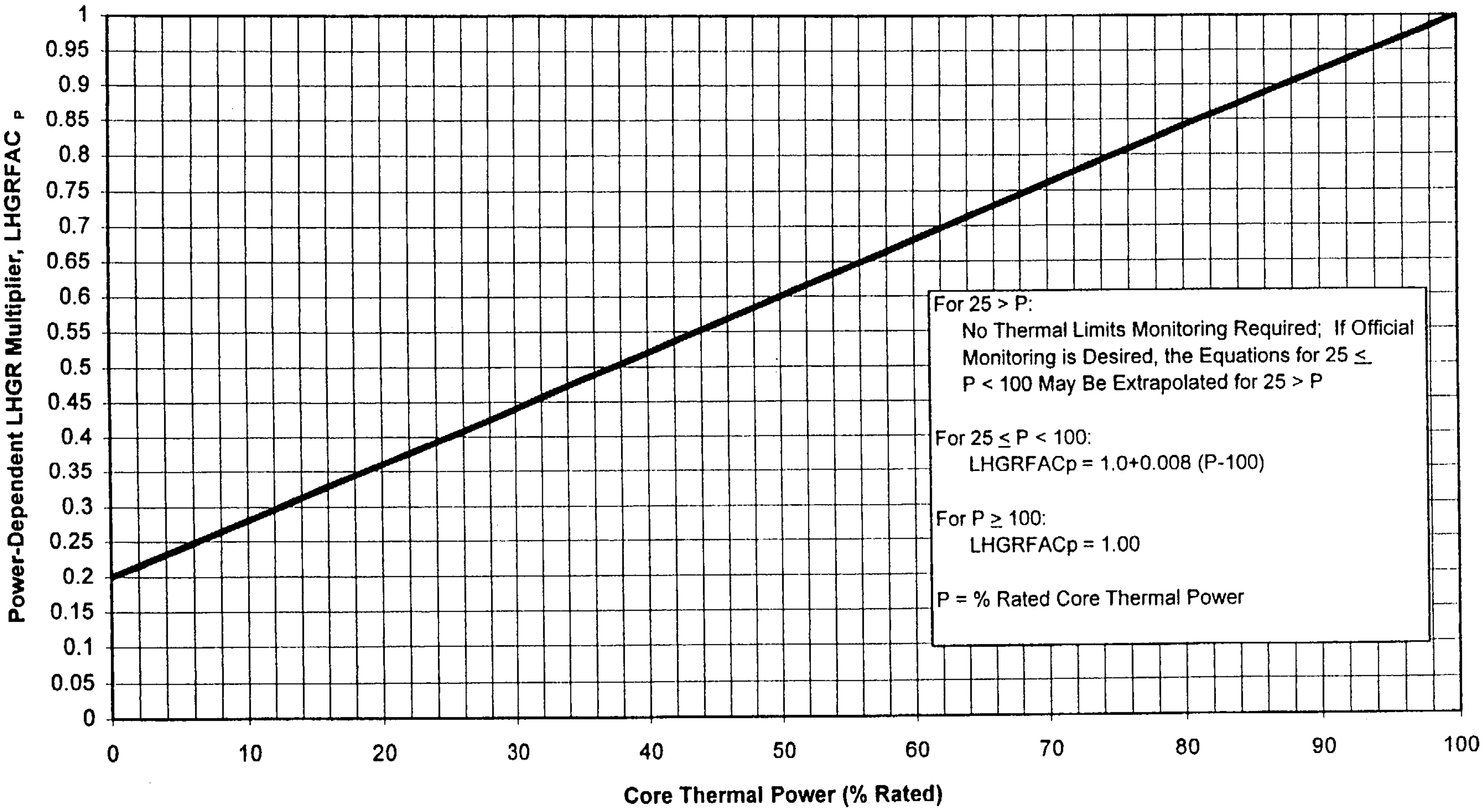
LHGRFACp = 1.0+0.005224 (P-100)

For 100 < P, LHGRFACp = 1.00

P = % Rated Core Thermal Power

Figure 3.2-2 Power-Dependent LHGR Multiplier for GE Fuel (TCV(s) Slow Closure) (formerly $MAPFAC_P$)

(References 11 and 19)



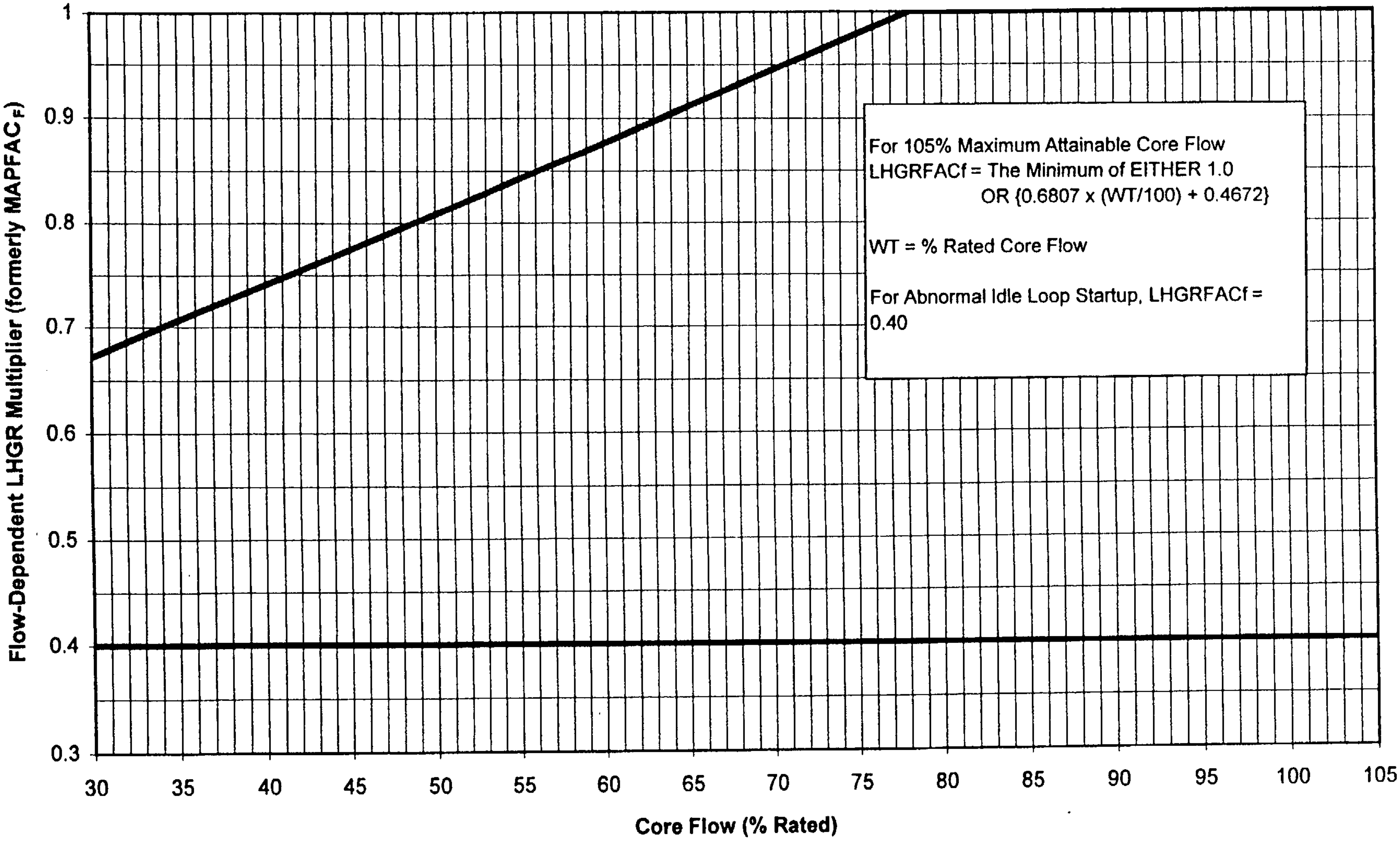
For 25 > P:
No Thermal Limits Monitoring Required; If Official Monitoring is Desired, the Equations for 25 ≤ P < 100 May Be Extrapolated for 25 > P

For 25 ≤ P < 100:
LHGRFACp = 1.0+0.008 (P-100)

For P ≥ 100:
LHGRFACp = 1.00

P = % Rated Core Thermal Power

Figure 3.2-3 Flow-Dependent LHGR Multiplier for GE Fuel (formerly MAPFAC $_F$)
(References 8, 13, 18, and 19)



For 105% Maximum Attainable Core Flow
LHGRFACf = The Minimum of EITHER 1.0
OR {0.6807 x (WT/100) + 0.4672}

WT = % Rated Core Flow

For Abnormal Idle Loop Startup, LHGRFACf = 0.40

Table 3-1
LHGRFAC$_P$ for Siemens Fuel

(References 3 and 51)

Operation from BOC to Coastdown**

Percent Core Thermal Power*

EOOS Combination	0	25	25	60	80	80	100
No EOOS	0.77	0.77	0.77	1.00			1.00
Single RR Loop only	0.77	0.77	0.77	1.00			1.00
EOOS***	0.67	0.67	0.67		0.85	0.89	0.89
EOOS***/Single RR Loop	0.67	0.67	0.67		0.85	0.89	0.89

* Values are interpolated between relevant power levels. For operation at exactly 25% or 80% CTP, the more limiting value is used. 3489 MWt is rated power.

** Coastdown thermal limits are not provided in this COLR

*** Allowable EOOS conditions are listed in Section 5.

Table 3-2
LHGRFAC$_F$ for Siemens Fuel

(Reference 3)

Values Applicable for up to 105% Maximum Attainable Core Flow

Flow (% rated)	LHGRFAC$_F$ ATRIUM-9B
0	0.69
30	0.69
76	1.00
105	1.00

These LHGRFAC$_f$ multipliers apply from BOC through coastdown and in all EOOS scenarios.

4. Control Rod Withdrawal Block Instrumentation (3.3.2.1)

4.1 Tech Spec Reference:

Tech Spec Table 3.3.2.1-1.

4.2 Description:

The Rod Block Monitor Upscale Instrumentation Setpoints are determined from the relationships shown below:

ROD BLOCK MONITOR UPSCALE TRIP FUNCTION	TRIP SETPOINT	ALLOWABLE VALUE
Two Recirculation Loop Operation*	0.66 W + 51%**	0.66 W + 54%**
Single Recirculation Loop Operation*	0.66 W + 45.7%**	0.66 W + 48.7%**

---

* This setpoint may be lower/higher and will still comply with the RWE Analysis, because RWE is analyzed unblocked.

** Clamped, with an allowable value not to exceed the allowable value for recirculation loop flow (W) of 100%.

5. Allowed Modes of Operation (B 3.2.2, B 3.2.3)

The Allowed Modes of Operation with combinations of Equipment Out-of-Service are as described below:

	---------OPERATING REGION---------			
Equipment Out of Service Options[1]	Standard	MELLLA	ICF[7]	Coastdown[9]
None	Yes	Yes	Yes	No
Feedwater Heaters[2] (Reference 8)	Yes	No[3]	Yes	No
Single RR Loop[10] (Reference 8)	Yes	No[8]	N/A	No
Turbine Bypass Valves (Reference 8)	Yes	Yes	Yes	No
EOC Recirculation Pump Trip (Reference 8)	Yes	Yes	Yes	No
TCV Slow Closure/EOC Recirculation Pump Trip (Reference11)	Yes	Yes	Yes	No
TCV Slow Closure/EOC Recirculation Pump Trip / Feedwater Heaters [2] (References 11, 16, and 17)	Yes	No[3]	Yes	No
Turbine Bypass Valves / Feedwater Heaters [2,5] (Reference 8)	No	No	No	No
EOC Recirculation Pump Trip / Feedwater Heaters [2] (Reference 8)	Yes[4]	No[3]	Yes[4]	No
TCV Stuck Closed[6] (Reference 12)	Yes	Yes	Yes	No

1. Each EOOS condition may be combined with one SRV OOS, up to two TIP Machines OOS or the equivalent number of TIP channels (100% available at startup from a refuel outage), a 20°F reduction in feedwater temperature (without Feedwater Heaters considered OOS), cycle startup with uncalibrated LPRMs (BOC to 500 MWd/MTU), and/or up to 50% of the LPRMs out of service.
2. Up to 100°F Reduction in Feedwater Temperature Allowed with Feedwater Heaters Out-of-Service. Feedwater Heaters OOS may be an actual OOS condition, or an intentionally entered mode of operation to extend the cycle energy.
3. If operating with Feedwater Heaters Out-of-Service, operation in MELLLA is supported by current transient analyses, but administratively prohibited due to core stability concerns.
4. EOC Recirculation Pump Trip OOS/Feedwater Heaters OOS is allowed during non-coastdown operation using the TCV Slow Closure/EOC Recirculation Pump Trip OOS/Feedwater Heaters OOS operating limits.
5. Only when operating in coastdown, otherwise this combination is not allowed.
6. Operation is only allowed when less than 10.5 million lbm/hr steam flow and when average position of 3 open TCVs is less than 50% open, with FCL <103%, and the MCFL setpoint ≥ 120%. TCV Stuck Closed may be in combination with any EOOS except TBVOOS or TCV Slow Closure. If in combination with other EOOS(s), thermal limits may require adjustment for the other EOOS(s) as designated in Sections 1, 2, and 3.
7. ICF is analyzed for up to 105% core flow.
8. The SLO boundary was not moved up with the incorporation of MELLLA. The flow boundary for SLO at uprated conditions remains the ELLLA boundary for pre-uprate conditions. (Reference 20)
9. Coastdown is defined to begin at a core average exposure of 30,266.2 MWd/MTU (which is the licensing basis exposure used by SPC). (Reference 3)
10. Single loop operation is allowed with any of the EOOS options listed in this table.

6. Traversing In-Core Probe System (3.2.1, 3.2.2, 3.2.3)

6.1 Tech Spec Reference:

Tech Spec Sections 3.2.1, 3.2.2, 3.2.3 for thermal limits require the TIP system for recalibration of the LPRM detectors and monitoring thermal limits.

6.2 Description:

When the traversing in-core probe (TIP) system (for the required measurement locations) is used for recalibration of the LPRM detectors and monitoring thermal limits, the TIP system shall be operable with the following:

1. movable detectors, drives and readout equipment to map the core in the required measurement locations, and
2. indexing equipment to allow all required detectors to be calibrated in a common location.

For BOC to BOC + 500 MWD/MT, cycle analyses support thermal limit monitoring without the use of the TIPs.

Following the first TIP set (required prior to BOC + 500 MWD/MT), the following applies for use of the SUBTIP methodology:

With one or more TIP measurement locations inoperable, the TIP data for an inoperable measurement location may be replaced by data obtained from a 3-dimensional BWR core monitoring software system adjusted using the previously calculated uncertainties, provided the following conditions are met:

1. All TIP traces have previously been obtained at least once in the current operating cycle when the reactor core was operating above 20% power, (References 14, 15 and 23) and
2. The total number of simulated channels (measurement locations) does not exceed 42% (18 channels).

Otherwise, with the TIP system inoperable, suspend use of the system for the above applicable monitoring or calibration functions.

6.3 Bases:

The operability of the TIP system with the above specified minimum complement of equipment ensures that the measurements obtained from use of this equipment accurately represent the spatial neutron flux distribution of the reactor core. The normalization of the required detectors is performed internal to the core monitoring software system.

Substitute TIP data, if needed, is 3-dimensional BWR core monitoring software calculated data which is adjusted based on axial and radial factors calculated from previous TIP sets. Since uncertainty could be introduced by the simulation and adjustment process, a maximum of 18 channels may be simulated to ensure that the uncertainties assumed in the substitution process methodology remain valid.

Section 2

LaSalle Unit 2 Cycle 9

Reload Transient Analysis Results

August 2001

Technical Requirements Manual - Appendix J
L2C9 Reload Transient Analysis Results

Table of Contents

Attachment	Preparer	Document
1	ComEd	Neutronics Licensing Report
2	Siemens Power Corporation	Reload Analysis Report
3	Siemens Power Corporation	Plant Transient Analysis
4	General Electric	ARTS Improvement Program Analysis, Supplement 1 (Excerpts)
5	General Electric	TCV Slow Closure Analysis (Excerpts)
6	Framatome ANP	LaSalle Unit 2 Cycle 9 Operating Limits for Proposed ITS Scram Times and Corrected Fuel Thermal Conductivity

Attachment 1

LaSalle Unit 2 Cycle 9

Neutronics Licensing Report

NJB

Doc ID# DG00-001303

NUCLEAR FUEL MANAGEMENT
TRANSMITTAL OF DESIGN INFORMATION

☐ SAFETY RELATED
☐ NON-SAFETY RELATED
☐ REGULATORY RELATED

Originating Organization
☒ Nuclear Fuel Management
☐ Other (specify) ________

NFM ID# NFM0000115
Sequence 0
Page 1 of 21

Station: LaSalle Unit: 2 Cycle: 9 Generic: ______

To: Jeffery K. Nugent (LS)

Subject: LaSalle Unit 2 Cycle 9 Neutronics Licensing Report

Ming-Yuan Hsiao Preparer	Ming-Yuan Hsiao Preparer's Signature	9-15-00 Date
Peter A. Weggeman Reviewer	Reviewer's Signature	9.15-00 Date
Adelmo S. pallotta NFM Department Head	Approver's Signature	10/5/00 Date

Status of Information:
☐ Verified
☐ Unverified
☐ Engineering Judgement

Action Tracking # for Method and Schedule of Verification for Unverified DESIGN INFORMATION : ____________

Description of Information: Provide the station and BSS group LaSalle Unit 2 Cycle 9 Neutronics Licensing Report (NLR).

Purpose of Information:

Seq. 0: Provide the station and BSS group LaSalle Unit 2 Cycle 9 Neutronics Licensing Report (NLR).

Source of Information: As referenced

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Adelmo S. Pallotta
Edward A. McVey
Ming Y. Hsiao

COMMONWEALTH EDISON COMPANY
NUCLEAR FUEL SERVICES

NEUTRONICS LICENSING REPORT

for

LaSalle Unit 2 Cycle 9

preparer: MYH, 8-31-00

reviewer PAW 8.31.00

Licensing Basis

This document, in conjunction with the references 1, 2 and 4 in Section VIII provide the licensing basis for LaSalle Unit 2 Reload 8, Cycle 9.

Table of Contents

I. Nuclear Design Analysis

I.1 Fuel Bundle Nuclear Design Analysis

Assembly Average Enrichment (ATRIUM-9B), w/o U-235

SPCA9-391B-14G8.0-100M	3.91
SPCA9-410B-19G8.0-100M	4.10
SPCA9-383B-16G8.0-100M	3.83
SPCA9-396B-12GZ-100M	3.96

Axial Enrichment and Burnable Poison Distribution

SPCA9-391B-14G8.0-100M	Figure 1
SPCA9-410B-19G8.0-100M	Figure 1
SPCA9-383B-16G8.0-100M	Figure 2
SPCA9-396B-12GZ-100M	Figure 2

Radial Enrichment and Burnable Poison Distribution

SPCA9-4.53L-11G8.0-100M	Figure 3
SPCA9-4.56L-12G8.0-100M	Figure 4
SPCA9-4.21L-13G8.0-100M	Figure 5
SPCA9-4.27L-12G8.0-100M	Figure 6
SPCA9-3.96L-8G5.0-100M	Figure 7
SPCA9-4.58L-8G6.0-100M	Figure 8
SPCA9-4.58L-8G6.0/4G3.0-100M	Figure 9

preparer: myH, 8-31-00   reviewer PAW 8-31-00

I.2 Core Nuclear Design Analysis

I.2.1 Core Configuration and Licensing Exposure Limits

Bundle Type	Cycle Loaded	Number in Core
GE9B-P8CWB322-11GZ-100M-150-CECO	7	84
GE9B-P8CWB320-9GZ-100M-150-CECO	7	76
SPCA9-381B-13GZ7-80M	8	128
SPCA9-384B-11GZ6-80M	8	128
SPCA9-391B-14G8.0-100M	9	40
SPCA9-410B-19G8.0-100M	9	120
SPCA9-383B-16G8.0-100M	9	132
SPCA9-396B-12GZ-100M	9	56

Licensing Exposure Limits

Value of Interest	Core Average Exposure (MWD/MT)	Cycle Incremental Exposure (MWD/MT)
Nominal EOC 8 Exposure	27892	13750
Short EOC 8 Exposure	27392	13250
Minimum EOC 8 Energy for which C9 Neutronic Licensing Analyses are Valid	27392	13250
BOC 9 Exposure *(assuming nominal EOC 8 energy)*	11799	0
BOC 9 Exposure *(assuming short EOC 8 energy)*	11470	0
Nominal EOC 9 Exposure *(assuming nominal EOC 8 energy)*	29598	17800

Core UO_2 Weights

Cycle of Interest	UO_2 Total Weight (MT)
Cycle 8	135.11
Cycle 9	133.50

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reviewer PAW 9-1-00

I.2.2 Core Reactivity Characteristics

All values reported below are with zero xenon and are for 68°F moderator temperature. The MICROBURN-B cold BOC best estimate K-effective bias is 1.004 at BOC. The shutdown margin calculations are based on the short EOC8 energy given in Section I.2.1.

BOC Cold K-Effective, All Rods Out	1.11257
BOC Cold K-Effective All Rods In	0.95674
BOC Cold K-Effective, Strongest Rod Out	0.99360
BOC Shutdown Margin, % ΔK	1.040
Minimum Shutdown Margin, % ΔK	1.020
Reactivity Defect (R-value), % ΔK	0.020
Cycle Incremental Exposure Corresponding to Minimum Shutdown Margin R-Value (MWD/MTU)	250
Standby Liquid Control System Shutdown Margin, Cold Condition, (% ΔK)	17.8

LaSalle station has upgraded its Standby Liquid Control System so that the B-10 enrichment has been increased from 18.9% to 45%. The above SBLC analysis assumes 660 ppm with the boron enriched to 45% B-10.

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II. Control Rod Withdrawal Error

The control rod withdrawal error event is analyzed at 100% of rated power, 100% of rated flow and unblocked conditions only.

Distance Withdrawn (ft)	ΔCPR
12 (Unblocked)	0.30

The design complies with the SPC 1% plastic strain and centerline melt criteria via conformance to the PAPT (Protection Against Power Transient) LHGR limits. The design complies with the GE centerline melt criteria via conformance to the GE thermal overpower protection (TOP) criteria. The design complies with the GE 1% plastic strain criteria via conformance to the GE mechanical overpower protection (MOP) criteria..

III. Fuel Loading Error

The Fuel Loading Error, including fuel mislocation and misorientation, is classified as an accident. By demonstrating that the Fuel Loading Error meets the more stringent Anticipated Operational Occurrence (AOO) requirements, the offsite dose requirement is assured to be met. Because the events listed below result in a ΔCPR value that is less than that of the limiting transient, the AOO requirements and hence off-site dose requirements are met for the Fuel Loading Error.

III.1 Fuel Mislocation Error

The following value bounds both the SPC and the co-resident GE fuel types.

Event	ΔCPR
Mislocated Bundle	0.23

III.2 Fuel Misrotation Error

The following value bounds both the SPC and the co-resident GE fuel types.

Event	ΔCPR
Misoriented Bundle	0.15

IV. Control Rod Drop Accident

LaSalle is a banked position withdrawal sequence plant. In order to allow the site the option of inserting control rods using the simplified control rod sequence shown in Table 1, a control rod drop accident analysis was performed for the simplified sequence. The results from this simplified sequence analysis bound those where BPWS guidelines are followed. The results demonstrate that the simplified shutdown sequence meets the Technical Specification limit of 280 cal/g for a control rod drop accident. Therefore, the simplified sequence is valid for for control rod insertion for shutdown.

An adder of 0.32 %ΔK is incorporated in this analysis (for other than 00 to 48 control rod drops) to account for possible rod mispositioning errors as well as clumping effects.

Maximum Dropped Control Rod Worth, %ΔK	1.375
Doppler Coefficient, Δk/k/°F	-9.50E-06
Effective Delayed Neutron Fraction used	0.0053
Four-Bundle Local Peaking Factor	1.281
Maximum Deposited Fuel Rod Enthalpy, (cal/g)	222
Number of Rods Greater than 170 cal/g	266

Note that the limit on maximum deposited fuel rod enthalpy is 280 cal/g and the limit on the number of rods greater than 170 cal/g (failed rods) is 770 for the GE 8x8 fuel and 850 for the SPC ATRIUM-9B fuel (in LaSalle UFSAR).

V. Loss of Feedwater Heating

The loss of feedwater heating event is analyzed at 100% of rated power for 81%, 100% and 105% of rated flow and an assumed inlet temperature decrease of 145°F. The event was analyzed from BOC to EOC. The ΔCPR value reported below is bounding for both the SPC and the co-resident GE fuel types and all the analyzed flows.

Event	**ΔCPR**
Loss of Feedwater Heating	0.23

The design complies with the SPC 1% plastic strain and centerline melt criteria via conformance to the PAPT (Protection Against Power Transient) LHGR limits. The design complies with the GE

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reviewer
PAW 10-4-00

1% plastic strain criteria via conformance to the mechanical overpower protection (MOP) limit. The design does not meet the GE thermal overpower protection (TOP) criteria during a loss of feedwater heating event; hence, the LHGR values in the COLR for the affected lattice are adjusted accordingly (References 9, 13 and 14) as follows:

GE9B-P8CWB322-11GZ-100M-150-CECO Bundle (Fuel Type 1)
LHGR Limits for L2C9

Nodal Exposure (GWD/ST)	Nodal Exposure (GWD/MT)	LHGR Limit
0	0	13.75
11.8459	13.06	13.75
25.2182	27.80	11.75
45.6410	50.31	10.31
55.2370	60.89	6.00

GE9B-P8CWB320-9GZ-100M-150-CECO Bundle (Fuel Type 2)
LHGR Limits for L2C9

Nodal Exposure (GWD/ST)	Nodal Exposure (GWD/MT)	LHGR Limit
0	0	14.25
11.0152	12.14	14.25
23.7593	26.19	12.18
43.6866	48.16	10.80
54.3675	59.93	6.00

VI. Maximum Exposure Limit Compliance

Note that the following exposures are based on a nominal Cycle 8 EOC exposure of 13750 MWD/MT and a nominal Cycle 9 exposure of 17800 MWD/MT. If Cycle 9 reaches it's long window (approximately 500 MWD/MTU beyond the nominal Cycle 9 energy), the exposure limits will still be met.

Exposure (MWD/MT)	GE9B Projected (MWD/MT)	GE9B Limit (MWD/MT)	ATRIUM-9B Projected (MWD/MT)	ATRIUM-9B Limit* (MWD/MT)
Peak Batch	39989	42000	36794	NA
Peak Assembly	45399	NA	39460	48000
Peak Rod	NA	NA	43243	55000
Peak Pellet	62595	65000	54918	66000

*The ATRIUM-9B exposure limits identified are not applicable until document EMF-85-74 is added to the Technical Specifications (Tech Specs). Until this document is added to the Tech Specs, the ATRIUM-9B exposure limits are 48.0 GWD/MT for Peak Fuel Assembly (no change), 50.0 GWD/MT for Peak Fuel Rod and 60.0 GWD/MT for Peak Fuel Pellet.

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VII. Spent Fuel Pool and Fresh Fuel Vault Criticality Compliance

For the L2C9 reload, there are four new SPC ATRIUM-9B assembly types consisting of seven unique enriched lattices, as identified in **I.1 Fuel Bundle Nuclear Design Analysis.**

VII.1 Fresh Fuel Vault Criticality Compliance

The fuel storage vault criticality analysis that is detailed in Reference 5 remains valid for the above lattices. All the new (ATRIUM-9B) assemblies comply with the fresh fuel vault criticality limits, i.e., all lattices have an enrichment of less than 5.00 wt % U-235 and a gadolinia content that is greater than 6 rods at 3.0 wt% Gd_2O_3.

Note that the new fuel vault is a moderation-controlled area which implies that hydrogenous materials will be limited within the new fuel storage array. Administrative controls as generally defined in GE SIL No. 152 (dated March 31,1976) must be incorporated for the area.

VII.2 L1 Spent Fuel Pool Criticality Compliance

The LaSalle Unit 1 spent fuel pool criticality analysis that is detailed in Reference 6 remains valid for the above lattices. All the new (ATRIUM-9B) assemblies comply with the spent fuel pool criticality limits, i.e., all lattices have an enrichment of less than 4.60 wt % U-235 and a gadolinia content that is greater than 8 rods at 3.0 wt% Gd_2O_3.

VII.3 L2 Spent Fuel Pool Criticality Compliance

The LaSalle Unit 2 spent fuel pool criticality analysis that is detailed in Reference 7 remains valid for the above lattices. As shown below, all the new (ATRIUM-9B) assemblies comply with the LaSalle Unit 2 spent fuel pool criticality limit of
k-eff < 0.95.

Lattice Type	Maximum k-inf*	Maximum in-Rack k-eff**	Spent Fuel Pool k-eff Limit
SPCA9-4.21L-13G8.0-100M	1.169	< 0.85	0.95
SPCA9-4.27L-12G8.0-100M	1.180	< 0.85	0.95
SPCA9-4.53L-11G8.0-100M	1.192	< 0.85	0.95
SPCA9-4.56L-12G8.0-100M	1.187	< 0.85	0.95
SPCA9-3.96L-8G5.0-100M	1.231	< 0.86	0.95
SPCA9-4.58L-8G6.0/4G3.0-100M	1.233	< 0.86	0.95
SPCA9-4.58L-8G6.0-100M	1.236	< 0.86	0.95

* From 68 °F, uncontrolled CASMO-3G results.
** From Figure 6.1 of Reference 7.

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VIII. References

1. "LaSalle Unit 2 Cycle 9 Reload Analysis", Siemens Power Corporation, EMF-2437, Latest Revision.
2. "LaSalle Unit 2 Cycle 9 Plant Transient Analysis", Siemens Power Corporation, EMF-2440, Latest Revision.
3. "LaSalle 2 cycle 9 Core Design," NDIT NFM0000056 Seq. 1, April 7, 2000 and "L2C9 FLLP," BNDL:00-005, Revision 0, 4/7/2000.
4. Commonwealth Edison, Nuclear Fuel Services, NFSR-0091, "Benchmark of CASMO/MICROBURN BWR Nuclear Design Methods", as supplemented and approved.
5. "Criticality Safety Analysis for ATRIUM-9B Fuel, LaSalle Units 1 and 2 New Fuel Storage Vault," Siemens Power Corporation, EMF-95-134(P), December 1995. [NDIT 960089, Rev. 0]
6. "Criticality Safety Analysis for ATRIUM-9B Fuel, LaSalle Unit 1 Spent Fuel Storage Pool (BORAL Rack)," Siemens Power Corporation, EMF-96-117(P), April 1996. [NDIT 960087, Rev. 0]
7. "Criticality Safety Analysis for ATRIUM-9B Fuel, LaSalle Unit 2 Spent Fuel Storage Pool (Boraflex Rack)," Siemens Power Corporation, EMF-95-088(P), February 1996. [NDIT 960088, Rev. 0]
8. "L2C9 Standby Liquid Control System Worth Calculations," BNDL:00-028, Revision 0, July 14, 2000.
9. "L2C9 Loss of Feedwater Heating Licensing Analysis," BNDL:00-024, Revision 0, July 13, 2000.
10. "LaSalle Unit 2 Cycle 9 RWE - delta CPR," BNDL:00-026, Revision 0, August 23, 2000.
11. "L2C9 Rod Withdrawal Error MOP/TOP Analysis," BNDL:00-023, Revision 0, August 17, 2000.
12. "LaSalle Unit 2 Cycle 9 Neutronic Licensing Shutdown Margin Calculation," BNDL:00-032, Revision 0, August 17, 2000.
13. "LaSalle 2 Cycle 9 LFWH TOP Violation and LHGR Limit Calculation," Letter NFM:BND:00-050, July 13, 2000.
14. "LaSalle 2 Cycle 9 GE9 Curve Adjustment for LFWH TOP Violation," GE Letter KF-00-063, August 24, 2000.
15. "LaSalle 2 Cycle 9 LFWH TOP Violation and LHGR Limit Calculation," Letter NFM:BND:00-050, July 13, 2000.
16. "L2C9 Mislocation Licensing Analysis," BNDL:00-025, September 2000.
17. "L2C9 Bundle Misorientation Analysis," BNDL:00-030, September 2000.

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reviewer PAW 8.31.00

Table 1

L2C9 Simplified Shutdown Sequence

Shutdown From an A1 Sequence

Rod Group*	Insertion (Bank)	Comments**
7 or 8	48-00	Either Group 7 or 8 may be inserted first.
10	48-00	Groups 7 and 8 must be fully inserted prior to inserting any Group 10 rod.
9	48-00	Group 10 must be fully inserted prior to inserting any Group 9 rod.
5 or 6	48-00	Groups 5 and 6 may be inserted without banking anytime after Groups 7 and 8 have been inserted and before Group 4 is inserted.
4	48-00	Groups 5 through 10 must be fully inserted prior to inserting any Group 4 rod.
3	48-00	Group 4 must be fully inserted prior to inserting any Group 3 rod.
2	48-00	Group 3 must be fully inserted prior to inserting any Group 2 rod.
1	48-00	Group 2 must be fully inserted prior to inserting any Group 1 rod.

Shutdown from an A2 Sequence

Rod Group*	Insertion (Bank)	Comments**
9 or 10	48-00	Either Group 9 or 10 may be inserted first.
8	48-00	Groups 9 and 10 must be fully inserted prior to inserting any Group 8 rod.
7	48-00	Group 8 must be fully inserted prior to inserting any Group 7 rod.
5 or 6	48-00	Groups 5 and 6 may be inserted without banking anytime after Groups 9 and 10 have been inserted and before Group 4 is inserted.
4	48-00	Groups 5 through 10 must be fully inserted prior to inserting any Group 4 rod.
3	48-00	Group 4 must be fully inserted prior to inserting any Group 3 rod.
2	48-00	Group 3 must be fully inserted prior to inserting any Group 2 rod.
1	48-00	Group 2 must be fully inserted prior to inserting any Group 1 rod.

*Group definitions are from LAP-100-13 Revision 21.

** The standard BPWS rules concerning out-of-service rods apply to the shutdown sequences.

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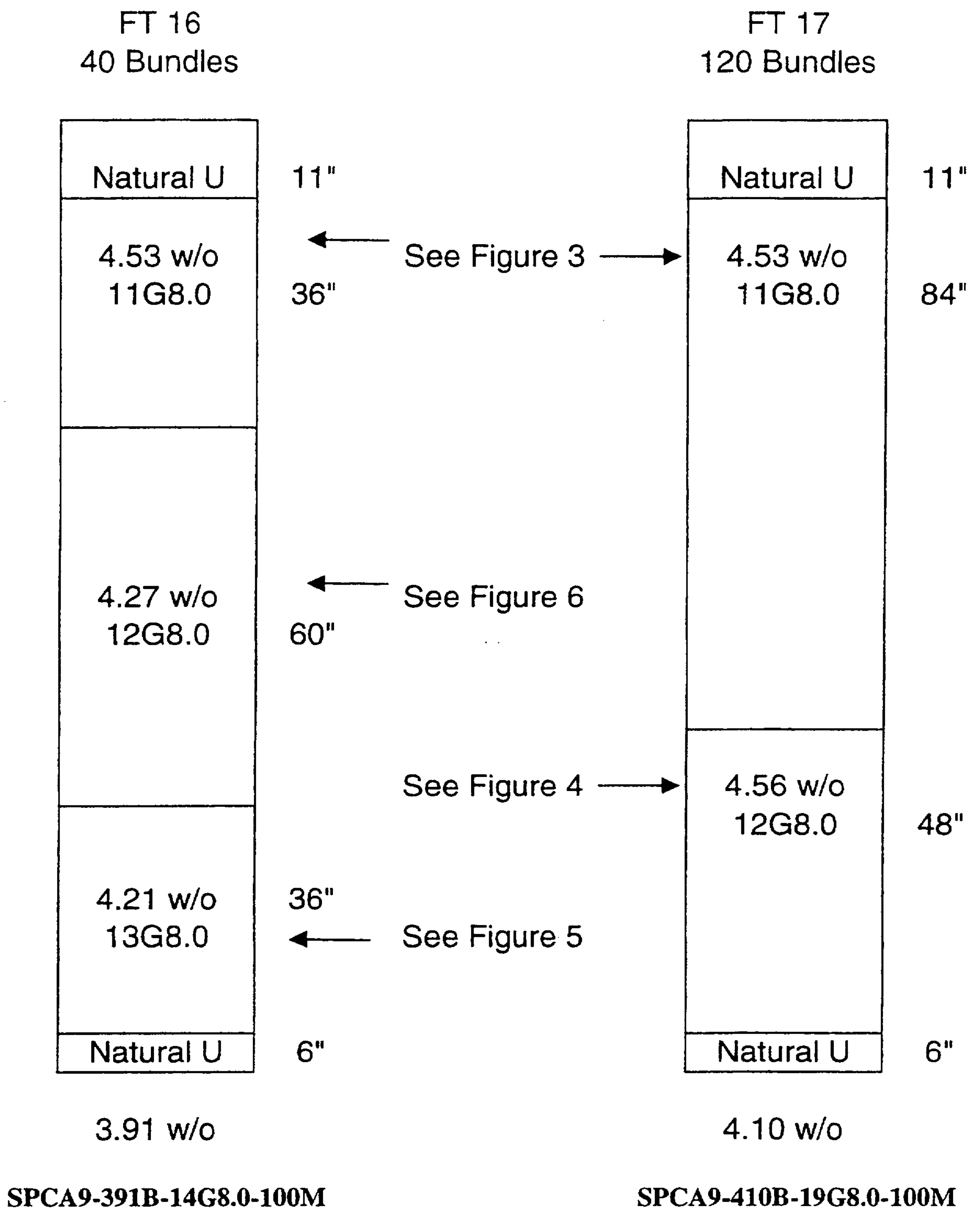

Figure 1. L2C9 Bundle Design (Fuel Types 16 and 17)

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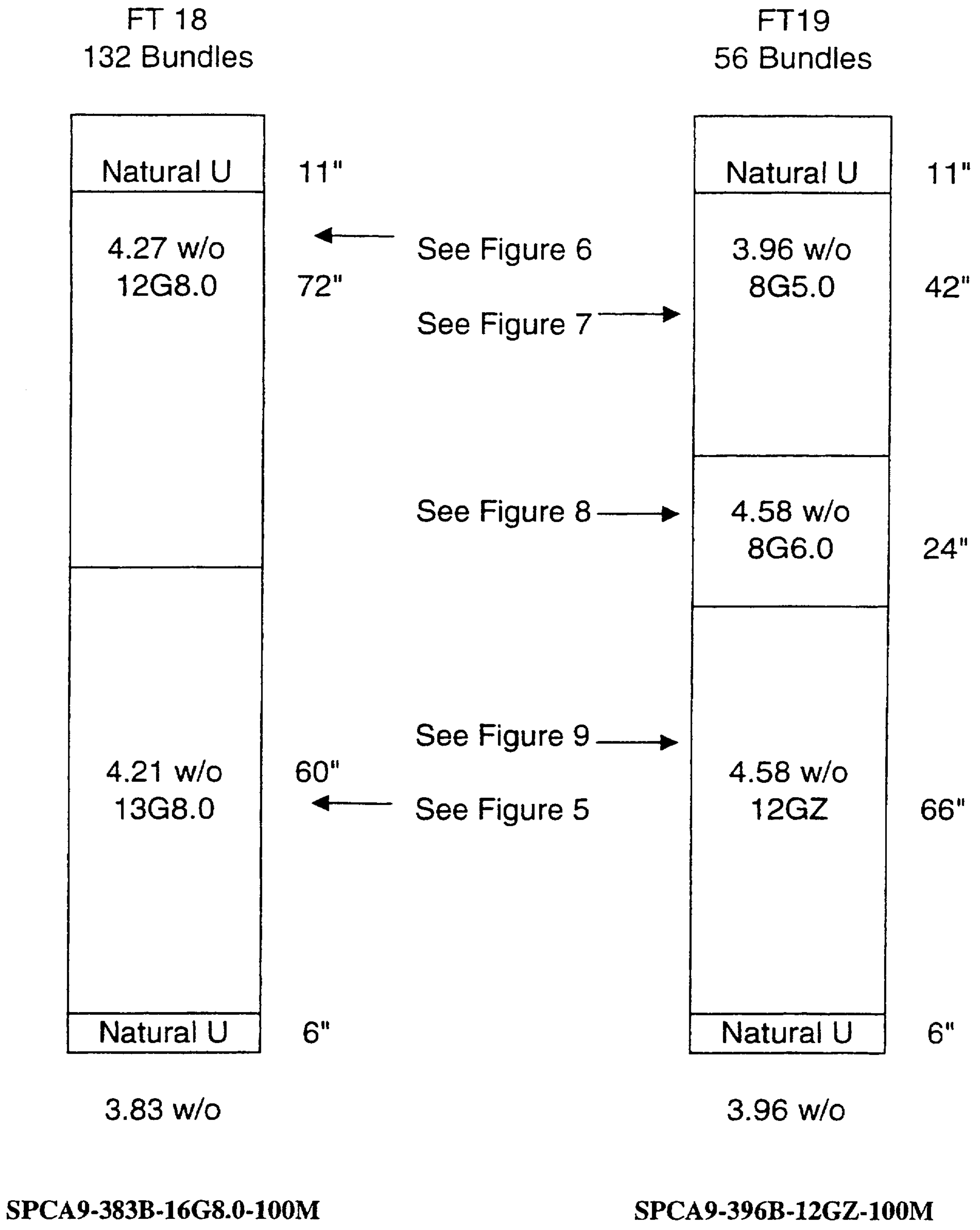
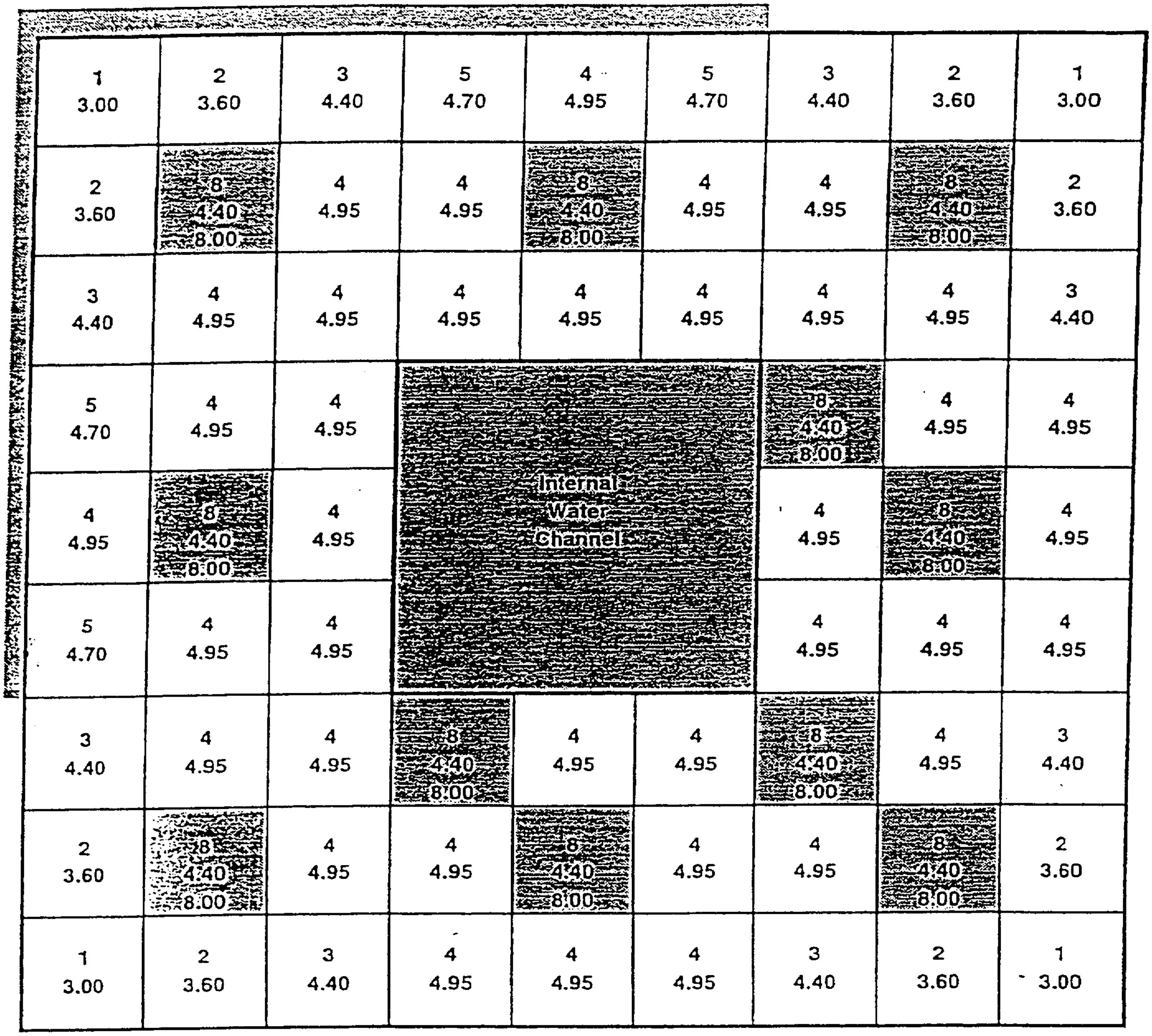


Figure 2. L2C9 Bundle Design (Fuel Types 18 and 19)

preparer: MYH, 8-31-00

reviewer DAW 8-31-00



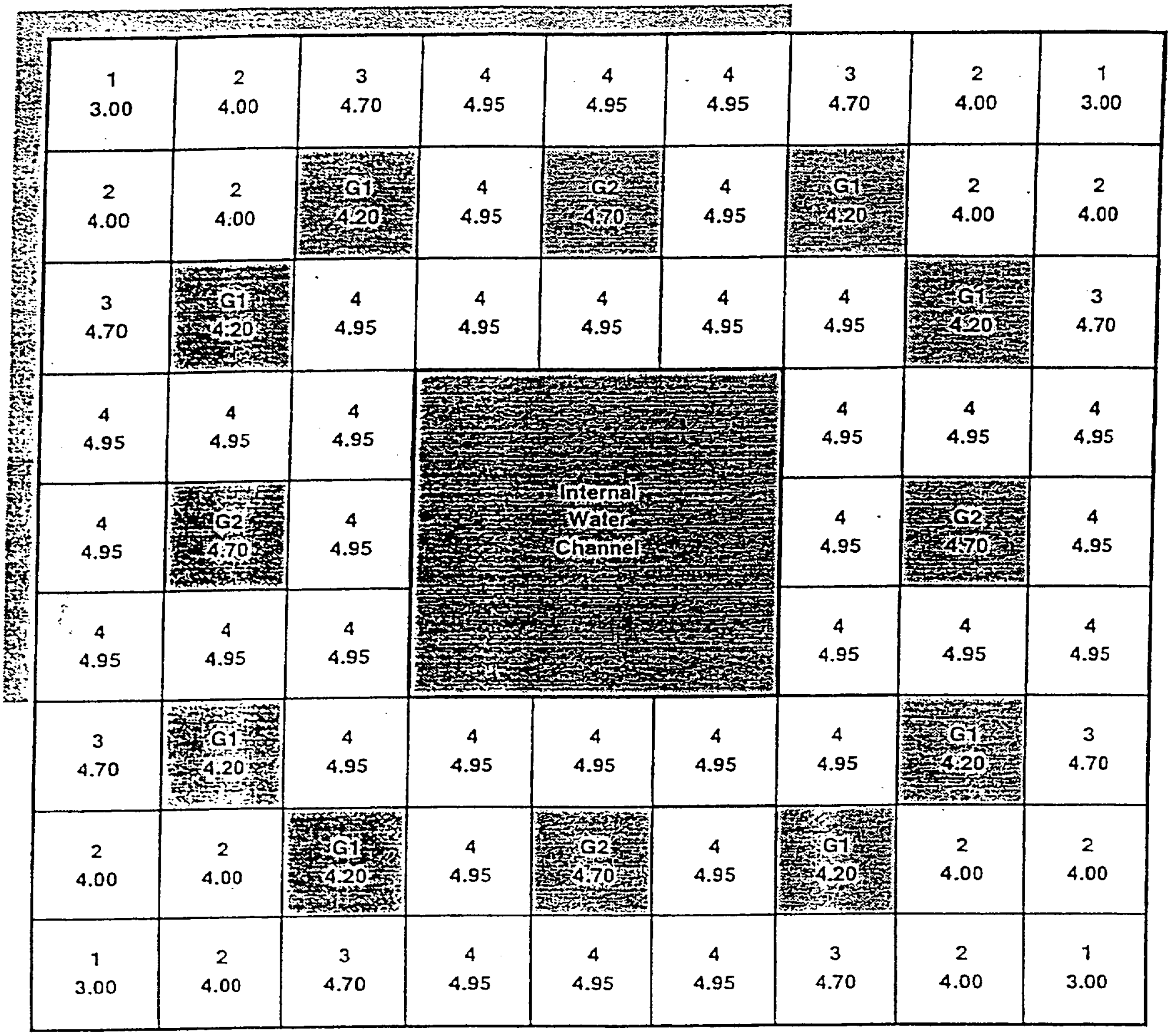
1 3.00	2 3.60	3 4.40	5 4.70	4 4.95	5 4.70	3 4.40	2 3.60	1 3.00
2 3.60	8 4.40 8.00	4 4.95	4 4.95	8 4.40 8.00	4 4.95	4 4.95	8 4.40 8.00	2 3.60
3 4.40	4 4.95	4 4.95	4 4.95	4 4.95	4 4.95	4 4.95	4 4.95	3 4.40
5 4.70	4 4.95	4 4.95	Internal Water Channel			8 4.40 8.00	4 4.95	4 4.95
4 4.95	8 4.40 8.00	4 4.95				4 4.95	8 4.40 8.00	4 4.95
5 4.70	4 4.95	4 4.95				4 4.95	4 4.95	4 4.95
3 4.40	4 4.95	4 4.95	8 4.40 8.00	4 4.95	4 4.95	8 4.40 8.00	4 4.95	3 4.40
2 3.60	8 4.40 8.00	4 4.95	4 4.95	8 4.40 8.00	4 4.95	4 4.95	8 4.40 8.00	2 3.60
1 3.00	2 3.60	3 4.40	4 4.95	4 4.95	4 4.95	3 4.40	2 3.60	1 3.00

TYPE	#	ENR	GD
1	4	3.00	0
2	8	3.60	0
3	8	4.40	0
4	37	4.95	0
5	4	4.70	0
6	0		0
7	0		0
8	11	4.40	8.00
9	0	0.00	0

Figure 3. SPCA9-4.53L-11G8.0-100M Lattice Enrichment Distribution

preparer: MYH, 8-31-00

reviewer PAW 8-31-00



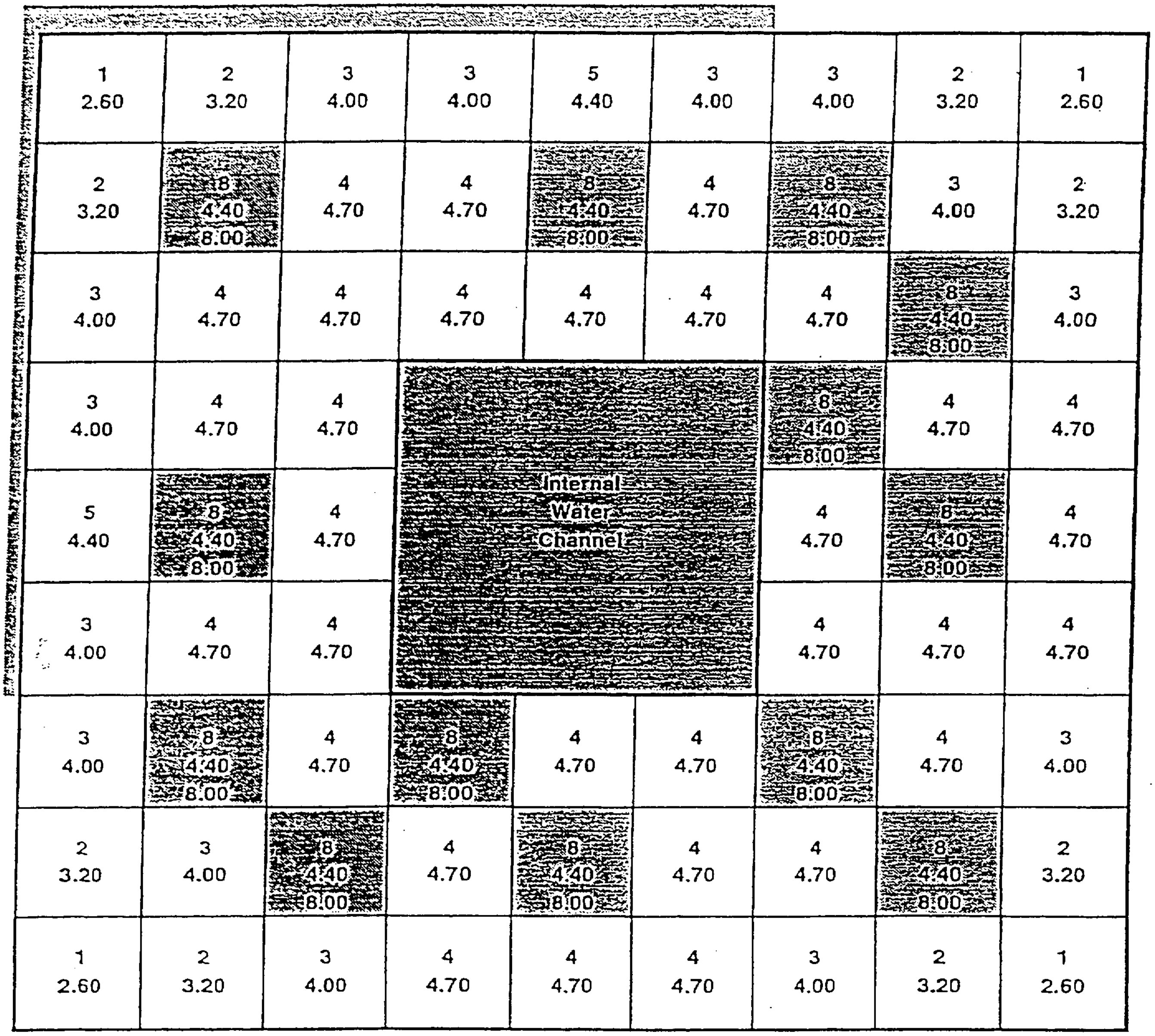
1 3.00	2 4.00	3 4.70	4 4.95	4 4.95	4 4.95	3 4.70	2 4.00	1 3.00
2 4.00	2 4.00	G1 4.20	4 4.95	G2 4.70	4 4.95	G1 4.20	2 4.00	2 4.00
3 4.70	G1 4.20	4 4.95	4 4.95	4 4.95	4 4.95	4 4.95	G1 4.20	3 4.70
4 4.95	4 4.95	4 4.95	Internal Water Channel			4 4.95	4 4.95	4 4.95
4 4.95	G2 4.70	4 4.95				4 4.95	G2 4.70	4 4.95
4 4.95	4 4.95	4 4.95				4 4.95	4 4.95	4 4.95
3 4.70	G1 4.20	4 4.95	4 4.95	4 4.95	4 4.95	4 4.95	G1 4.20	3 4.70
2 4.00	2 4.00	G1 4.20	4 4.95	G2 4.70	4 4.95	G1 4.20	2 4.00	2 4.00
1 3.00	2 4.00	3 4.70	4 4.95	4 4.95	4 4.95	3 4.70	2 4.00	1 3.00

1	Rods (4)	3.00 w/o U-235
2	Rods (12)	4.00 w/o U-235
3	Rods (8)	4.70 w/o U-235
4	Rods (36)	4.95 w/o U-235
G1	Rods (8)	4.20 w/o U-235+8.0 w/o Gd2O3
G2	Rods (4)	4.70 w/o U-235+8.0 w/o Gd2O3

Figure 4. SPCA9-4.56L-12G8.0-100M Lattice Enrichment Distribution

preparer: mYH, 8-31-00

reviewer PAW 8.31.00



1 2.60	2 3.20	3 4.00	3 4.00	5 4.40	3 4.00	3 4.00	2 3.20	1 2.60
2 3.20	8 4.40 8.00	4 4.70	4 4.70	8 4.40 8.00	4 4.70	8 4.40 8.00	3 4.00	2 3.20
3 4.00	4 4.70	4 4.70	4 4.70	4 4.70	4 4.70	4 4.70	8 4.40 8.00	3 4.00
3 4.00	4 4.70	4 4.70				8 4.40 8.00	4 4.70	4 4.70
5 4.40	8 4.40 8.00	4 4.70		Internal Water Channel		4 4.70	8 4.40 8.00	4 4.70
3 4.00	4 4.70	4 4.70				4 4.70	4 4.70	4 4.70
3 4.00	8 4.40 8.00	4 4.70	8 4.40 8.00	4 4.70	4 4.70	8 4.40 8.00	4 4.70	3 4.00
2 3.20	3 4.00	8 4.40 8.00	4 4.70	8 4.40 8.00	4 4.70	4 4.70	8 4.40 8.00	2 3.20
1 2.60	2 3.20	3 4.00	4 4.70	4 4.70	4 4.70	3 4.00	2 3.20	1 2.60

TYPE	#	ENR	GD
1	4	2.60	0
2	8	3.20	0
3	14	4.00	0
4	31	4.70	0
5	2	4.40	0
6	0		0
7	0		0
8	13	4.40	8.00
9	0	0.00	0

Figure 5. SPCA9-4.21L-13G8.0-100M Lattice Enrichment Distribution

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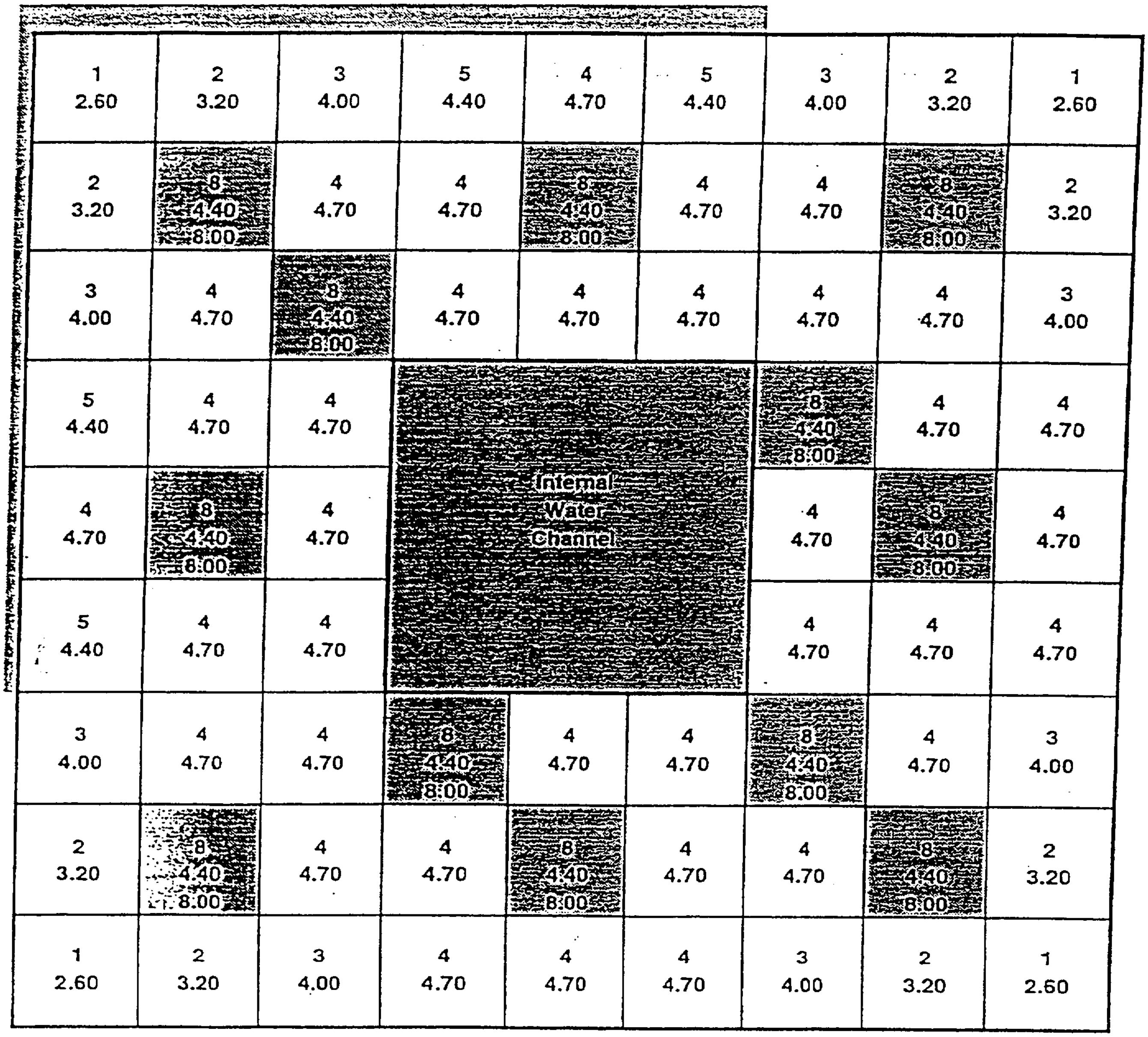
reviewer PAW 8.31.00



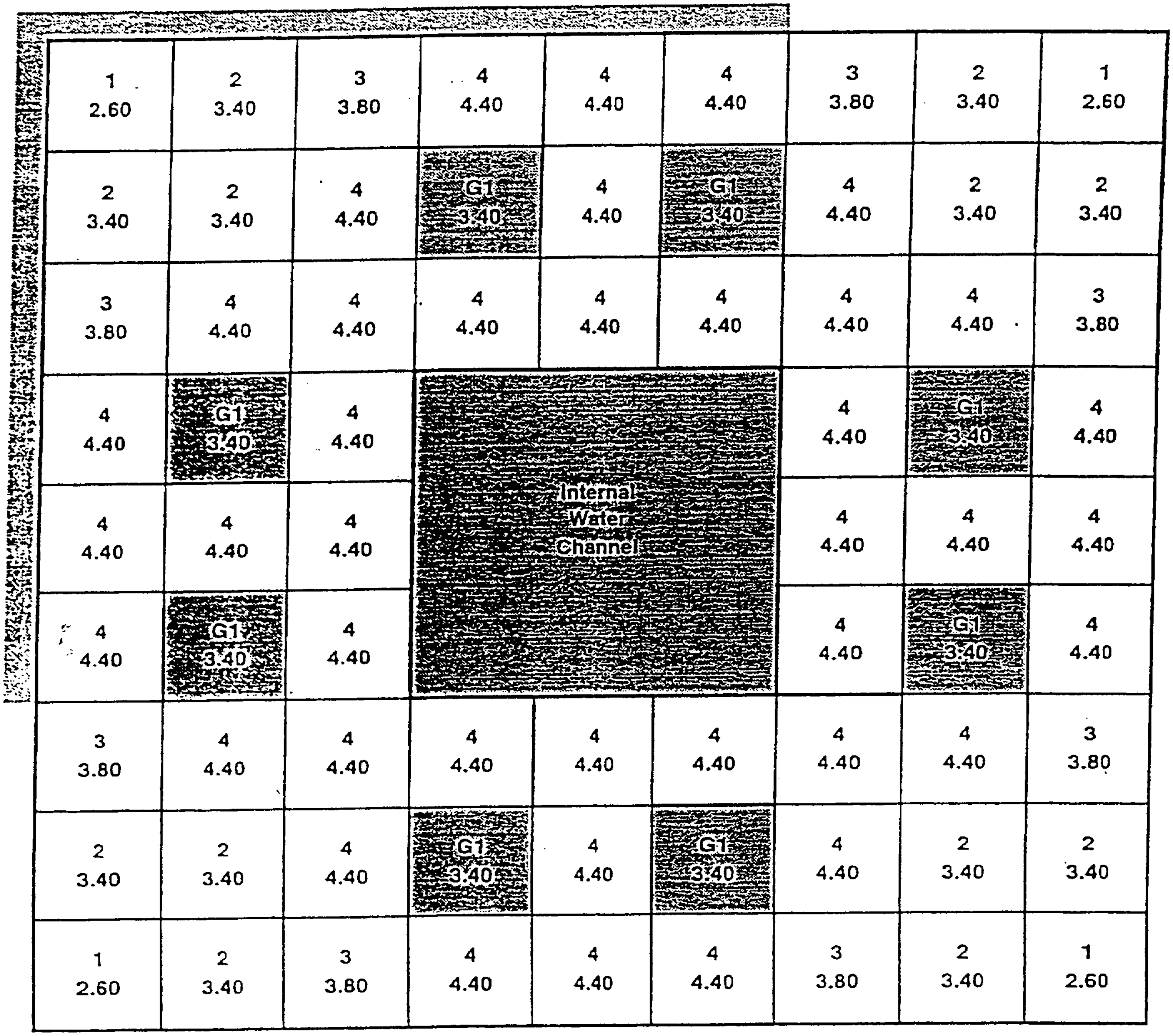
1 2.60	2 3.20	3 4.00	5 4.40	4 4.70	5 4.40	3 4.00	2 3.20	1 2.60
2 3.20	8 4.40 8.00	4 4.70	4 4.70	8 4.40 8.00	4 4.70	4 4.70	8 4.40 8.00	2 3.20
3 4.00	4 4.70	8 4.40 8.00	4 4.70	4 4.70	4 4.70	4 4.70	4 4.70	3 4.00
5 4.40	4 4.70	4 4.70	Internal Water Channel			8 4.40 8.00	4 4.70	4 4.70
4 4.70	8 4.40 8.00	4 4.70				4 4.70	8 4.40 8.00	4 4.70
5 4.40	4 4.70	4 4.70				4 4.70	4 4.70	4 4.70
3 4.00	4 4.70	4 4.70	8 4.40 8.00	4 4.70	4 4.70	8 4.40 8.00	4 4.70	3 4.00
2 3.20	8 4.40 8.00	4 4.70	4 4.70	8 4.40 8.00	4 4.70	4 4.70	8 4.40 8.00	2 3.20
1 2.60	2 3.20	3 4.00	4 4.70	4 4.70	4 4.70	3 4.00	2 3.20	1 2.60

TYPE	#	ENR	GD
1	4	2.60	0
2	8	3.20	0
3	8	4.00	0
4	36	4.70	0
5	4	4.40	0
6	0		0
7	0		0
8	12	4.40	8.00
9	0	0.00	0

Figure 6. SPCA9-4.27L-12G8.0-100M Lattice Enrichment Distribution

preparer: MYH, 8-31-00

reviewer PAW 8-31-00



1 2.60	2 3.40	3 3.80	4 4.40	4 4.40	4 4.40	3 3.80	2 3.40	1 2.60
2 3.40	2 3.40	4 4.40	G1 3.40	4 4.40	G1 3.40	4 4.40	2 3.40	2 3.40
3 3.80	4 4.40	4 4.40	4 4.40	4 4.40	4 4.40	4 4.40	4 4.40	3 3.80
4 4.40	G1 3.40	4 4.40	Internal Water Channel			4 4.40	G1 3.40	4 4.40
4 4.40	4 4.40	4 4.40				4 4.40	4 4.40	4 4.40
4 4.40	G1 3.40	4 4.40				4 4.40	G1 3.40	4 4.40
3 3.80	4 4.40	4 4.40	4 4.40	4 4.40	4 4.40	4 4.40	4 4.40	3 3.80
2 3.40	2 3.40	4 4.40	G1 3.40	4 4.40	G1 3.40	4 4.40	2 3.40	2 3.40
1 2.60	2 3.40	3 3.80	4 4.40	4 4.40	4 4.40	3 3.80	2 3.40	1 2.60

1	Rods (4)	2.60 w/o U-235
2	Rods (12)	3.40 w/o U-235
3	Rods (8)	3.80 w/o U-235
4	Rods (40)	4.40 w/o U-235
G1	Rods (8)	3.40 w/o U-235+5.0 w/o Gd2O3

Figure 7. SPCA9-3.96L-8G5.0-100M Lattice Enrichment Distribution

preparer: MYH, 8-31-00

reviewer PAW 8.31-00

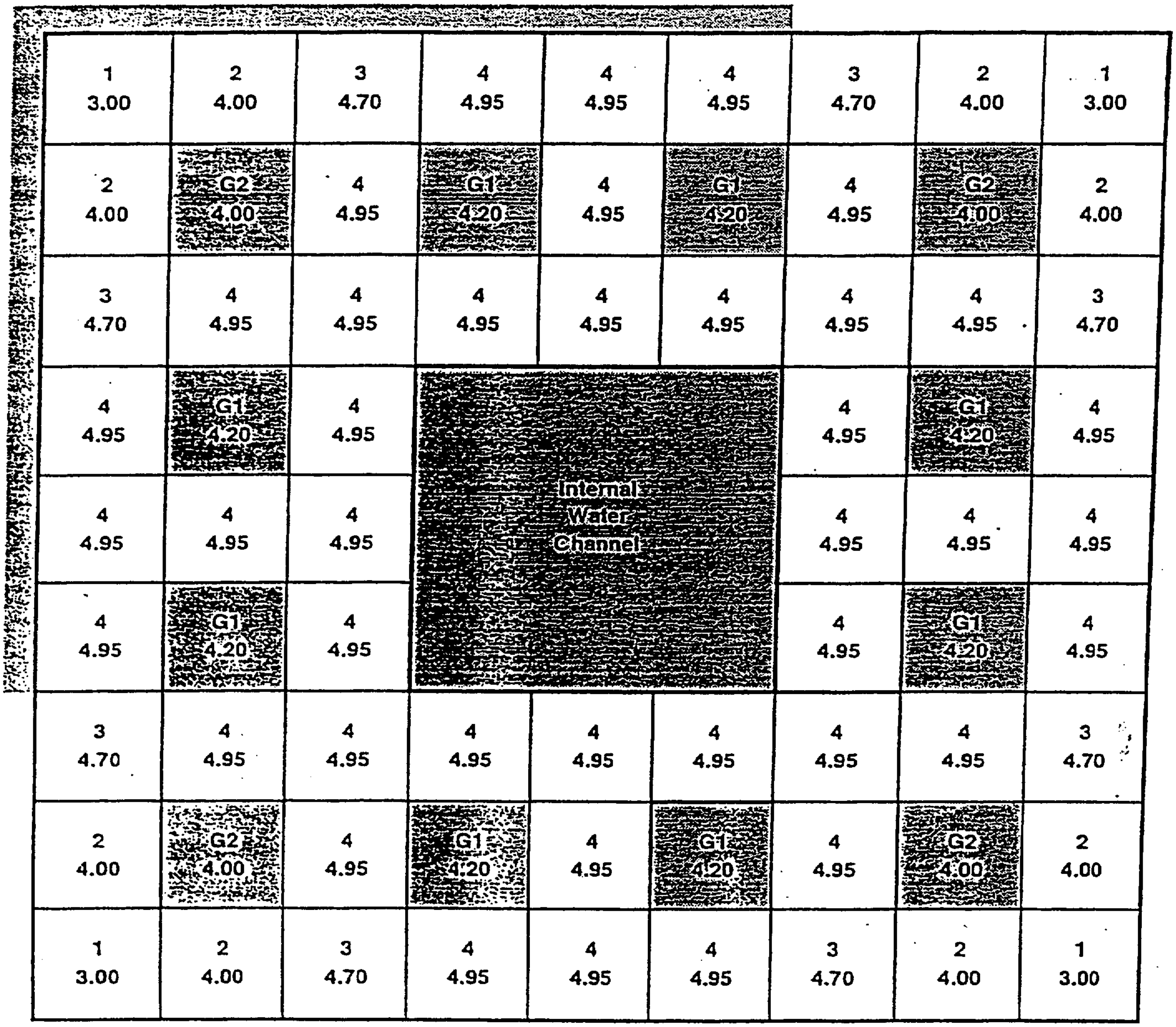
1 3.00	2 4.00	3 4.70	4 4.95	4 4.95	4 4.95	3 4.70	2 4.00	1 3.00
2 4.00	2 4.00	4 4.95	G1 4.20	4 4.95	G1 4.20	4 4.95	2 4.00	2 4.00
3 4.70	4 4.95	4 4.95	4 4.95	4 4.95	4 4.95	4 4.95	4 4.95	3 4.70
4 4.95	G1 4.20	4 4.95	Internal Water Channel			4 4.95	G1 4.20	4 4.95
4 4.95	4 4.95	4 4.95				4 4.95	4 4.95	4 4.95
4 4.95	G1 4.20	4 4.95				4 4.95	G1 4.20	4 4.95
3 4.70	4 4.95	4 4.95	4 4.95	4 4.95	4 4.95	4 4.95	4 4.95	3 4.70
2 4.00	2 4.00	4 4.95	G1 4.20	4 4.95	G1 4.20	4 4.95	2 4.00	2 4.00
1 3.00	2 4.00	3 4.70	4 4.95	4 4.95	4 4.95	3 4.70	2 4.00	1 3.00

1	Rods (4)	3.00 w/o U-235
2	Rods (12)	4.00 w/o U-235
3	Rods (8)	4.70 w/o U-235
4	Rods (40)	4.95 w/o U-235
G1	Rods (8)	4.20 w/o U-235+6.0 w/o Gd2O3

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

preparer: mYH, 8-31-00

reviewer PAW 8-31-00



1 3.00	2 4.00	3 4.70	4 4.95	4 4.95	4 4.95	3 4.70	2 4.00	1 3.00
2 4.00	G2 4.00	4 4.95	G1 4.20	4 4.95	G1 4.20	4 4.95	G2 4.00	2 4.00
3 4.70	4 4.95	4 4.95	4 4.95	4 4.95	4 4.95	4 4.95	4 4.95	3 4.70
4 4.95	G1 4.20	4 4.95				4 4.95	G1 4.20	4 4.95
4 4.95	4 4.95	4 4.95		Internal Water Channel		4 4.95	4 4.95	4 4.95
4 4.95	G1 4.20	4 4.95				4 4.95	G1 4.20	4 4.95
3 4.70	4 4.95	4 4.95	4 4.95	4 4.95	4 4.95	4 4.95	4 4.95	3 4.70
2 4.00	G2 4.00	4 4.95	G1 4.20	4 4.95	G1 4.20	4 4.95	G2 4.00	2 4.00
1 3.00	2 4.00	3 4.70	4 4.95	4 4.95	4 4.95	3 4.70	2 4.00	1 3.00

1	Rods (4)	3.00 w/o U-235
2	Rods (8)	4.00 w/o U-235
3	Rods (8)	4.70 w/o U-235
4	Rods (40)	4.95 w/o U-235
G1	Rods (8)	4.20 w/o U-235+6.0 w/o Gd2O3
G2	Rods (4)	4.00 w/o U-235+3.0 w/o Gd2O3

Figure 9. SPCA9-4.58L-8G6.0/4G3.0-100M Lattice Enrichment Distribution

preparer: myH, 8-31-00

reviewer PAW 8-31-00

Attachment 2

LaSalle Unit 2 Cycle 9

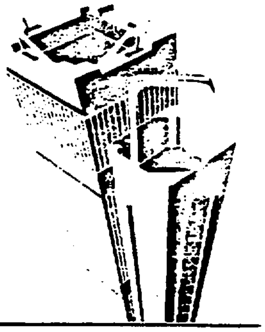
Reload Analysis Report

SIEMENS

EMF-2437
Revision 0

LaSalle Unit 2 Cycle 9 Reload Analysis

October 2000



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Nuclear Division

Siemens Power Corporation

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EMF-2437
Revision 0

LaSalle Unit 2 Cycle 9
Reload Analysis

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M. E. Garrett, Manager
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T. M. Howe, Manager
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Nature of Changes

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

Contents

Tables

Figures

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

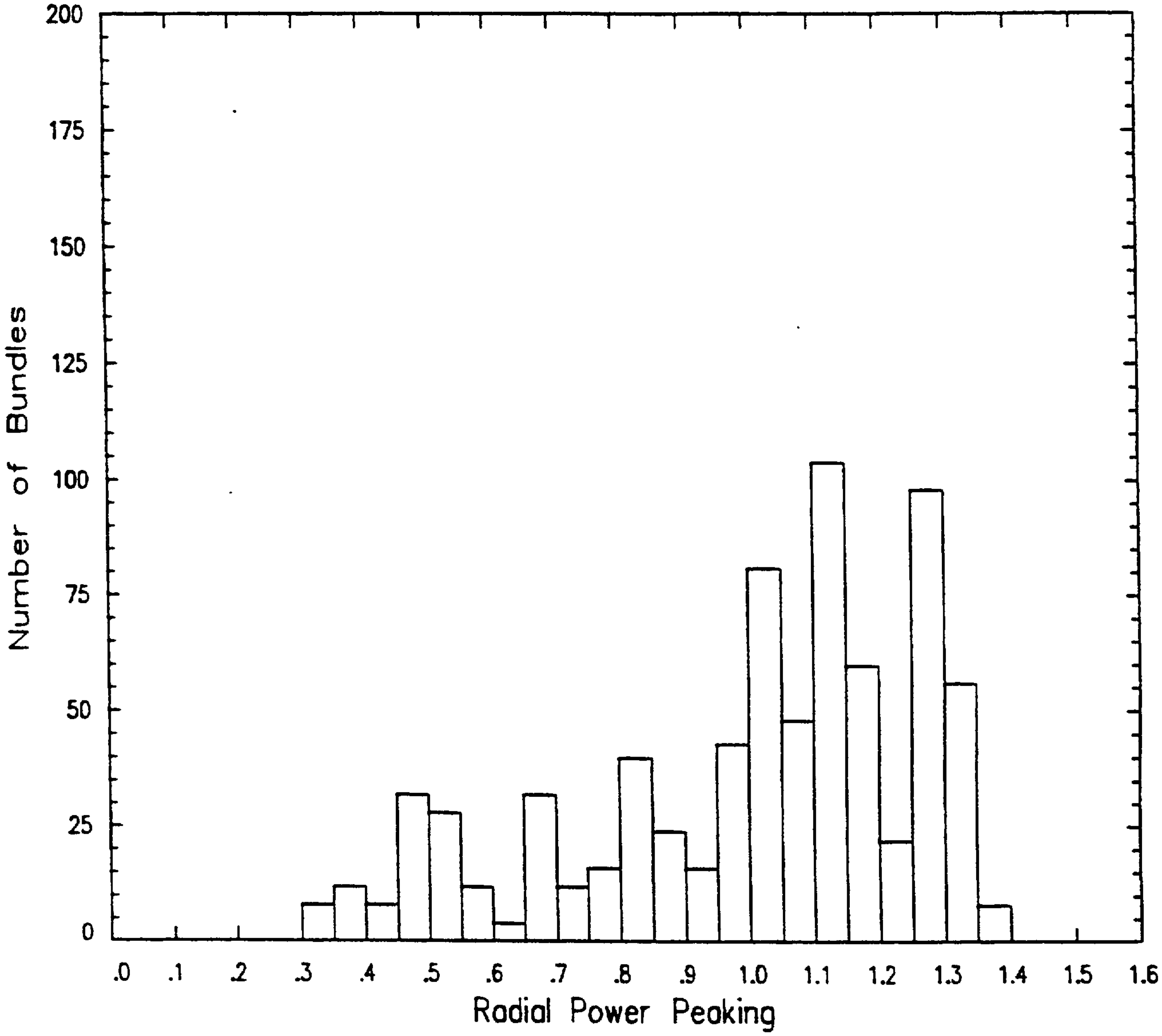

Figure 3.1 Radial Power Distribution for SLMCPR Determination

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.

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* 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

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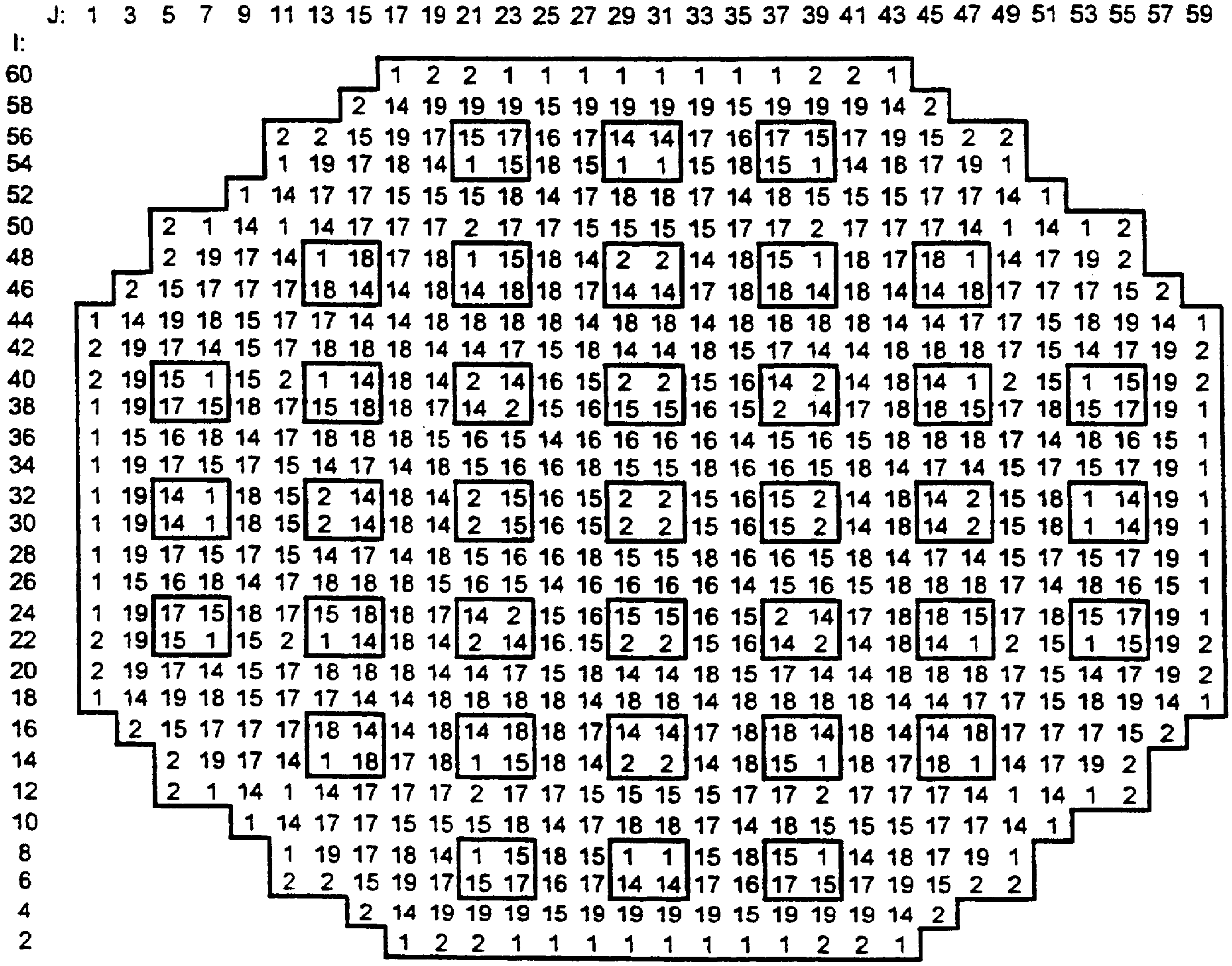
* The control rod data represents original equipment control blades at LaSalle and were used in the neutronic calculations.



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.

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* 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

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* 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)

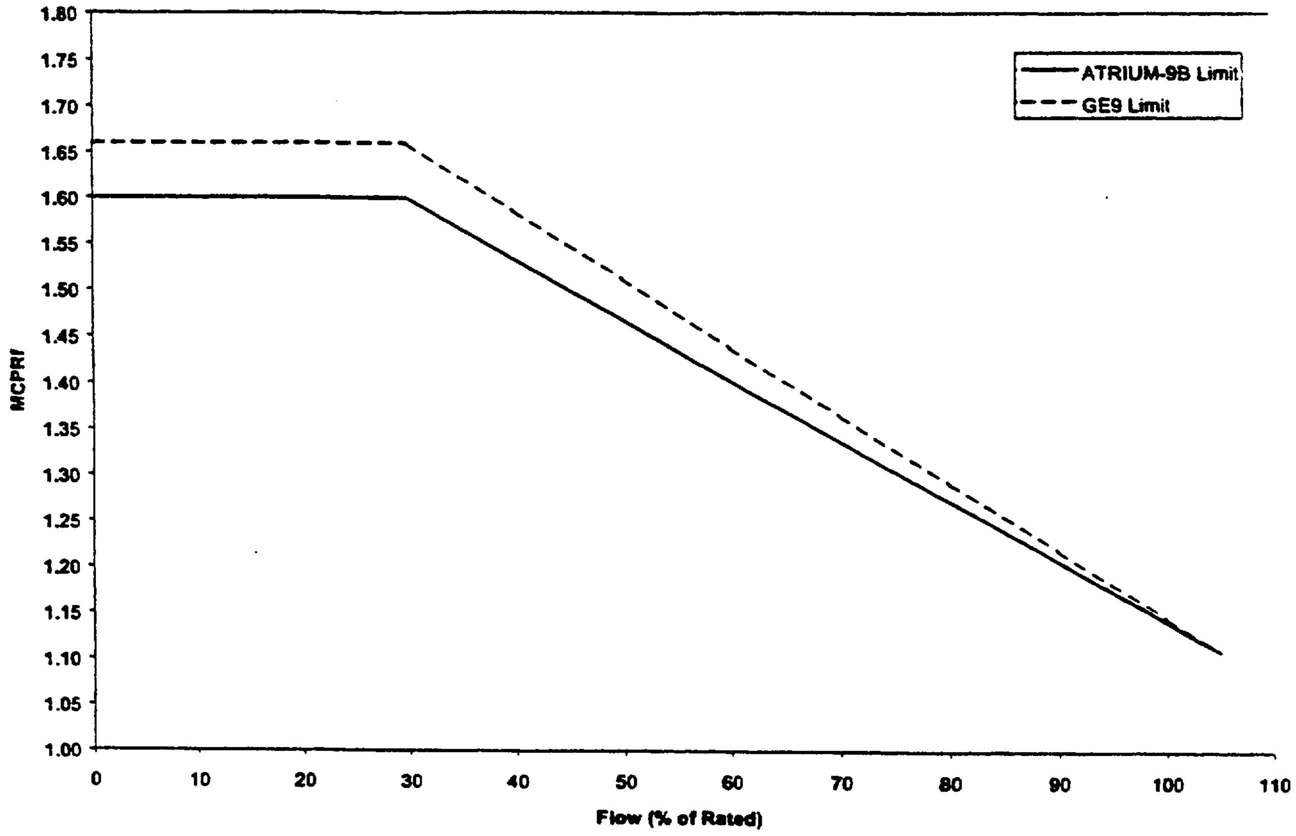
EOOS / EOD Condition	Power (% rated)	ATRIUM-9B Fuel		GE9 Fuel
		$MCPR_p$	$LHGRFAC_p$	$MCPR_p$
Coastdown with turbine control valve (TCV) slow closure **AND/OR** no RPT	0	2.70	0.68	2.70
	25	2.20	0.68	2.20
	25	2.15	0.68	2.15
	80	1.70	0.85	1.96
	80	1.62	0.88	1.85
	100	1.55	0.88	1.67
Coastdown with idle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

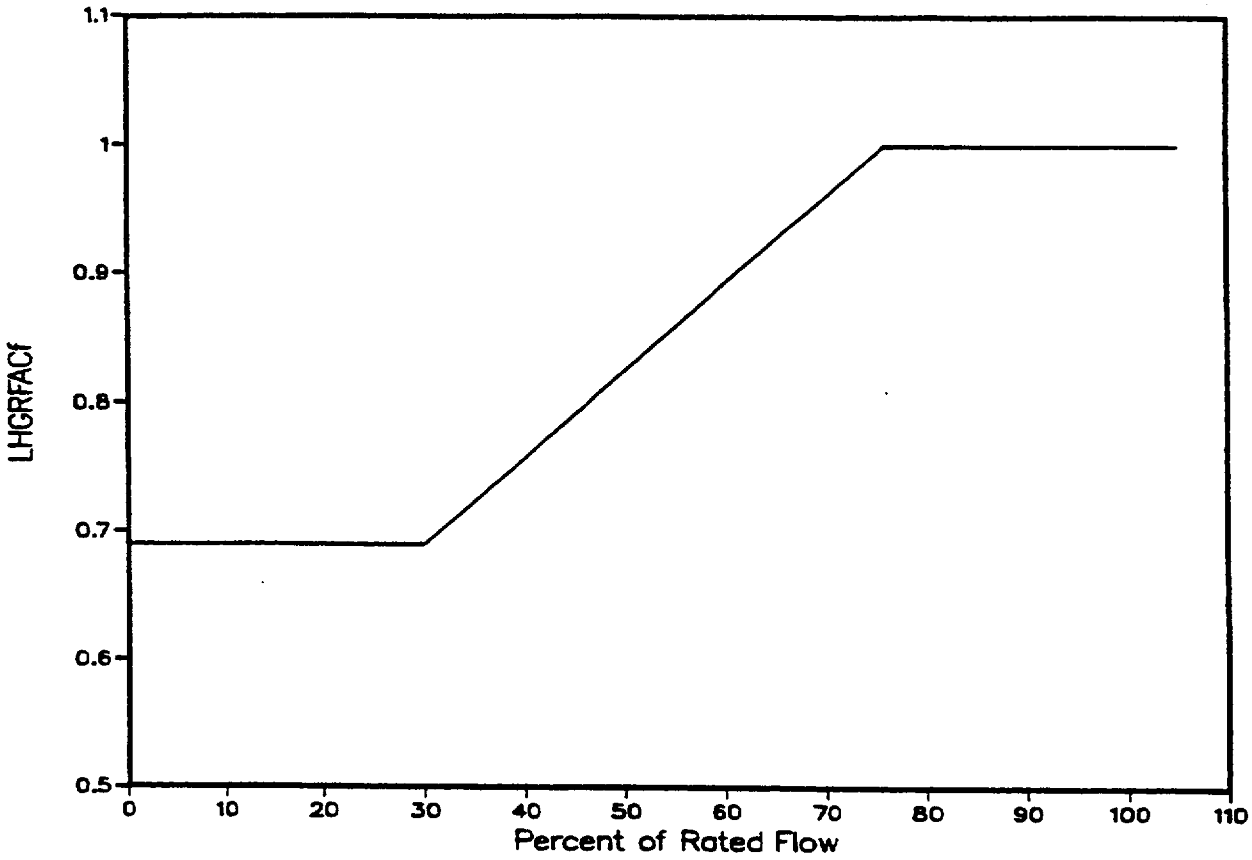
Table 5.4 FFTR/Coastdown Operation Base Case and EOOS MCPR$_p$ Limits and LHGRFAC$_p$ Multipliers for TSSS Insertion Times
(Continued)

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



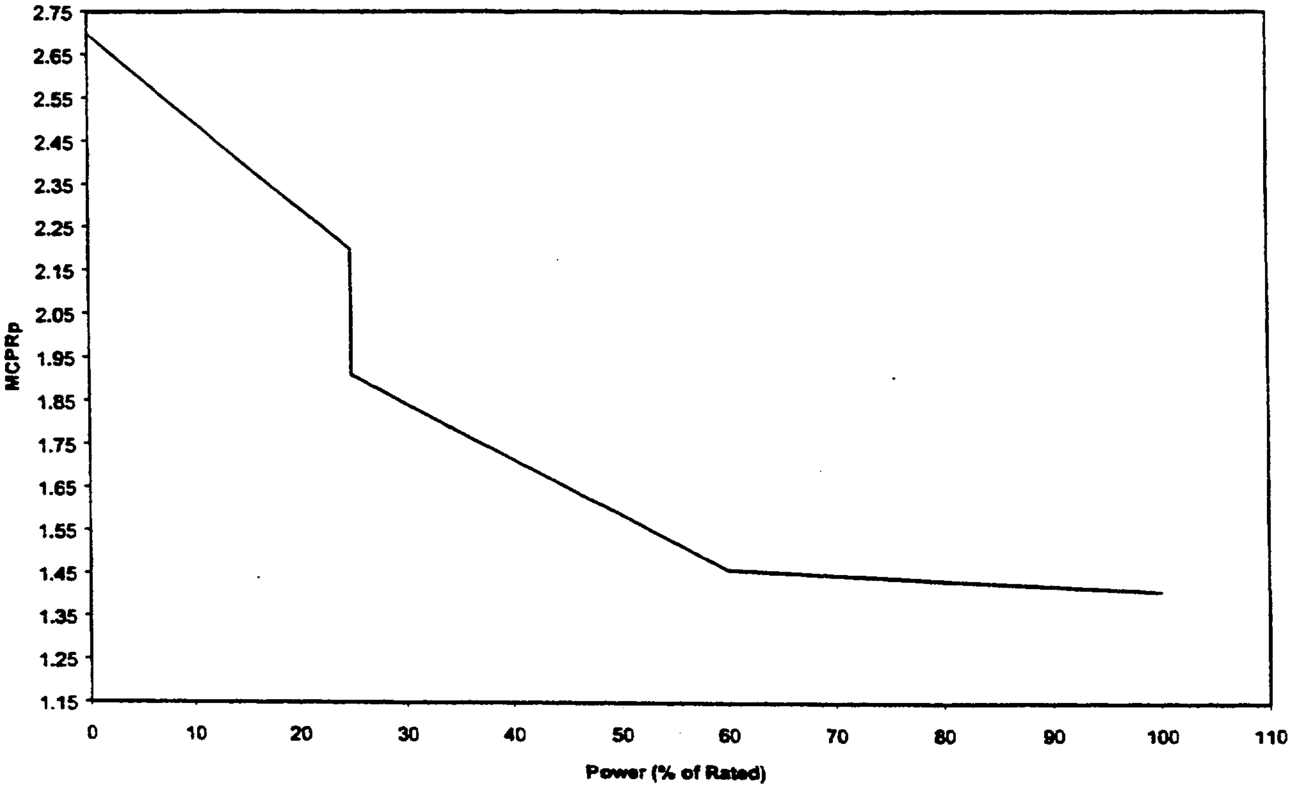
Flow (% of rated)	MCPR$_f$ ATRIUM-9B	MCPR$_f$ GE9 (penalty included)
0	1.60	1.66
30	1.60	1.66
105	1.11	1.11

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



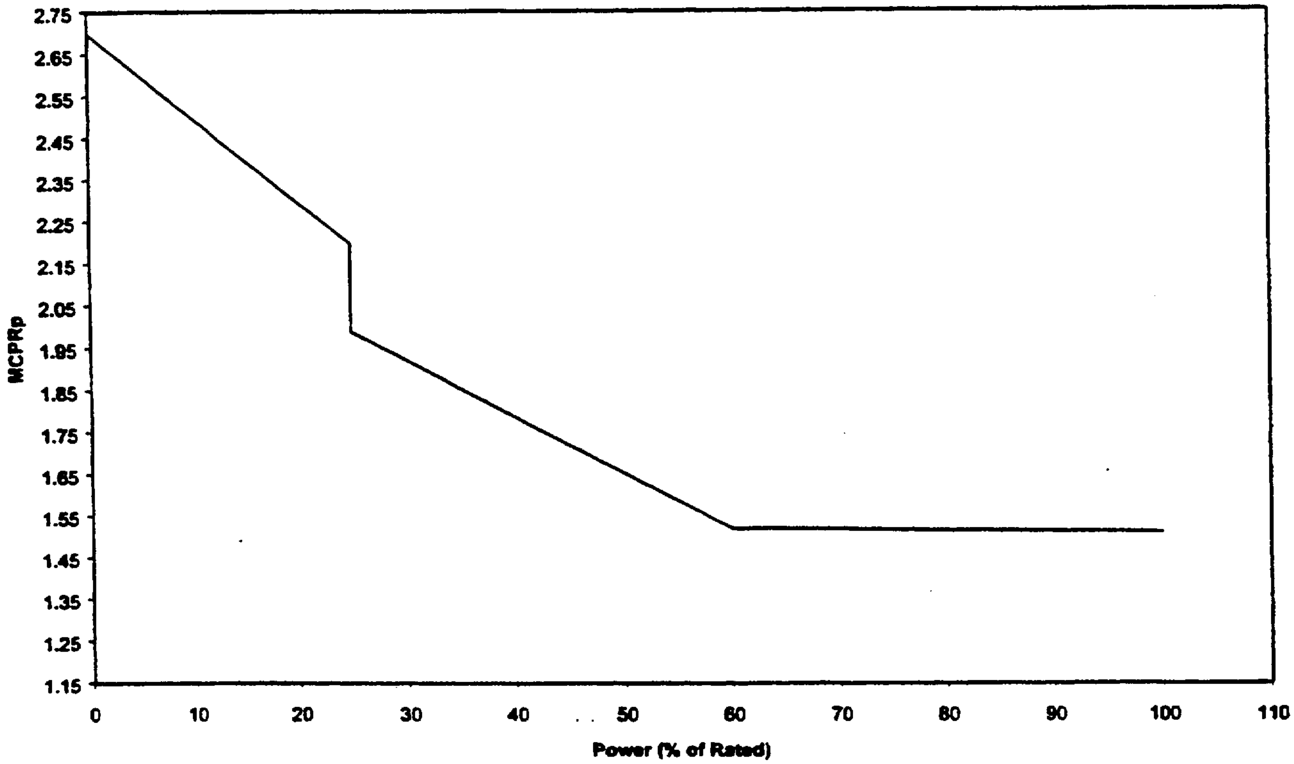
Flow (% rated)	$LHGRFAC_f$
0	0.69
30	0.69
76	1.00
105	1.00

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



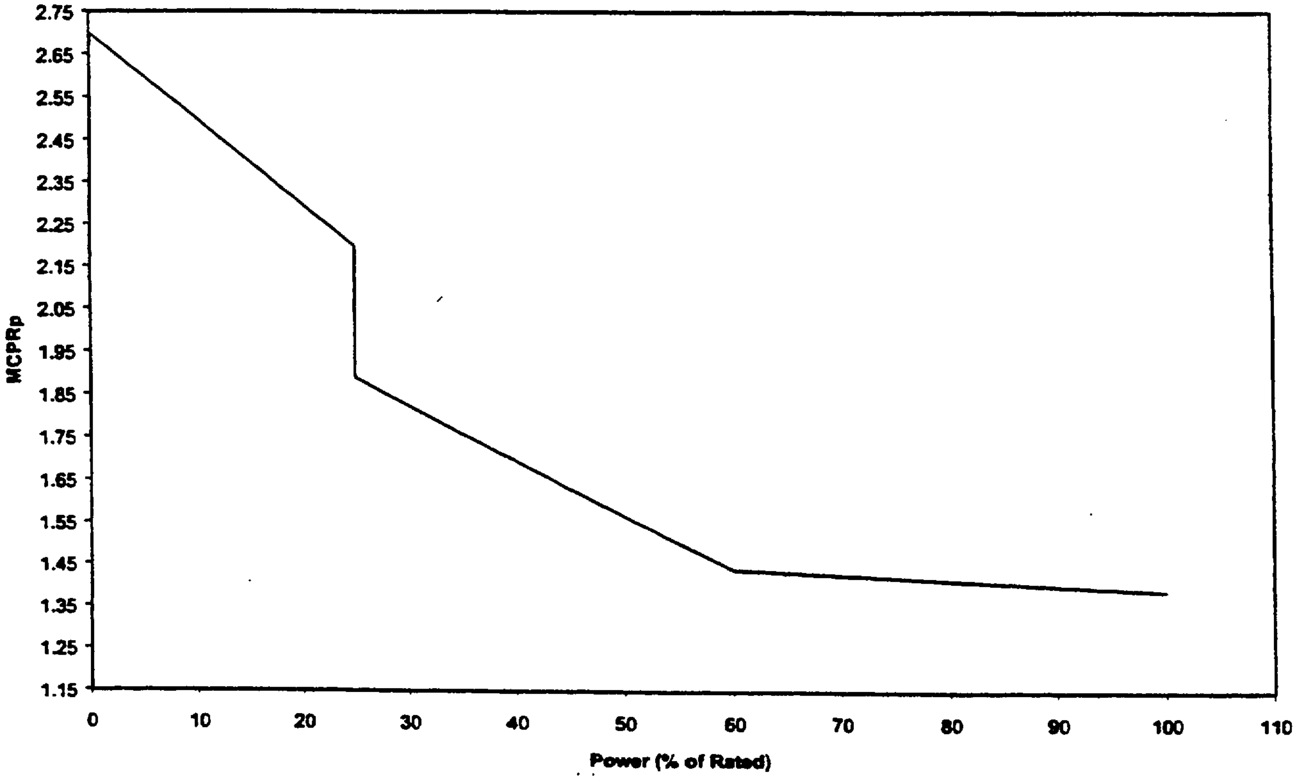
Power (%)	MCPR$_p$ Limit
100	1.41
60	1.46
25	1.91
25	2.20
0	2.70

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



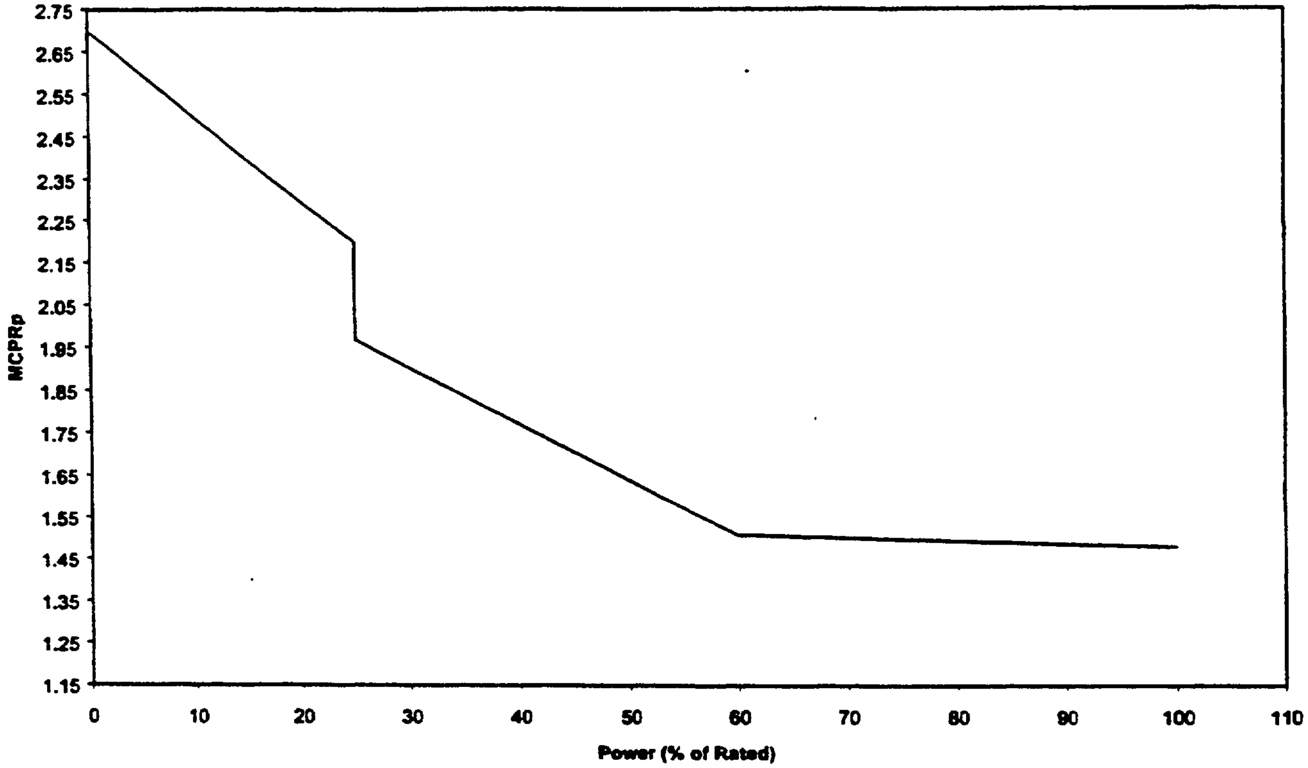
Power (%)	MCPR$_p$ Limit
100	1.51
60	1.52
25	1.99
25	2.20
0	2.70

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

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* 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

Average Planar Exposure (GWd/MTU)	LHGR (kW/ft)
0.0	14.4
15.0	14.4
61.1	8.32

GE9 Fuel
Steady-State LHGR Limits

< To be furnished by ComEd. >

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. >

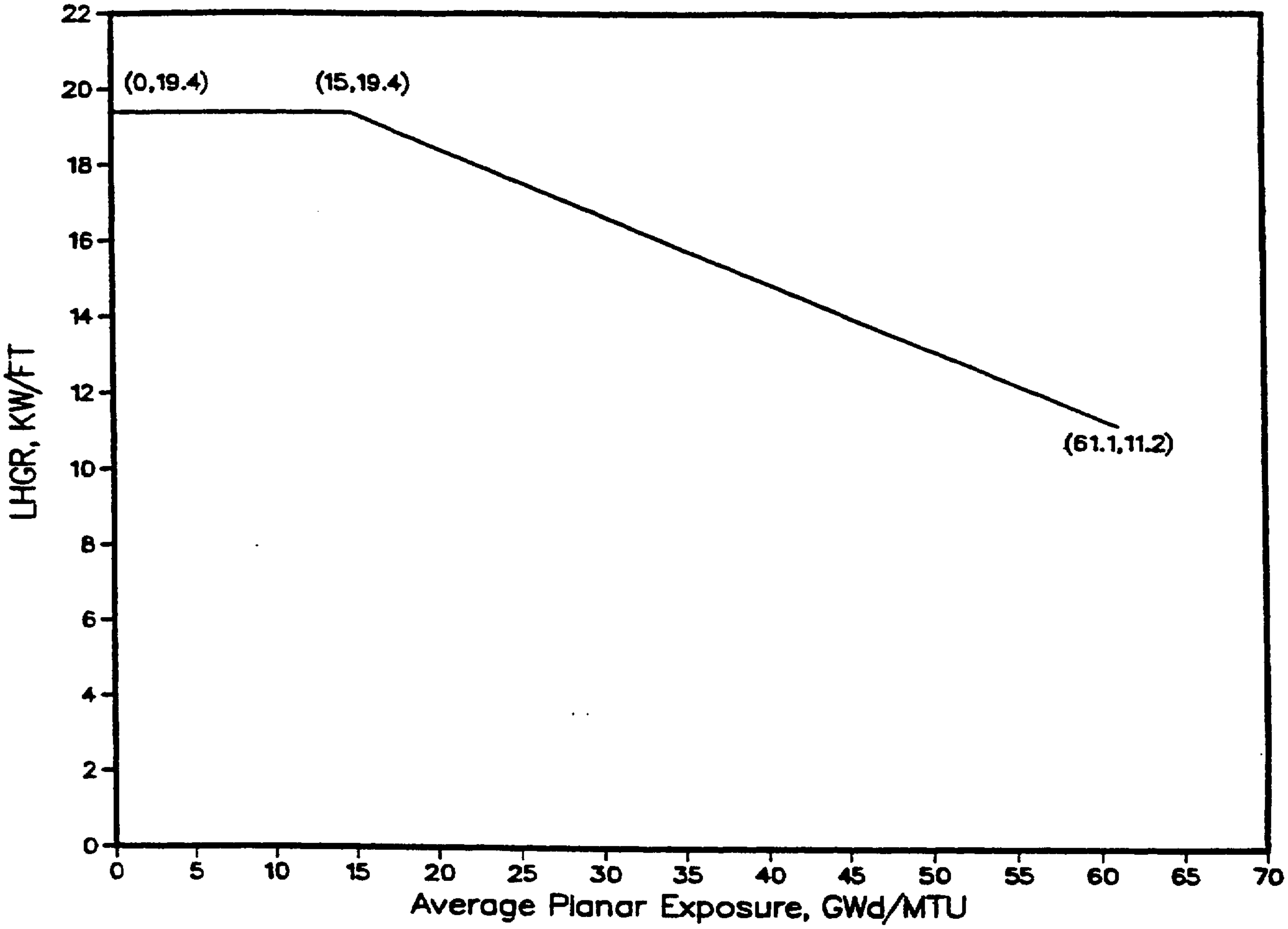

Figure 7.1 Protection Against Power Transient LHGR Limit for ATRIUM-9B Fuel

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.

8.3 ANF-1125(P)(A) and ANF-1125(P)(A), Supplements 1 and 2, *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, *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-2404(P) Revision 1, *Fuel Design Report for LaSalle Unit 2 Cycle 9 ATRIUM™-9B Fuel Assemblies*, Siemens Power Corporation, September 2000.

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-2440 Revision 0, *LaSalle Unit 2 Cycle 9 Plant Transient Analysis*, Siemens Power Corporation, October 2000.

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) Revision 0, *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) Revision 0, *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 2 Cycle 9 Transient Power History for Confirming Mechanical Limits for GE9 Fuel." DEG:00:185, August 3, 2000.

9.11 Letter, D. E. Garber (SPC) to R. J. Chin (ComEd), "10 CFR 50.46 Reporting for the LaSalle Units," DEG:00:203, August 29, 2000.

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

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Attachment 3

LaSalle Unit 2 Cycle 9

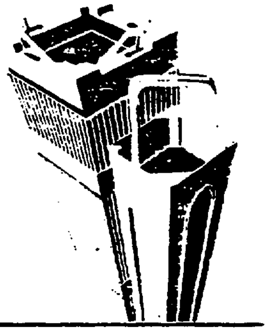
Plant Transient Analysis

SIEMENS

EMF-2440
Revision 0

LaSalle Unit 2 Cycle 9
Plant Transient Analysis

October 2000



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EMF-2440
Revision 0

LaSalle Unit 2 Cycle 9
Plant Transient Analysis

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Nature of Changes

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

Contents

Contents *(Continued)*

Tables

Figures

Figures *(Continued)*

Figures *(Continued)*

Figures *(Continued)*

Nomenclature

AOO	anticipated operational occurrence
ComEd	Commonwealth Edison Company
CPR	critical power ratio
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
HFR	heat flux ratio
ICF	increased core flow
L2C9	LaSalle Unit 2 Cycle 9
LFWH	loss-of-feedwater heating
LHGR	linear heat generation rate
$LHGRFAC_f$	flow-dependent linear heat generation rate factors
$LHGRFAC_p$	power-dependent linear heat generation rate factors
LHGROL	linear heat generation rate operating limit
LPRM	local power range monitor
LRNB	generator load rejection with no bypass
MCPR	minimum critical power ratio
$MCPR_f$	flow-dependent minimum critical power ratio
$MCPR_p$	power-dependent minimum critical power ratio
MELLLA	maximum extended load line limit analysis
MFC	manual flow control
MSIV	main steam isolation valve
NSS	nominal scram speed
PAPT	protection against power transient
RPT	recirculation pump trip
SLMCPR	safety limit MCPR
SLO	single-loop operation
SPC	Siemens Power Corporation
SRV	safety/relief valve
SRVOOS	safety/relief valve out-of-service
SSLHGR	steady-state LHGR

Nomenclature *(Continued)*

TBVOOS	turbine bypass valve out-of-service
TCV	turbine control valve
TIP	traversing incore probe
TIPOOS	tip machine(s) out-of-service
TSSS	technical specification scram speed
TSV	turbine stop valve
TTNB	turbine trip with no bypass
ΔCPR	change in critical power ratio

1.0 Introduction

This report presents results of the plant transient analyses performed by Siemens Power Corporation (SPC) as part of the reload safety analyses to support LaSalle Unit 2 Cycle 9 (L2C9) operation. The Cycle 9 core contains 348 fresh ATRIUM™-9B* assemblies, 256 previously loaded ATRIUM-9B assemblies and 160 previously loaded GE9 assemblies. Those portions of the reload safety analysis for which Commonwealth Edison Company (ComEd) has responsibility are presented elsewhere. The appropriate operating limits for Cycle 9 operation must be determined in conjunction with results from ComEd analyses. The scope of the transient analyses performed by SPC is presented in Reference 1.

The analyses reported in this document were performed using the plant transient analysis methodology approved by the Nuclear Regulatory Commission (NRC) for generic application to boiling water reactors (Reference 2). The transient analyses were performed in accordance with the NRC technical limitations as stated in the methodology (References 3–7). Parameters for the transient analyses are documented in Reference 8.

The Cycle 9 transient analysis consists of the calculation of the limiting transients identified in Reference 9 to support base case operation† for the power/flow map presented in Figure 1.1. Results are also presented to support operation in the extended operating domain (EOD) and equipment out-of-service (EOOS) scenarios identified in Table 1.1. The analysis results are used to establish operating limits to protect against fuel failures. Minimum critical power ratio (MCPR) limits are established to protect the fuel from overheating during normal operation and anticipated operational occurrences (AOOs). Power-dependent MCPR ($MCPR_p$) limits are required in order to provide the necessary protection during operation at reduced power. Flow-dependent MCPR ($MCPR_f$) limits provide protection against fuel failures during flow excursions initiated at reduced flow. Cycle 9 power- and flow-dependent MCPR limits are presented to protect both ATRIUM-9B and GE9 fuel.

Protection against violating the linear heat generation rate (LHGR) limits at rated and off-rated conditions is provided through the application of power- and flow-dependent LHGR factors

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* ATRIUM is a trademark of Siemens.

† Base case operation is defined as two-loop operation within the standard operating domain, including the ICF and MELLLA regions, with all equipment in-service.

($LHGRFAC_p$ and $LHGRFAC_f$, respectively). These factors or multipliers are applied directly to the steady-state LHGR limit to ensure that the LHGR does not exceed the protection against power transient (PAPT) limit during postulated AOOs. Cycle 9 power- and flow-dependent LHGR multipliers are presented for ATRIUM-9B fuel.

Results of analyses that demonstrate compliance with the ASME Boiler and Pressure Vessel Code overpressurization limit are presented.

The results of the plant transient analyses are used in a subsequent reload analysis report (Reference 15) along with core and accident analysis results to justify plant operating limits and set points.

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)
Combined 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 machines 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 channels) and/or up to 50% of the LPRMs out-of-service is supported.

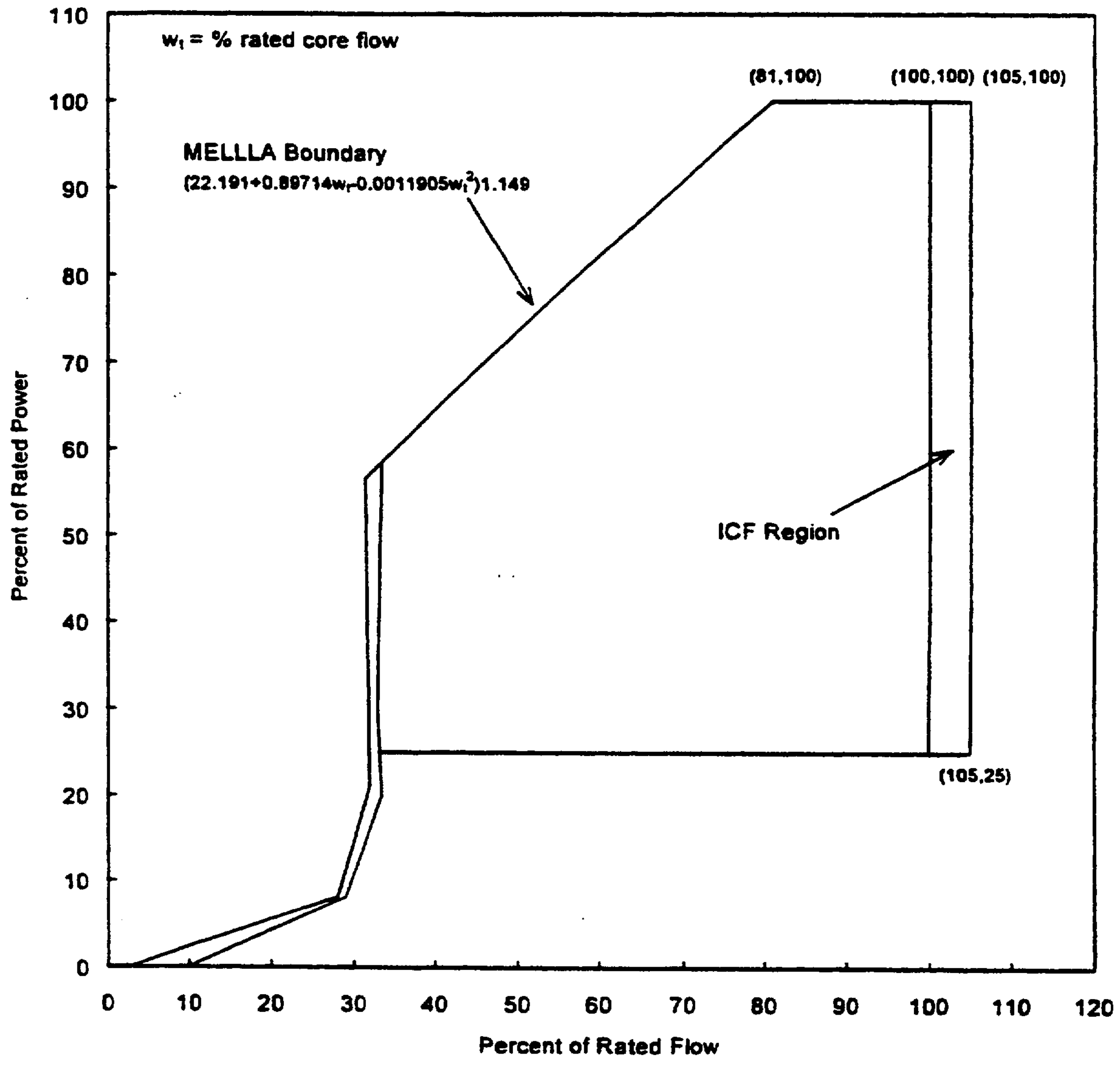

Figure 1.1 LaSalle County Nuclear Station
Power / Flow Map

2.0 Summary

The determination of the thermal limits (MCPR limits and LHGRFAC multipliers) for LaSalle Unit 2 Cycle 9 is based on analyses of the limiting operational transients identified in Reference 9. Although the Reference 9 conclusions are based on 18-month cycles, the limiting operational transients identified remain valid for 24-month cycles. The transients evaluated are the generator load rejection with no bypass (LRNB), feedwater controller failure to maximum demand (FWCF) and loss-of-feedwater heating (LFWH). Thermal limits identified for Cycle 9 operation include both MCPR limits and LHGRFAC multipliers. The MCPR operating limits are established so that less than 0.1% of the fuel rods in the core are expected to experience boiling transition during an AOO initiated from rated or off-rated conditions and are based on a two-loop operation MCPR safety limit of 1.11. LHGRFAC multipliers are applied directly to the LHGR limits at reduced power and/or flow conditions to protect against fuel melting and overstraining of the cladding during an AOO. Operating limits are established to support both base case operation and the EOOS scenarios presented in Table 1.1. Operating limits are also established for the EOD and combined EOD/EOOS conditions presented in Table 1.1.

Base case $MCPR_p$ limits and $LHGRFAC_p$ multipliers are based on results presented in Section 3.0. Results presented in Sections 4.0–6.0 are used to establish the operating limits for operation in the EOD, EOOS, and combined EOD/EOOS scenarios.

Cycle 9 $MCPR_p$ limits and $LHGRFAC_p$ multipliers for ATRIUM-9B fuel and $MCPR_p$ limits for GE9 fuel that support base case operation and operation in the EOD, EOOS and combined EOD/EOOS scenarios are presented in Tables 2.1–2.4. Tables 2.1 and 2.2 present base case limits and multipliers for Technical Specifications scram speed (TSSS) insertion times and nominal scram speed (NSS) insertion times, respectively. Table 2.3 presents the limits and multipliers for coastdown operation. The combined FFTR/coastdown limits and multipliers are identified in Table 2.4.

$MCPR_f$ limits for both ATRIUM-9B and GE9 that protect against fuel failures during a slow flow excursion event in manual flow control are presented in Figure 2.1. Automatic flow control is not supported for L2C9. The GE9 $MCPR_f$ limits include the effect of applying the MCPR penalty described in Reference 10. The $MCPR_f$ limits presented are applicable for all EOD and EOOS conditions presented in Table 1.1.

The Cycle 9 LHGRFAC$_f$ multipliers for the ATRIUM-9B fuel are presented in Figure 2.2 and are applicable in all the EOD and EOOS scenarios presented in Table 1.1. 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% clad strain and centerline melt criteria for GE9 fuel is discussed in Reference 19.

The results of the maximum overpressurization analyses show that the requirements of the ASME code regarding overpressure protection are met for Cycle 9. The analysis shows that the dome pressure limit of 1325 psig is not exceeded and the vessel pressure does not exceed the limit of 1375 psig.

Table 2.1 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

---

* Limits support operation with any combination of 1 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 2.1 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

---

* Limits support operation with any combination of 1 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 2.2 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

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* Limits support operation with any combination of 1 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 2.3 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

---

* Limits support operation with any combination of 1 SRVOOS, up to 2 TIPOOS (or the equivalent number of TIP channels), up to a 20°F reduction in feedwater, and up to 50% of the LPRMs out of service in the standard, ICF, and MELLLA regions of the power/flow map.

Table 2.3 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

---

* Limits support operation with any combination of 1 SRVOOS, up to 2 TIPOOS (or the equivalent number of TIP channels), up to a 20°F reduction in feedwater temperature, and up to 50% of the LPRMs out of service in the standard, ICF, and MELLLA regions of the power/flow map.

Table 2.4 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

---

* Limits support operation with any combination of 1 SRVOOS, up to 2 TIPOOS (or the equivalent number of TIP channels), and up to 50% of the LPRMs out of service in the standard, ICF, and MELLLA regions of the power/flow map.

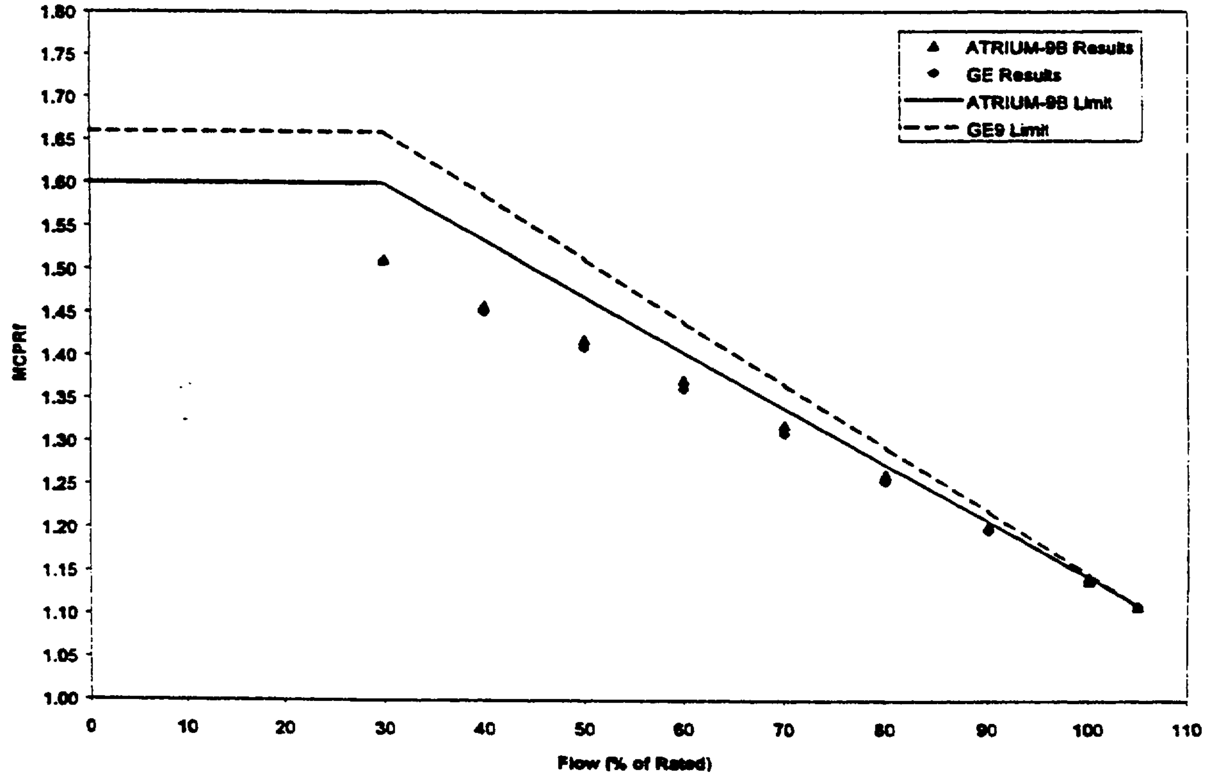
Table 2.4 FFTR/Coastdown Operation Base Case and EOOS $MCPR_p$ Limits and $LHGRFAC_p$ Multipliers for TSSS Insertion Times*

(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

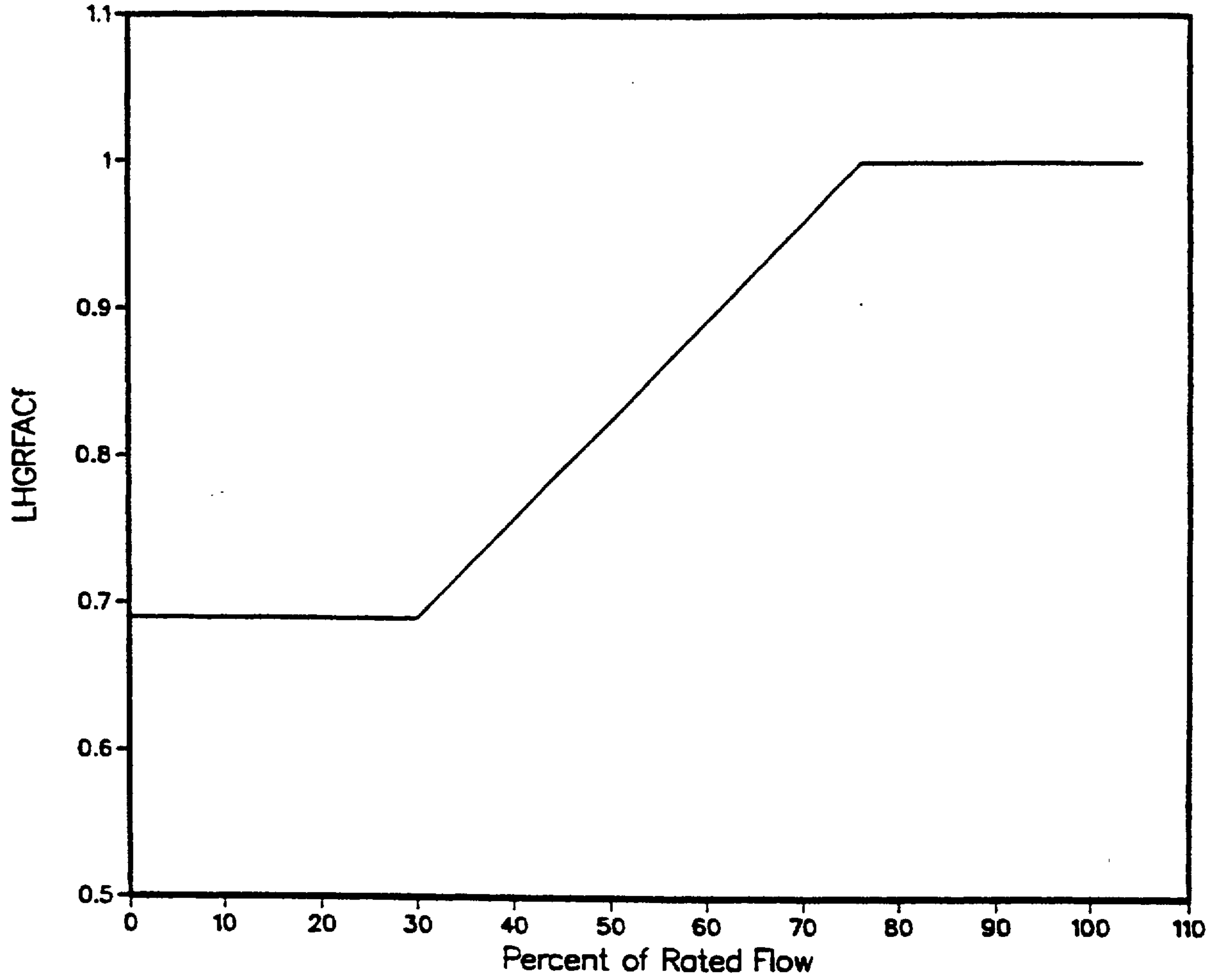
---

* Limits support operation with any combination of 1 SRVOOS, up to 2 TIPOOS (or the equivalent number of TIP channels), and up to 50% of the LPRMs out of service in the standard, ICF, and MELLLA regions of the power/flow map.



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 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

3.0 Transient Analysis for Thermal Margin - Base Case Operation

This section describes the analyses performed to determine the power- and flow-dependent MCPR and LHGR operating limits for base case operation at LaSalle Unit 2 Cycle 9.

COTRANSA2 (Reference 4), XCOBRA-T (Reference 11), XCOBRA (Reference 7) and CASMO-3G/MICROBURN-B (Reference 3) are the major codes used in the thermal limits analyses as described in SPC's THERMEX methodology report (Reference 7) and neutronics methodology report (Reference 3). COTRANSA2 is a system transient simulation code, which includes an axial one-dimensional neutronics model that captures the effects of axial power shifts associated with the system transients. XCOBRA-T is a transient thermal-hydraulics code used in the analysis of thermal margins for the limiting fuel assembly. XCOBRA is used in steady-state analyses. The ANFB critical power correlation (Reference 6) is used to evaluate the thermal margin of the fuel assemblies. Calculations have been performed to demonstrate the applicability of the ANFB critical power correlation to GE9 fuel at LaSalle using the Reference 12 methodology. Fuel pellet-to-cladding gap conductance values are based on RODEX2 (Reference 13) calculations for the LaSalle Unit 2 Cycle 9 core configuration.

3.1 *System Transients*

System transient calculations have been performed to establish thermal limits to support L2C9 operation. Reference 9 identifies the potential limiting events that need to be evaluated on a cycle-specific basis. The potentially limiting transients for which SPC has analysis responsibility are the LRNB and FWCF events. Other transient events are either bound by the consequences of one of the limiting transients, or are part of ComEd's analysis responsibility.

Reactor plant parameters for the system transient analyses are shown in Table 3.1 for the 100% power/100% flow conditions. Additional plant parameters used in the analyses are presented in Reference 8. Analyses have been performed to determine power-dependent MCPR and LHGR limits that protect operation throughout the power/flow domain depicted in Figure 1.1. At LaSalle, direct scram and recirculation pump high- to low-speed transfer on turbine stop valve (TSV) and turbine control valve (TCV) position are bypassed at power levels less than 25% of rated. Reference 14 indicates that MCPR and LHGR limits need to be monitored at power levels greater than or equal to 25% of rated. As a result, all analyses used to establish base case $MCPR_p$ limits and $LHGRFAC_p$ multipliers are performed with both direct scram and RPT operable for power levels at or above 25% of rated.

The limiting exposure for rated power pressurization transients is at end of full power (EOFP) when the control rods are fully withdrawn. Off-rated power analyses were performed at earlier cycle exposures to ensure that the operating limits provide the necessary protection.

All pressurization transients assumed only the 11 highest set point safety relief valves (SRVs) were operable, consistent with the discussion in Section 7. In order to support operation with 1 SRV out-of-service, the pressurization transient analyses were performed with the lowest set point SRV out-of-service, which makes a total of 10 SRVs available.

The term, recirculation pump trip (RPT), is used synonymously with recirculation pump high- to low-speed transfer as it applies to pressurization transients. During the high- to low-speed transfer, the recirculation pumps trip off line and coast. When they reach the low-speed setting, the pumps reengage at the low speed. The time it takes for the pumps to coast to the low-speed condition is much longer than the duration of the pressurization transients. Therefore, a recirculation pump trip has the same effect on pressurization transients as a recirculation pump high- to low-speed transfer.

Reductions in feedwater temperature of less than 20°F from the nominal feedwater temperature are considered base case operation, not an EOOS condition. As discussed in Reference 9, the reduced feedwater temperature is limiting for FWCF transients. As a result, the base case FWCF results are based on a 20°F reduction in feedwater temperature.

The results of the system pressurization transients are sensitive to the scram speed used in the calculations. To take advantage of scram speeds faster than the TSSS insertion times presented in Reference 14 scram speed-specific $MCPR_p$ limits and $LHGRFAC_p$ multipliers are provided. The NSS insertion times used in the analyses reported are presented in Reference 8 and reproduced in Table 3.2. The NSS $MCPR_p$ limits and $LHGRFAC_p$ multipliers can only be applied if the scram speed surveillance tests meet the NSS insertion times. System transient analyses were performed to establish $MCPR_p$ limits and $LHGRFAC_p$ multipliers for base case operation for both NSS and TSSS insertion times.

3.1.1 Load Rejection No Bypass

The load rejection causes a fast closure of the turbine control valve. The resulting compression wave travels through the steam lines into the vessel and creates a rapid pressurization. The increase in pressure causes a decrease in core void, which in turn causes a rapid increase in power. The fast closure of the turbine control valve also causes a reactor scram and a recirculation pump high- to low-speed transfer which helps mitigate the pressurization effects. Turbine bypass system operation, which also mitigates the consequences of the event, is not credited. The excursion of the core power due to the void collapse is terminated primarily by the reactor scram and revoiding of the core. The analysis assumes 3-element feedwater level control; however, manual- or single-element feedwater level control will not significantly affect thermal limit or pressure results.

The generator load rejection without turbine bypass system (LRNB) is a more limiting transient than the turbine trip no bypass (TTNB) transient. The initial position of the TCV is such that it closes faster than the turbine stop valve. This more than makes up for any differences in the scram signal delays between the two events. This has been demonstrated in calculations that support the Reference 9 conclusion that the TTNB event is bound by the LRNB event.

LRNB analyses were performed for several power/flow conditions to support generation of the thermal limits. Table 3.3 presents the LRNB transient results for both TSSS and NSS insertion times for Cycle 9. For illustration, Figures 3.1–3.3 are presented to show the responses of various reactor and plant parameters during the LRNB event initiated at 100% of rated power and 105% of rated core flow with TSSS insertion times.

3.1.2 Feedwater Controller Failure

The increase in feedwater flow due to a failure of the feedwater control system to maximum demand results in an increase in the water level and a decrease in the coolant temperature at the core inlet. The increase in core inlet subcooling causes an increase in core power. As the feedwater flow continues at maximum demand, the water level will continue to rise and eventually reaches the high water level trip set point. The initial water level is conservatively assumed to be at the lower level operating range at 30 inches above instrument zero to delay the high level trip and maximize the core inlet subcooling that results from the FWCF. The high water level trip causes the turbine stop valves to close in order to prevent damage to the turbine from excessive liquid inventory in the steam line. The valve closures create a compression wave that travels to the core causing a void collapse and subsequent rapid power excursion. The closure of the turbine valves initiates a reactor scram and a recirculation pump high- to low-speed transfer. In addition, the turbine bypass valves are assumed operable and provide some pressure relief. The core power excursion is mitigated in part by the pressure relief, but the primary mechanisms for termination of the event are reactor scram and revoiding of the core.

FWCF analyses were performed for several power/flow conditions to support generation of the thermal limits. Table 3.4 presents the base case FWCF transient results for both TSSS and NSS insertion times for Cycle 9. For illustration, Figures 3.4–3.6 are presented to show the responses of various reactor and plant parameters during the FWCF event initiated at 100% of rated power and 105% of rated core flow with TSSS insertion times.

3.1.3 Loss-of-Feedwater Heating

ComEd has the analysis responsibility for the loss-of-feedwater heating (LFWH) event at rated conditions. At reactor power levels less than rated, the LFWH event is less limiting than the LFWH event at rated conditions for the following reasons:

- At lower power/flow conditions with other core conditions such as control rod patterns and exposure unchanged, the initial MCPR is higher than the MCPR at rated power and flow. This results in additional MCPR margin to the MCPR safety limit.
- The possible change in feedwater temperature during an LFWH event decreases as the reactor power decreases.

3.2 *MCPR Safety Limit*

The MCPR safety limit is defined as the minimum value of the critical power ratio at which the fuel can be operated, with the expected number of rods in boiling transition not exceeding 0.1% of the fuel rods in the core. The MCPR safety limit for all fuel in the LaSalle Unit 2 Cycle 9 core was determined using the methodology described in Reference 5. The effects of channel bow on core limits are determined using a statistical procedure. The mean channel bow is determined from the exposure of the fuel channels and measured channel bow data. CASMO-3G is used to determine the effect on the local peaking factor distribution. Once the channel bow effects on the local peaking factors are determined, the impact on the core limits is determined in the MCPR safety limit analysis. Further discussion of how the effects of channel bow are accounted for is presented in Reference 5. The main input parameters and uncertainties used in the safety limit analysis are listed in Table 3.5. The radial power uncertainty includes the effects of up to 2 TIPOOS or the equivalent number of TIP channels (100% available at startup), up to 50% of the LPRMs out-of-service, and an LPRM calibration interval of 2500 EFPH as discussed in References 16 and 24. The channel bow local peaking uncertainty is a function of the nominal and bowed local peaking factors and the standard deviation of the measured bow data.

The determination of the safety limit explicitly includes the effects of channel bow and relies on the following assumptions:

- Cycle 9 will not contain channels used for more than one fuel bundle lifetime.
- The channel exposure at discharge will not exceed 48,000 MWd/MTU based on the fuel bundle average exposure.
- The Cycle 9 core contains all CarTech-supplied channels.

Analyses were performed with input parameters (including the radial power and local peaking factor distributions) consistent with each exposure step in the design basis step-through. The analysis that produced the highest number of rods in boiling transition corresponds to a Cycle 9 exposure of 15,000 MWd/MTU. The radial power distribution corresponding to a Cycle 9 exposure of 15,000 MWd/MTU is shown in Figure 3.7. Eight fuel types were represented in the LaSalle Unit 2 Cycle 9 safety limit analysis: four SPC ATRIUM-9B fuel types loaded in Cycle 9 (SPCA9-391B-14G8.0-100M, SPCA9-410B-19G8.0-100M, SPCA9-383B-16G8.0-100M, and SPCA9-396B-12GZ-100M); two ATRIUM-9B fuel types loaded in Cycle 8 (SPCA9-381B-13GZ7-80M and SPCA9-384B-11GZ6-80M); and two GE9 fuel types loaded in Cycle 7 (GE9B-P8CWB322-11GZ-100M-150 and GE9B-P8CWB320-9GZ-100M-150).

The local power peaking factors, including the effects of channel bow, at 70% void and assembly exposures consistent with a Cycle 9 exposure of 15,000 MWd/MTU are presented in Figures 3.8 through 3.11 for the Cycle 9 SPC ATRIUM-9B fuel. The bowed local peaking factor data used in the MCPR safety limit analysis for fuel type SPCA9-391B-14G8.0-100M is at an assembly average exposure of 18,000 MWd/MTU. The data for fuel types SPCA9-410B-19G8.0-100M and SPCA9-383B-16G8.0-100M is at an assembly average exposure of 17,500 MWd/MTU. The data is at an assembly average exposure of 15,000 MWd/MTU for fuel type SPCA9-396B-12GZ-100M.

The results of the analysis support a two-loop operation MCPR safety limit of 1.11 and a single-loop operation MCPR safety limit of 1.12 for all fuel types in the Cycle 9 core. These results are applicable for all EOD and EOOS conditions presented in Table 1.1 and support startup with uncalibrated LPRMs for an exposure range of BOC to 500 MWd/MTU .

3.3 *Power-Dependent MCPR and LHGR Limits*

Figures 3.12 and 3.13 present the base case operation TSSS ATRIUM-9B and GE9 $MCPR_p$ limits for Cycle 9. Figures 3.14 and 3.15 present the ATRIUM-9B and GE9 $MCPR_p$ limits for base case operation with NSS insertion times. The limits are based on the ΔCPR results from the limiting system transient analyses discussed above and a MCPR safety limit of 1.11.

Relative to the TSSS $MCPR_p$ limits, using the faster NSS insertion times provide lower $MCPR_p$ limits.

The pressurization transient analyses provide the necessary information to determine appropriate multipliers on the fuel design LHGR limit for ATRIUM-9B fuel to support off-rated power operation. Application of the $LHGRFAC_p$ multipliers to the steady-state LHGR limit ensures that the LHGR during AOOs initiated at reduced power does not exceed the PAPT limits. The method used to calculate the $LHGRFAC_p$ multipliers is presented in Appendix A. The results of the LRNB and FWCF analyses discussed above were used to determine the base case $LHGRFAC_p$ multipliers. The base case ATRIUM-9B $LHGRFAC_p$ multipliers for Cycle 9 TSSS and NSS insertion times are presented in Figures 3.16 and 3.17, respectively.

3.4 *Flow-Dependent MCPR and LHGR Limits*

Flow-dependent MCPR and LHGR limits are established to support operation at off-rated core flow conditions. The limits are based on the CPR and heat flux changes experienced by the fuel during slow flow excursions. The slow flow excursion event assumes a failure of the recirculation flow control system such that the core flow increases slowly to the maximum flow physically attainable by the equipment. An uncontrolled increase in flow creates the potential for a significant increase in core power and heat flux. A conservatively steep flow run-up path was determined starting at a low-power/low-flow state point of 58.1%P/30%F increasing to the high-power/high-flow state point of 124.2%P/105%F.

$MCPR_f$ limits are determined for the manual flow control (MFC) mode of operation for both ATRIUM-9B and GE9 fuel. XCOBRA is used to calculate the change in critical power ratio during a two-loop flow run-up to the maximum flow rate. The $MCPR_f$ limit is set so that the increase in core power resulting from the maximum increase in core flow is such that the MCPR safety limit of 1.11 is not violated. Calculations were performed for several initial flow rates to determine the corresponding MCPR values that put the limiting assembly on the MCPR safety limit at the high-flow condition at the end of the flow excursion.

Results of the MFC flow run-up analysis are presented in Table 3.6 for both the ATRIUM-9B and GE9 fuel. $MCPR_f$ limits that provide the required protection during MFC operation are presented in Figure 2.1. The Cycle 9 $MCPR_f$ limits were established such that they support base case operation and operation in the EOD, EOOS, and combined EOD/EOOS scenarios. The $MCPR_f$ limits are valid for all exposure conditions during Cycle 9. Since a low- to high-speed pump upshift is required to attain high-flow rates, for initial core flows less than 30% of rated, the limit is conservatively set equal to the 30% flow value. The $MCPR_f$ penalty described in Reference 10 has been applied to the GE9 $MCPR_f$ limits shown in Figure 2.1. The penalty is a function of core flow with a value of 0.0 at 100% of rated and increases linearly to 0.05 at 40% of rated. The penalty continues to increase to 30% of rated core flow where a penalty of 0.06 is applied.

SPC has performed $LHGRFAC_f$ analyses with the CASMO-3G/MICROBURN-B core simulator codes. The analysis assumes that the recirculation flow increases slowly along the limiting rod line to the maximum flow physically attainable by the equipment. A series of flow excursion analyses were performed at several exposures throughout the cycle starting from different initial power/flow conditions. Xenon is assumed to remain constant during the event. The $LHGRFAC_f$ multipliers were established to ensure that the LHGR during the flow run-up does not violate the PAPT LHGR limit. Since a low- to high-speed pump upshift is required to attain high-flow rates, for initial core flows less than 30% of rated, the $LHGRFAC_f$ multiplier is conservatively set equal to the 30% flow value. The $LHGRFAC_f$ values as a function of core flow for the ATRIUM-9B fuel are presented in Figure 2.2. The Cycle 9 $LHGRFAC_f$ multipliers were established to support base case operation and operation in the EOD, EOOS, and combined EOD/EOOS scenarios for all Cycle 9 exposure conditions.

3.5 *Nuclear Instrument Response*

The impact of loading ATRIUM-9B fuel into the LaSalle core will not affect the nuclear instrument response. The neutron lifetime is an important parameter affecting the time response of the incore detectors. The neutron lifetime is a function of the nuclear and mechanical design of the fuel assembly, the in-channel void fraction, and the fuel exposure. The neutron lifetimes are similar for the SPC and GE LaSalle fuel with typical values of $39(10^{-6})$ to $40(10^{-6})$ seconds for the ATRIUM-9B lattices and $41(10^{-6})$ to $43(10^{-6})$ seconds for the GE9 lattices as calculated with the CASMO-3G code at core average void and exposure conditions. Therefore, the neutron lifetimes for a full core of ATRIUM-9B fuel, a mixed core of ATRIUM-9B and GE9 fuel, and a full core of GE9 fuel are essentially equivalent.

Table 3.1 LaSalle Unit 2 Plant Conditions at Rated Power and Flow

Reactor thermal power	3489 MWt
Total core flow	108.5 Mlbm/hr
Core active flow	93.7 Mlbm/hr
Core bypass flow*	14.8 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
Turbine 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)	1162 Btu/hr-ft^2-°F

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* 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

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* 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 slightly conservative results (Reference 22).

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	0.30	1.01	0.40	422	127
100 / 100	0.29	1.01	0.39	431	128
100 / 81	0.28	1.01	0.38	437	126
80 / 105	0.29	1.04	0.39	324	100
80 / 57.2	0.29	1.05	0.39	265	96
60 / 105	0.27	1.06	0.36	245	73
60 / 35.1	0.17	1.13	0.21	96	63
40 / 105	0.23*	1.13	0.27	100*	46*
25 / 105	0.17*	1.22*	0.19*	44*	27*
NSS Insertion Times					
100 / 105	0.28	1.02	0.37	380	124
100 / 81	0.22	1.03	0.30	358	120
80 / 105	0.27	1.04	0.36	302	98
80 / 57.2	0.20	1.09	0.26	218	90
60 / 105	0.26	1.07	0.35	236	73
60 / 35.1	0.13	1.18	0.14	76	60
40 / 105	0.20	1.14	0.27	115	47
25 / 105	0.15*	1.22	0.17	42*	27*

---

* The analysis results 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	0.25	1.09	0.31	298	123
100 / 100	0.24	1.11	0.31	288	122
100 / 81	0.23	1.09	0.28	285	121
80 / 105	0.28	1.07	0.35	253	101
80 / 57.2	0.19	1.16	0.23	154	91
60 / 105	0.35*	1.02*	0.41	154*	77*
60 / 35.1	0.11	1.25	0.14	74	63
40 / 105	0.51*	0.94*	0.57*	104*	58*
25 / 105	0.80*	0.79*	0.88*	69*	44*
NSS Insertion Times					
100 / 105	0.23	1.10	0.29	263	120
100 / 81	0.18	1.11	0.22	237	116
80 / 105	0.27	1.10	0.33	235	99
80 / 57.2	0.15	1.20	0.17	131	88
60 / 105	0.33	1.05*	0.40	188	79
60 / 35.1	0.11	1.28	0.13	65	63
40 / 105	0.48*	0.95*	0.55*	96*	57*
25 / 105	0.78*	0.79*	0.86*	66*	44*

---

[*] The analysis results 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 GE9	Reference 17 Reference 12	Convoluted Convoluted
Radial power	References 16 and 21	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)	22.4	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)	5167.29	—	—

---

* 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)	105% Maximum Core Flow	
	GE9	ATRIUM-9B
30	1.52	1.52
40	1.46	1.46
50	1.41	1.42
60	1.37	1.38
70	1.31	1.32
80	1.26	1.27
90	1.20	1.21
100	1.14	1.14
105	1.11	1.11

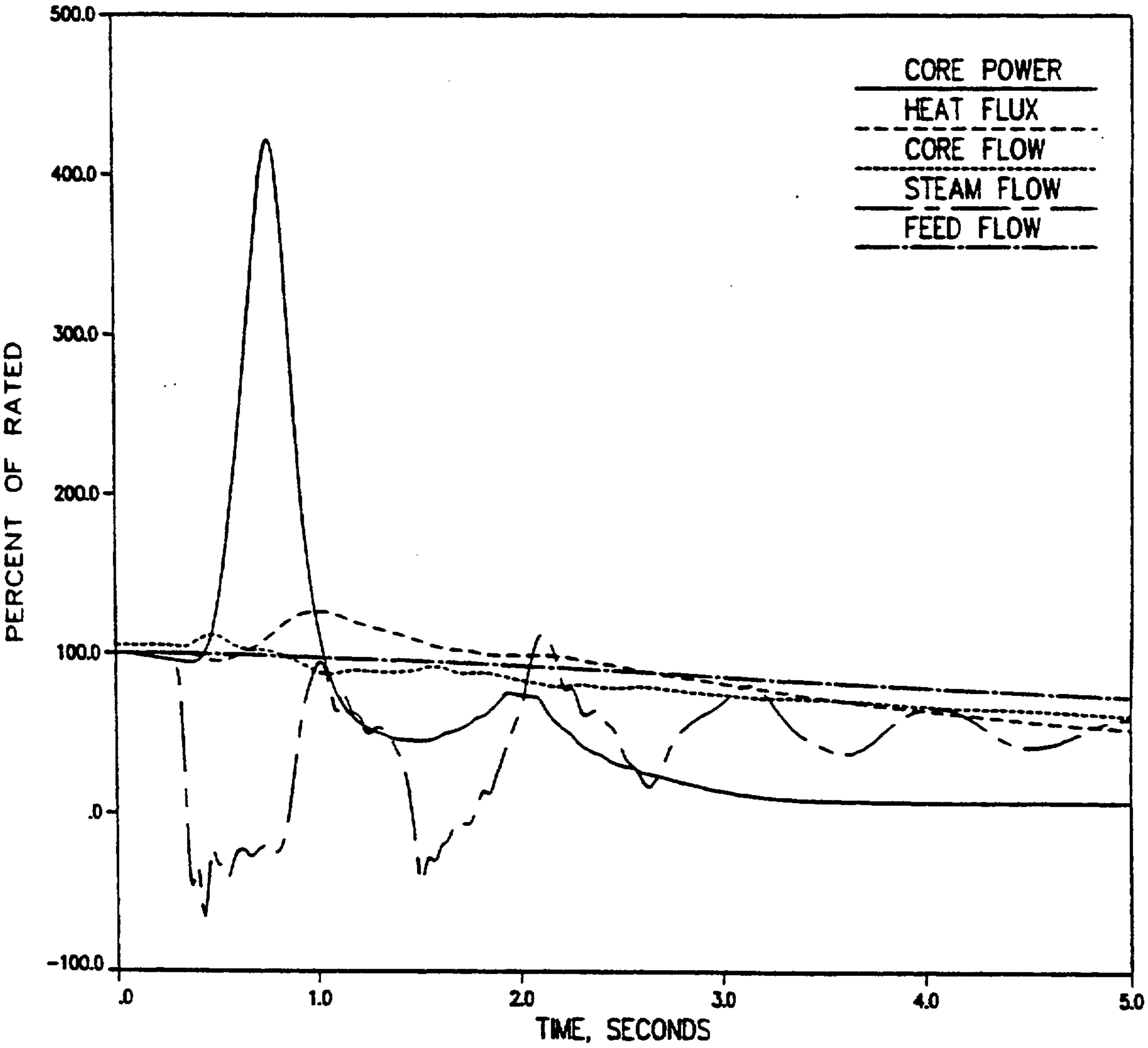


Figure 3.1 EOC Load Rejection No Bypass at 100/105 – TSSS Key Parameters

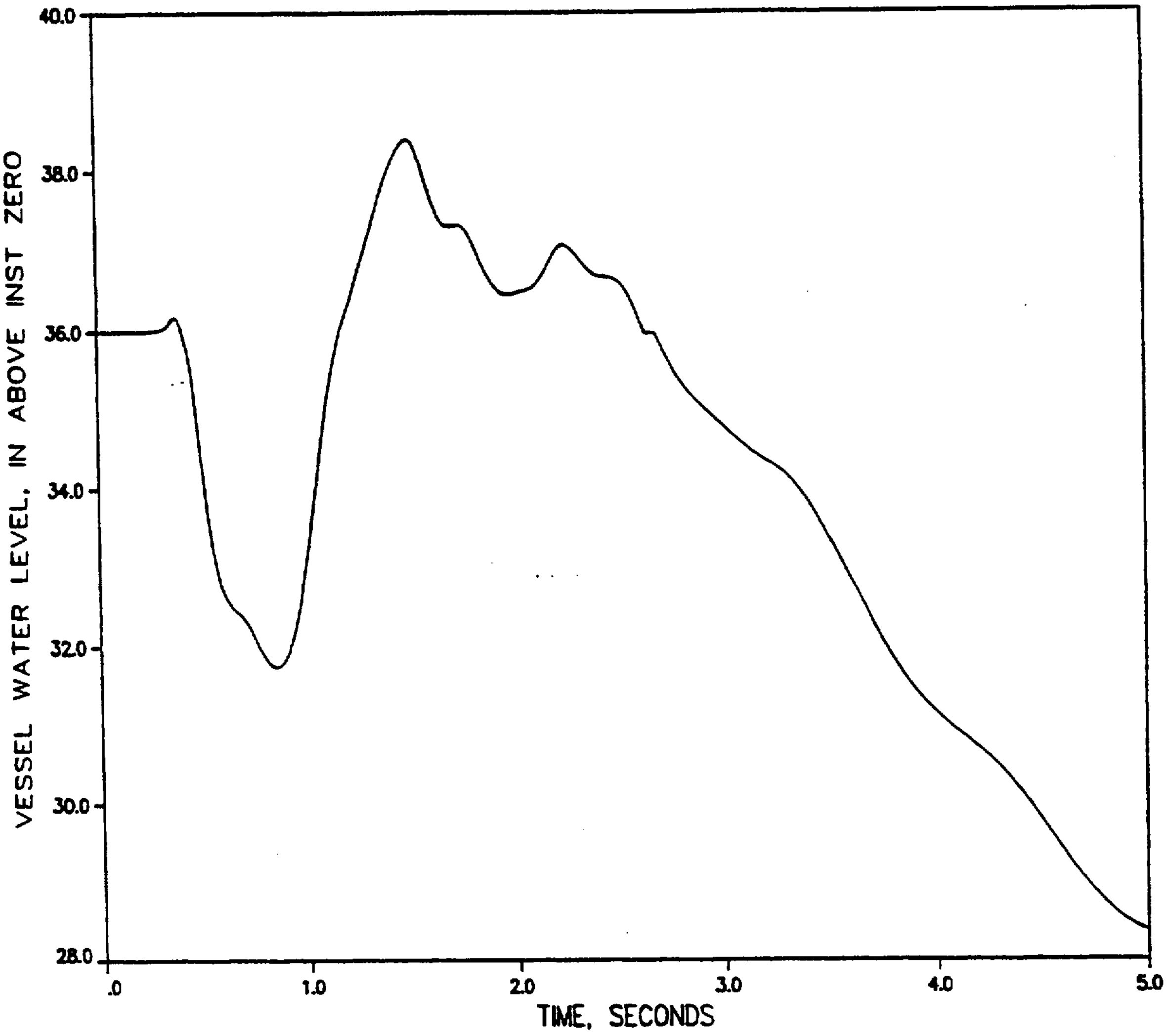


Figure 3.2 EOC Load Rejection No Bypass at 100/105 – TSSS Vessel Water Level

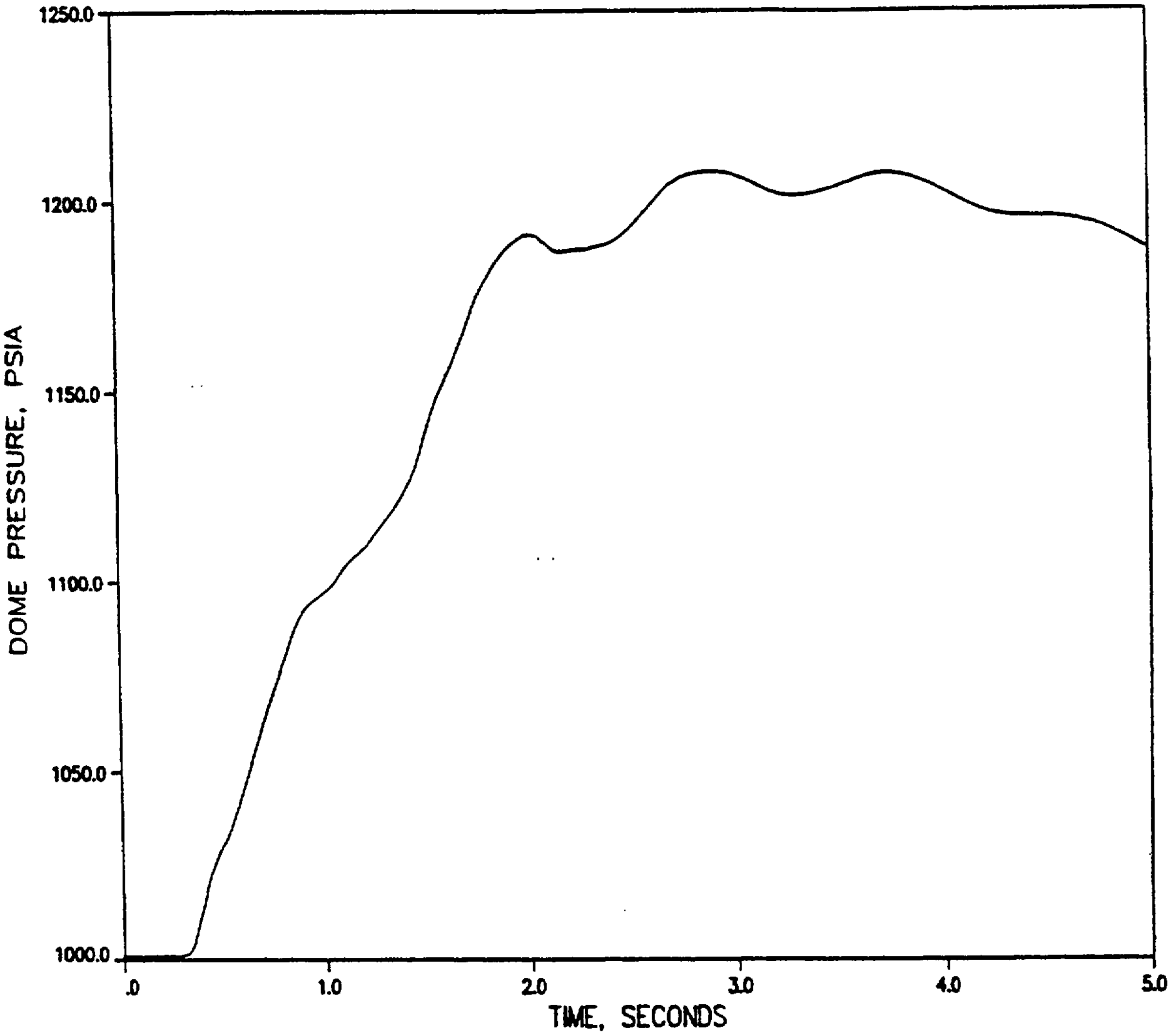


Figure 3.3 EOC Load Rejection No Bypass at 100/105 – TSSS Dome Pressure

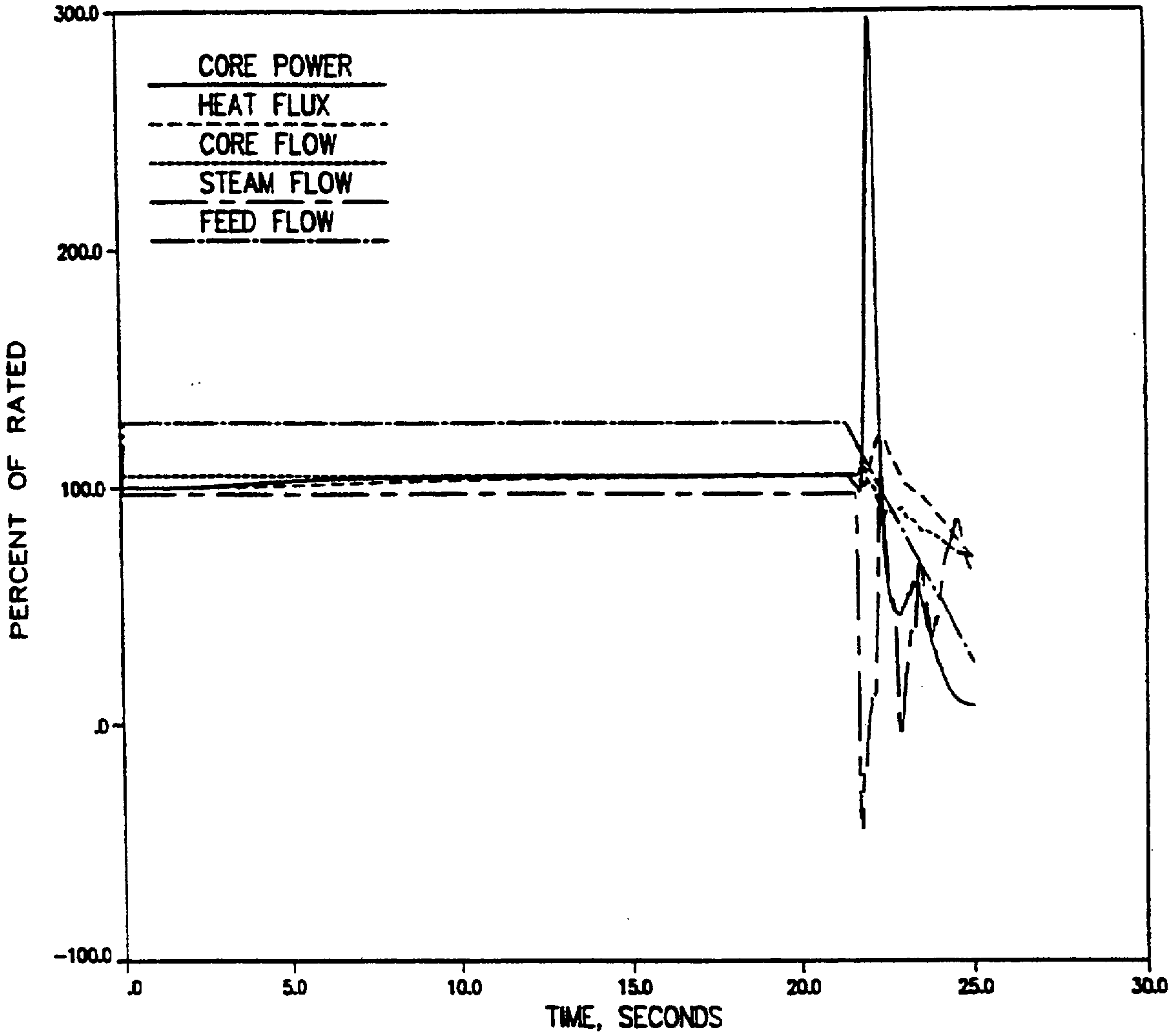


Figure 3.4 EOC Feedwater Controller Failure at 100/105 – TSSS Key Parameters

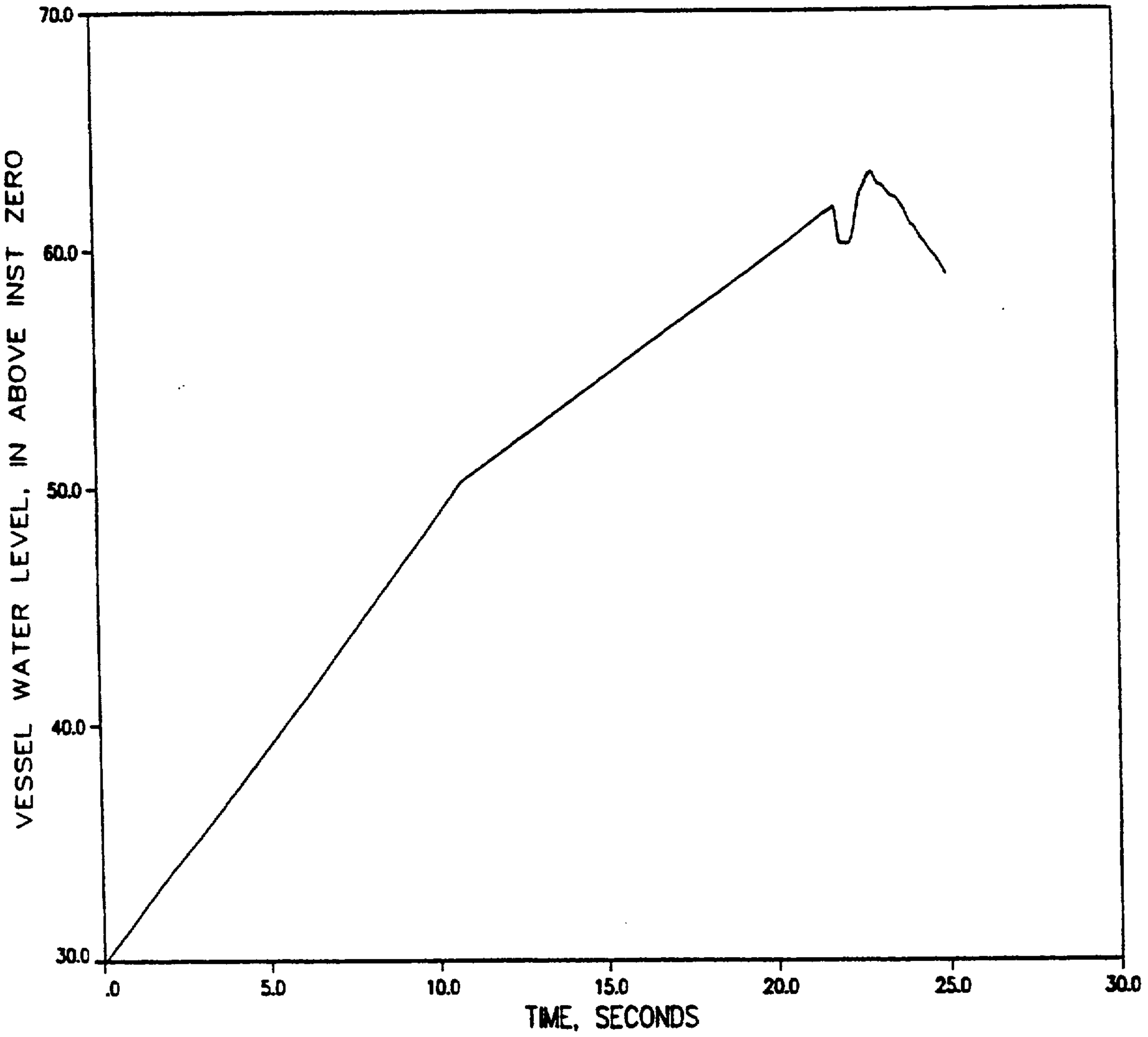


Figure 3.5 EOC Feedwater Controller Failure at 100/105 – TSSS Vessel Water Level

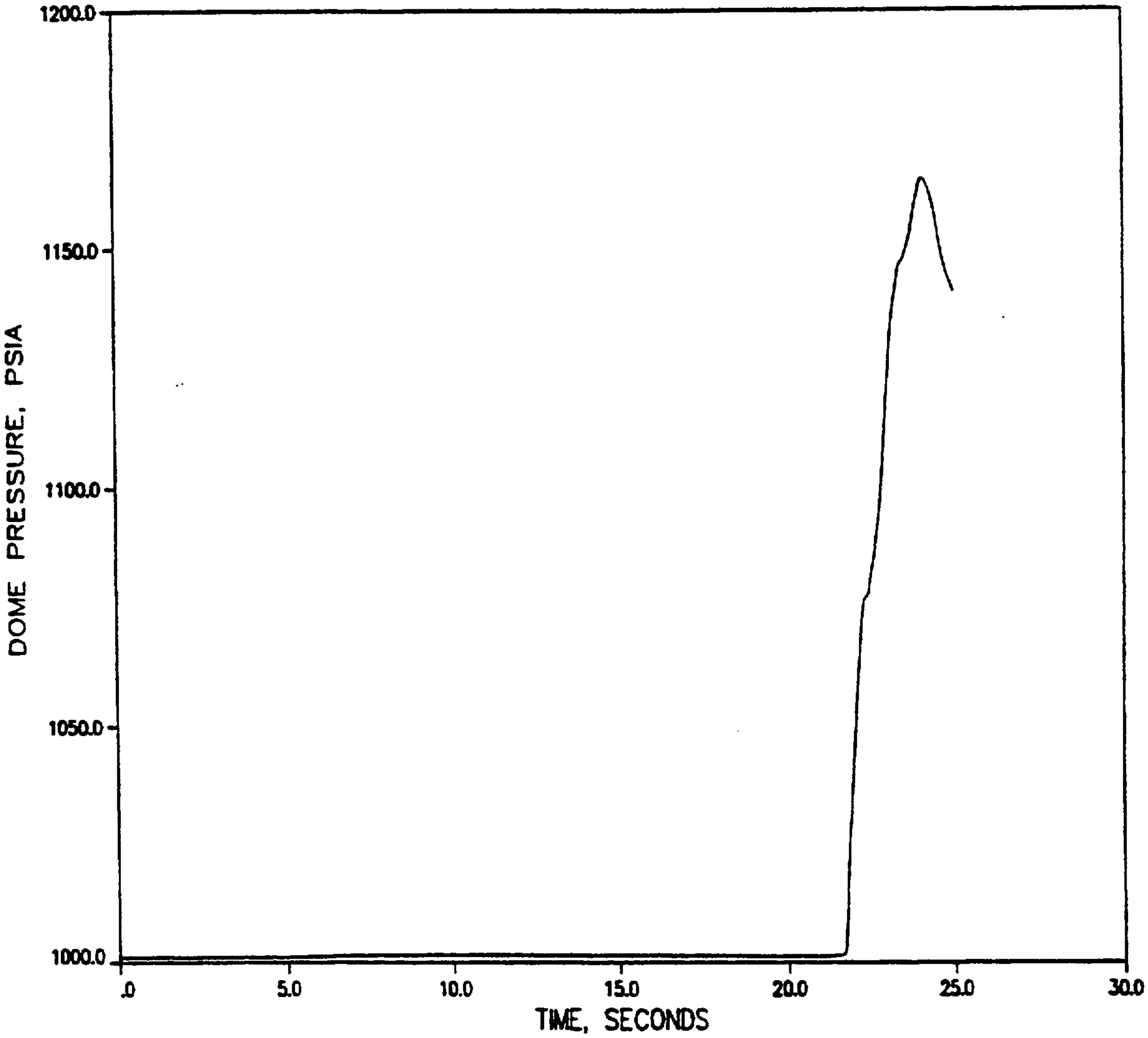


Figure 3.6 EOC Feedwater Controller Failure at 100/105 – TSSS Dome Pressure

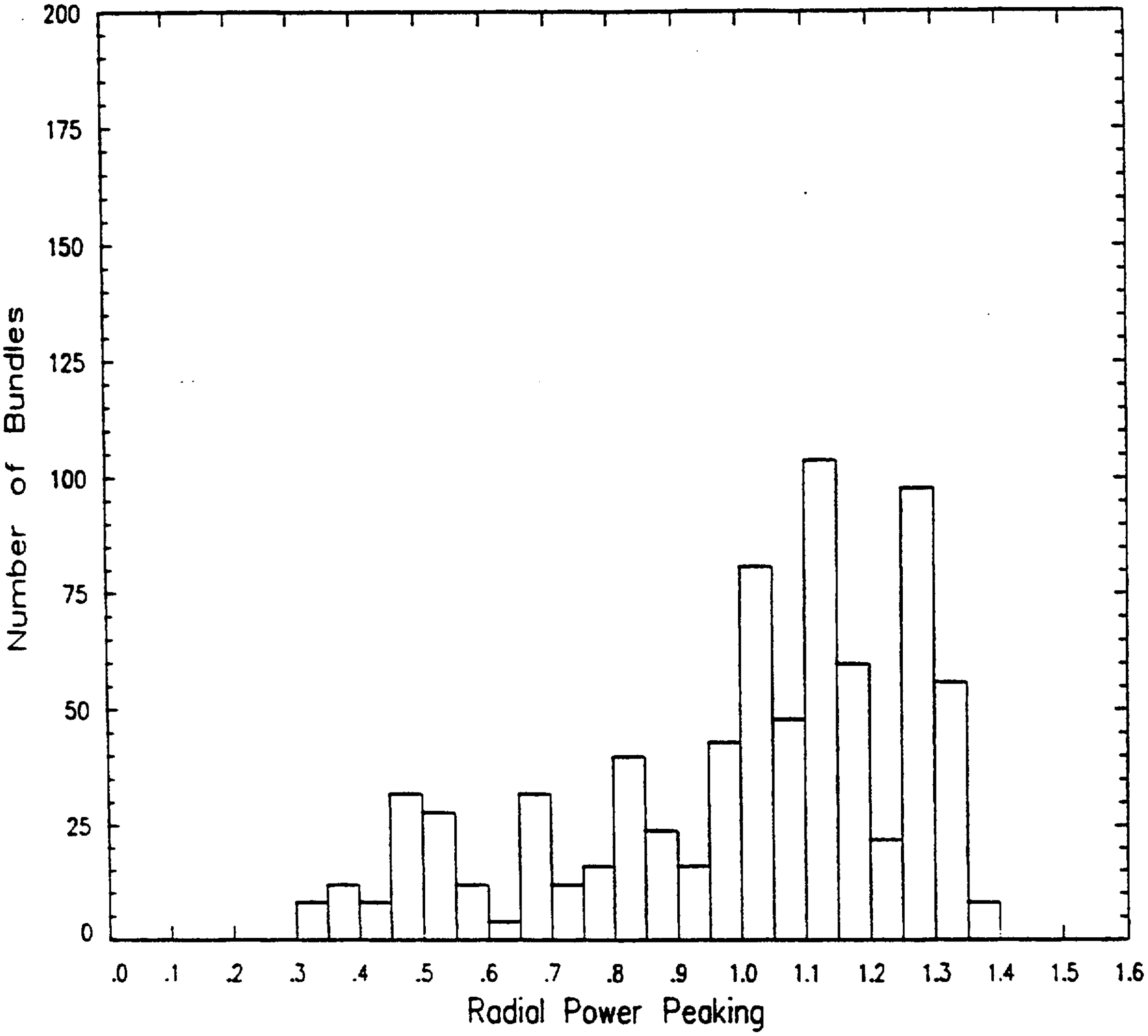


Figure 3.7 Radial Power Distribution for SLMCPR Determination

Control Rod Corner

Control Rod Corner

1.052	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 3.8 LaSalle Unit 2 Cycle 9
Safety Limit Local Peaking Factors
SPCA9-391B-14G8.0-100M With Channel Bow
(Assembly Exposure of 18,000 MWd/MTU)

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 3.9 LaSalle Unit 2 Cycle 9
Safety Limit Local Peaking Factors
SPCA9-410B-19G8.0-100M With Channel Bow
(Assembly Exposure of 17,500 MWd/MTU)

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

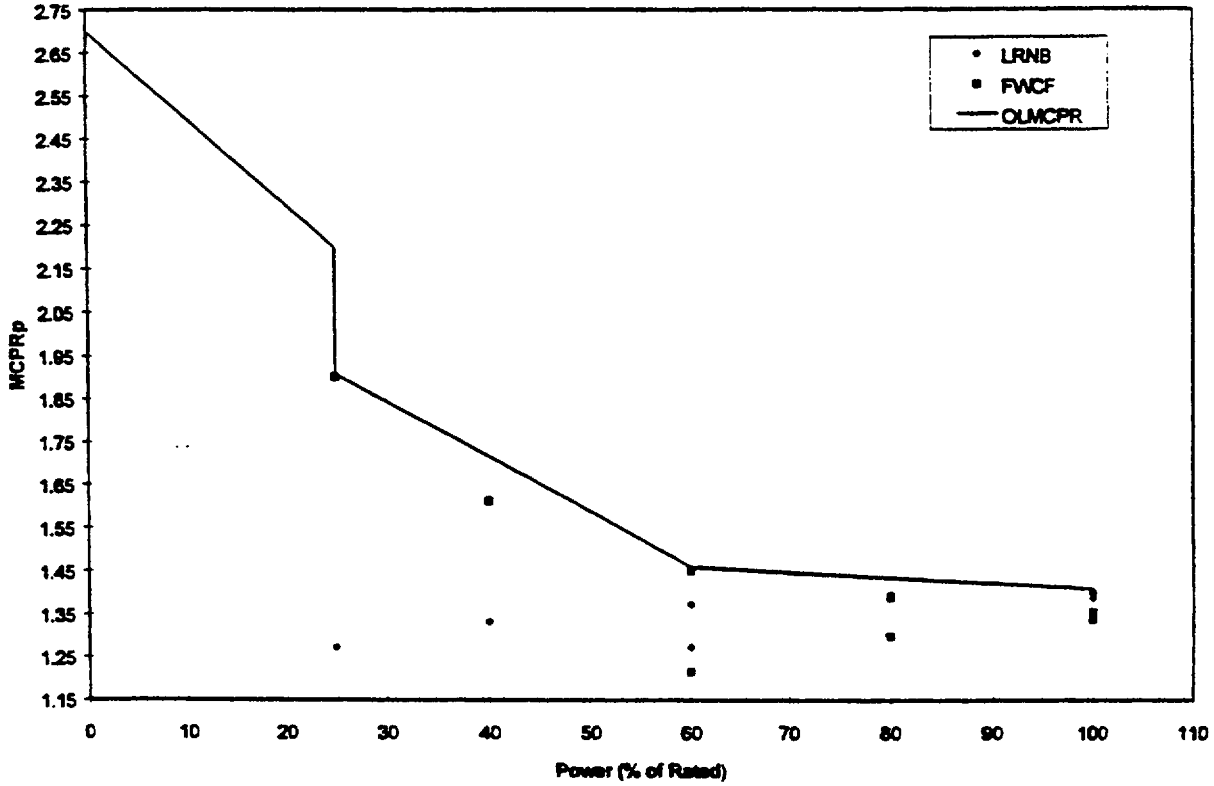
Figure 3.10 LaSalle Unit 2 Cycle 9
Safety Limit Local Peaking Factors
SPCA9-383B-16G8.0-100M With Channel Bow
(Assembly Exposure of 17,500 MWd/MTU)

Control Rod Corner

Control Rod Corner

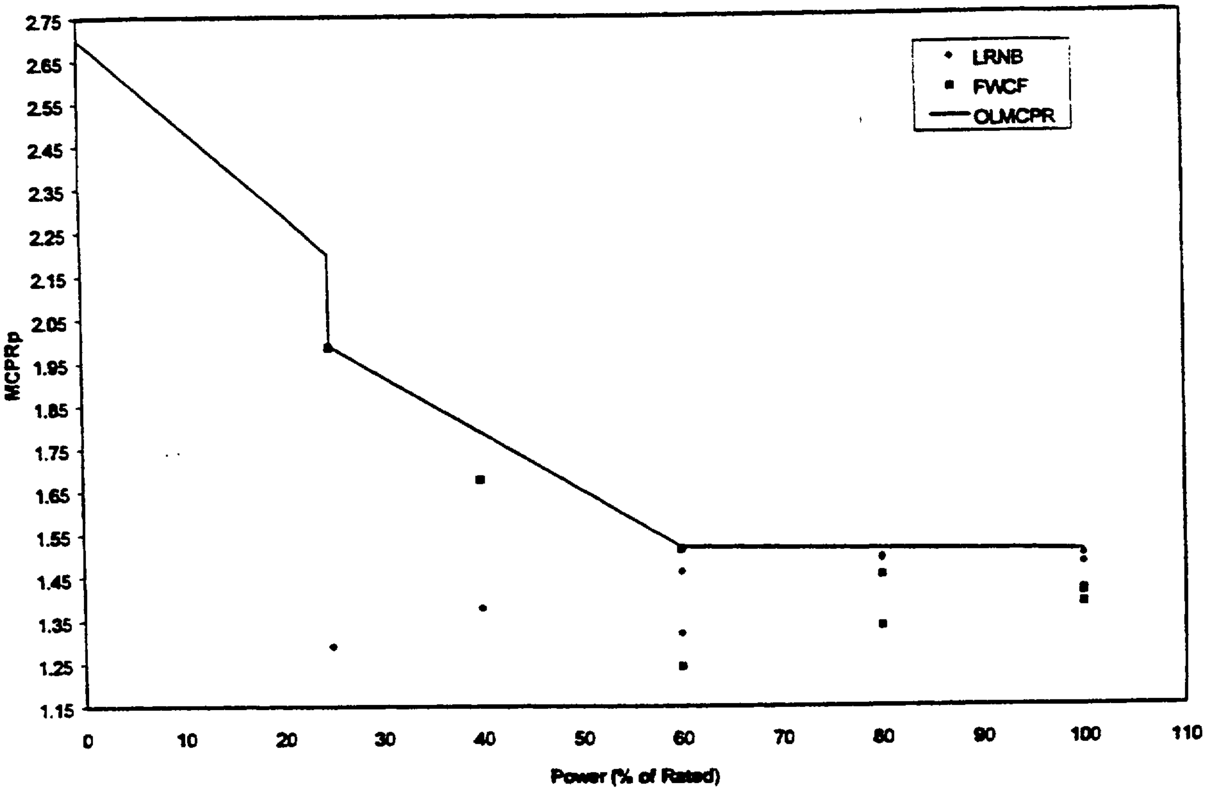
1.025	1.058	1.062	1.117	1.100	1.108	1.043	1.026	0.979
1.058	0.934	1.018	0.852	1.003	0.845	0.999	0.903	1.005
1.062	1.018	1.003	1.067	1.092	1.058	0.984	0.983	1.006
1.117	0.852	1.067	Internal Water Channel			1.046	0.823	1.056
1.100	1.003	1.092				1.072	0.968	1.039
1.108	0.845	1.058				1.038	0.816	1.046
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 3.11 LaSalle Unit 2 Cycle 9
Safety Limit Local Peaking Factors
SPCA9-396B-12GZ-100M With Channel Bow
(Assembly Exposure of 15,000 MWdMTU)



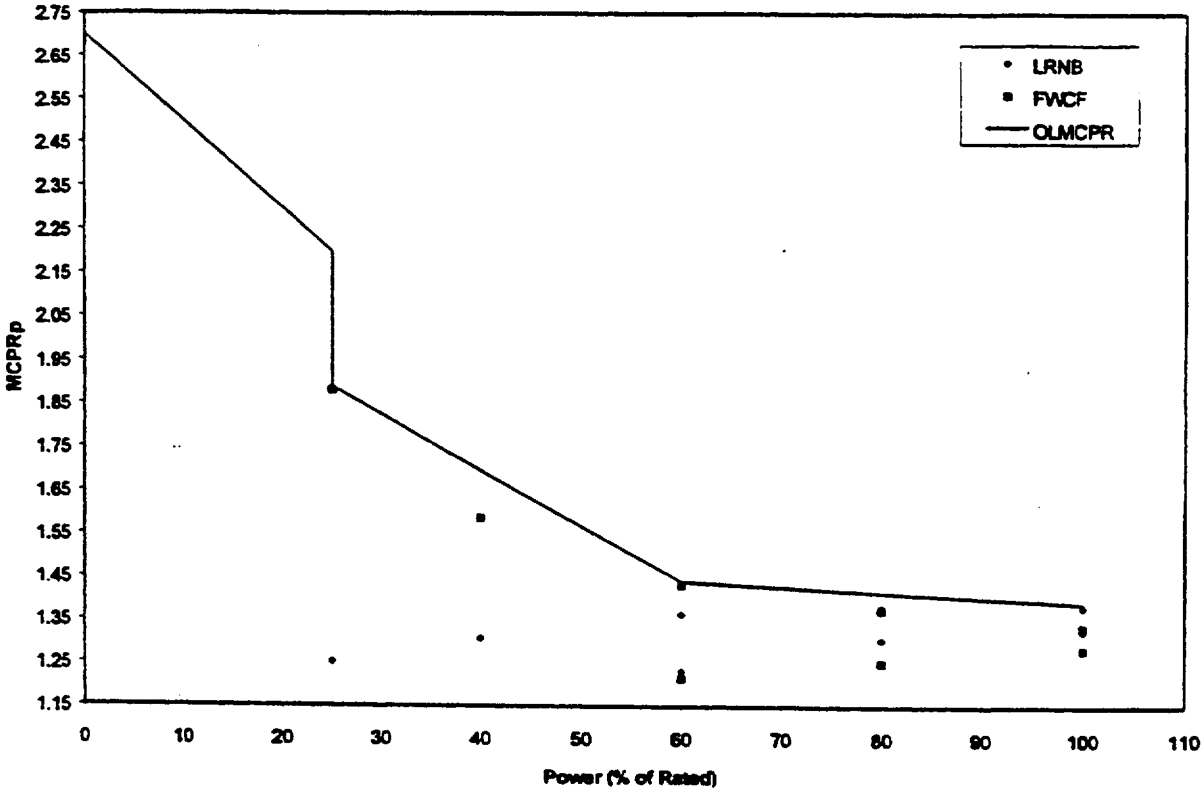
Power (%)	$MCPR_p$ Limit
100	1.41
60	1.46
25	1.91
25	2.20
0	2.70

Figure 3.12 EOC Base Case Power-Dependent MCPR Limits for ATRUM-9B Fuel – TSSS Insertion Times



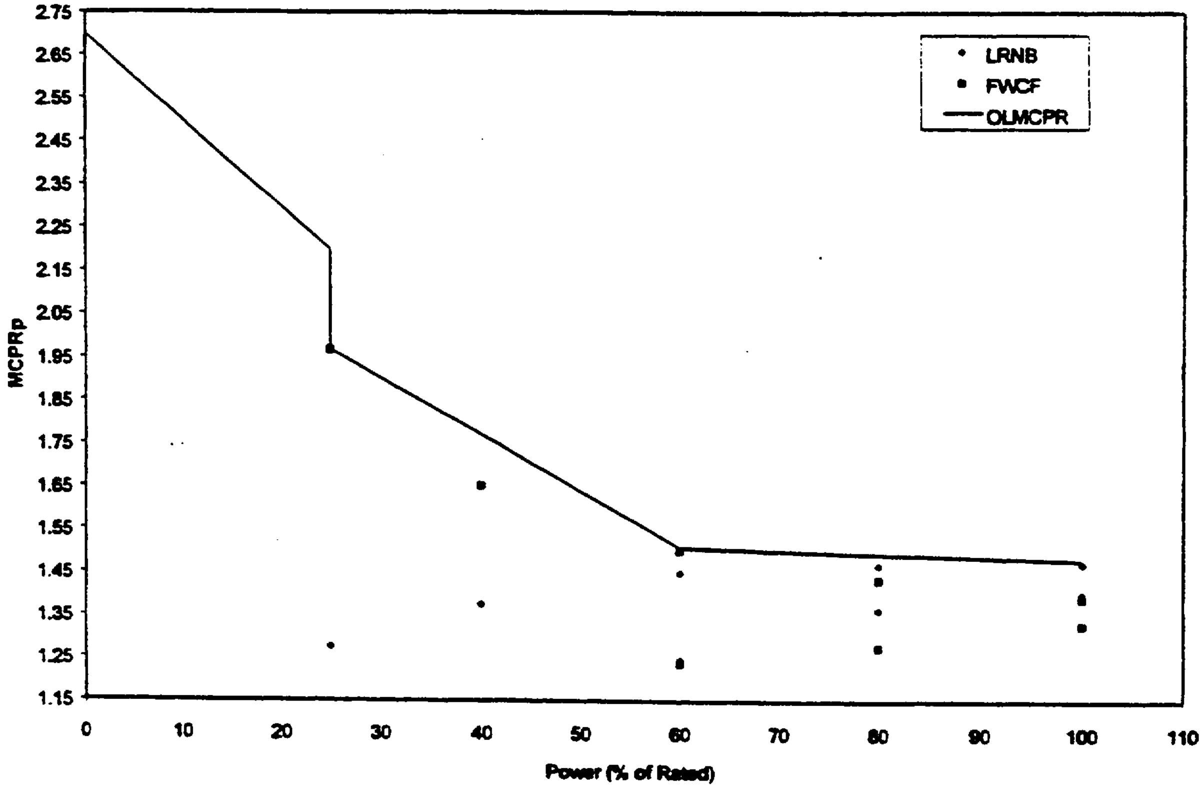
Power (%)	$MCPR_p$ Limit
100	1.51
60	1.52
25	1.99
25	2.20
0	2.70

Figure 3.13 EOC Base Case Power-Dependent MCPR Limits for GE9 Fuel – TSSS Insertion Times



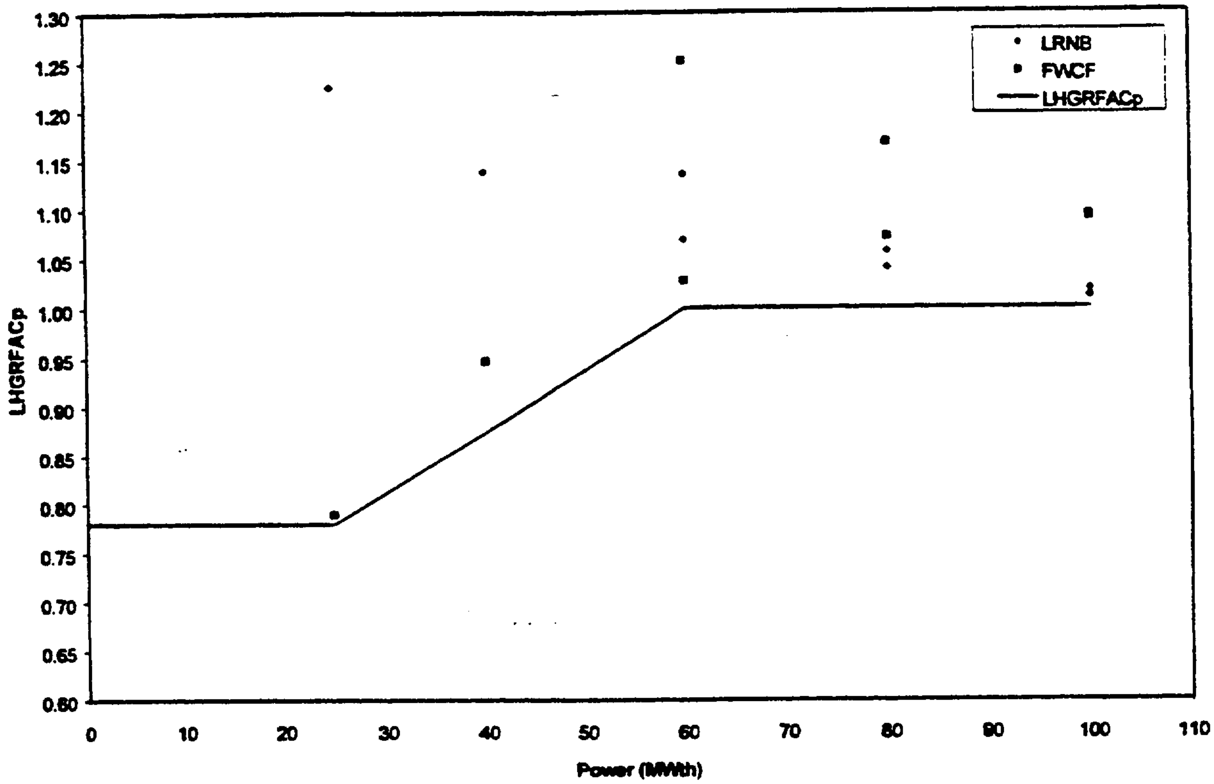
Power (%)	$MCPR_p$ Limit
100	1.39
60	1.44
25	1.89
25	2.20
0	2.70

Figure 3.14 EOC Base Case Power-Dependent MCPR Limits for ATRUM-9B Fuel – NSS Insertion Times



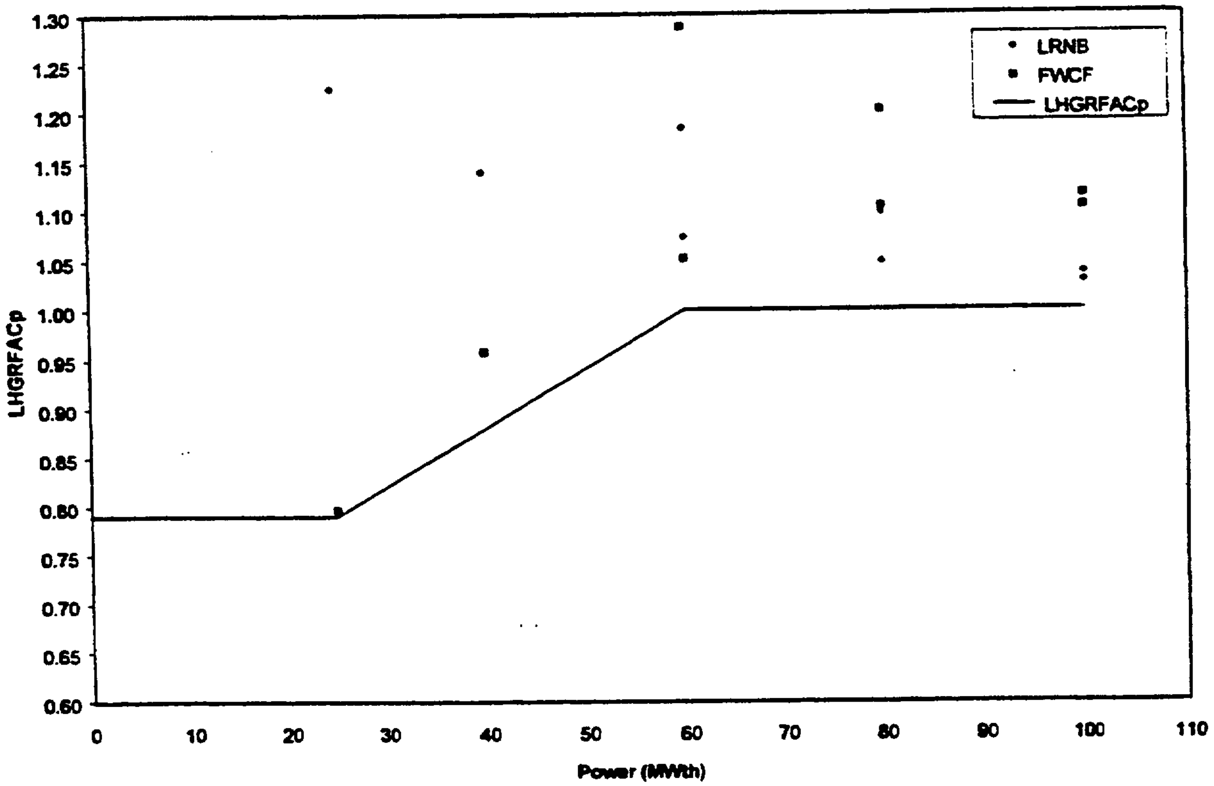
Power (%)	$MCPR_p$ Limit
100	1.48
60	1.51
25	1.97
25	2.20
0	2.70

Figure 3.15 EOC Base Case Power-Dependent MCPR Limits for GE9 Fuel – NSS Insertion Times



Power (%)	$LHGRFAC_p$ Multiplier
100	1.00
60	1.00
25	0.78
25	0.78
0	0.78

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



Power (%)	$LHGRFAC_p$ Multiplier
100	1.00
60	1.00
25	0.79
25	0.79
0	0.79

Figure 3.17 EOC Base Case Power-Dependent LHGR Multipliers for ATRUM-9B Fuel – NSS Insertion Times

4.0 Transient Analysis for Thermal Margin - Extended Operating Domain

This section describes the development of the MCPR and LHGR limits to support operation in the following extended operating domains:

- Increased core flow (ICF) to 105% of rated flow.
- Power coastdown to 40% of rated power.
- Final feedwater temperature reduction (FFTR) of up to 100°F and with ICF. Since FFTR is typically used in connection with coastdown, analyses were performed to support combined FFTR/coastdown operation.

Results of the limiting transient analyses are used to determine appropriate $MCPR_p$ limits and $LHGRFAC_p$ multipliers for ATRIUM-9B and GE9 fuel to support operation in the EOD scenarios. $MCPR_p$ limits are established for both ATRIUM-9B and GE9 fuel while $LHGRFAC_p$ multipliers are only established for the ATRIUM-9B fuel.

As discussed in Reference 9, the MCPR safety limit analysis for the base case remains valid for operation in the EODs discussed below. Also, the flow-dependent MCPR and LHGR analyses described in Section 3.4 were performed such that the results are applicable for all the EODs.

4.1 *Increased Core Flow*

The base case analyses presented in Section 3.0 were performed to support operation in the power/flow domain presented in Figure 1.1, which includes operation in the ICF region. The coastdown and combined FFTR/coastdown analyses are performed in conjunction with ICF to conservatively maximize the exposure at which a given power level can be attained. As a result, the analyses performed support operation in the ICF extended operating domain for all exposures.

4.2 *Coastdown Analysis*

Coastdown analyses were performed to ensure that appropriate $MCPR_p$ limits and $LHGRFAC_p$ multipliers are applied to support coastdown operation. The analyses were performed for coastdown operation to 40% of rated power using a conservative coastdown rate equivalent to a 10% decrease in rated power per 1000 MWd/MTU increase in exposure. An additional 1000 MWd/MTU was added to the EOFP exposure prior to the start of coastdown to provide operation support for operation at up to 10% of rated power above the equilibrium xenon coastdown power level. The $MCPR_p$ limits and $LHGRFAC_p$ multipliers are based on results of

LRNB and FWCF analyses. The analyses were performed at cycle exposures consistent with the assumed coastdown rate. This corresponds to the highest exposure at which the power can be obtained. The base case coastdown ΔCPRs for both the ATRIUM-9B and GE9 fuel as well as the ATRIUM-9B $LHGRFAC_p$ results are presented in Table 4.1 for the indicated power/flow conditions. The ATRIUM-9B $MCPR_p$ limits and $LHGRFAC_p$ multipliers for coastdown operation are presented in Figures 4.1 and 4.2. The GE9 coastdown $MCPR_p$ limits are presented in Figure 4.3.

4.3 *Combined Final Feedwater Temperature Reduction/Coastdown*

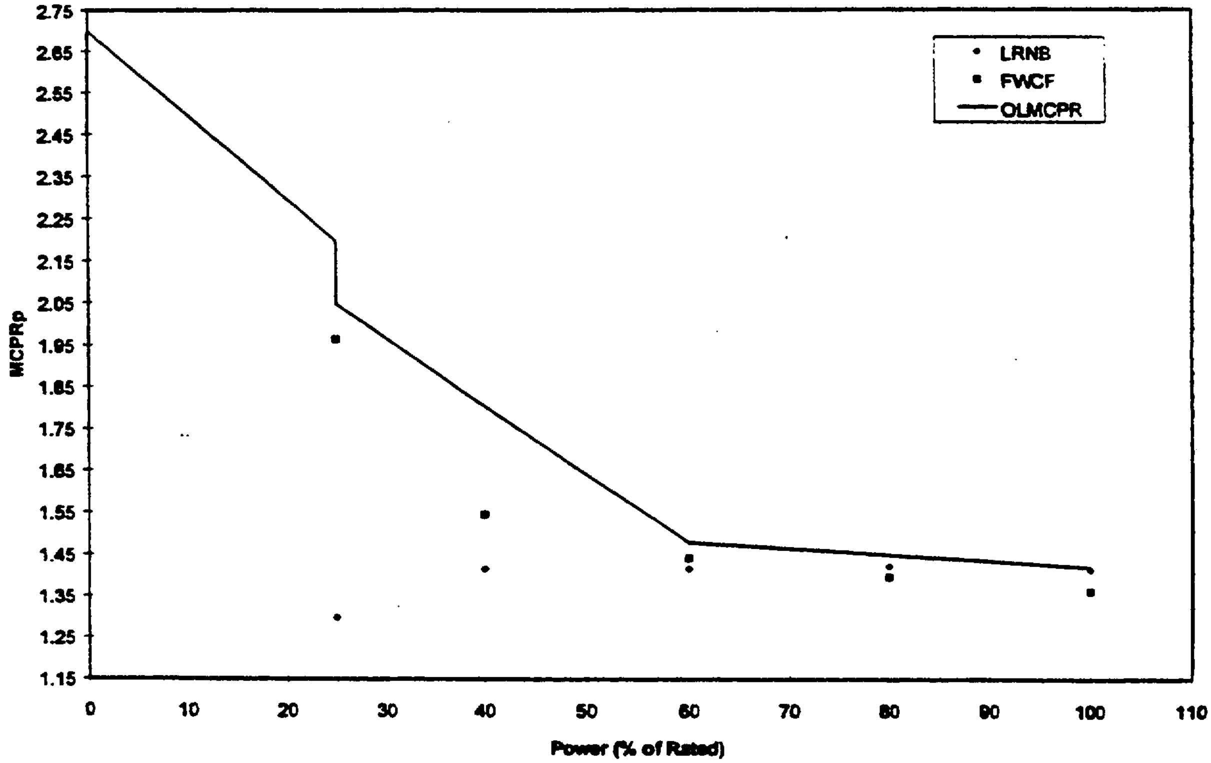
Analyses were performed to support FFTR with thermal coastdown to ensure that appropriate $MCPR_p$ limits and $LHGRFAC_p$ multipliers are established. The combined FFTR/coastdown analysis used a 100°F feedwater temperature reduction applied at EOFP to extend full thermal power operation. The coastdown exposure extension discussed in Section 4.2 (1000 MWd/MTU to support operation at up to 10% of rated power above the equilibrium xenon power level) was then applied. LRNB and FWCF analyses were performed to establish $MCPR_p$ limits and $LHGRFAC_p$ multipliers. The Cycle 9 FFTR/coastdown ΔCPR results for both ATRIUM-9B and GE9 fuel as well as the $LHGRFAC_p$ results are presented in Table 4.2 for the indicated power flow conditions. The ATRIUM-9B $MCPR_p$ limits and $LHGRFAC_p$ multipliers for combined FFTR/coastdown operation are presented in Figures 4.4 and 4.5. The GE9 coastdown $MCPR_p$ limits are presented in Figure 4.6.

Table 4.1 Coastdown Operation Transient Results

Event	Power/ Flow (% rated / % rated)	ATRIUM		GE9
		ΔCPR	$LHGRFAC_p$	ΔCPR
LRNB	100 / 105	0.31	1.00	0.41
LRNB	80 / 105	0.32	1.00	0.35
LRNB	60 / 105	0.31	0.99	0.35
LRNB	40 / 105	0.31	0.96	0.31
LRNB	25 / 105	0.19	1.13	0.19
FWCF	100 / 105	0.26	1.08	0.32
FWCF	80 / 105	0.29	1.08	0.31
FWCF	60 / 105	0.34	1.08	0.36
FWCF	40 / 105	0.44	1.12	0.44
FWCF	25 / 105	0.86	1.08	0.88

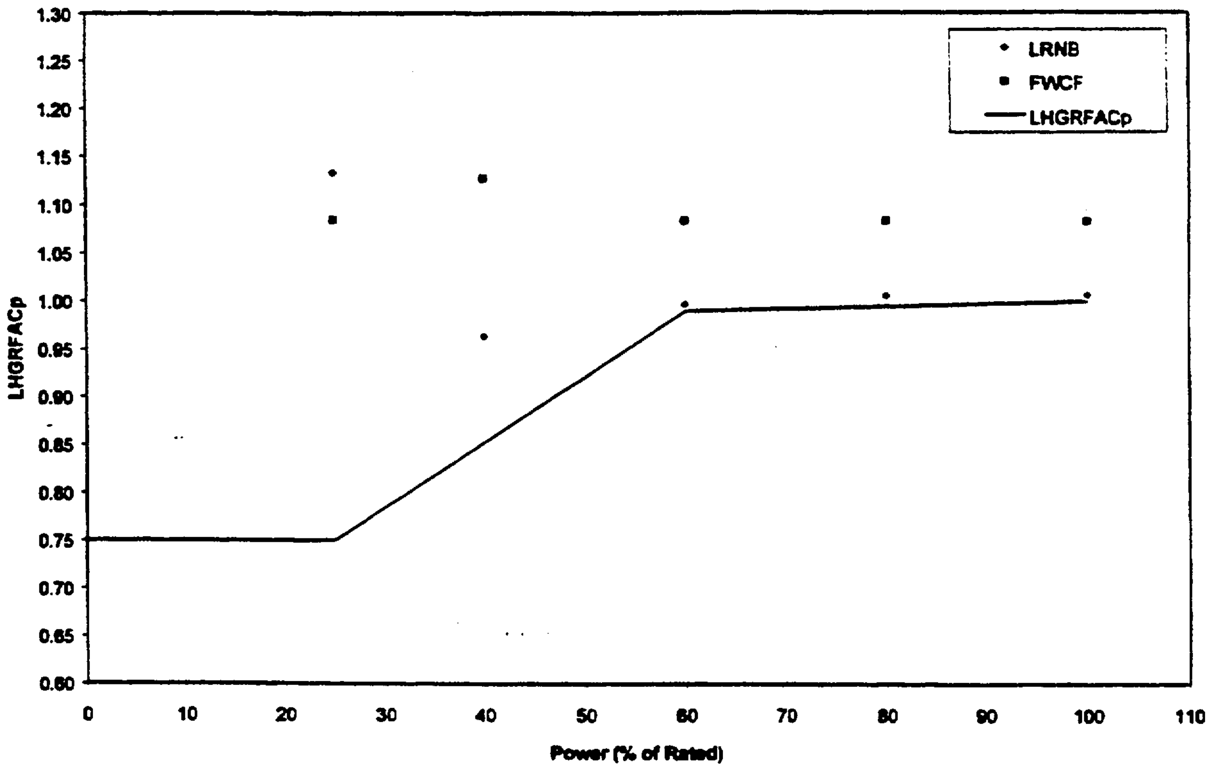
Table 4.2 FFTR/Coastdown Operation Transient Results

Event	Power/ Flow (% rated / % rated)	ATRIUM		GE9
		ΔCPR	$LHGRFAC_p$	ΔCPR
LRNB	100 / 105	0.26	1.04	0.29
LRNB	80 / 105	0.25	1.04	0.30
LRNB	60 / 105	0.27	1.01	0.28
LRNB	40 / 105	0.25	0.99	0.25
LRNB	25 / 105	0.14	1.18	0.15
FWCF	100 / 105	0.26	1.09	0.28
FWCF	80 / 105	0.30	1.09	0.33
FWCF	60 / 105	0.37	1.09	0.40
FWCF	40 / 105	0.50	1.07	0.50
FWCF	25 / 105	1.10	0.95	1.12



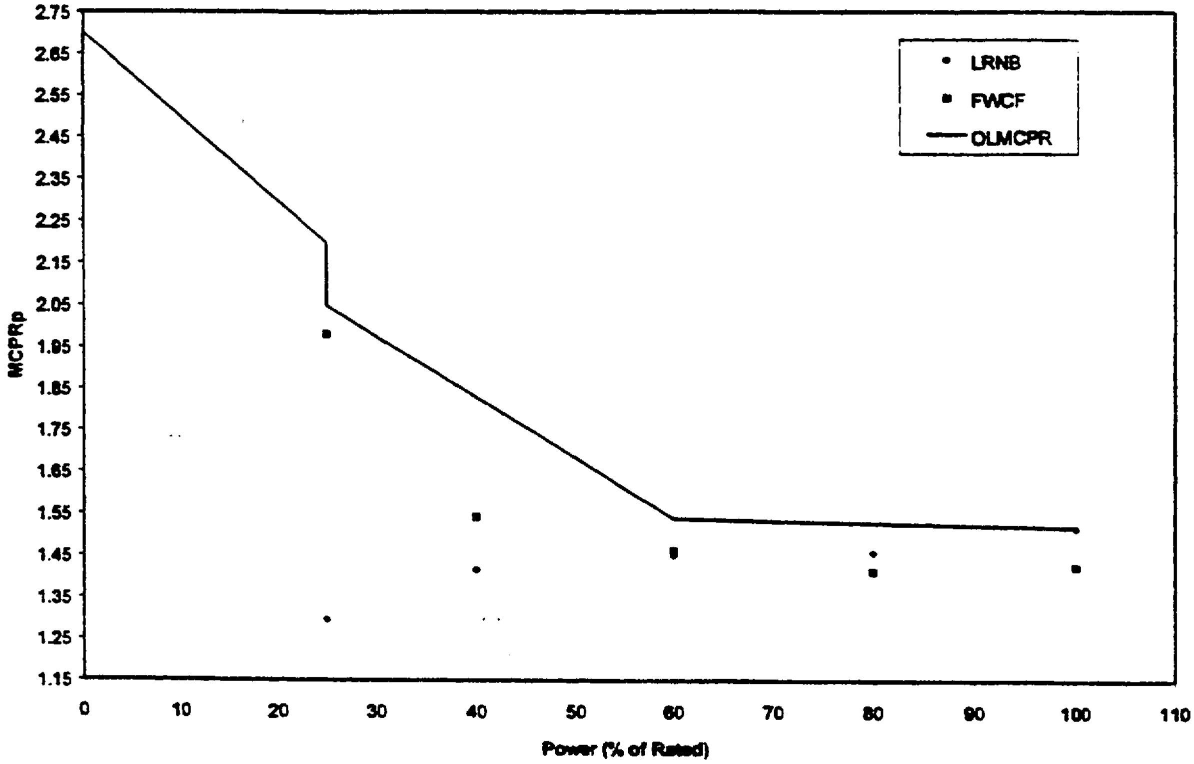
Power (%)	$MCPR_p$ Limit
100	1.42
60	1.48
25	2.05
25	2.20
0	2.70

Figure 4.1 Coastdown Power-Dependent MCPR Limits for ATRUM-9B Fuel



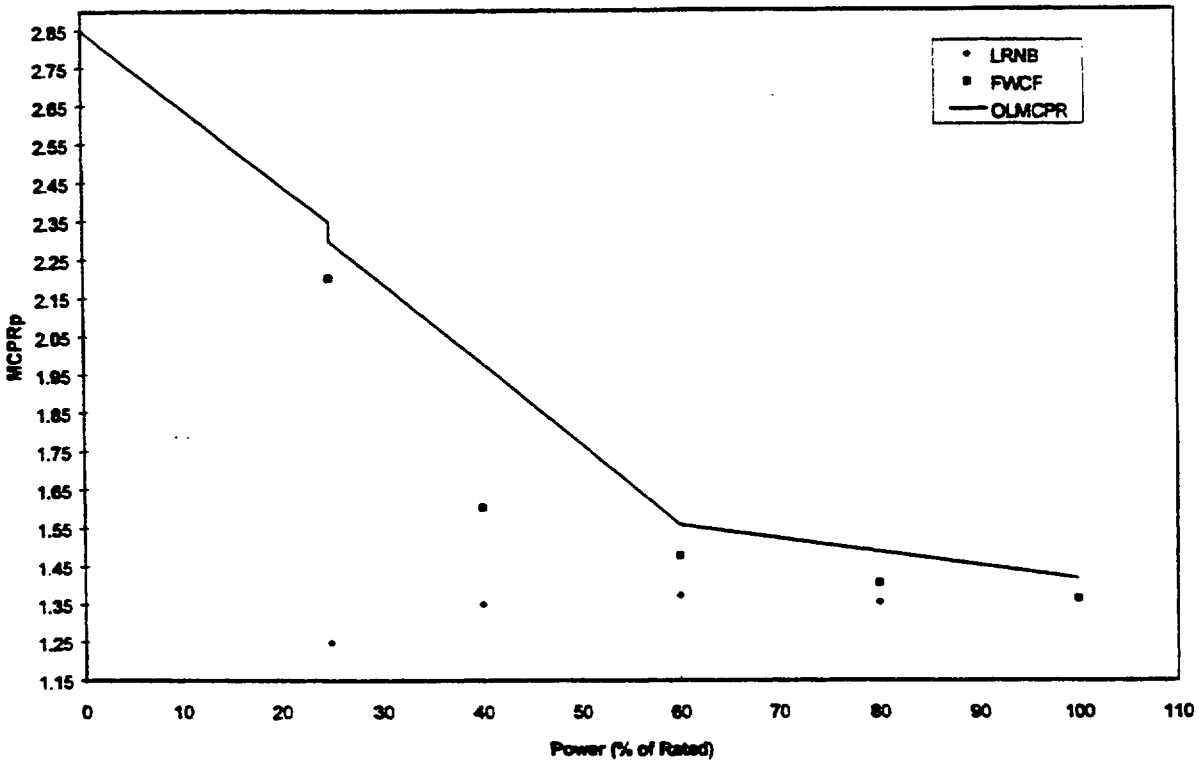
Power (%)	LHGRFAC$_p$ Multiplier
100	1.00
60	0.99
25	0.75
25	0.75
0	0.75

Figure 4.2 Coastdown Power-Dependent LHGR Multipliers for ATRUM-9B Fuel



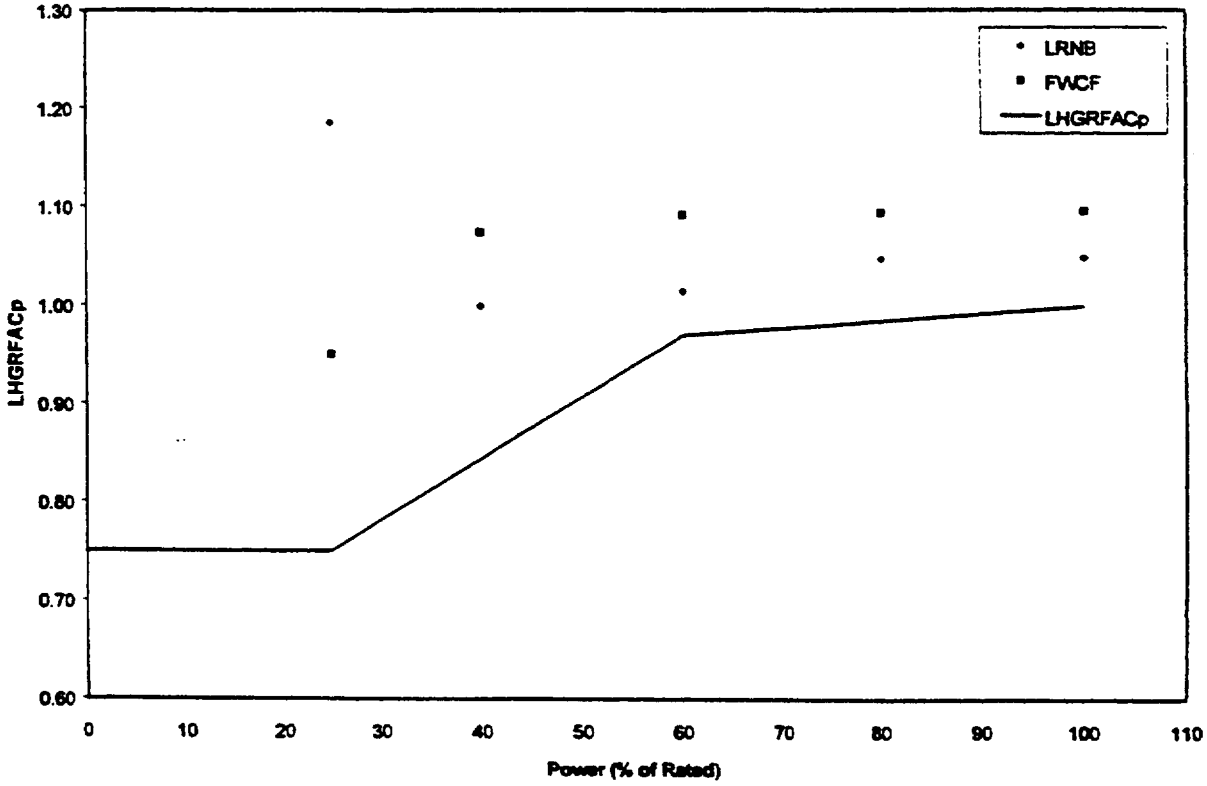
Power (%)	$MCPR_p$ Limit
100	1.52
60	1.54
25	2.05
25	2.20
0	2.70

Figure 4.3 Coastdown Power-Dependent MCPR Limits for GE9 Fuel



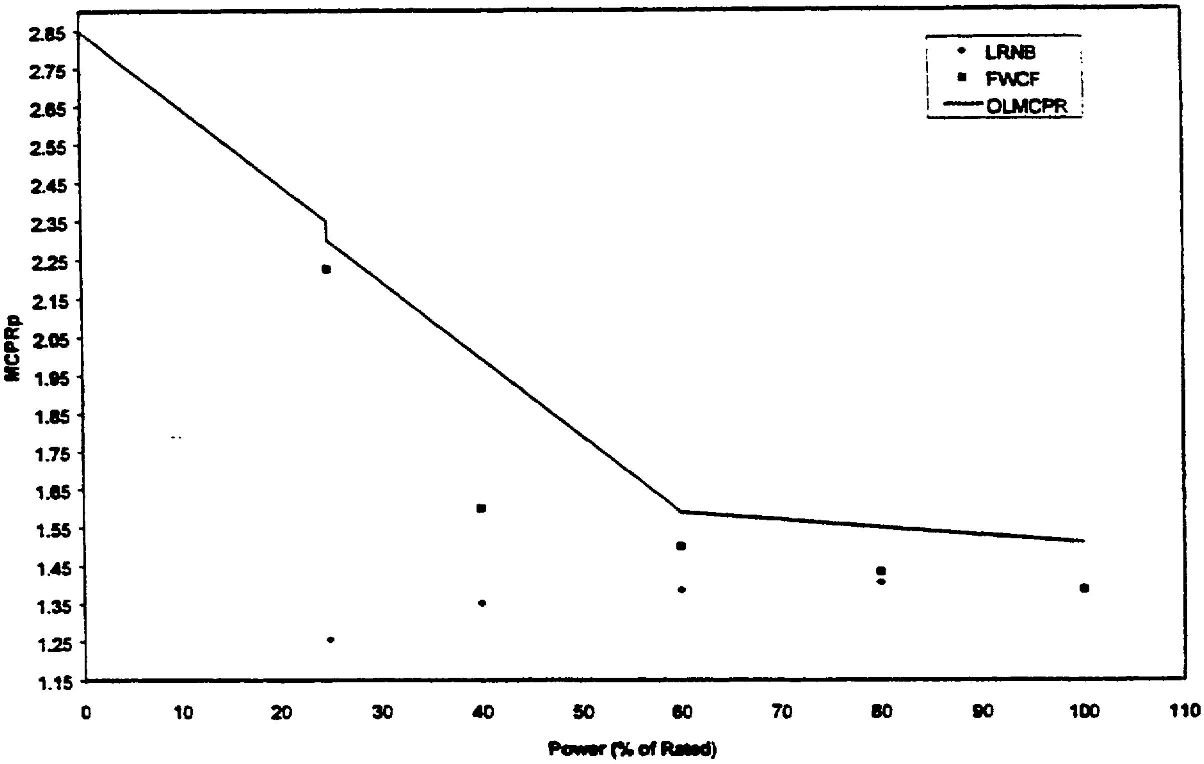
Power (%)	$MCPR_p$ Limit
100	1.42
60	1.56
25	2.30
25	2.35
0	2.85

Figure 4.4 FFTR/Coastdown Power-Dependent MCPR Limits for ATRUM-9B Fuel



Power (%)	$LHGRFAC_p$ Multiplier
100	1.00
60	0.97
25	0.65
25	0.65
0	0.65

Figure 4.5 FFTR/Coastdown Base Case Power-Dependent LHGR Multipliers for ATRUM-9B Fuel



Power (%)	$MCPR_p$ Limit
100	1.52
60	1.59
25	2.30
25	2.35
0	2.85

Figure 4.6 FFTR/Coastdown Power-Dependent MCPR Limits for GE9 Fuel

5.0 Transient Analysis for Thermal Margin - Equipment Out-of-Service

This section describes the development of the MCPR and LHGR operating limits to support operation with the following EOOS scenarios:

- Feedwater heaters out-of-service (FHOOS) – 100°F feedwater temperature reduction.
- 1 recirculation pump loop (SLO).
- Turbine bypass system out-of-service (TBVOOS).
- Recirculation pump trip out-of-service (No RPT).
- Slow closure of 1 or more turbine control valves.

Operation with 1 SRV out-of-service, up to 2 TIPOOS (or the equivalent number of TIP channels) and up to 50% of the LPRMs out-of-service is supported by the base case thermal limits presented in Section 3.0. No further discussion for these EOOS scenarios is presented in this section. The EOOS analyses presented in this section also include the same EOOS scenarios protected by the base case limits.

Results of the limiting transient analyses are used to establish appropriate $MCPR_p$ limits and $LHGRFAC_p$ multipliers to support operation in the EOOS scenarios. All EOOS analyses were performed with TSSS insertion times.

As discussed in Reference 9, the base case MCPR safety limit for two-loop operation remains applicable for operation in the EOOS scenarios discussed below with the exception of single-loop operation. Also, the flow-dependent MCPR and LHGR analyses described in Section 3.4 were performed such that the results are applicable in all the EOOS scenarios.

5.1 *Feedwater Heaters Out-of-Service (FHOOS)*

The FHOOS scenario assumes a 100°F reduction in the feedwater temperature. Operation with FHOOS is similar to operation with FFTR except that the reduction in feedwater temperature due to FHOOS can occur at any time during the cycle. The effect of the reduced feedwater temperature is an increase in the core subcooling which can change the power shape and core void fraction. While the LRNB event is less severe due to the decrease in steam flow, the FWCF event can get worse due to the increase in core inlet subcooling. FWCF analyses were performed for Cycle 9 to determine thermal limits to support operation with FHOOS. The ΔCPR and $LHGRFAC_p$ results used to develop the EOC operating limits with FHOOS are presented in Table 5.1. The EOC $MCPR_p$ limits and $LHGRFAC_p$ multipliers for ATRIUM-9B fuel for FHOOS operation are presented in Figures 5.1 and 5.2, and the EOC FHOOS GE9 $MCPR_p$ limits are presented in Figure 5.3.

5.2 *Single-Loop Operation (SLO)*

5.2.1 Base Case Operation

The impact of SLO at LaSalle on thermal limits was presented in Reference 9. The only impact is on the MCPR safety limit. As presented in Section 3.2, the single-loop operation safety limit is 0.01 greater than the two-loop operating limit (1.12 compared to 1.11). The base case ΔCPRs and $LHGRFAC_p$ multipliers remain applicable. The net result is an increase to the base case $MCPR_p$ limits of 0.01 as a result of the increase in the MCPR safety limit.

5.2.2 Idle Loop Startup

The $MCPR_p$ limits and $LHGRFAC_p$ multipliers for the startup of an idle recirculation pump are based on the results of the abnormal startup of the idle recirculation loop analysis and the SLO MCPR safety limit analysis. As discussed in Section 3.2, the single-loop operation safety limit is 1.12 or 0.01 higher than the two-loop operation limit. The process used for the abnormal startup of the idle recirculation loop analysis for L2C9 is presented in Reference 20. The responses of the system parameters for the L2C9 analysis are consistent with those presented in Reference 20. The Reference 20 results demonstrated that the lowest power (35%P/47%F) conditions provide conservative results. Subsequently, the L2C9 analyses were performed at 35%P/47%F. The limiting exposure was determined to be BOC. The ΔCPR and $LHGRFAC_p$ results for the abnormal startup of the idle recirculation loop are presented in Table 5.2. Figures 5.4 and 5.5 present the ATRIUM-9B $MCPR_p$ limits and $LHGRFAC_p$ multipliers for idle loop startup. The GE9 $MCPR_p$ limits for idle loop startup are presented in Figure 5.6.

5.3 *Turbine Bypass Valves Out-of-Service (TBVOOS)*

The effect of operation with TBVOOS is a reduction in the system pressure relief capacity, which makes the pressurization events more severe. While the base case LRNB event is analyzed assuming the turbine bypass system out-of-service, operation with TBVOOS has an effect on the FWCF event. The FWCF event was evaluated for LaSalle Unit 2 Cycle 9 to support operation with TBVOOS. The ΔCPR and $LHGRFAC_p$ results used to develop the EOC operating limits with TBVOOS are presented in Table 5.3. The EOC $MCPR_p$ limits and $LHGRFAC_p$

multipliers for ATRIUM-9B fuel for TBVOOS operation are presented in Figures 5.7 and 5.8, and the EOC TBVOOS GE9 $MCPR_p$ limits are presented in Figure 5.9.

5.4 *Recirculation Pump Trip Out-of-Service (No RPT)*

This section summarizes the development of the thermal limits to support operation with the EOC RPT inoperable. When RPT is inoperable, no credit for tripping the recirculation pump on TSV position or TCV fast closure is assumed. The function of the RPT feature is to reduce the severity of the core power excursion caused by the pressurization transient. The RPT accomplishes this by helping revoid the core, thereby reducing the magnitude of the reactivity insertion resulting from the pressurization transient. Failure of the RPT feature can result in higher operating limits because of the higher positive reactivity in the core at the time of control rod insertion.

Analyses were performed for LRNB and FWCF events assuming no RPT. The ΔCPR and $LHGRFAC_p$ results used to develop the EOC operating limits with no RPT are presented in Table 5.4. The EOC $MCPR_p$ limits and $LHGRFAC_p$ multipliers for ATRIUM-9B fuel for operation with no RPT are presented in Figures 5.10 and 5.11, and the EOC no RPT GE9 $MCPR_p$ limits are presented in Figure 5.12.

5.5 *Slow Closure of the Turbine Control Valve*

LRNB analyses were performed to evaluate the impact of a TCV slow closure. Analyses were performed closing 3 valves in the normal fast closure mode and 1 valve in 2.0 seconds. Results provided in Reference 23 demonstrate that performing the analyses with 1 TCV closing in 2.0 seconds protects operation with up to 4 TCVs closing slowly. Sensitivity analyses below 80% power have shown that the pressure relief provided by all 4 TCVs closing slowly can be sufficient to preclude the high-flux scram set point from being exceeded. Therefore, credit for high-flux scram is not taken for analyses at 80% power and below. The 80% power TCV slow closure analyses were performed both with and without high-flux scram credited. The ΔCPR and $LHGRFAC_p$ results of the analyses performed are presented in Table 5.5.

The $MCPR_p$ limits and $LHGRFAC_p$ multipliers are established with a step change at 80% power. At 80% power, the lower-bound $MCPR_p$ limits and upper-bound $LHGRFAC_p$ multipliers are based on the analyses which credit high-flux scram; the upper-bound $MCPR_p$ limits and lower-bound $LHGRFAC_p$ multipliers are based on analyses which do not credit high-flux scram. While the TCV slow closure analysis is performed without RPT on valve position, it does not necessarily bound the LRNB no RPT or FWCF no RPT events at all power levels because the slow closing TCV provides some pressure relief until it completely closes. Therefore, the $MCPR_p$ limits and $LHGRFAC_p$ multipliers for the TCV slow closure EOOS scenario are established using the limiting of the no RPT results reported in Section 5.4 and the TCV slow closure results.

The EOC $MCPR_p$ limits and $LHGRFAC_p$ multipliers for ATRIUM-9B fuel for operation with TCV slow closure are presented in Figures 5.13 and 5.14 and the EOC TCV slow closure GE9 $MCPR_p$ limits are presented in Figure 5.15. The limits presented in Figures 5.13 through 5.15 protect the scenario of all 4 TCVs closing slowly.

5.6 *Combined FHOOS/TCV Slow Closure and/or No RPT*

$MCPR_p$ limits and $LHGRFAC_p$ multipliers were established to support operation with FHOOS, TCV slow closure and/or no RPT. The TCV slow closure ΔCPR and $LHGRFAC_p$ results with FHOOS become less limiting than the TCV slow closure event with nominal feedwater temperature since the initial steam flow with FHOOS is lower and produces a less severe pressurization event. Subsequently, no TCV slow closure with FHOOS analyses were performed. The TCV slow closure results with nominal feedwater temperature are considered in determining the combined FHOOS/TCV slow closure and/or no RPT $MCPR_p$ limits and $LHGRFAC_p$ multipliers. The limits were developed based on the limiting of either the TCV slow closure analysis results discussed in Section 5.5 or the analyses with both FHOOS and no RPT presented in Table 5.6.

The EOC $MCPR_p$ limits and $LHGRFAC_p$ multipliers for ATRIUM-9B fuel with FHOOS/TCV slow closure and/or no RPT are presented in Figures 5.16 and 5.17, and the EOC GE9 $MCPR_p$ limits for the same EOOS scenario are presented in Figure 5.18. The limits presented in Figures 5.16 through 5.18 protect the scenario of all 4 TCVs closing slowly.

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

Event	Power/ Flow (% rated / % rated)	ATRIUM		GE9
		ΔCPR	$LHGRFAC_p$	ΔCPR
FWCF	100 / 105	0.26	1.08*	0.31
FWCF	100 / 81	0.23	1.11	0.28
FWCF	80 / 105	0.30	1.03*	0.36
FWCF	60 / 105	0.40*	0.97*	0.46*
FWCF	40 / 105	0.62*	0.87*	0.69*
FWCF	25 / 105	1.03*	0.69*	1.11*

---

* 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

Power / Flow (% rated / % rated)	FCV Position	ATRIUM-9B	
		ΔCPR*	LHGRFAC$_p$
35 / 47	27% open	1.46†	0.42†

---

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

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

Event	Power / Flow (% rated / % rated)	ATRIUM		GE9
		ΔCPR	LHGRFAC$_p$	ΔCPR
FWCF	100 / 105	0.32	1.02	0.41
FWCF	100 / 81	0.31	0.99	0.41
FWCF	80 / 105	0.35	1.00*	0.45
FWCF	80 / 57.2	0.31	1.05	0.41
FWCF	60 / 105	0.41*	0.97*	0.51
FWCF	60 / 35.1	0.18	1.14	0.25
FWCF	40 / 105	0.58*	0.90*	0.66*
FWCF	25 / 105	0.87*	0.76*	0.97*

---

* 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

Event	Power / Flow (% rated / % rated)	ATRIUM		GE9
		ΔCPR	$LHGRFAC_p$	ΔCPR
LRNB	100 / 105	0.40	0.89	0.50
LRNB	100 / 81	0.32	0.91	0.47
LRNB	80 / 105	0.35	0.94	0.47
LRNB	80 / 57.2	0.30	0.97	0.44
LRNB	60 / 105	0.32	0.99	0.44
FWCF	100 / 105	0.31	0.97	0.40
FWCF	100 / 81	0.26	0.99	0.35
FWCF	80 / 105	0.33	1.00*	0.43
FWCF	60 / 105	0.38	0.97*	0.48
FWCF	40 / 105	0.51*	0.91*	0.59*
FWCF	25 / 105	0.78*	0.79*	0.87*

---

* 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		GE9
			ΔCPR	$LHGRFAC_p$	ΔCPR
LRNB	1 TCV closing at 2.0 sec	100 / 105*	0.42	0.93	0.52
LRNB	1 TCV closing at 2.0 sec	100 / 81*	0.33	0.97	0.49
LRNB	1 TCV closing at 2.0 sec	80 / 105*	0.40	0.96	0.49
LRNB	1 TCV closing at 2.0 sec	80 / 57.2*	0.50	0.97	0.73
LRNB	1 TCV closing at 2.0 sec	80 / 105†	0.52‡	0.86‡	0.62
LRNB	1 TCV closing at 2.0 sec	80 / 57.2†	0.58	0.92‡	0.84
LRNB	1 TCV closing at 2.0 sec	60 / 105†	0.61‡	0.83‡	0.71‡
LRNB	1 TCV closing at 2.0 sec	60 / 35.1†	0.63‡	0.94‡	0.86
LRNB	1 TCV closing at 2.0 sec	40 / 105†	0.78	0.77‡	0.84
LRNB	1 TCV closing at 2.0 sec	25 / 105†	0.99	0.70‡	0.97‡

---

* Scram initiated by high-neutron flux.

† Scram initiated by high dome pressure

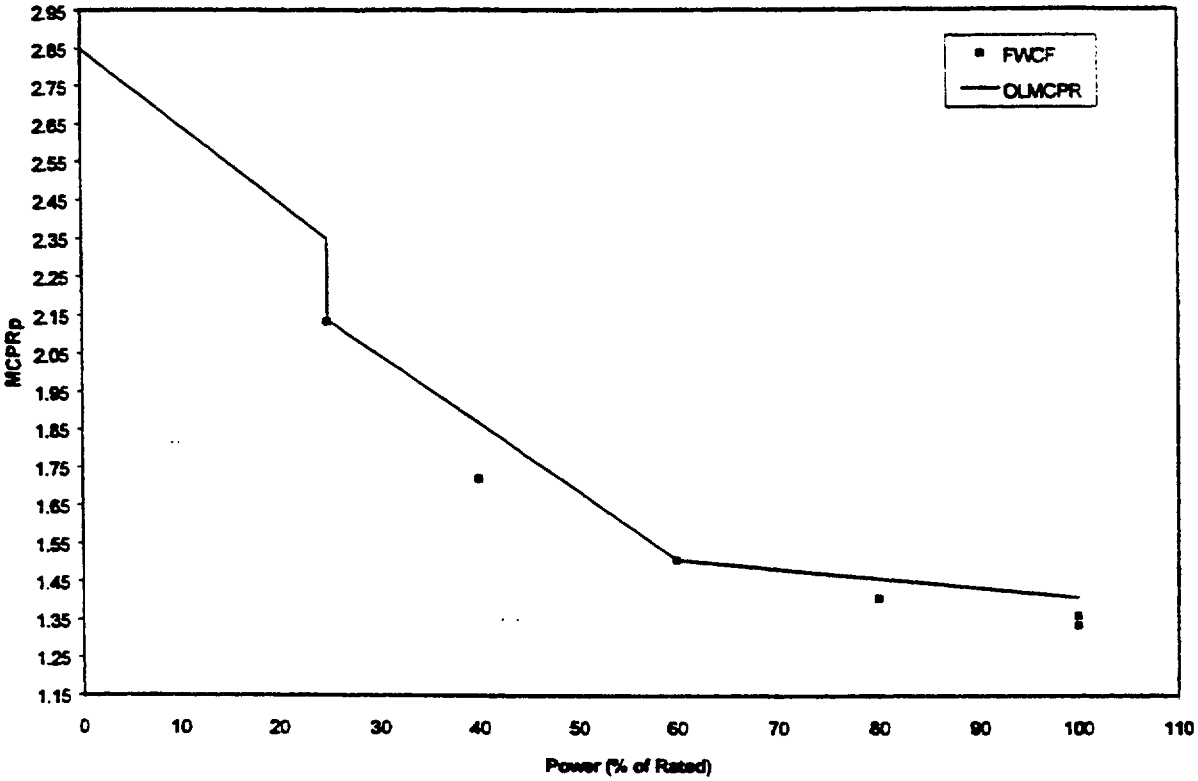
‡ The analysis results presented are from an earlier cycle exposure. The ΔCPR and $LHGRFAC_p$ results are conservatively used to establish the thermal limits.

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

Event	Power / Flow (% rated / % rated)	ATRIUM-9B		GE9
		ΔCPR	$LHGRFAC_p$	ΔCPR
FWCF	100 / 105	0.30	0.98	0.39
FWCF	100 / 81	0.25	1.03	0.33
FWCF	80 / 105	0.35	0.98*	0.43
FWCF	60 / 105	0.42	0.94*	0.51
FWCF	40 / 105	0.61*	0.85*	0.70*
FWCF	25 / 105	1.01*	0.68*	1.09*

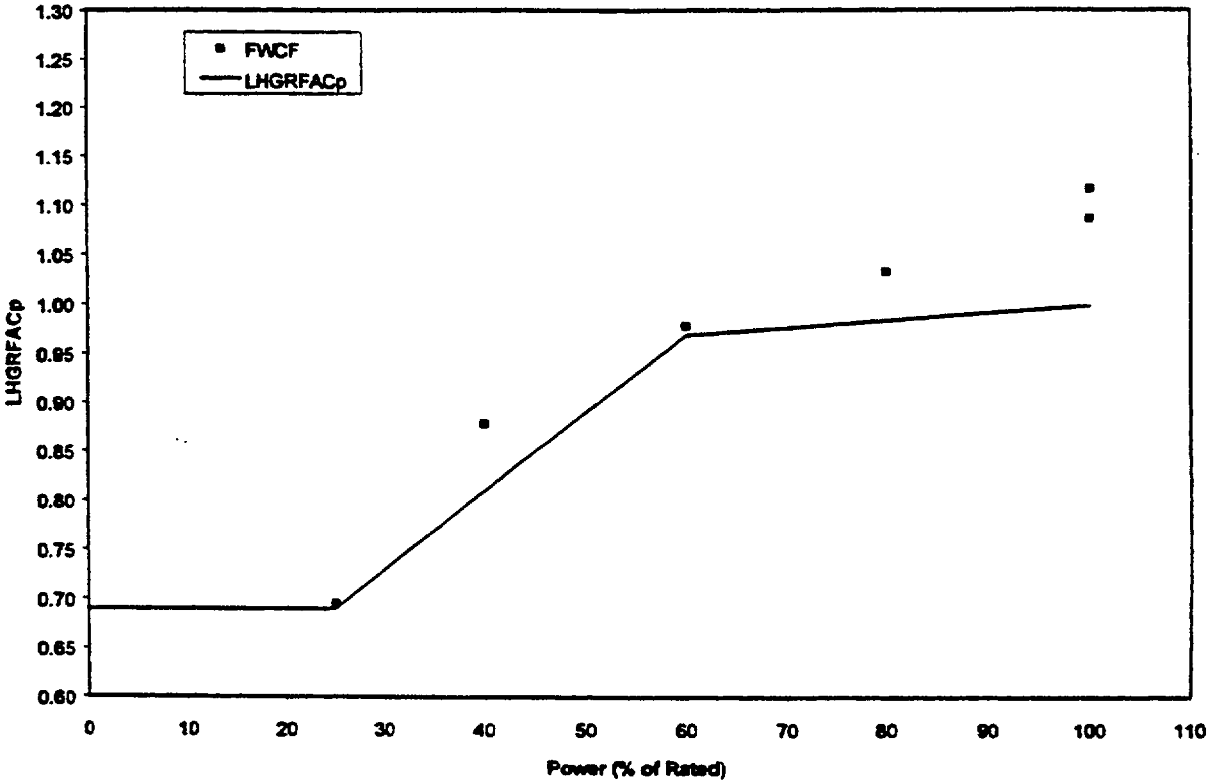
---

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



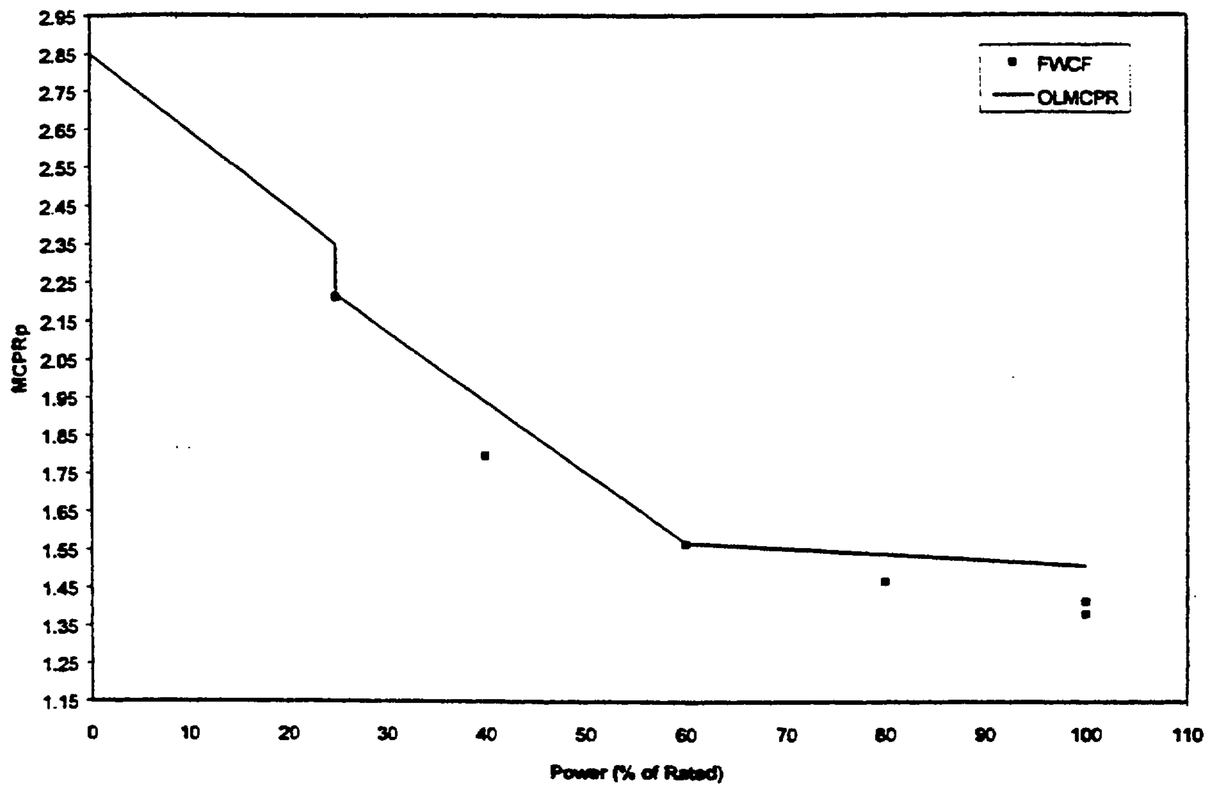
Power (%)	$MCPR_p$ Limit
100	1.41
60	1.51
25	2.14
25	2.35
0	2.85

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



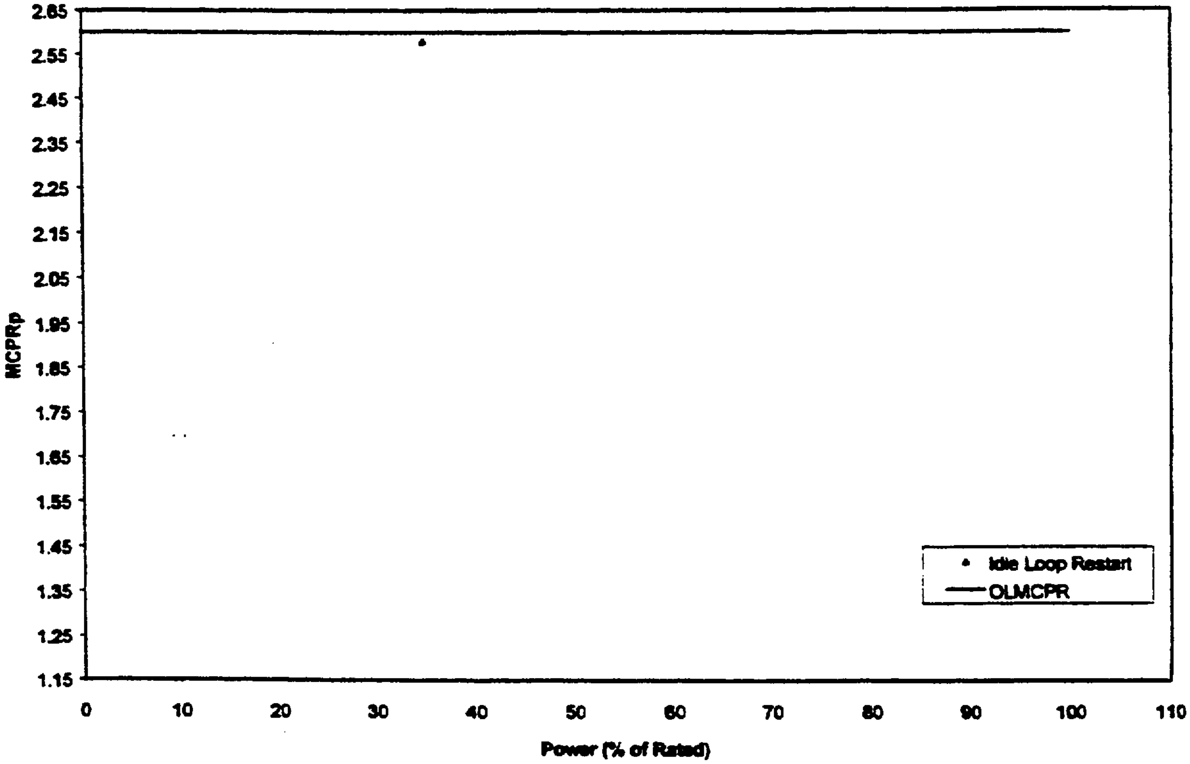
Power (%)	LHGRFAC$_p$ Multiplier
100	1.00
60	0.97
25	0.69
25	0.69
0	0.69

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



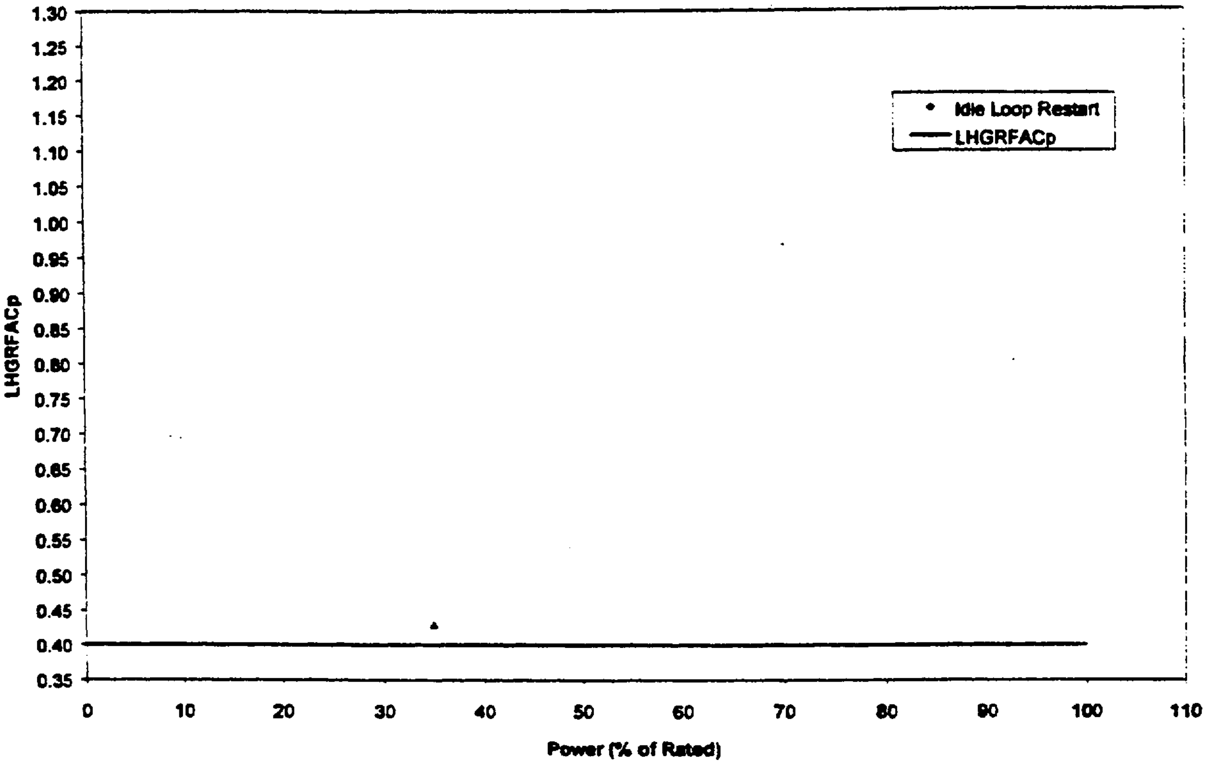
Power (%)	$MCPR_p$ Limit
100	1.51
60	1.57
25	2.22
25	2.35
0	2.85

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



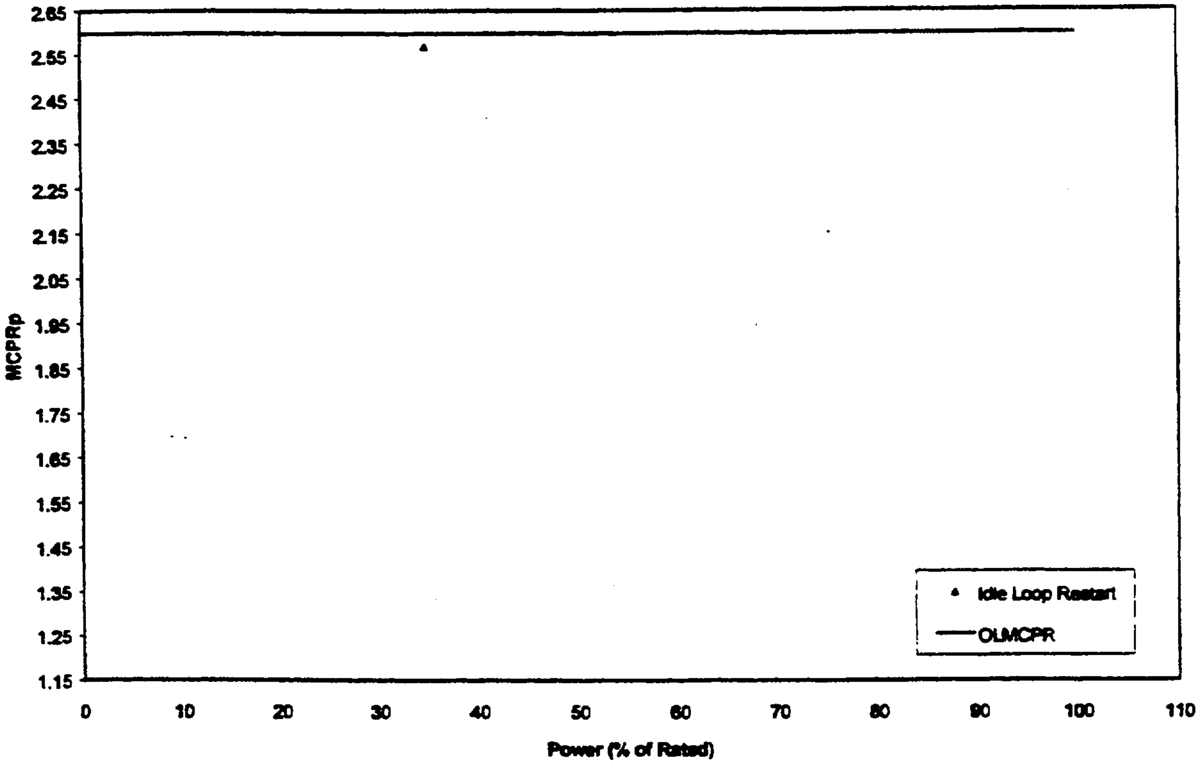
Power (%)	MCPR$_p$ Limit
100	2.60
60	2.60
25	2.60
25	2.60
0	2.60

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



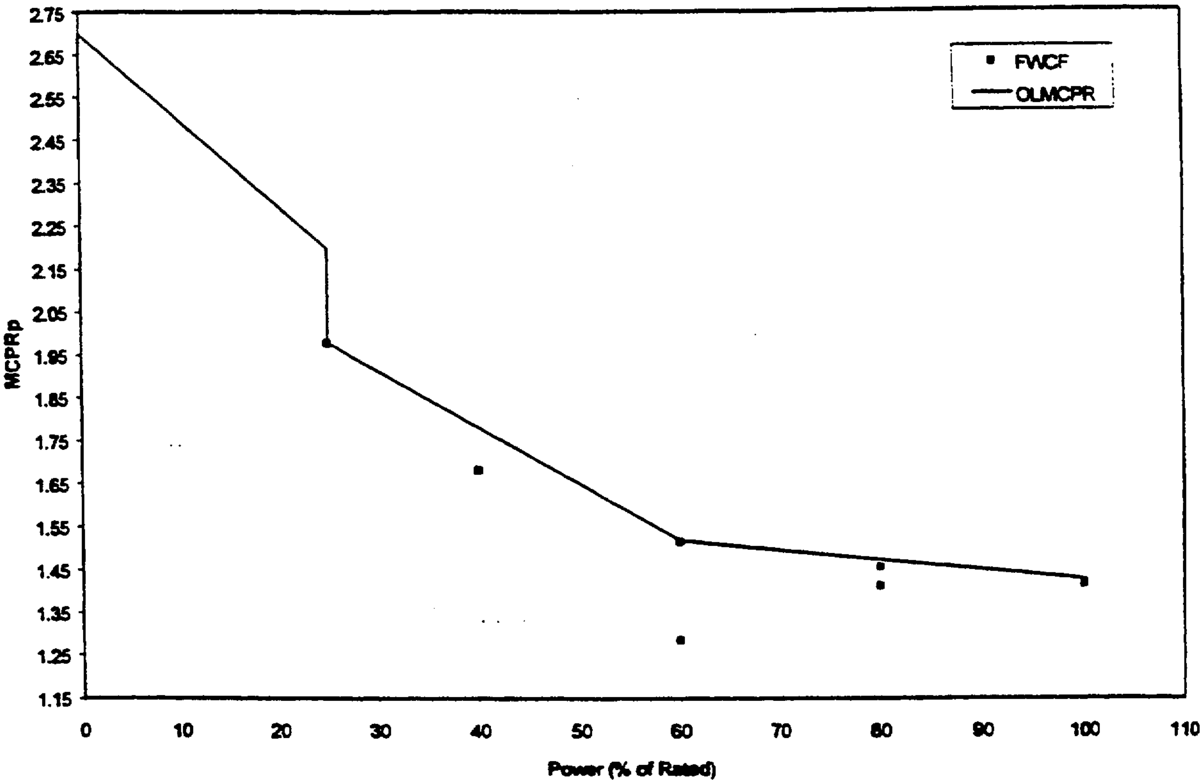
Power (%)	LHGRFAC$_p$ Multiplier
100	0.40
60	0.40
25	0.40
25	0.40
0	0.40

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



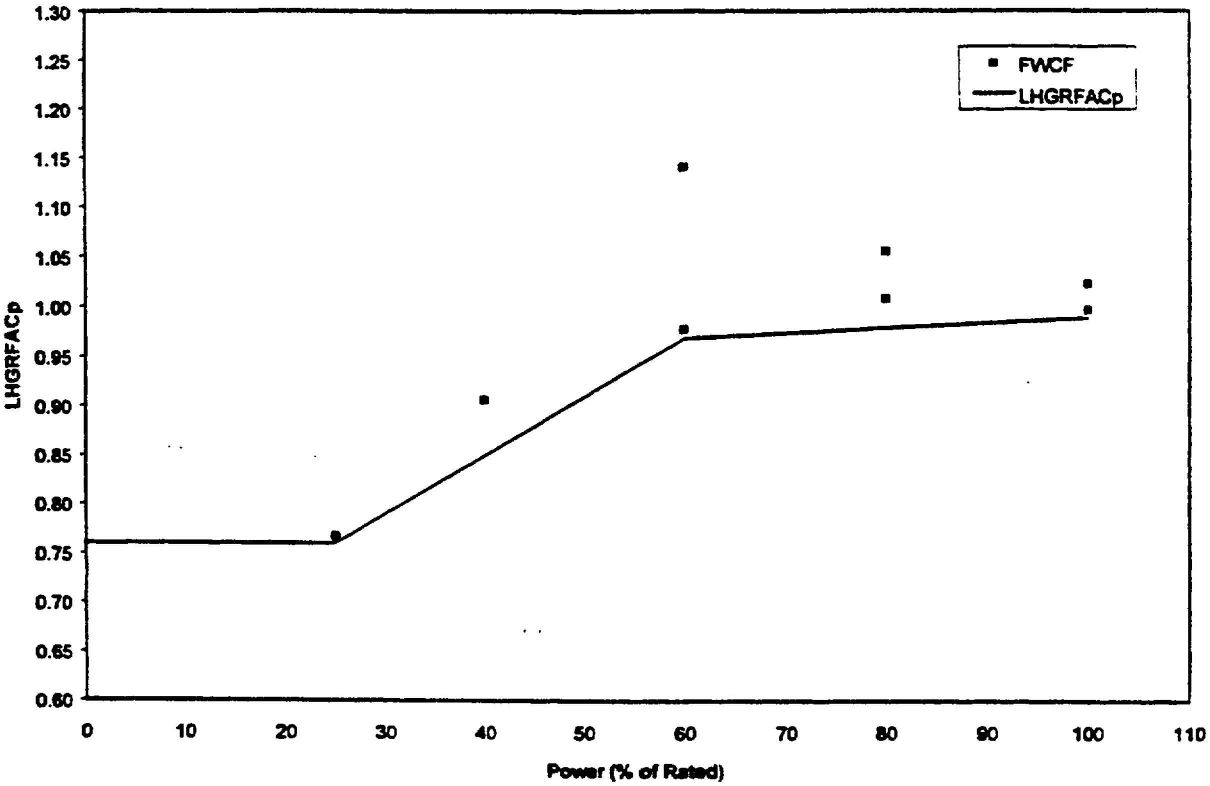
Power (%)	$MCPR_p$ Limit
100	2.60
60	2.60
25	2.60
25	2.60
0	2.60

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



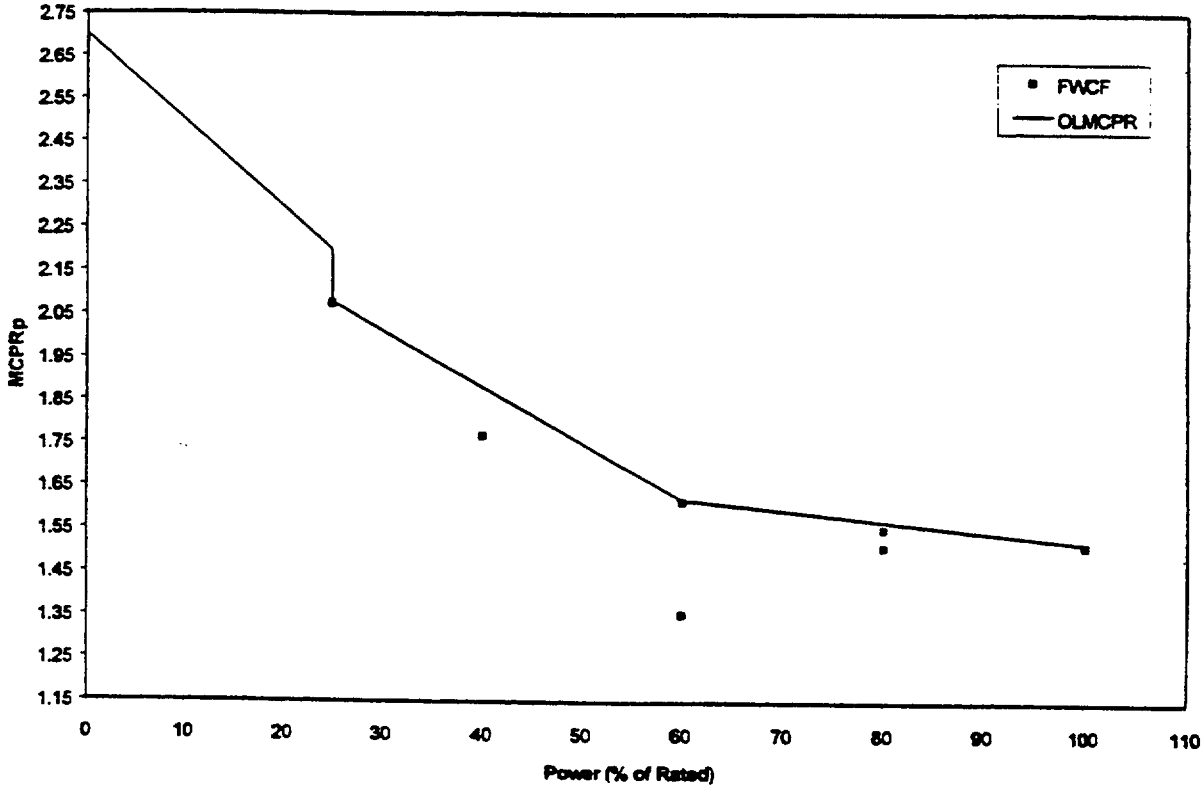
Power (%)	$MCPR_p$ Limit
100	1.43
60	1.52
25	1.98
25	2.20
0	2.70

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



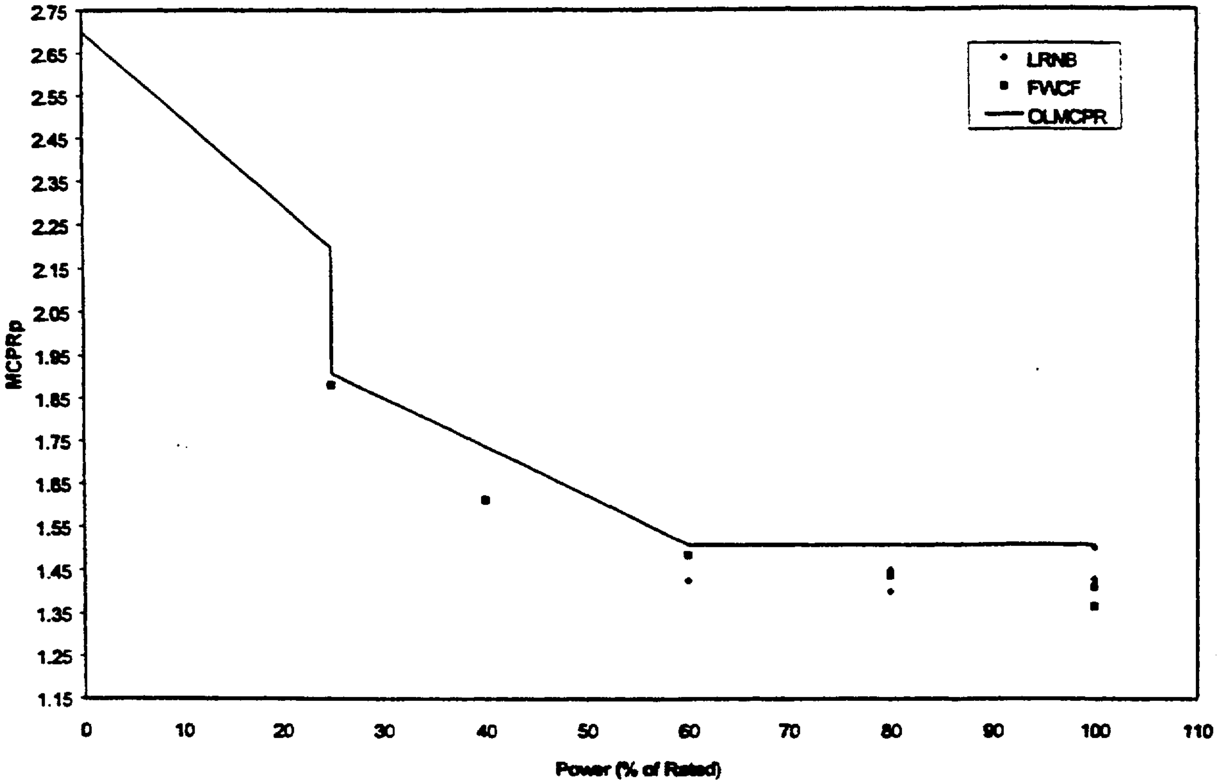
Power (%)	LHGRFAC$_p$ Multiplier
100	0.99
60	0.97
25	0.76
25	0.76
0	0.76

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



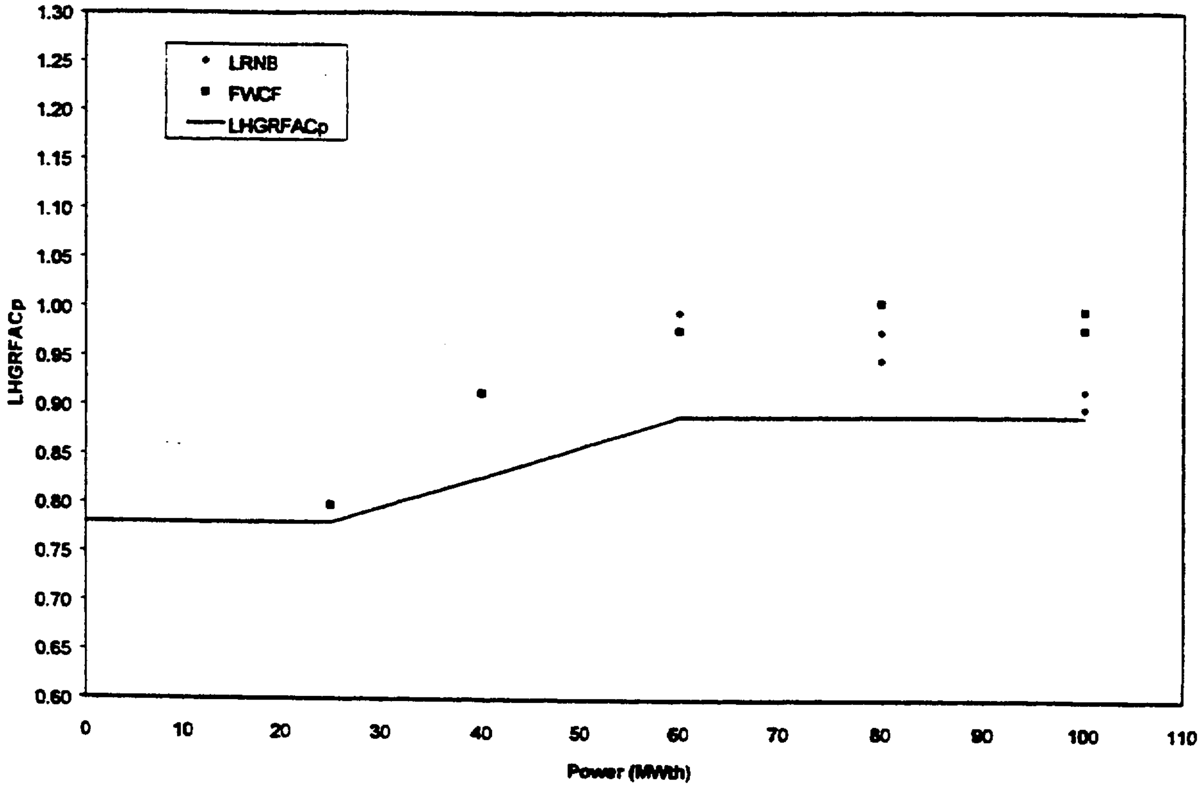
Power (%)	$MCPR_p$ Limit
100	1.52
60	1.62
25	2.08
25	2.20
0	2.70

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



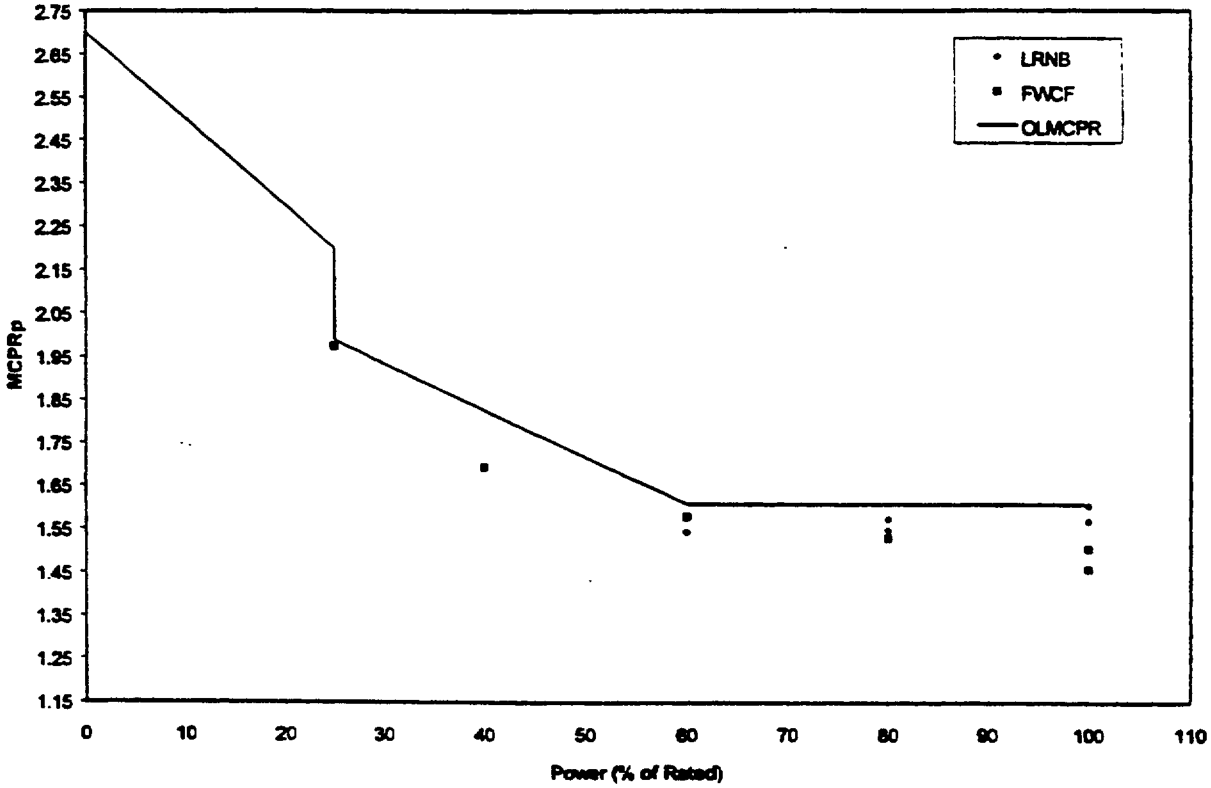
Power (%)	$MCPR_p$ Limit
100	1.51
60	1.51
25	1.91
25	2.20
0	2.70

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



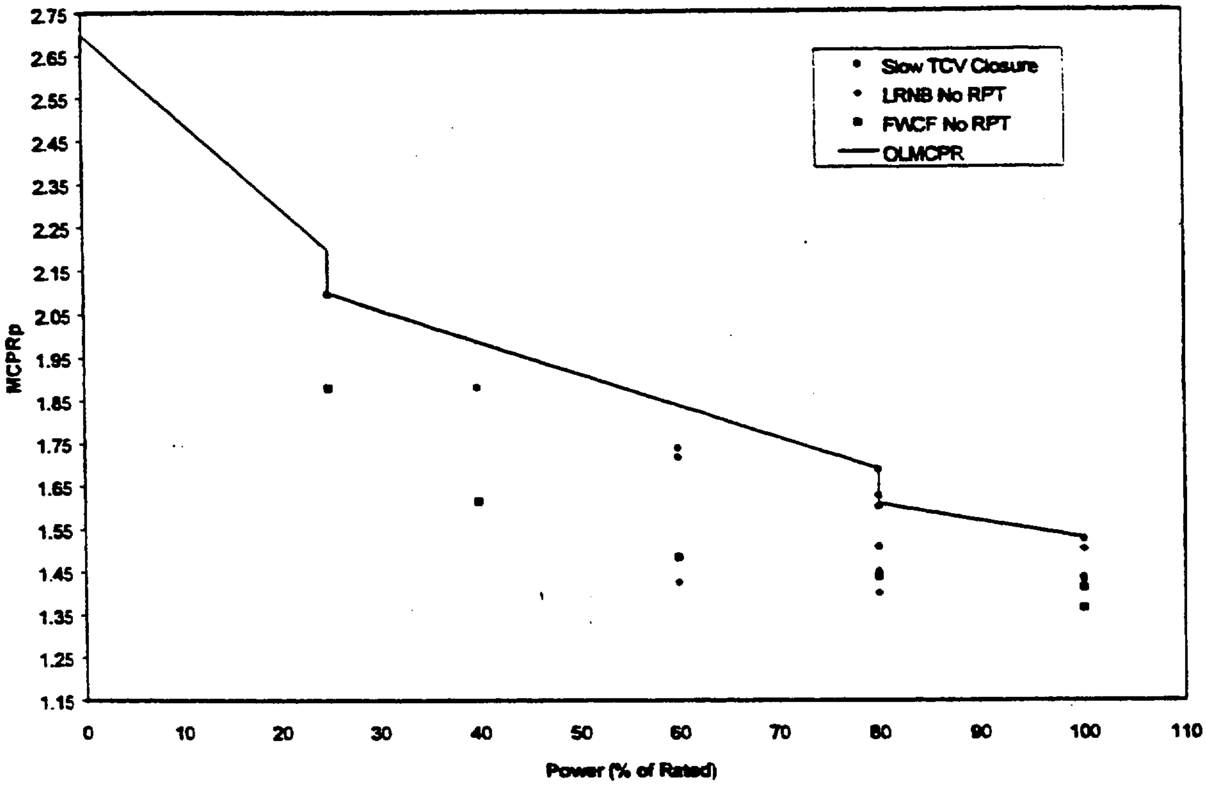
Power (%)	LHGRFAC$_p$ Multiplier
100	0.89
60	0.89
25	0.78
25	0.78
0	0.78

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



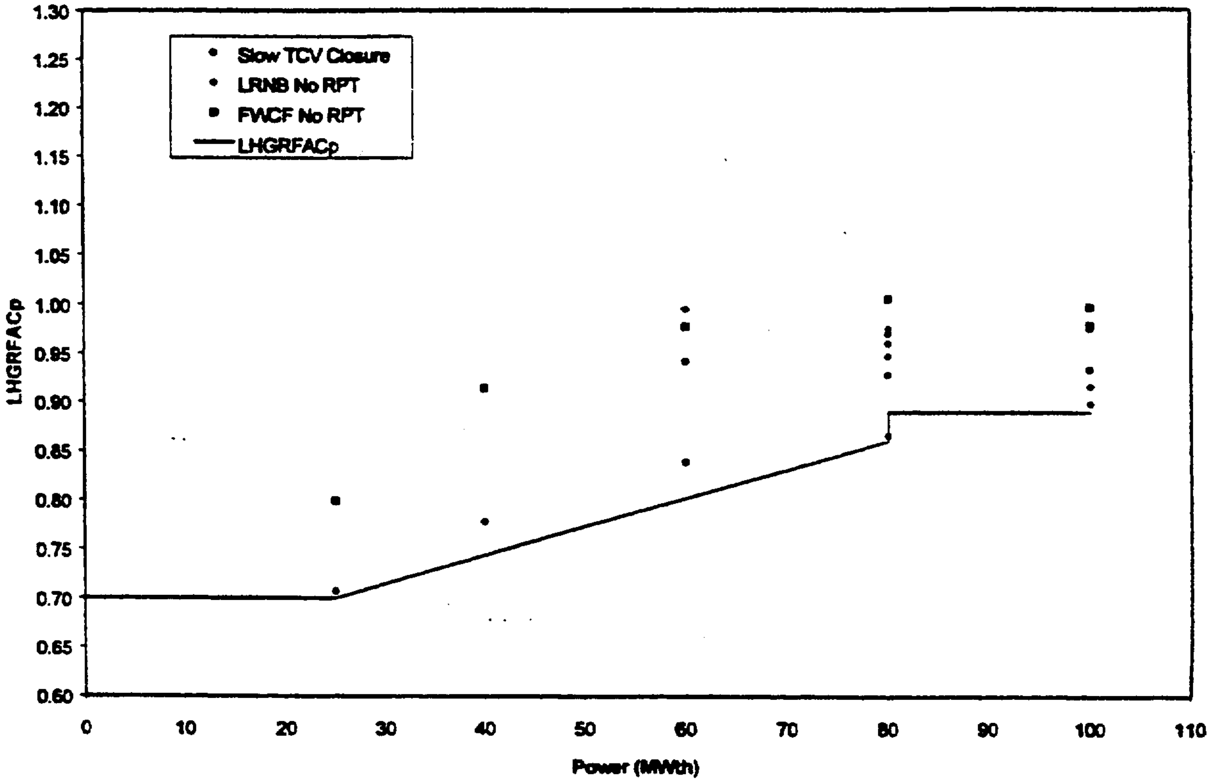
Power (%)	$MCPR_p$ Limit
100	1.61
60	1.61
25	1.99
25	2.20
0	2.70

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



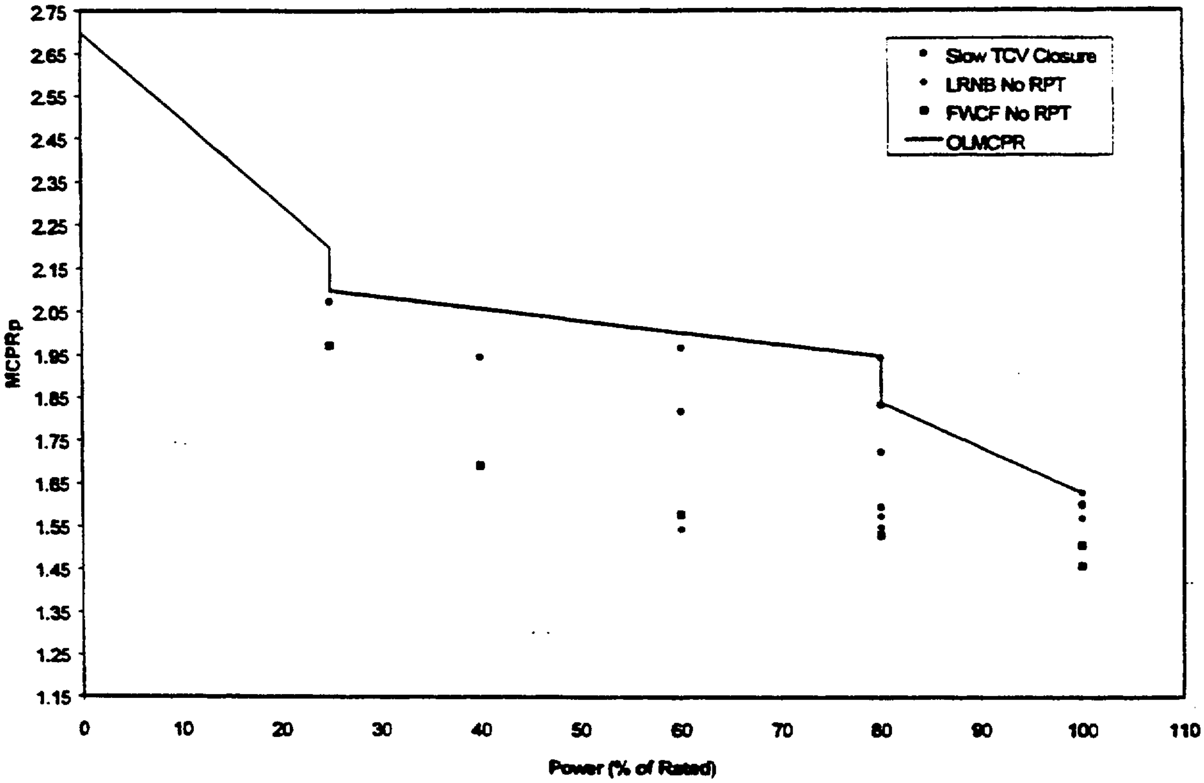
Power (%)	$MCPR_p$ Limit
100	1.53
80	1.61
80	1.69
25	2.10
25	2.20
0	2.70

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



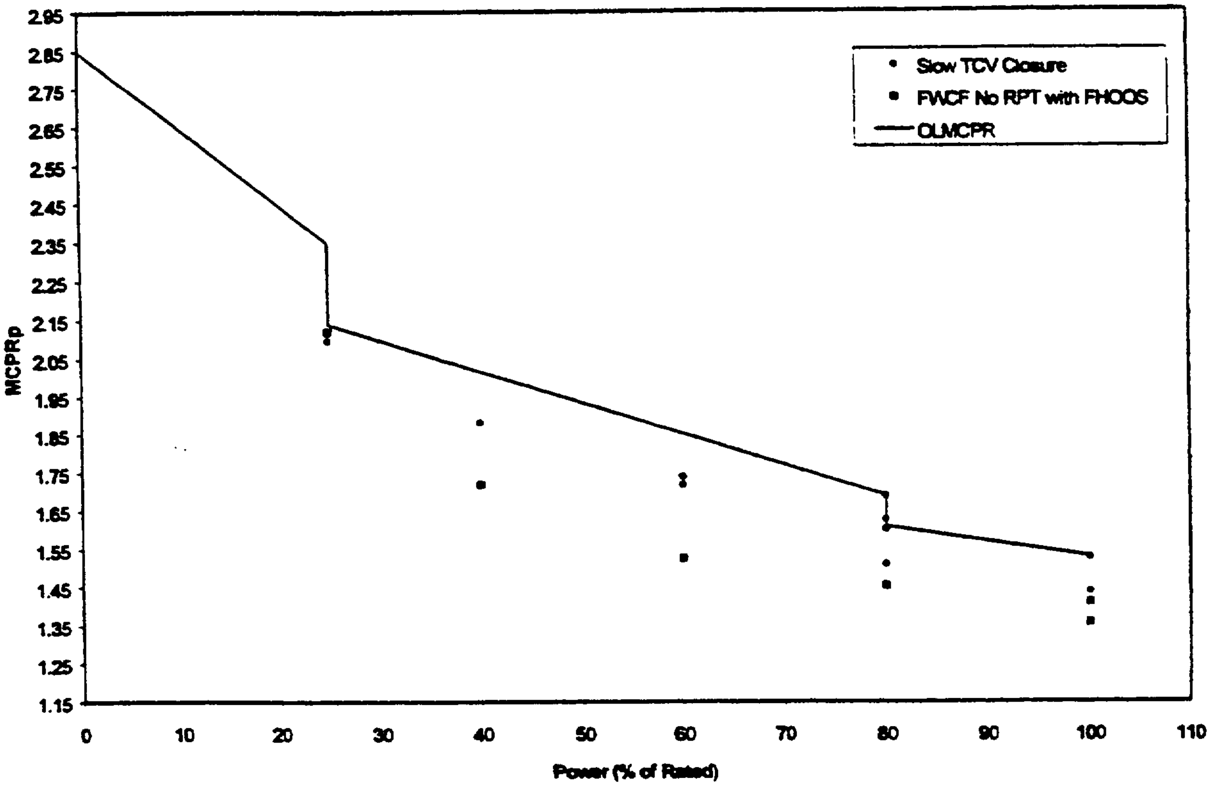
Power (%)	$LHGRFAC_p$ Multiplier
100	0.89
80	0.89
80	0.86
25	0.70
25	0.70
0	0.70

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



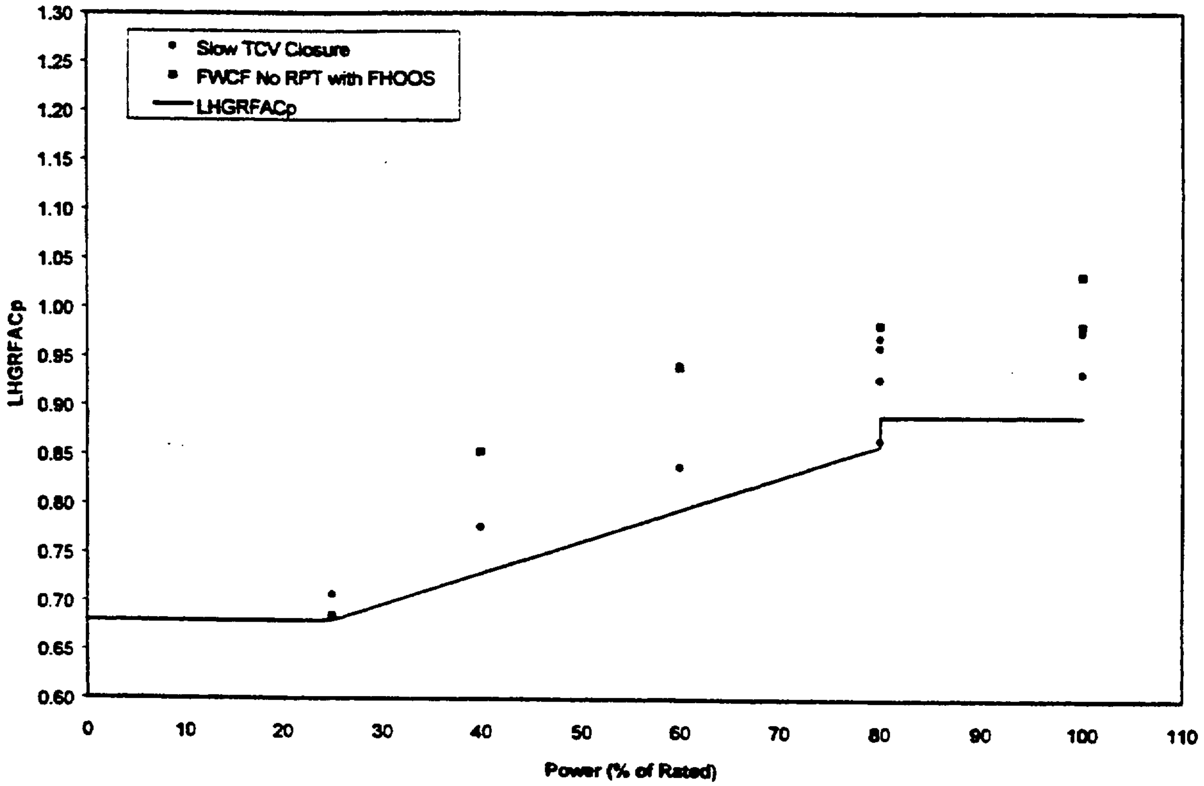
Power (%)	$MCPR_p$ Limit
100	1.63
80	1.84
80	1.95
25	2.10
25	2.20
0	2.70

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



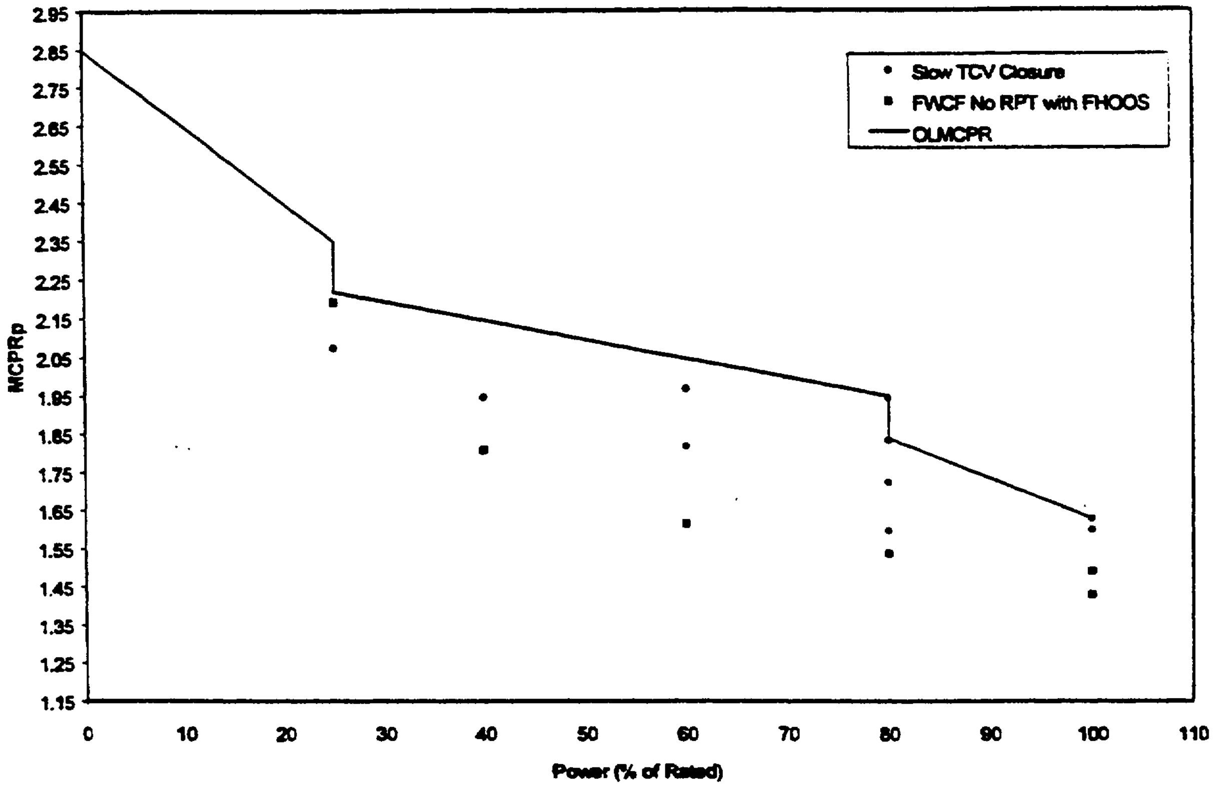
Power (%)	$MCPR_p$ Limit
100	1.53
80	1.61
80	1.69
25	2.14
25	2.35
0	2.85

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



Power (%)	LHGRFAC$_p$ Multiplier
100	0.89
80	0.89
80	0.86
25	0.68
25	0.68
0	0.68

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



Power (%)	$MCPR_p$ Limit
100	1.63
80	1.84
80	1.95
25	2.22
25	2.35
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

6.0 Transient Analysis for Thermal Margin - EOD/EOOS Combinations

This section describes the transient analyses performed to determine the MCPR and LHGR operating limits to support operation in the coastdown and combined FFTR/coastdown extended operating domains in conjunction with the following EOOS scenarios:

- Feedwater heaters out-of-service (FHOOS) – 100°F feedwater temperature reduction.
- 1 recirculation pump loop (SLO).
- Turbine bypass system out-of-service (TBVOOS).
- Recirculation pump trip out-of-service (no RPT).
- Slow closure of 1 or more turbine control valves and/or no RPT.

Each of the EOOS scenarios presented also includes the failure of 1 SRV.

Results of the limiting transient analyses are used to establish $MCPR_p$ limits and $LHGRFAC_p$ multipliers to support operation in the combined EOD/EOOS scenarios. All combined EOD/EOOS analyses were performed with TSSS insertion times.

As discussed in Reference 9, the base case MCPR safety limit for two-loop operation remains applicable for operation in the combined EOD/EOOS scenarios with the exception of single-loop operation. Also, the flow-dependent MCPR and LHGR analyses described in Section 3.4 remain applicable in all the combined EOD/EOOS scenarios.

6.1 *Coastdown With EOOS*

The impact of EOOS scenarios on coastdown operation is discussed below. The $MCPR_p$ limits and $LHGRFAC_p$ values established for nominal coastdown operation remain applicable for coastdown operation with 1 safety/relief valve out-of-service, up to 2 TIPOOS (or the equivalent number of TIP channels) and up to 50% of the LPRMs out-of-service (Reference 9).

6.1.1 Coastdown With Feedwater Heaters Out-of-Service

The discussion and results presented in Section 4.3 for combined FFTR/coastdown operation are applicable to coastdown operation with FHOOS.

6.1.2 Coastdown With One Recirculation Loop

The impact of SLO at LaSalle on thermal limits was presented in Reference 9. The only impact is on the MCPR safety limit. As presented in Section 3.2, the single-loop operation safety limit is

0.01 greater than the two-loop operating limit (1.12 compared to 1.11). The base case coastdown ΔCPRs and $LHGRFAC_p$ multipliers remain applicable. The net result is an increase to the base case coastdown $MCPR_p$ limits of 0.01 as a result of the increase in the MCPR safety limit.

6.1.3 Coastdown With TBVOOS

The exposure extension during coastdown can make the effects of the pressurization transients more severe. The TBVOOS assumption also increases the severity of pressurization events. The nominal coastdown analysis for the load rejection event is performed assuming the turbine bypass system is inoperable. Therefore, the impact of the TBVOOS on the load rejection event is included in the nominal coastdown results.

The FWCF event was evaluated to ensure appropriate $MCPR_p$ limits and $LHGRFAC_p$ values are established to support coastdown operation with TBVOOS. The results of the Cycle 9 coastdown FWCF with TBVOOS analyses for both ATRIUM-9B and GE9 fuel are presented in Table 6.1. Figures 6.1 and 6.2 show the ATRIUM-9B $MCPR_p$ limits and $LHGRFAC_p$ multipliers that support coastdown operation with TBVOOS. The coastdown with TBVOOS $MCPR_p$ limits for GE9 fuel are presented in Figure 6.3.

6.1.4 Coastdown With No RPT

To ensure that appropriate $MCPR_p$ limits and $LHGRFAC_p$ multipliers are established to support coastdown operation with no RPT, analyses were performed for LRNB and FWCF events with RPT assumed inoperable. The results of the Cycle 9 coastdown no RPT analyses for both ATRIUM-9B and GE9 fuel are presented in Table 6.2. Figures 6.4 and 6.5 show the ATRIUM-9B $MCPR_p$ limits and $LHGRFAC_p$ multipliers that support coastdown operation with no RPT. The coastdown with no RPT $MCPR_p$ limits for GE9 fuel are presented in Figure 6.6.

6.1.5 Coastdown With Slow Closure of the Turbine Control Valve

The slow closure of the turbine control valve event changes the characteristics of the LRNB event in that no direct scram or RPT occurs on valve position. The effect of the increase in exposure resulting from coastdown operation can make the event more severe. The ΔCPR and $LHGRFAC_p$ results are presented in Table 6.3. While the TCV slow closure analysis is performed without RPT on valve position, it does not necessarily bound the LRNB no RPT or FWCF no RPT events at all power levels because the slow closing TCV provides some pressure relief until it completely closes. Therefore, the $MCPR_p$ limits and $LHGRFAC_p$ multipliers for the coastdown with TCV slow closure scenario are established using the limiting of the coastdown no RPT results reported in Section 6.1.4 or the TCV slow closure results.

Figures 6.7 and 6.8 present the ATRIUM-9B coastdown with TCV slow closure and/or no RPT $MCPR_p$ limits and $LHGRFAC_p$ multipliers and Figure 6.9 presents the coastdown with TCV slow closure and/or no RPT GE9 $MCPR_p$ limits.

6.2 *Combined FFTR/Coastdown With EOOS*

The impact of EOOS scenarios on combined FFTR/coastdown operation is discussed below. The FFTR/coastdown $MCPR_p$ limits and $LHGRFAC_p$ values established for combined FFTR/coastdown operation remain applicable for FFTR/coastdown operation with 1 safety/relief valve out-of-service, up to 2 TIPOOS (or the equivalent number of TIP channels) and up to 50% of the LPRMs out-of-service (Reference 9).

6.2.1 Combined FFTR/Coastdown With One Recirculation Loop

The impact of SLO at LaSalle on thermal limits was presented in Reference 9. The only impact is on the MCPR safety limit. As presented in Section 3.2, the single-loop operation safety limit is 0.01 greater than the two-loop operating limit (1.12 compared to 1.11). The base case FFTR/coastdown ΔCPRs and $LHGRFAC_p$ multipliers remain applicable. The net result is an increase to the base case FFTR/coastdown $MCPR_p$ limits of 0.01 as a result of the increase in the MCPR safety limit.

6.2.2 Combined FFTR/Coastdown With TBVOOS

The exposure extension and decrease in core inlet enthalpy during combined FFTR/coastdown operation can make the effects of the pressurization transients more severe. The TBVOOS assumption also increases the severity of pressurization events. The nominal FFTR/coastdown analysis for the load rejection event is performed assuming the turbine bypass system is inoperable. Therefore, the impact of the TBVOOS on the load rejection event is included in the nominal FFTR/coastdown results.

The FWCF event was evaluated to ensure appropriate $MCPR_p$ limits and $LHGRFAC_p$ values are established to support combined FFTR/coastdown operation with TBVOOS. The results of the Cycle 9 FFTR/coastdown FWCF with TBVOOS analyses for both ATRIUM-9B and GE9 fuel are presented in Table 6.4. Figures 6.10 and 6.11 show the ATRIUM-9B $MCPR_p$ limits and $LHGRFAC_p$ multipliers that support combined FFTR/coastdown operation with TBVOOS. The FFTR/coastdown with TBVOOS $MCPR_p$ limits for GE9 fuel are presented in Figure 6.12.

6.2.3 Combined FFTR/Coastdown With No RPT

To ensure that appropriate $MCPR_p$ limits and $LHGRFAC_p$ multipliers are established to support FFTR/coastdown operation with no RPT, analyses were performed for LRNB and FWCF events with RPT assumed inoperable. The results of the Cycle 9 FFTR/coastdown no RPT analyses for both ATRIUM-9B and GE9 fuel are presented in Table 6.5. Figures 6.13 and 6.14 show the ATRIUM-9B $MCPR_p$ limits and $LHGRFAC_p$ multipliers that support combined FFTR/coastdown operation with no RPT. The FFTR/coastdown with no RPT $MCPR_p$ limits for GE9 fuel are presented in Figure 6.15.

6.2.4 Combined FFTR/Coastdown With Slow Closure of the Turbine Control Valve

Slow closure of the turbine control valve changes the characteristics of the LRNB event in that no direct scram or RPT occurs on valve position. While the decrease in steam flow due to the FFTR tends to lessen the severity of the event, the FFTR/coastdown exposure extension may have the opposite effect. The ΔCPR and $LHGRFAC_p$ results are presented in Table 6.6. While the TCV slow closure analysis is performed without RPT on valve position, it does not necessarily bound the LRNB no RPT or FWCF no RPT events at all power levels because the slow closing TCV provides some pressure relief until it completely closes. Therefore, the $MCPR_p$ limits and $LHGRFAC_p$ multipliers for the combined FFTR/coastdown with TCV slow closure scenario are established using the limiting of the FFTR/coastdown no RPT results reported in Section 6.2.3 or the TCV slow closure results.

Figures 6.16 and 6.17 present the ATRIUM-9B combined FFTR/coastdown with TCV slow closure and/or no RPT $MCPR_p$ limits and $LHGRFAC_p$ multipliers and Figure 6.18 presents the FFTR/coastdown with TCV slow closure and/or no RPT GE9 $MCPR_p$ limits.

Table 6.1 Coastdown Turbine Bypass Valves Out-of-Service Analysis Results

Event	Power / Flow (% rated / % rated)	ATRIUM		GE9
		ΔCPR	$LHGRFAC_p$	ΔCPR
FWCF	100 / 105	0.33	1.01	0.42
FWCF	80 / 105	0.37	1.01	0.40
FWCF	60 / 105	0.42	1.00	0.46
FWCF	40 / 105	0.54	1.00	0.55
FWCF	25 / 105	0.86	1.08	0.88

Table 6.2 Coastdown Recirculation Pump Trip Out-of-Service Analysis Results

Event	Power / Flow (% rated / % rated)	ATRIUM		GE9
		ΔCPR	$LHGRFAC_p$	ΔCPR
LRNB	100 / 105	0.44	0.89	0.56
LRNB	80 / 105	0.42	0.91	0.45
LRNB	60 / 105	0.39	0.91	0.47
LRNB	40 / 105	0.39	0.87	0.41
LRNB	25 / 105	0.29	1.01	0.28
FWCF	100 / 105	0.32	0.96	0.42
FWCF	80 / 105	0.35	0.98	0.38
FWCF	60 / 105	0.39	0.99	0.44
FWCF	40 / 105	0.47	0.97	0.48
FWCF	25 / 105	0.86	1.06	0.88

Table 6.3 Coastdown Turbine Control Valve Slow Closure Analysis Results

Event	Slow Valve Characteristics	Power / Flow (% rated / % rated)	ATRIUM-9B		GE9
			ΔCPR	$LHGRFAC_p$	ΔCPR
LRNB	1 TCV closing at 2.0 sec	100 / 105*	0.44	0.93	0.55
LRNB	1 TCV closing at 2.0 sec	80 / 105*	0.45	0.94	0.48
LRNB	1 TCV closing at 2.0 sec	80 / 105†	0.52	0.95	0.55
LRNB	1 TCV closing at 2.0 sec	60 / 105†	0.59	0.96	0.61
LRNB	1 TCV closing at 2.0 sec	40 / 105†	0.79	0.87	0.78
LRNB	1 TCV closing at 2.0 sec	25 / 105†	0.99	0.74	0.93

---

* Scram initiated by high-neutron flux.

† Scram initiated by high dome pressure

Table 6.4 FFTR/Coastdown Turbine Bypass Valves Out-of-Service Analysis Results

Event	Power / Flow (% rated / % rated)	ATRIUM		GE9
		ΔCPR	$LHGRFAC_p$	ΔCPR
FWCF	100 / 105	0.32	1.03	0.35
FWCF	80 / 105	0.36	1.03	0.40
FWCF	60 / 105	0.44	1.01	0.47
FWCF	40 / 105	0.60	1.07	0.59
FWCF	25 / 105	1.10	0.95	1.12

Table 6.5 FFTR/Coastdown Recirculation Pump Trip Out-of-Service Analysis Results

Event	Power / Flow (% rated / % rated)	ATRIUM		GE9
		ΔCPR	$LHGRFAC_p$	ΔCPR
LRNB	100 / 105	0.39	0.92	0.41
LRNB	80 / 105	0.38	0.94	0.44
LRNB	60 / 105	0.40	0.92	0.41
FWCF	100 / 105	0.32	0.97	0.34
FWCF	80 / 105	0.36	0.98	0.41
FWCF	60 / 105	0.43	0.96	0.46
FWCF	40 / 105	0.56	0.91	0.56
FWCF	25 / 105	1.10	0.95	1.12

Table 6.6 FFTR/Coastdown Turbine Control Valve Slow Closure Analysis Results

Event	Slow Valve Characteristics	Power / Flow (% rated / % rated)	ATRIUM-9B		GE9
			ΔCPR	$LHGRFAC_p$	ΔCPR
LRNB	1 TCV closing at 2.0 sec	100 / 105*	0.39	0.96	0.40
LRNB	1 TCV closing at 2.0 sec	80 / 105*	0.38	0.98	0.42
LRNB	1 TCV closing at 2.0 sec	80 / 105†	0.49	0.98	0.52
LRNB	1 TCV closing at 2.0 sec	60 / 105†	0.60	0.94	0.58
LRNB	1 TCV closing at 2.0 sec	40 / 105†	0.72	0.83	0.71
LRNB	1 TCV closing at 2.0 sec	25 / 105†	0.98	0.76	0.83

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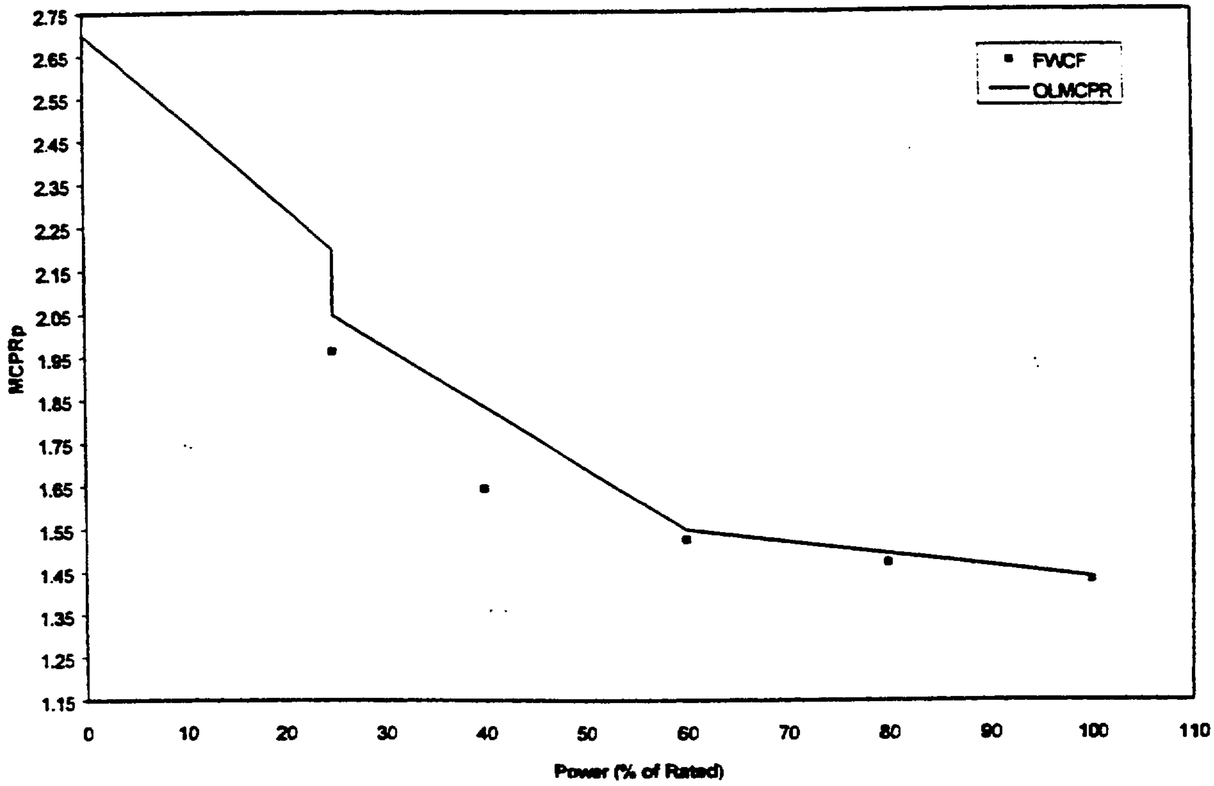
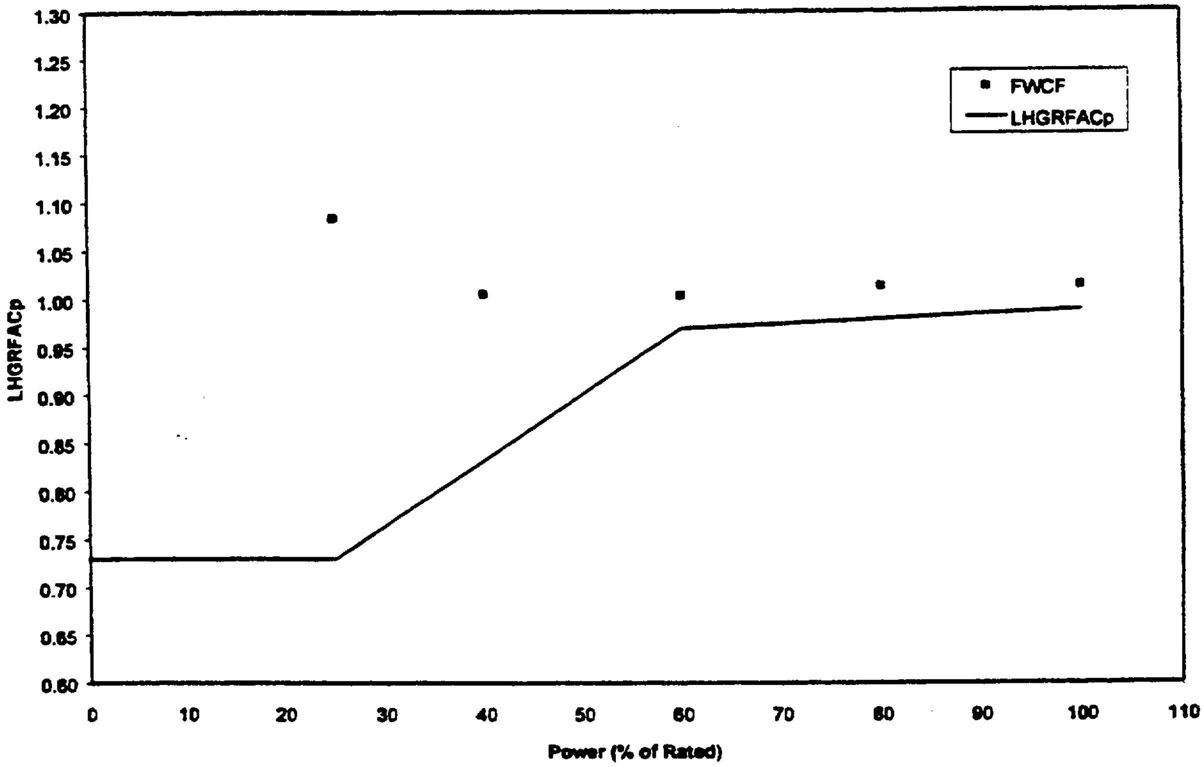
* Scram initiated by high-neutron flux.

† Scram initiated by high dome pressure



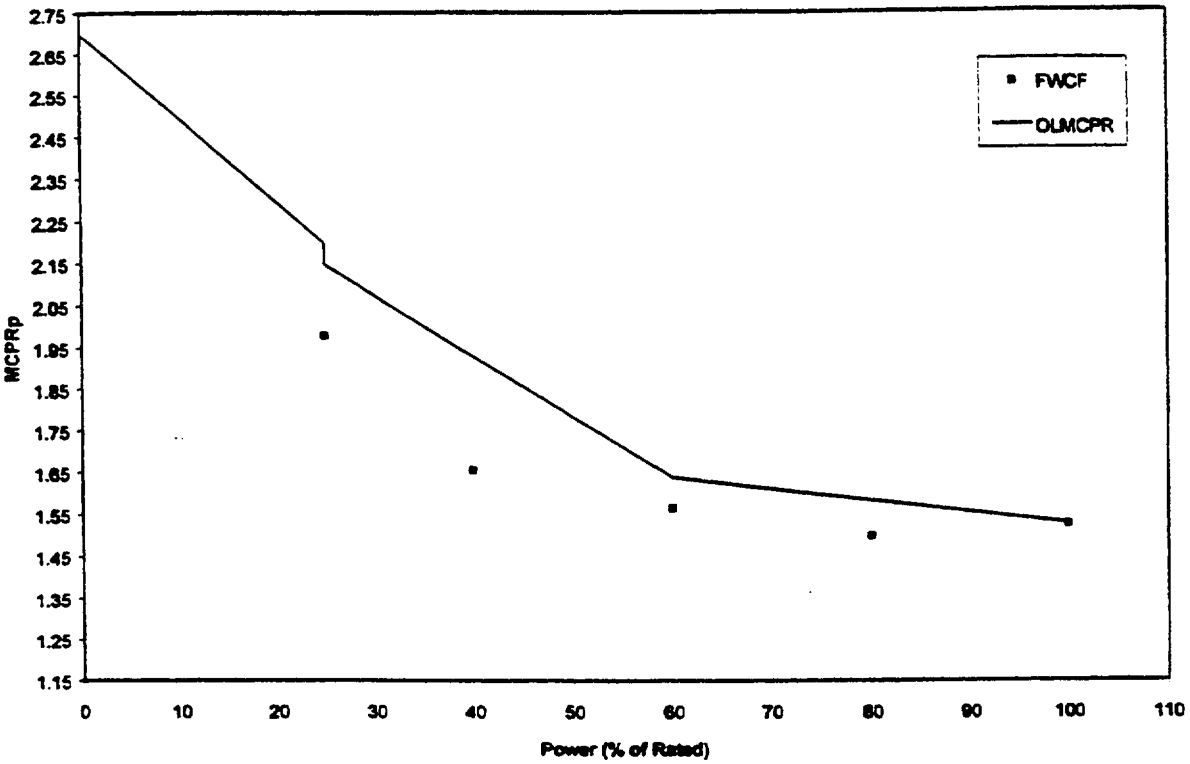
Power (%)	$MCPR_p$ Limit
100	1.44
60	1.55
25	2.05
25	2.20
0	2.70

Figure 6.1 Coastdown Turbine Bypass Valves Out-of-Service Power-Dependent MCPR Limits for ATRIUM-9B Fuel



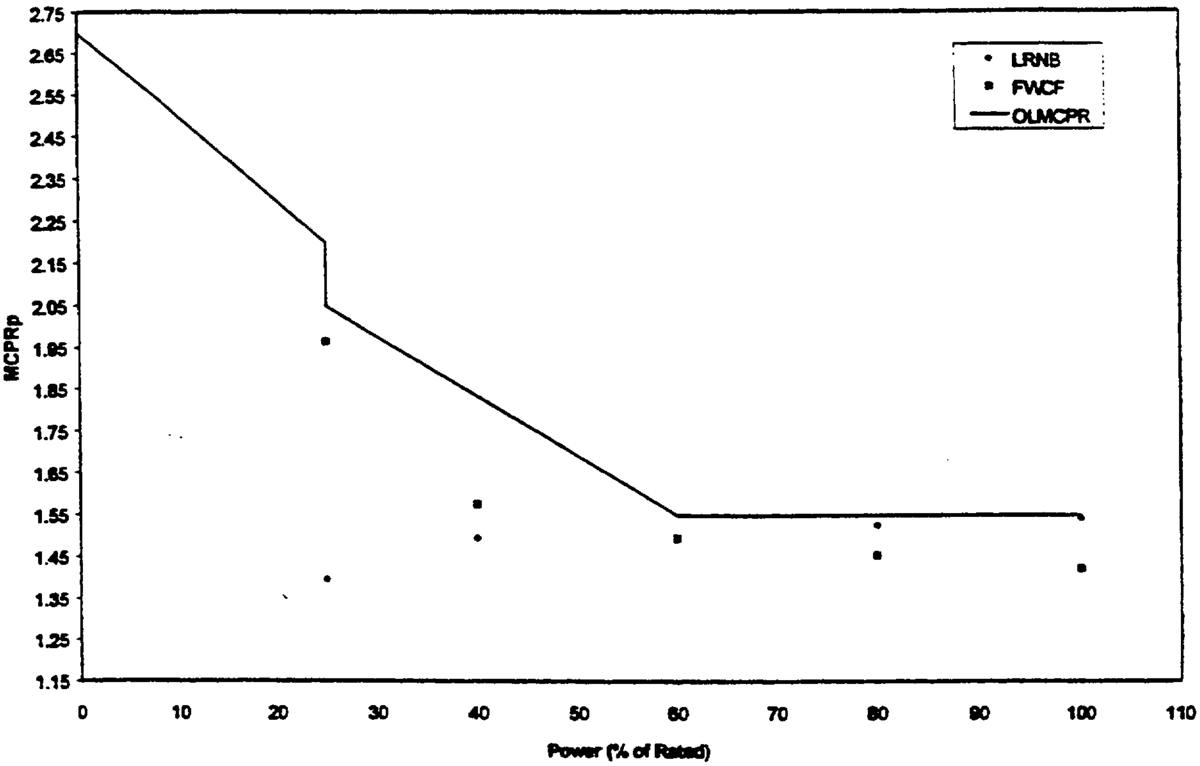
Power (%)	LHGRFAC$_p$ Multiplier
100	0.99
60	0.97
25	0.73
25	0.73
0	0.73

Figure 6.2 Coastdown Turbine Bypass Valves Out-of-Service Power-Dependent LHGR Multipliers for ATRIUM-9B Fuel



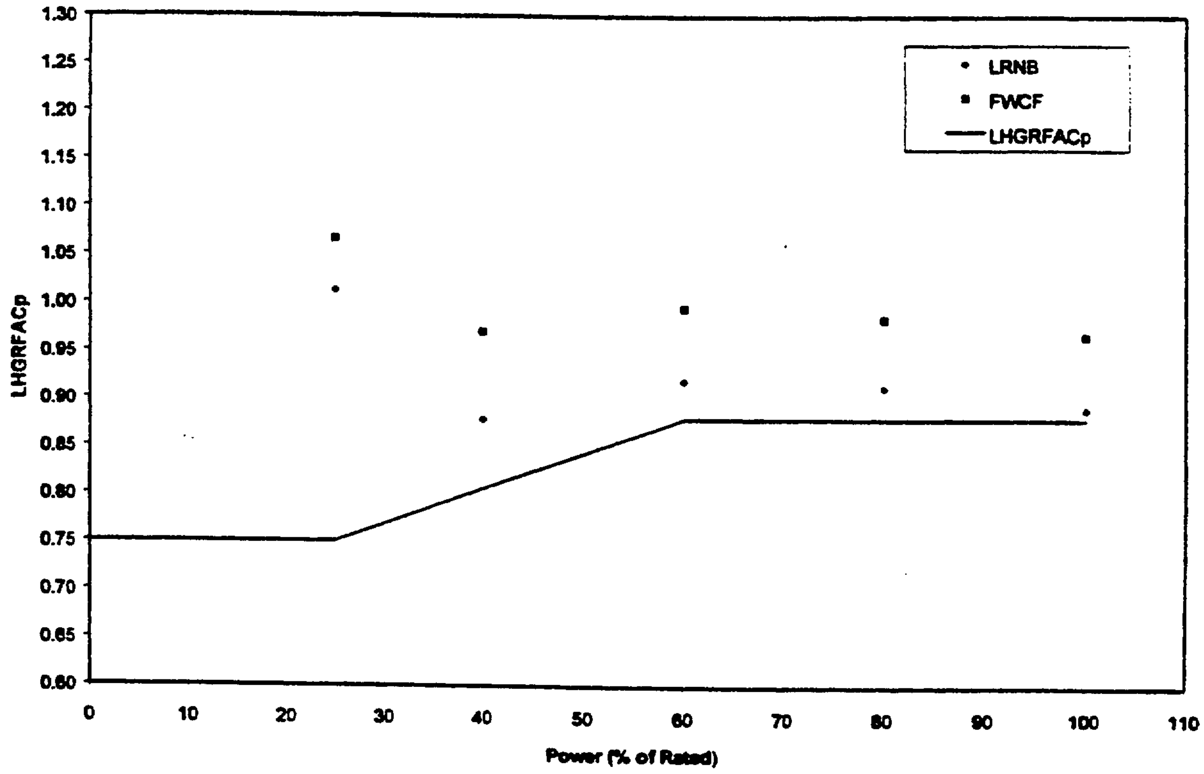
Power (%)	MCPR$_p$ Limit
100	1.53
60	1.64
25	2.15
25	2.20
0	2.70

Figure 6.3 Coastdown Turbine Bypass Valves Out-of-Service Power-Dependent MCPR Limits for GE9 Fuel



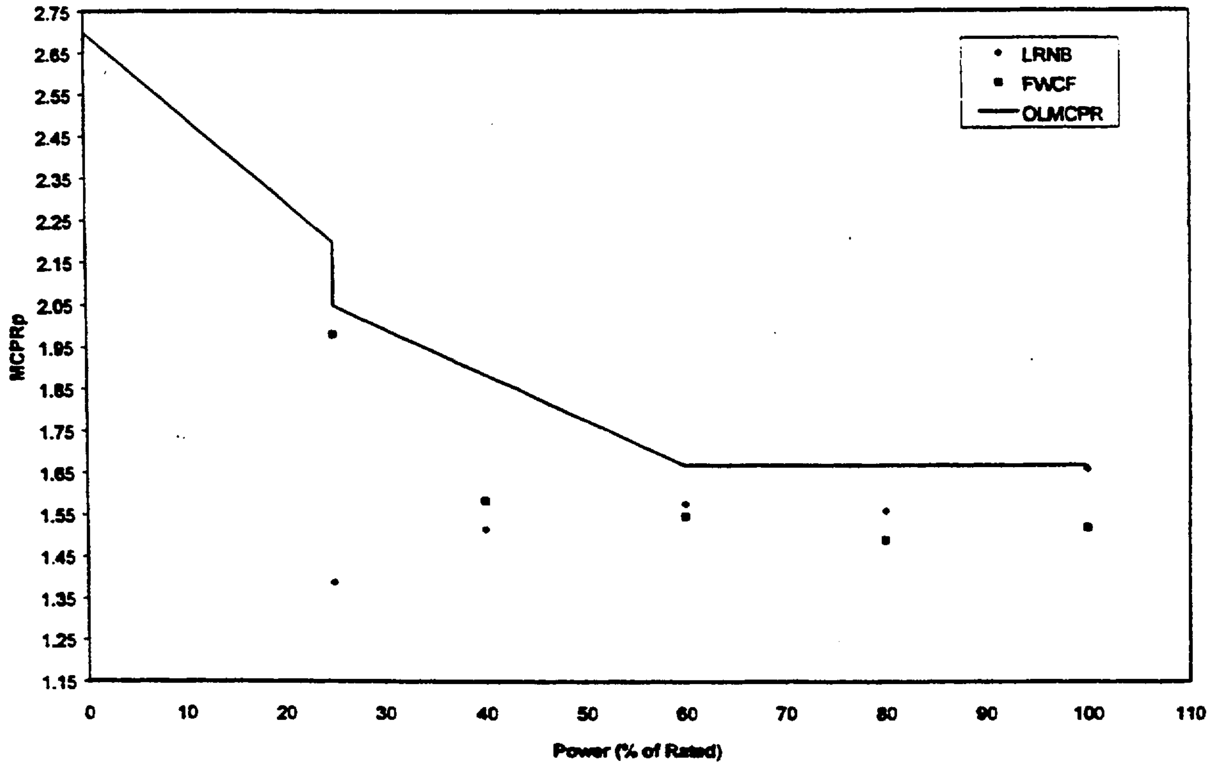
Power (%)	$MCPR_p$ Limit
100	1.55
60	1.55
25	2.05
25	2.20
0	2.70

Figure 6.4 Coastdown Recirculation Pump Trip Out-of-Service Power-Dependent MCPR Limits for ATRIUM-9B Fuel



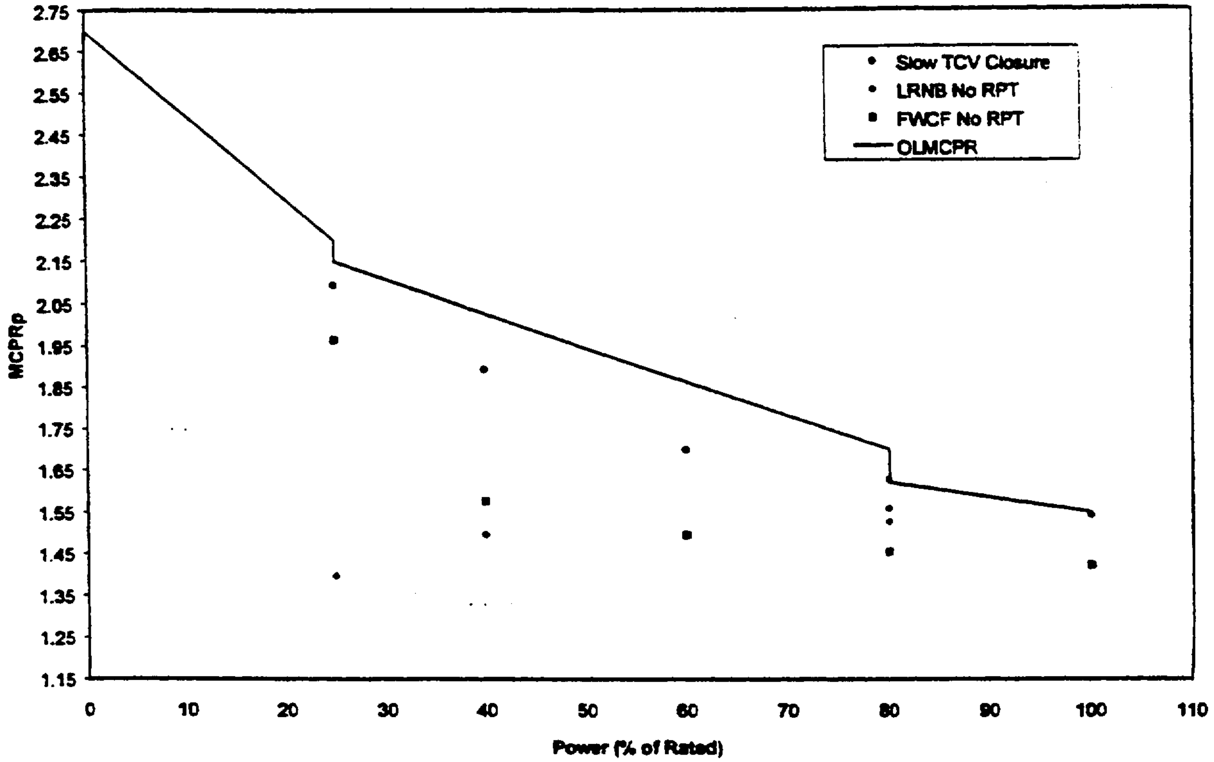
Power (%)	$LHGRFAC_p$ Multiplier
100	0.88
60	0.88
25	0.75
25	0.75
0	0.75

Figure 6.5 Coastdown Recirculation Pump Trip Out-of-Service Power-Dependent LHGR Multipliers for ATRIUM-9B Fuel



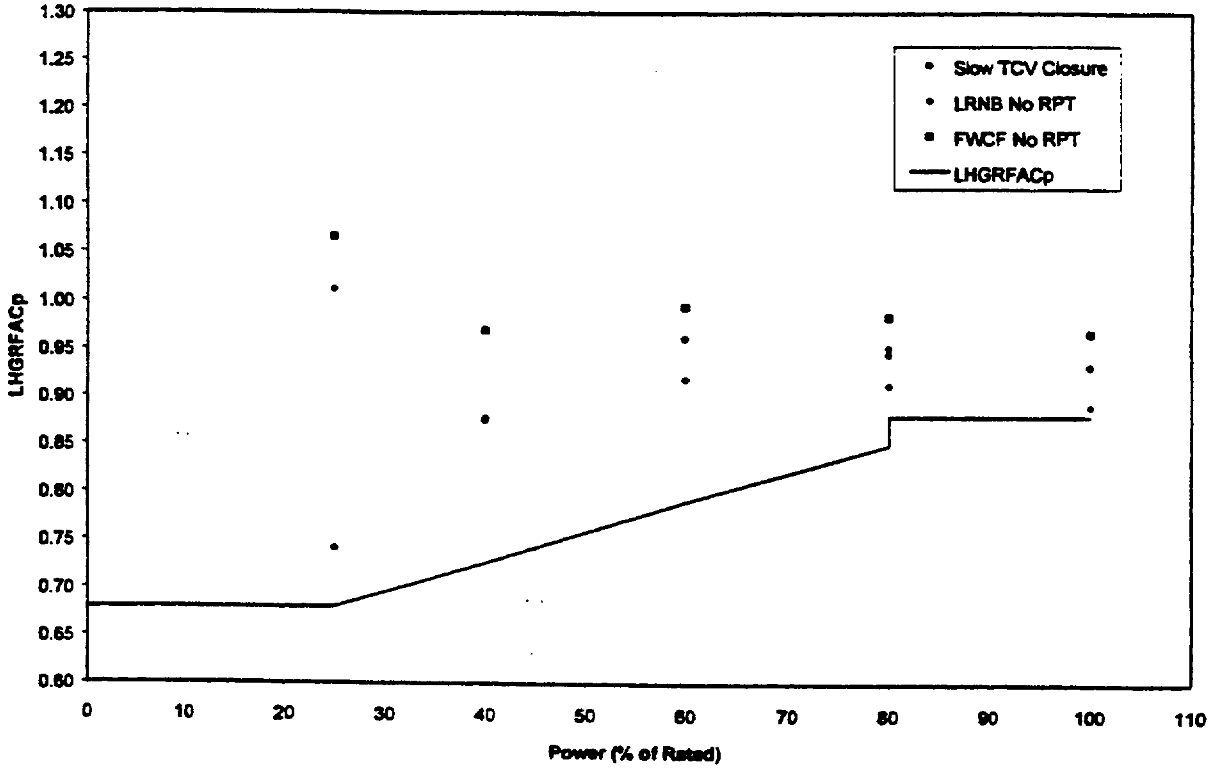
Power (%)	$MCPR_p$ Limit
100	1.67
60	1.67
25	2.05
25	2.20
0	2.70

Figure 6.6 Coastdown Recirculation Pump Trip Out-of-Service Power-Dependent MCPR Limits for GE9 Fuel



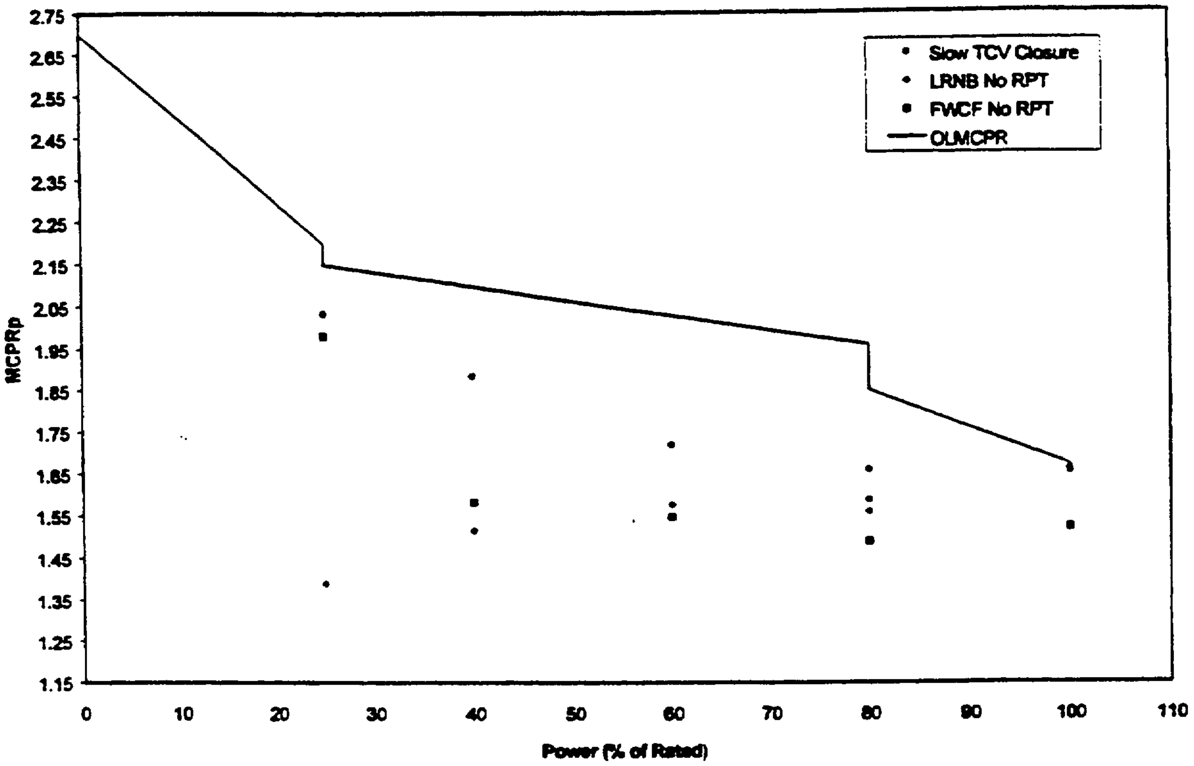
Power (%)	$MCPR_p$ Limit
100	1.55
80	1.62
80	1.70
25	2.15
25	2.20
0	2.70

Figure 6.7 Coastdown Turbine Control Valve Slow Closure and/or Recirculation Pump Trip Out-of-Service Power-Dependent MCPR Limits for ATRIUM-9B Fuel



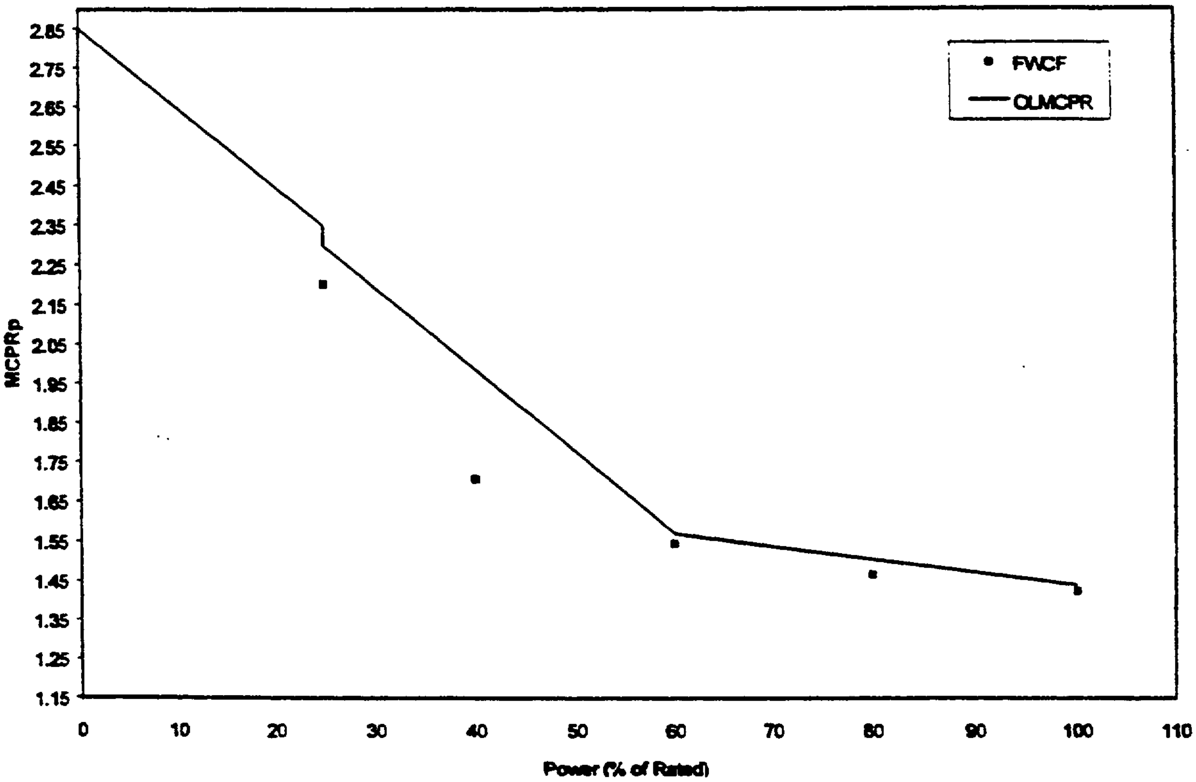
Power (%)	LHGRFAC$_p$ Multiplier
100	0.88
80	0.88
80	0.85
25	0.68
25	0.68
0	0.68

Figure 6.8 Coastdown Turbine Control Valve Slow Closure and/or Recirculation Pump Trip Out-of-Service Power-Dependent LHGR Multipliers for ATRIUM-9B Fuel



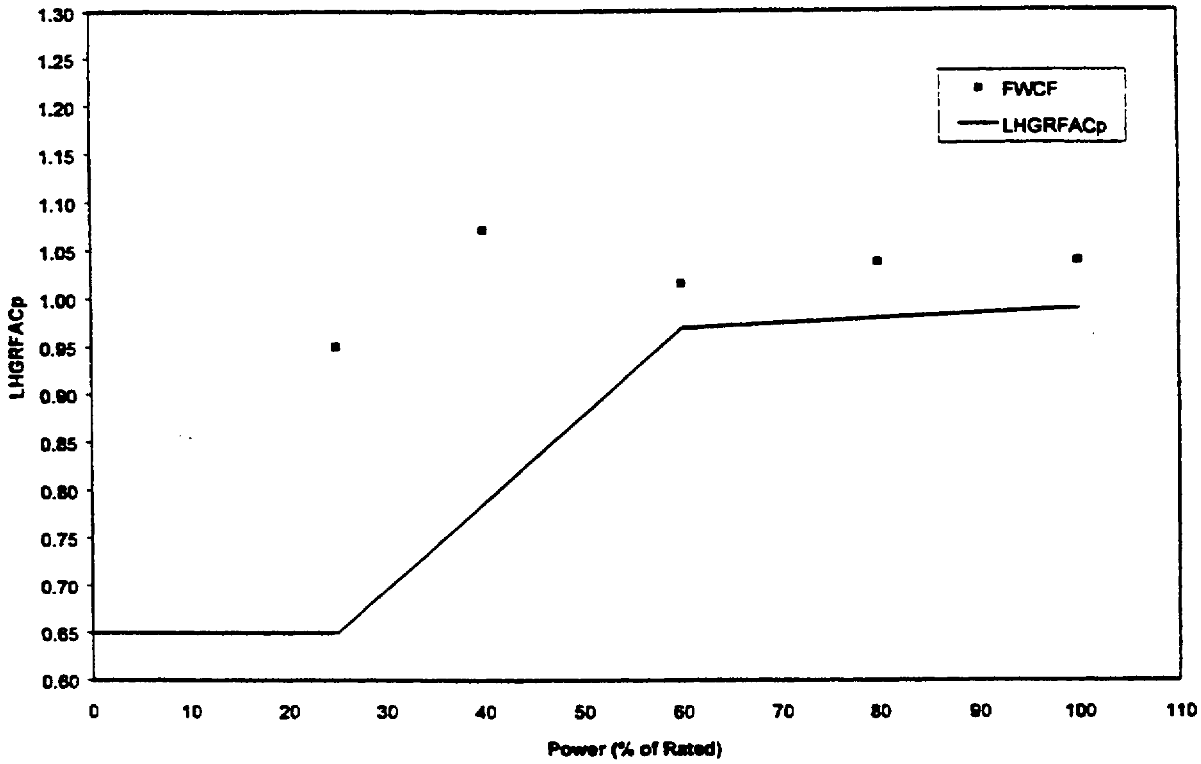
Power (%)	$MCPR_p$ Limit
100	1.67
80	1.85
80	1.96
25	2.15
25	2.20
0	2.70

Figure 6.9 Coastdown Turbine Control Valve Slow Closure and/or Recirculation Pump Trip Out-of-Service Power-Dependent MCPR Limits for GE9 Fuel



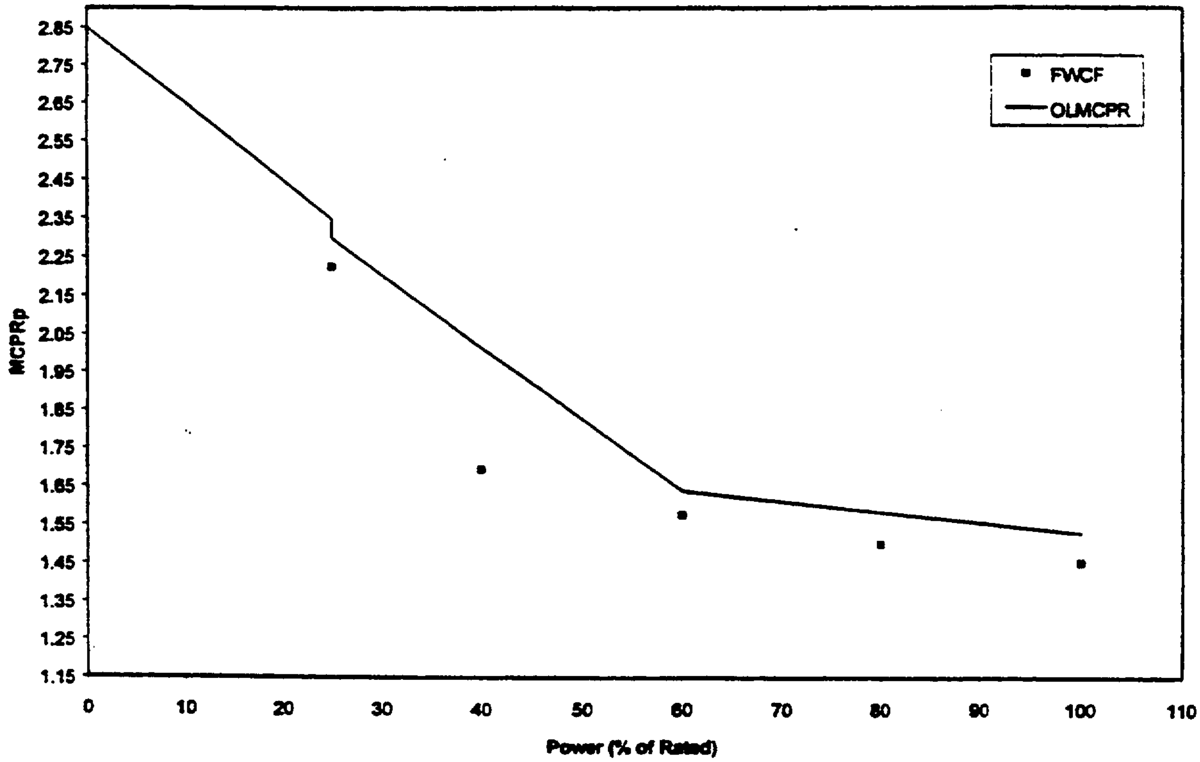
Power (%)	$MCPR_p$ Limit
100	1.44
60	1.57
25	2.30
25	2.35
0	2.85

Figure 6.10 FFTR/Coastdown Turbine Bypass Valves Out-of-Service Power-Dependent MCPR Limits for ATRIUM-9B Fuel



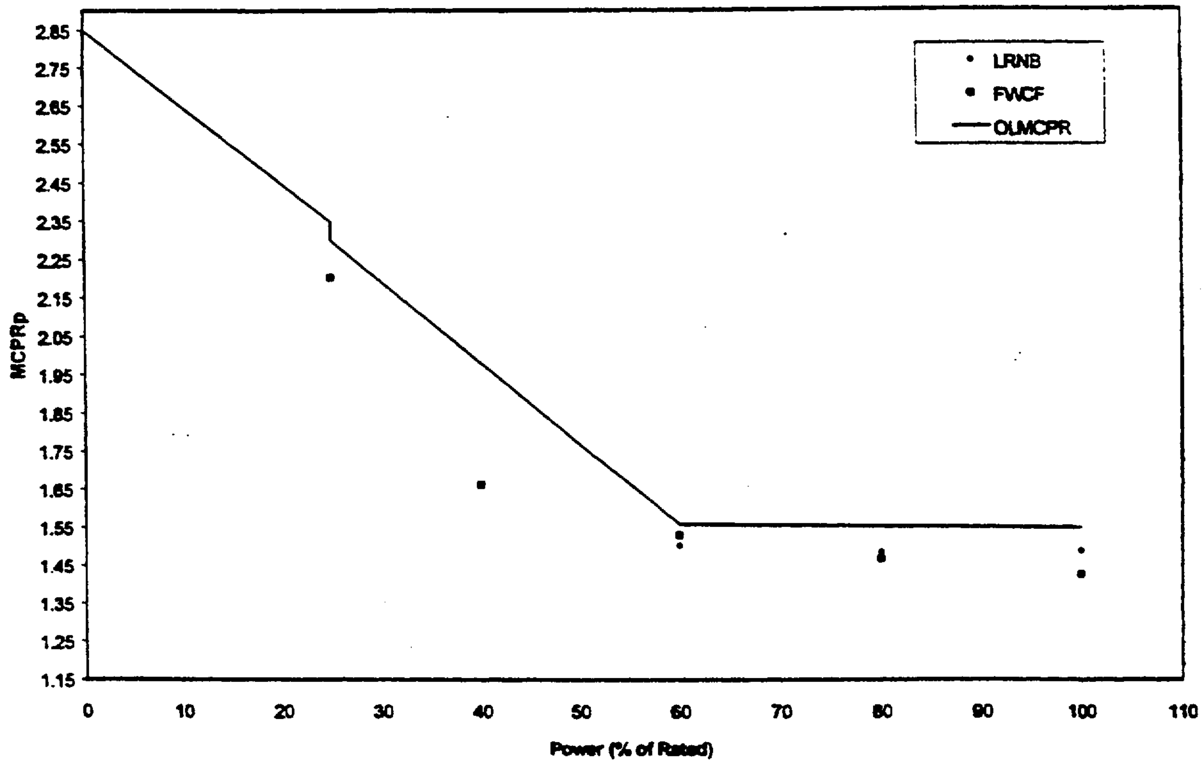
Power (%)	$LHGRFAC_p$ Multiplier
100	0.99
60	0.97
25	0.65
25	0.65
0	0.65

Figure 6.11 FFTR/Coastdown Turbine Bypass Valves Out-of-Service Power-Dependent LHGR Multipliers for ATRIUM-9B Fuel



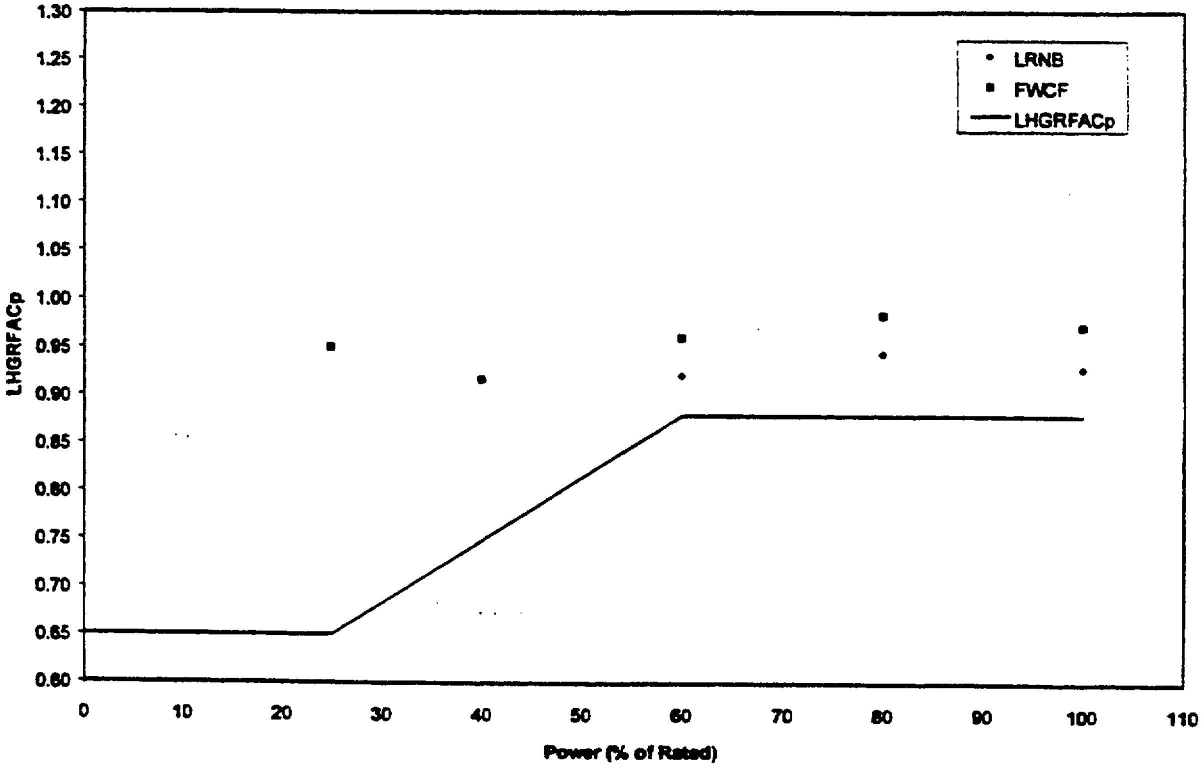
Power (%)	$MCPR_p$ Limit
100	1.53
60	1.64
25	2.30
25	2.35
0	2.85

Figure 6.12 FFTR/Coastdown Turbine Bypass Valves Out-of-Service Power-Dependent MCPR Limits for GE9 Fuel



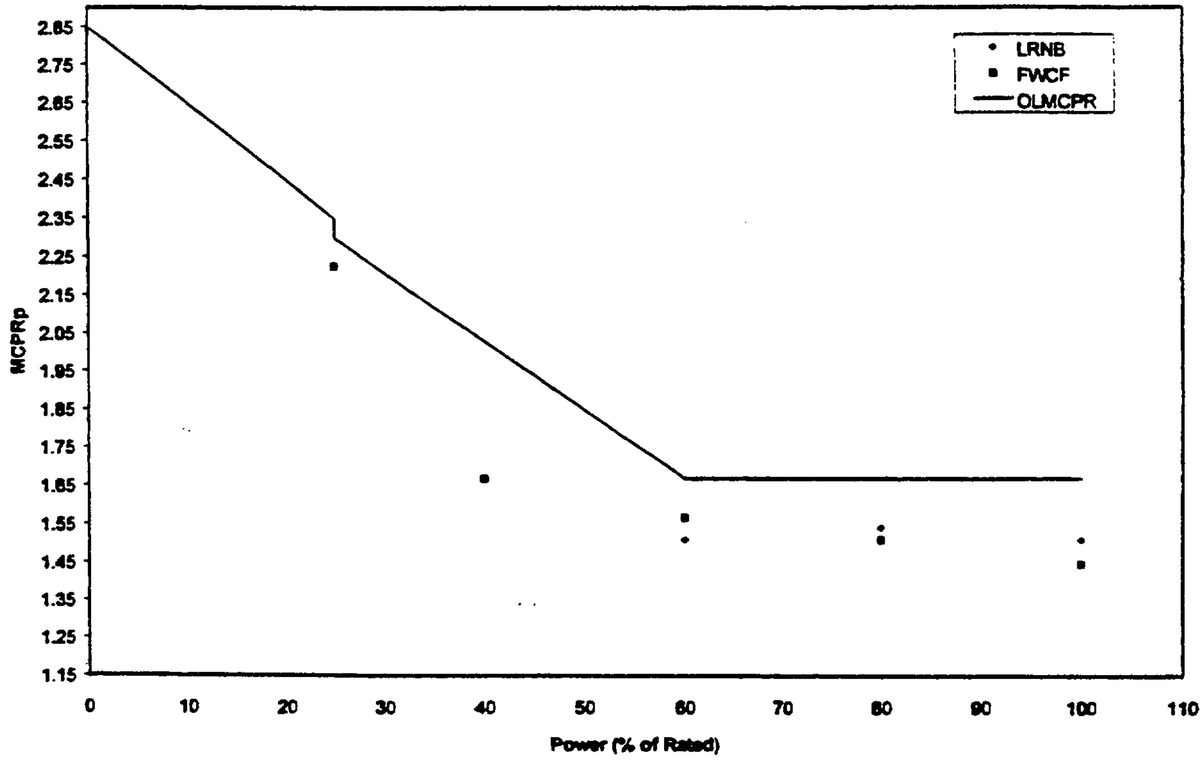
Power (%)	$MCPR_p$ Limit
100	1.55
60	1.56
25	2.30
25	2.35
0	2.85

Figure 6.13 FFTR/Coastdown Recirculation Pump Trip Out-of-Service Power-Dependent MCPR Limits for ATRIUM-9B Fuel



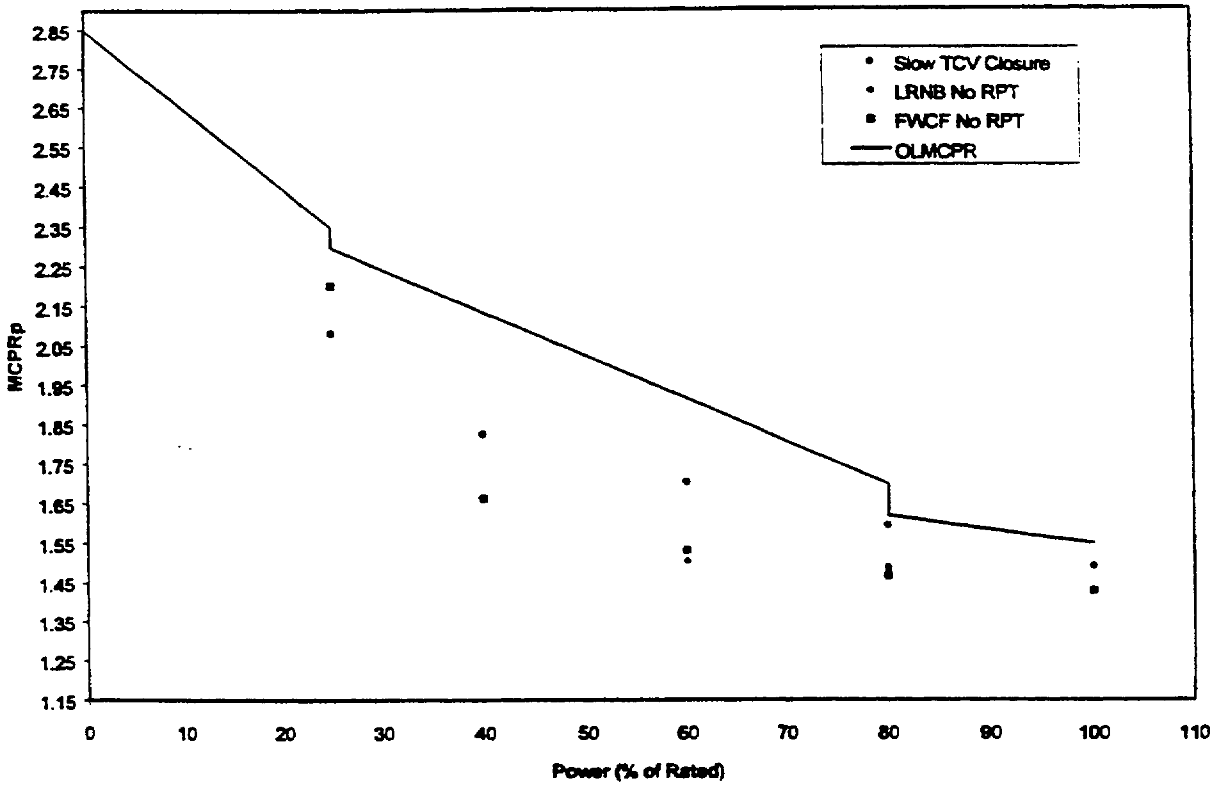
Power (%)	$LHGRFAC_p$ Multiplier
100	0.88
60	0.88
25	0.65
25	0.65
0	0.65

Figure 6.14 FFTR/Coastdown Recirculation Pump Trip Out-of-Service Power-Dependent LHGR Multipliers for ATRIUM-9B Fuel



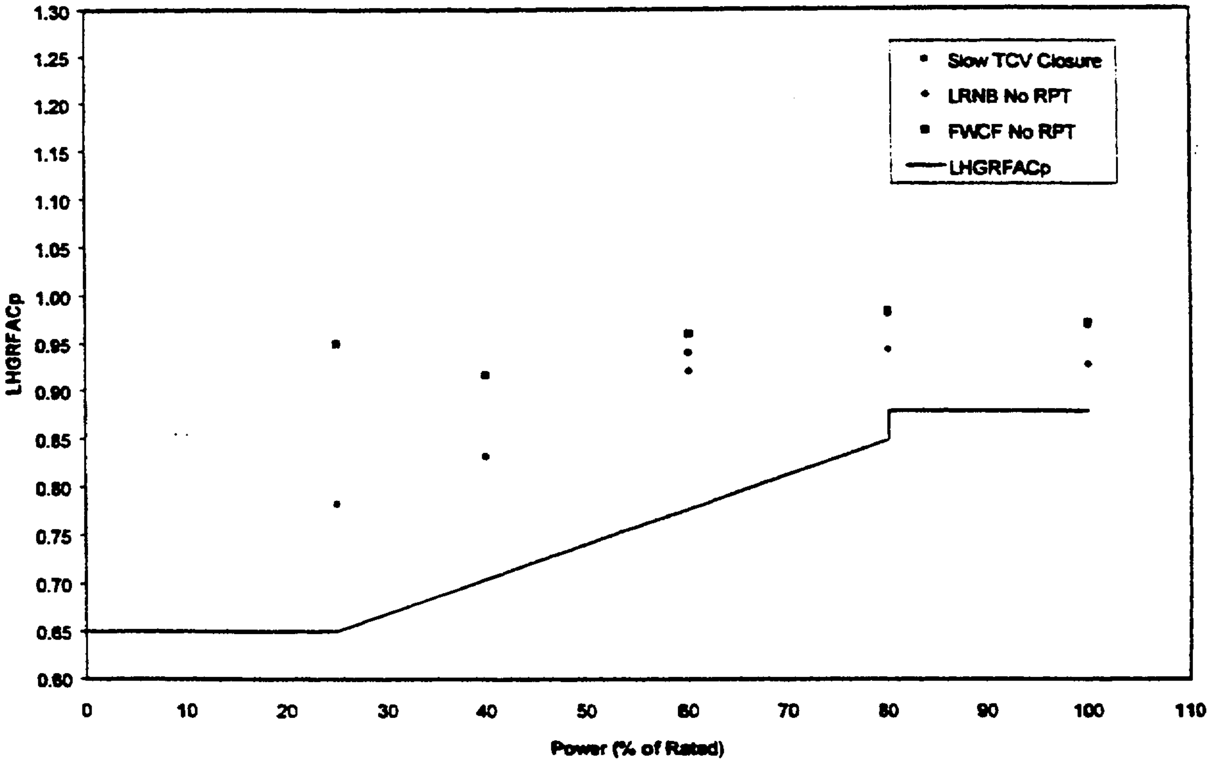
Power (%)	MCPR$_p$ Limit
100	1.67
60	1.67
25	2.30
25	2.35
0	2.85

Figure 6.15 FFTR/Coastdown Recirculation Pump Trip Out-of-Service Power-Dependent MCPR Limits for GE9 Fuel



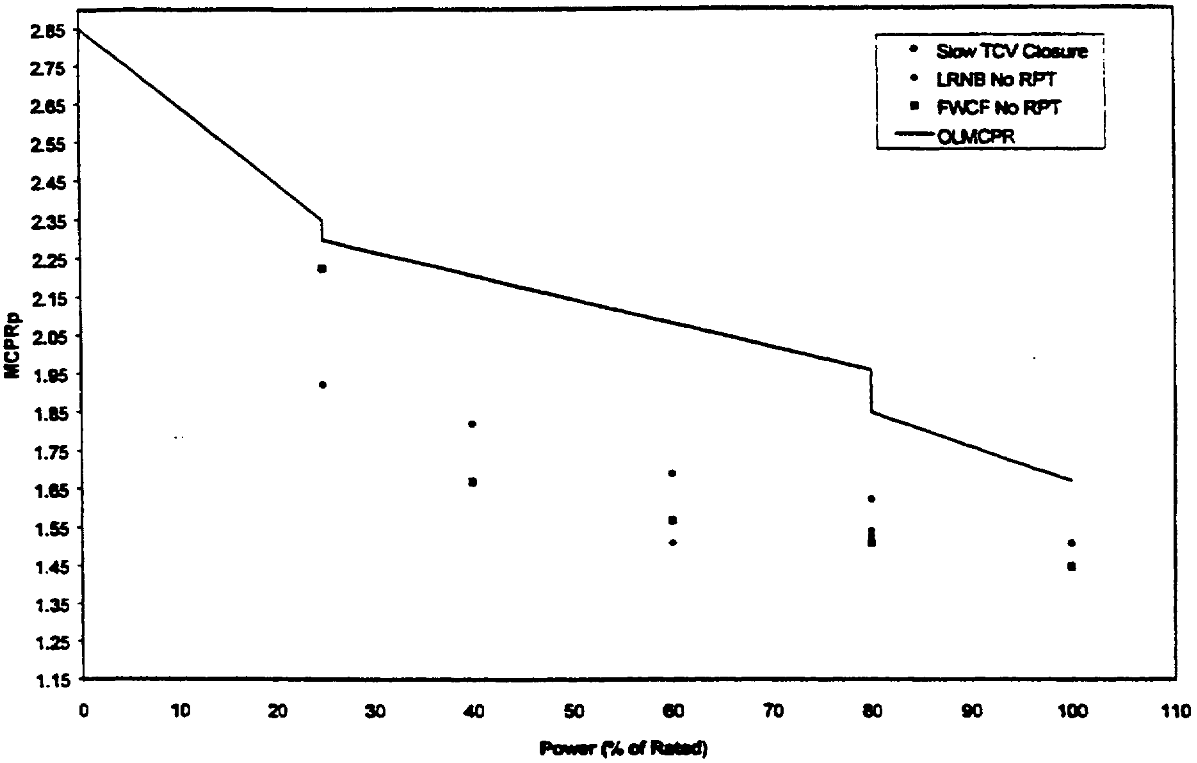
Power (%)	$MCPR_p$ Limit
100	1.55
80	1.62
80	1.70
25	2.30
25	2.35
0	2.85

Figure 6.16 FFTR/Coastdown Turbine Control Valve Slow Closure and/or Recirculation Pump Trip Out-of-Service Power-Dependent MCPR Limits for ATRIUM-9B Fuel



Power (%)	LHGRFAC$_p$ Multiplier
100	0.88
80	0.88
80	0.85
25	0.65
25	0.65
0	0.65

Figure 6.17 FFTR/Coastdown Turbine Control Valve Slow Closure and/or Recirculation Pump Trip Out-of-Service Power-Dependent LHGR Multipliers for ATRIUM-9B Fuel



Power (%)	$MCPR_p$ Limit
100	1.67
80	1.85
80	1.96
25	2.30
25	2.35
0	2.85

Figure 6.18 FFTR/Coastdown Turbine Control Valve Slow Closure and/or Recirculation Pump Trip Out-of-Service Power-Dependent MCPR Limits for GE9 Fuel

7.0 Maximum Overpressurization Analysis

This section describes the maximum overpressurization analyses performed to demonstrate compliance with the ASME Boiler and Pressure Vessel Code. The analysis shows that the safety/relief valves at LaSalle Unit 2 have sufficient capacity and performance to prevent the pressure from reaching the pressure safety limit of 110% of the design pressure.

7.1 *Design Basis*

The MSIV closure analysis was performed with the SPC plant simulator code COTRANSA2 (Reference 4) at a power/flow state point of 102% of uprated power/105% flow. Reference 9 indicates that an EOFP + 1000 MWd/MTU exposure is limiting for the overpressurization analysis. The following assumptions were made in the analysis.

- The most critical active component (direct scram on valve position) was assumed to fail. However, scram on high-neutron flux and high-dome pressure is available.
- At ComEd's request, analyses were performed to determine the minimum number of the highest set point SRVs required to meet the ASME and Technical Specification pressure limits. It was determined that having the 10 highest set point SRVs operable will meet the ASME and Technical Specification pressure limits. In order to support operation with 1 SRV out-of-service, the plant configuration needs to include at least 11 SRVs. As per ASME requirements, the SRVs are assumed to operate in the safety mode.
- TSSS insertion times were used.
- The initial dome pressure was set at the maximum allowed by the Technical Specifications (1035 psia).
- An MSIV closure time of 1.1 seconds was assumed in the analysis.
- EOC RPT is assumed inoperable; ATWS (high-dome pressure) RPT is available.

7.2 *Pressurization Transients*

Results of analysis for the MSIV closure event initiated at 102% power/105% flow are presented in Table 7.1. Figures 7.1–7.5 show the response of various reactor plant parameters to the MSIV closure event. The maximum pressure of 1346.2 psig occurs in the lower plenum at approximately 4.4 seconds. The maximum dome pressure of 1319.9 psig occurs at 4.6 seconds. The results demonstrate that the maximum vessel pressure limit of 1375 psig and dome pressure limit of 1325 psig are not exceeded.

**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 closure	373.7	136.6	1346.2	1319.9

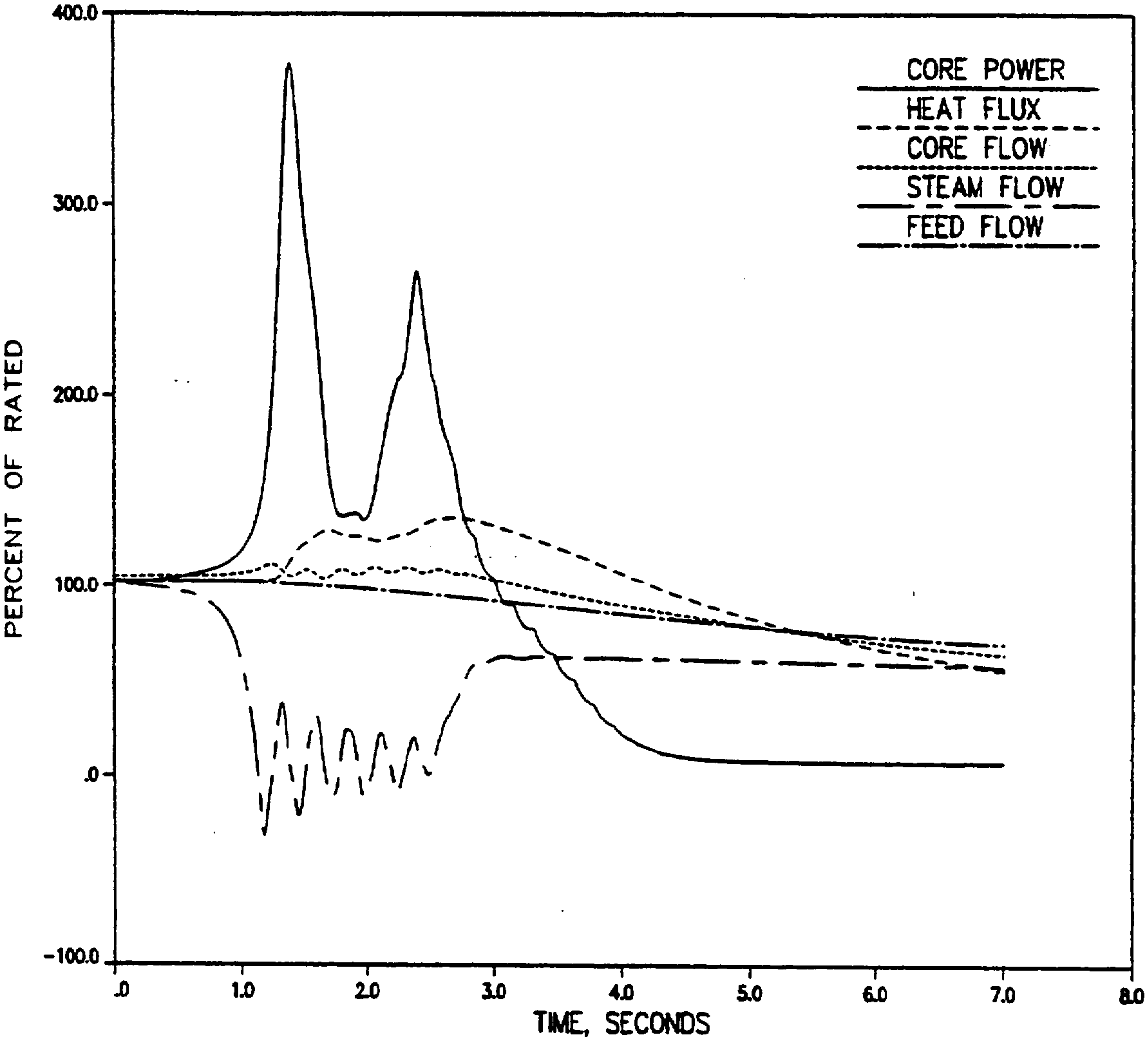


Figure 7.1 Overpressurization Event at 102/105 - MSIV Closure Key Parameters

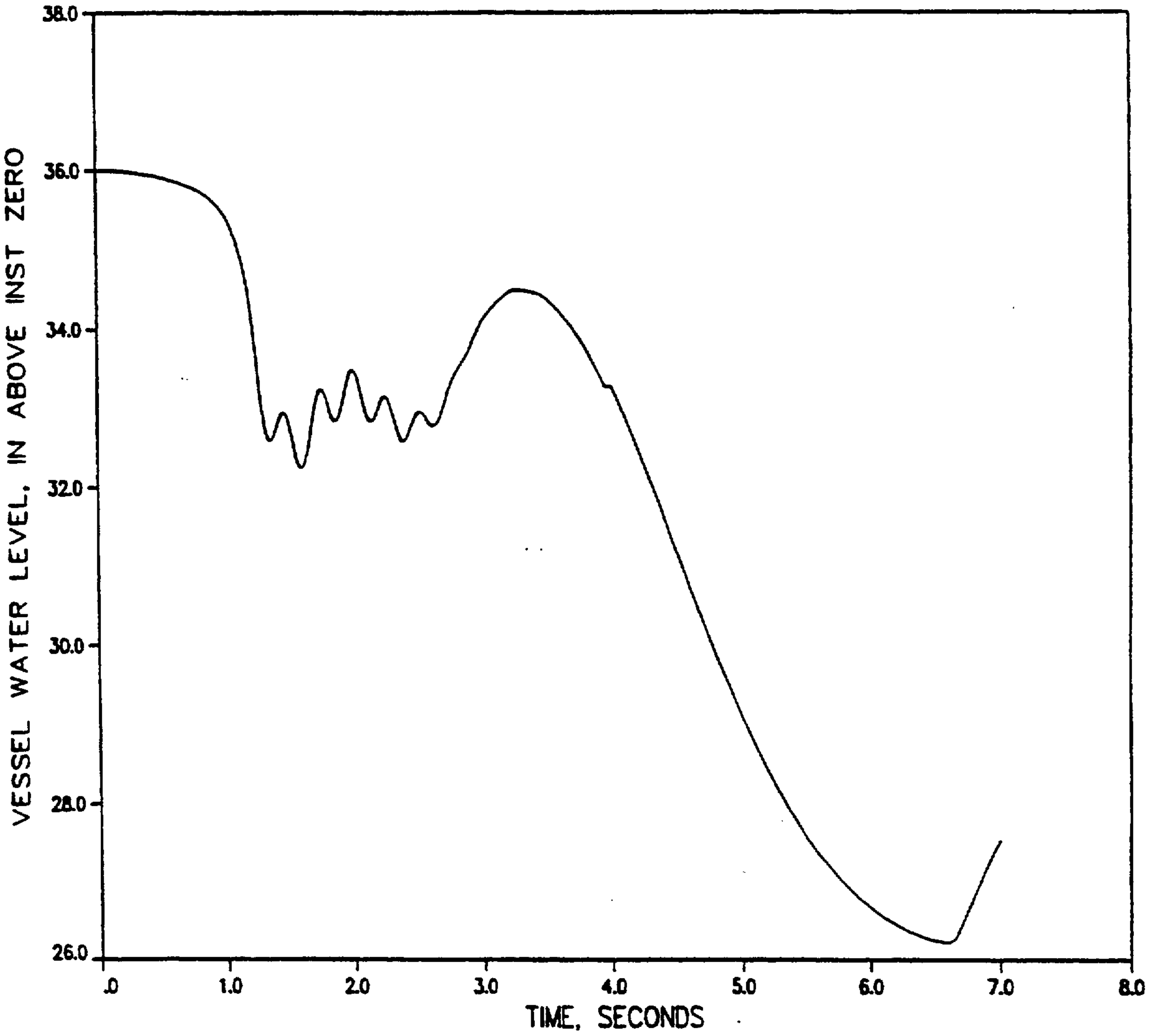


Figure 7.2 Overpressurization Event at 102/105 - MSIV Closure Vessel Water Level

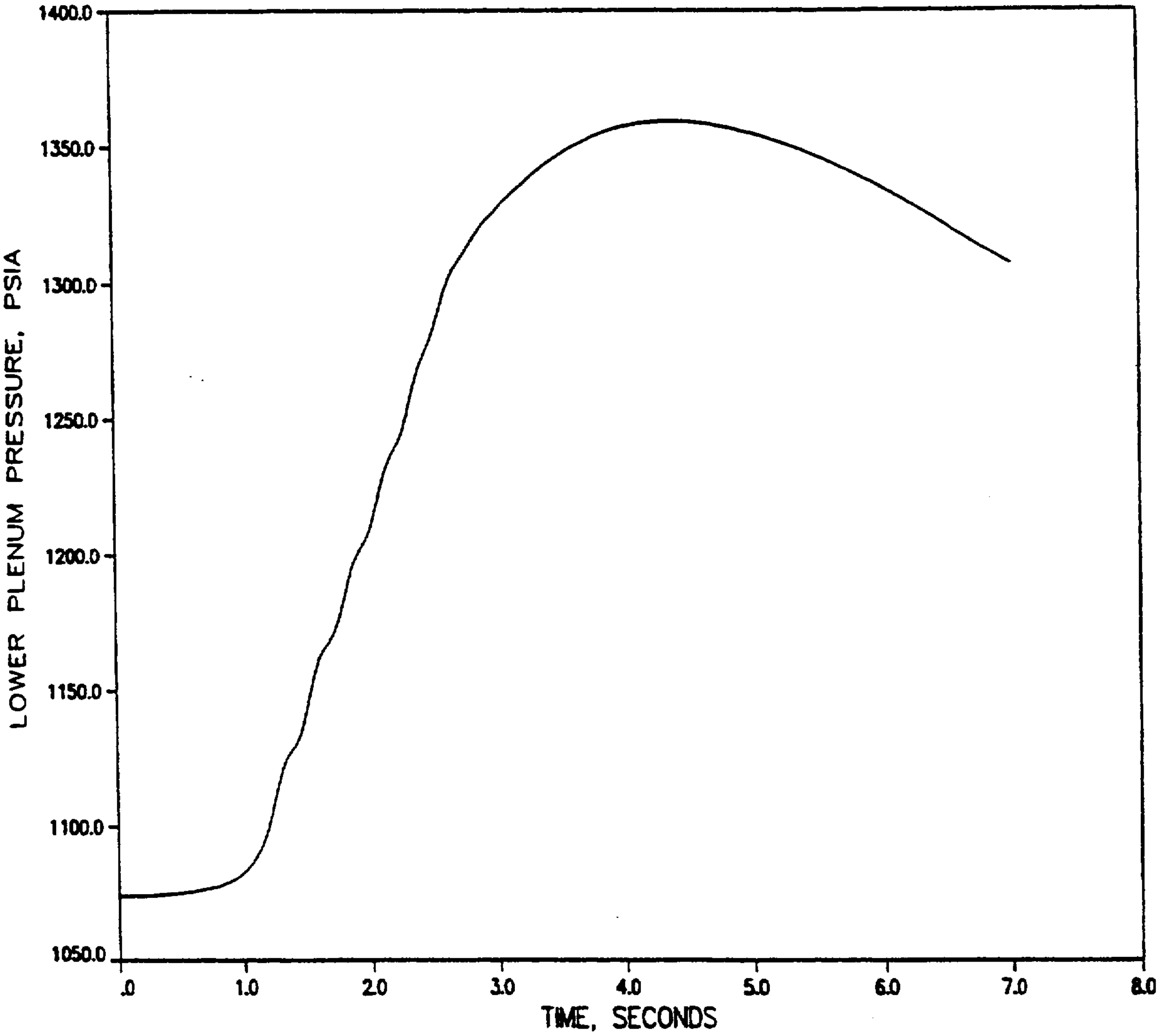


Figure 7.3 Overpressurization Event at 102/105 - MSIV Closure Lower-Plenum Pressure

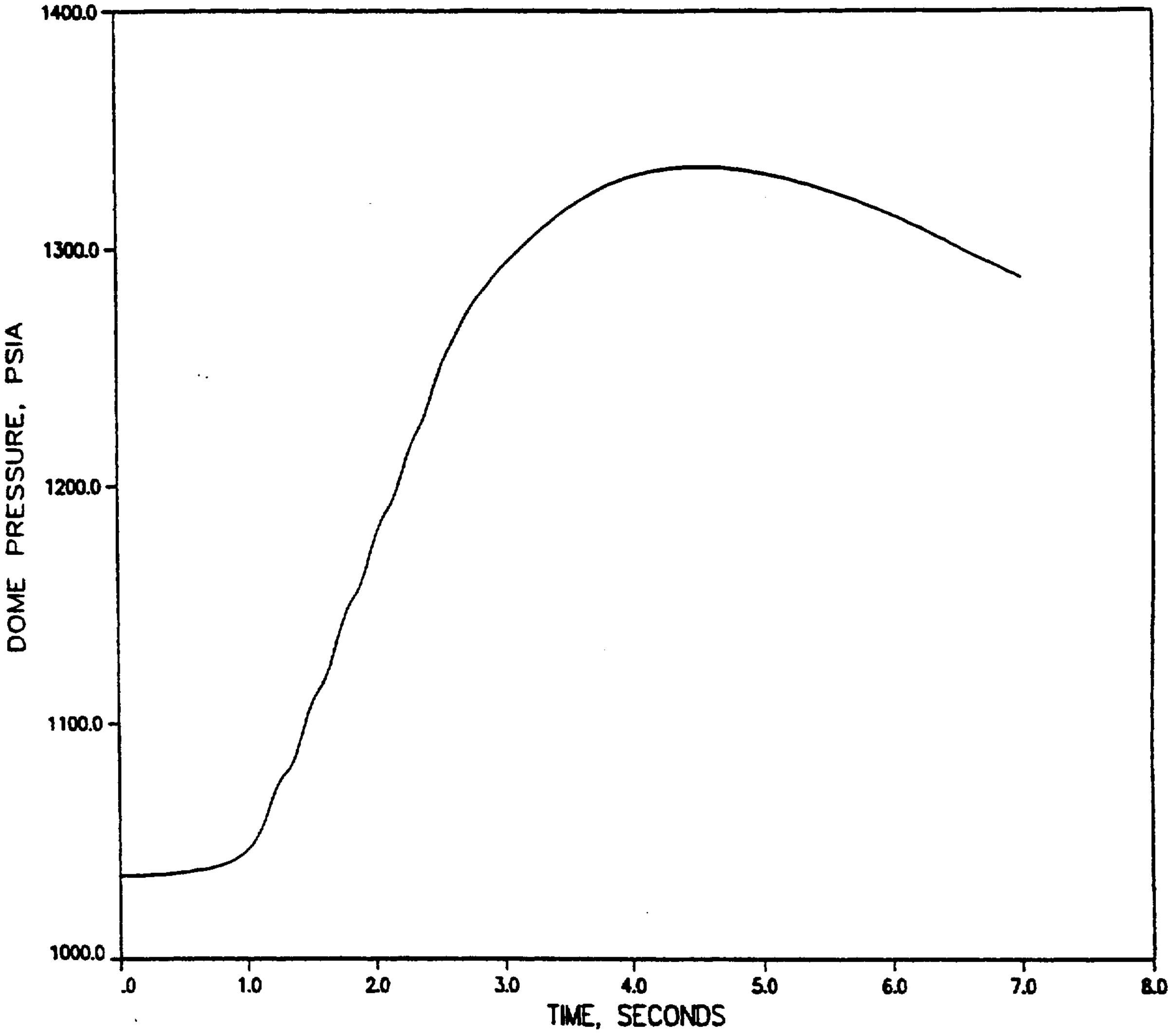
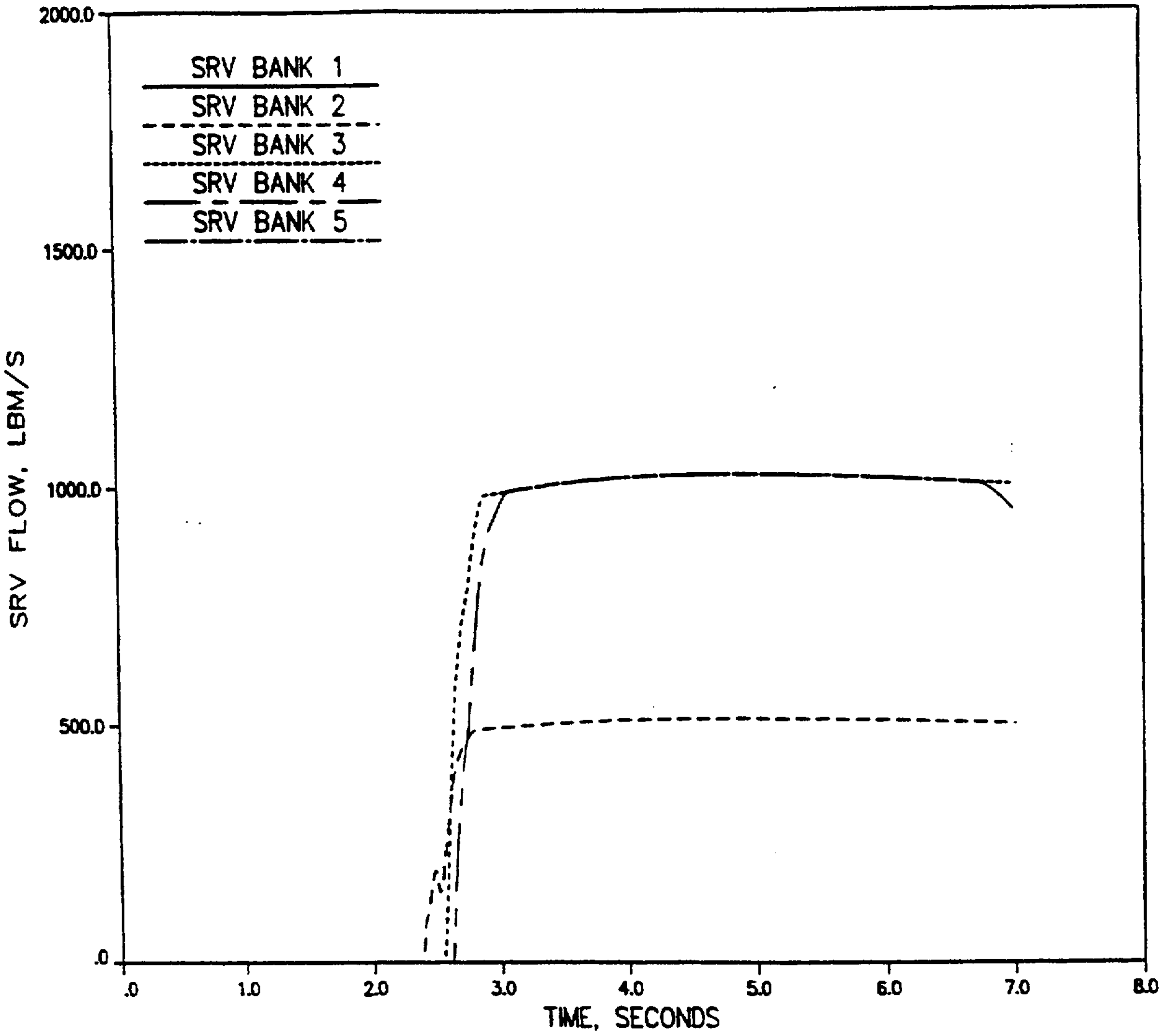


Figure 7.4 Overpressurization Event at 102/105 - MSIV Closure Dome Pressure



Bank	Number of SRVs	Opening Pressure (psia)
1	0	NA
2	2	1235.3
3	4	1245.6
4	4	1255.9
5	0	NA

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

8.0 References

1. Letter, D. E. Garber (SPC) to R. J. Chin (ComEd), "LaSalle Unit 2 Cycle 9 Calculation Plan," DEG:00:031, February 25, 2000.

2. XN-NF-80-19(P)(A) Volume 4 Revision 1, *Exxon Nuclear Methodology for Boiling Water Reactors: Application of the ENC Methodology to BWR Reloads,* Exxon Nuclear Company, June 1986.

3. 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 the CASMO-3G/MICROBURN-B Calculation Methodology*, Advanced Nuclear Fuels Corporation, November 1990.

4. 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.

5. 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.

6. ANF-1125(P)(A) and Supplement 1 and 2, *ANFB Critical Power Correlation*, Advanced Nuclear Fuels Corporation, April 1990.

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15. EMF-2437 Revision 0, *LaSalle Unit 2 Cycle 9 Reload Analysis*, Siemens Power Corporation, October 2000.

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18. ANF-1373(P), *Procedure Guide for SAFLIM2*, Siemens Power Corporation, February 1991.

19. Letter, D. E. Garber (SPC) to R. J. Chin (ComEd), "LaSalle Unit 2 Cycle 9 Transient Power History Data for Confirming Mechanical Limits for GE9 Fuel," DEG:00:185, August 3, 2000.

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Appendix A Power-Dependent LHGR Limit Generation

The linear heat generation rate (LHGR) operating limit is established to ensure that the steady-state LHGR (SSLHGR) limit is protected during normal operation and that the protection against power transient (PAPT) LHGR limit is protected during an anticipated operational occurrence (AOO). To ensure that the LHGR operating limit provides the necessary protection during operation at off-rated conditions, adjustments to the SSLHGR limits may be necessary. These adjustments are made by applying power and flow-dependent LHGR multipliers ($LHGRFAC_p$ and $LHGRFAC_f$, respectively) to the SSLHGR limit. The LHGR operating limit (LHGROL) for a given operating condition is determined as follows:

$$LHGROL = \min\,[LHGRFAC_p \times SSLHGR, LHGRFAC_f \times SSLHGR]$$

The power-dependent LHGR multipliers ($LHGRFAC_p$) are determined using the heat flux excursion experienced by the fuel during AOOs. The heat flux ratio (HFR) is defined as the ratio of the maximum nodal transient heat flux over the maximum nodal heat flux at the initiation of the transient. The HFR provides a measure of the LHGR excursion during the transient. The PAPT limit divided by the SSLHGR limit provides an upper limit for the HFR to ensure that the PAPT LHGR limit is not violated during an AOO. $LHGRFAC_p$ is set equal to the minimum of the PAPT/SSLHGR ratio over HFR, or 1.0. Based on the ATRIUM-9B LHGR limits presented in Reference A-1, $LHGRFAC_p$ is established as follows:

$$\frac{PAPT}{SSLHGR} = 1.35$$

$$HFR = \frac{Q_{maxt}}{Q_{max0}}$$

$$LHGRFAC_p = \min\left[\frac{1.35}{HFR}, 1.0\right]$$

In some cases, the established MCPR limit precludes operation at the SSLHGR limit. This allows for a larger LHGR excursion during the transient without violating the PAPT LHGR limit. This approach was used to provide less restrictive $LHGRFAC_p$ multipliers for some cases.

References

A.1 EMF-2404(P) Revision 1, *Fuel Design Report for LaSalle 2, Cycle 9 ATRIUM™-9B Fuel Assemblies*, Siemens Power Corporation, September 2000.

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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$_P$	Generi MAPFA
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 19)

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 19).

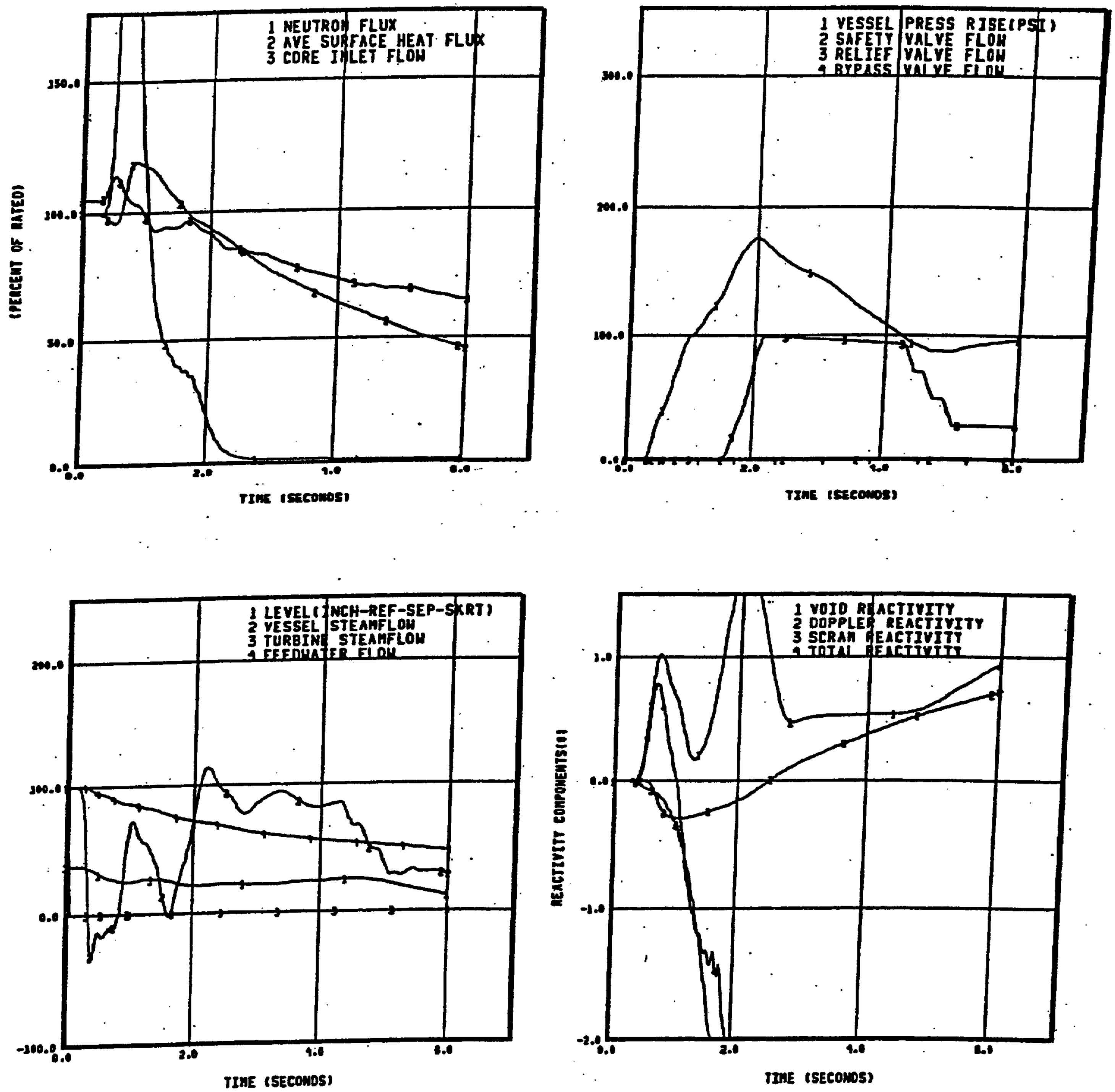
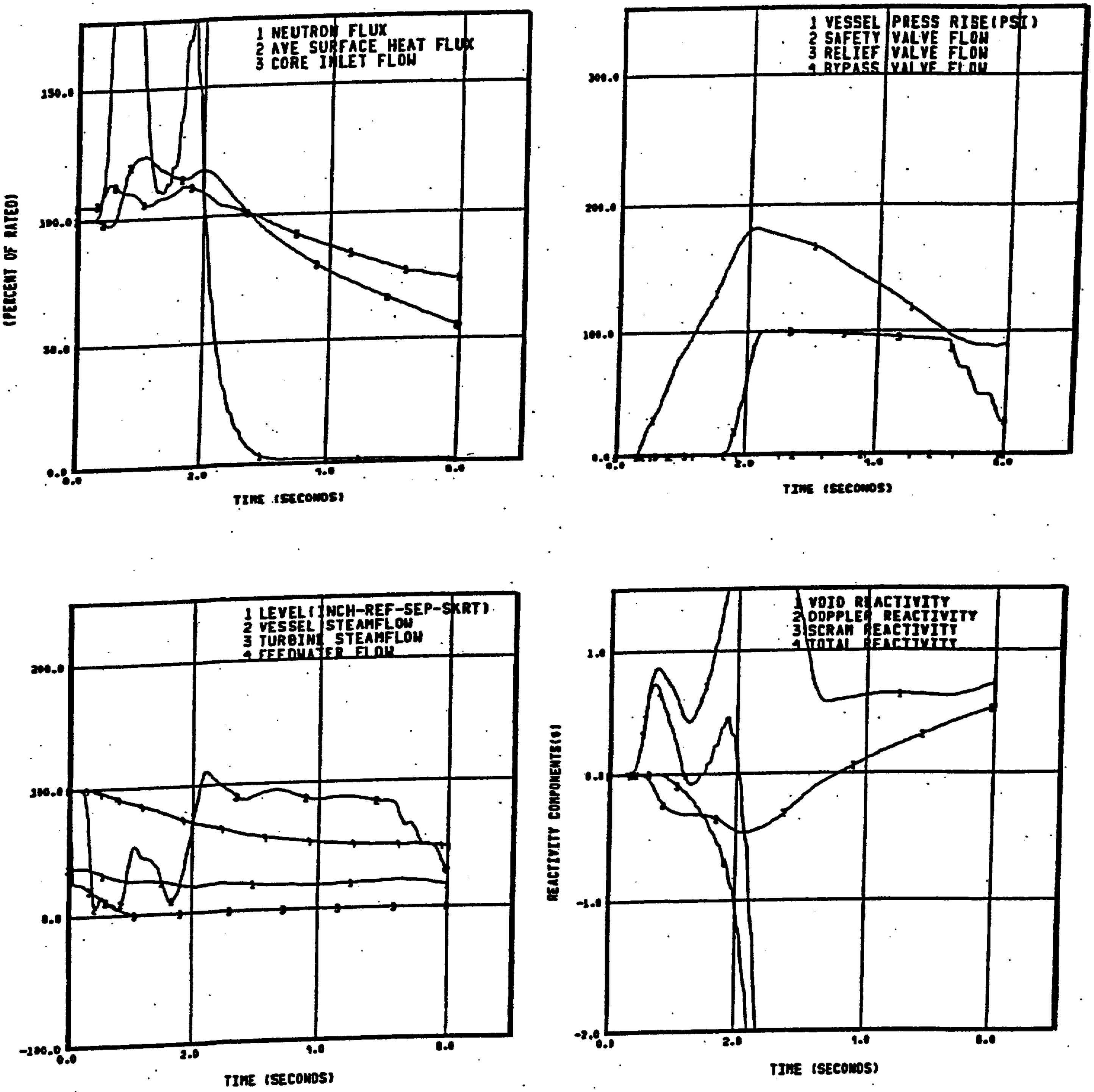


Figure 1. LRNBP from Rated Power, All TCV Fast Closure, Direct Scram, EOC-RPT



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

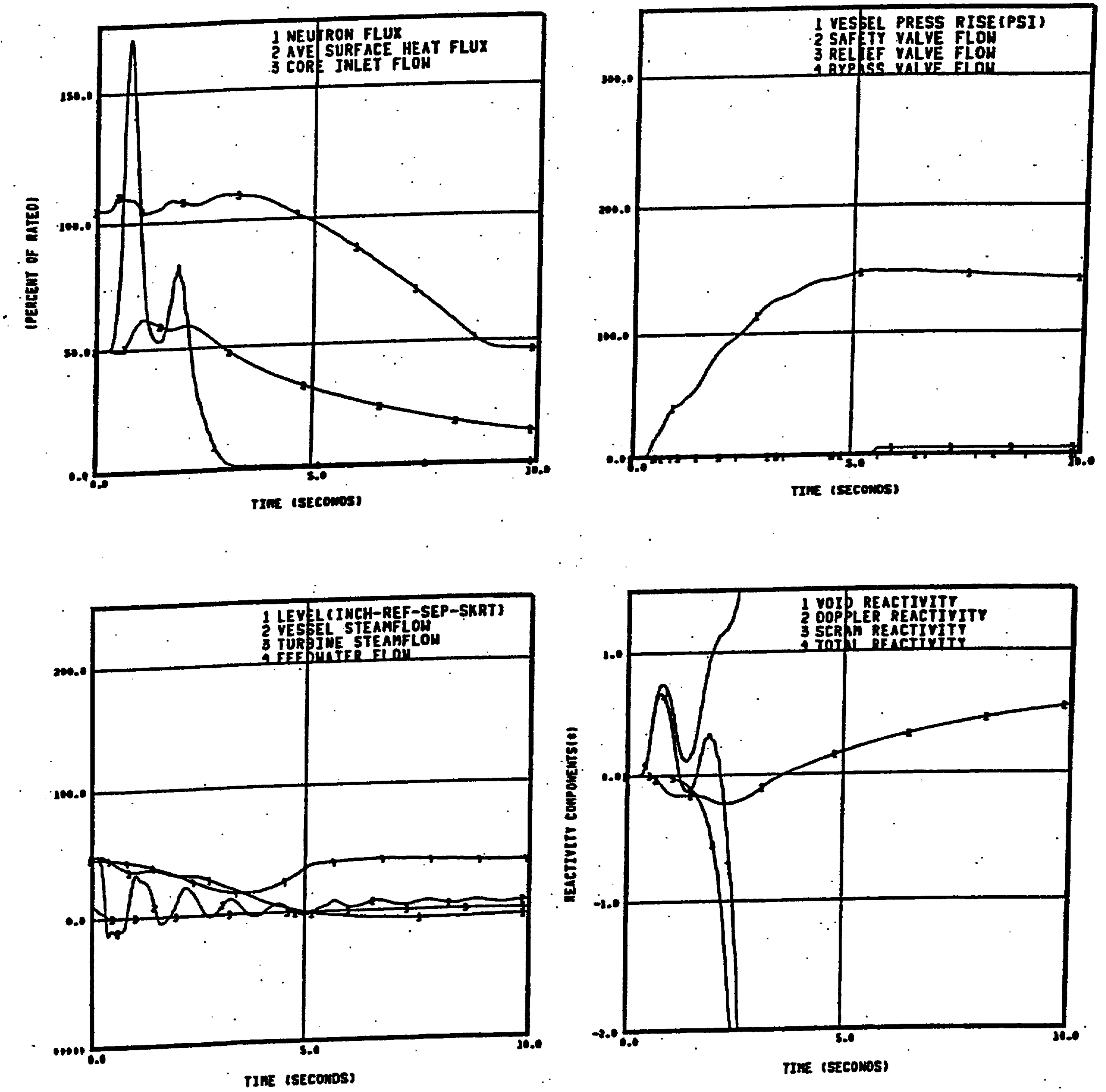


Figure 3. LRNBP from 50% Power, One TCV Slow Closure(50%/second)/Three TCV Fast Closure, Flux Scram

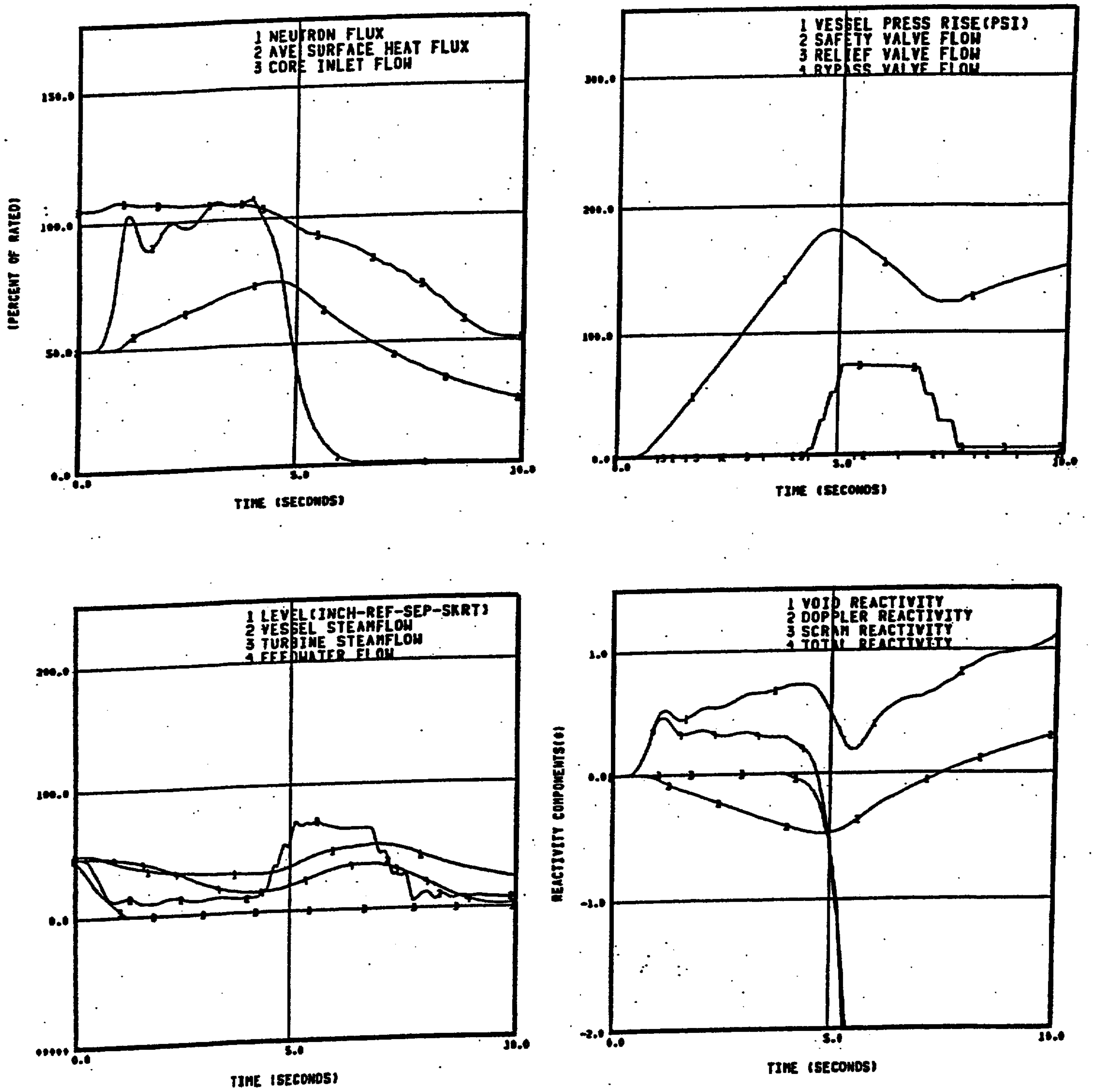


Figure 4. LRNBP from 50% Power, All TCV Closure at 19%/second, Pressure Scram

Attachment 6

LaSalle Unit 2 Cycle 9 Operating Limits for Proposed ITS Scram Times and Corrected Fuel Thermal Conductivity

FRAMATOME ANP

March 22, 2001
DEG:01:046

Dr. R. J. Chin
Nuclear Fuel Services (Suite 400)
Exelon Corporation
1400 Opus Place
Downers Grove, IL 60515-5701

Dear Dr. Chin:

LaSalle Unit 2 Cycle 9 Operating Limits for Proposed ITS Scram Times and Corrected Fuel Thermal Conductivity

Ref: 1:	LaSalle County Nuclear Station Unit 2 Technical Specifications, as amended.
Ref: 2:	EMF-2440 Revision 0, LaSalle Unit 2 Cycle 9 Plant Transient Analysis, Siemens Power Corporation, October 2000.
Ref: 3:	EMF-2437 Revision 0, LaSalle Unit 2 Cycle 9 Reload Analysis, Siemens Power Corporation, October 2000.
Ref: 4:	Letter, D. E. Garber (FRA-ANP) to R. J. Chin (Exelon), "LaSalle Unit 2 Cycle 9 Base Case Operating Limits for Proposed ITS Scram Times," DEG:01:014, January 18, 2001.
Ref: 5:	Letter, D. E. Garber (FRA-ANP) to R. J. Chin (Exelon), "Transmittal of Condition Report 9191," DEG:01:038, February 27, 2001.

Exelon has proposed replacing the current Technical Specifications (Reference 1) with Improved Technical Specifications (ITS) during LaSalle Unit 2 Cycle 9 (L2C9) operation. The operating limits for L2C9 (References 2 and 3) are established consistent with the scram times presented in Reference 1 and are not consistent with the proposed ITS surveillance times. Exelon has requested that FRA-ANP perform analyses to support a mid-cycle transition to the ITS for base case operation and one equipment out-of-service (EOOS) scenario. Reference 4 described the determination of analytical scram times consistent with the ITS and provided base case operating limits. Reference 5 identifies an error in the fuel thermal conductivity used in the transient analyses for LaSalle, including the analyses provided in Reference 4.

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Richland, WA 99352

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Fax: (509) 375-8402

The attachment provides the L2C9 base case and slow TCV closure/FHOOS and or no RPT transient analysis results and operating limits using the analytical scram times and the corrected fuel thermal conductivity. The base case operation limits provided in the attachment supercede those transmitted in Reference 4.

Very truly yours,

David Garber
Project Manager

slg

Enclosure

cc: P. Kong

LaSalle Unit 2 Cycle 9 Operating Limits for Proposed ITS Scram Times and Corrected Fuel Thermal Conductivity

Limiting Condition for Operation (LCO) 3.1.3.3 of the current LaSalle Unit 2 Technical Specifications (Reference 1) specifies the average scram insertion times of all operable control rods. The average control rod insertion times must not exceed the scram times for the requirements of LCO 3.1.3.3 to be met. Exelon is planning to implement Improved Technical Specifications (ITS) for LaSalle Unit 2 during Cycle 9. The scram surveillance times in the proposed ITS are slightly more restrictive than those presented in Reference 1. Additionally, the surveillance requirement for the ITS is that each rod must meet the scram times. The LaSalle Unit 2 Cycle 9 (L2C9) operating limits (References 2 and 3) are based on the average scram times presented in Reference 1. Therefore, the limiting transient analyses used to set the operating limits provided in References 2 and 3 must be reanalyzed with revised scram times in order to support the mid-cycle implementation of the ITS.

FRA-ANP provided proposed ITS surveillance scram times to Exelon in Reference 4, Table 1. The Reference 4 analytical scram times are presented in Table 1 for completeness.

FRA-ANP informed Exelon of an error in the fuel thermal conductivity used in COTRANSA2 calculations (Reference 5). The analysis results presented in Tables 2 and 3 include the effect of the corrected fuel thermal conductivity.

Reference 9 provided a disposition of LOCA and UFSAR events for ITS scram times for LaSalle. The Reference 9 disposition remains applicable.

Base Case Operation

Reference 4 provided base case operating limits for the proposed ITS scram times. After Reference 4 was issued, FRA-ANP informed Exelon of an error in the fuel thermal conductivity used in COTRANSA2 calculations (Reference 5). The analyses provided in Reference 4 have been reanalyzed using the corrected fuel thermal conductivity. The results of these analyses are presented in Table 2.

Figures 1 and 2 present the revised base case $MCPR_p$ limits for the ATRIUM™-9B* and GE9 fuel, respectively. The sum of the L2C9 safety limit MCPR (1.11 per Reference 2) and the ΔCPR results from Table 2 are also presented in Figures 1 and 2.

The Reference 2 base case $LHGRFAC_p$ multipliers and the $LHGRFAC_p$ results from Table 2 are presented in Figure 3. Review of Figure 3 shows that all of the ATRIUM-9B $LHGRFAC_p$ results are above the $LHGRFAC_p$ multipliers, and therefore, the Reference 2 base case $LHGRFAC_p$ multipliers remain applicable for the proposed ITS scram times.

TCV Slow Closure/FHOOS and/or No RPT

Exelon requested that FRA-ANP provide operating limits for the most limiting equipment out-of-service (EOOS) scenario provided in Reference 2. Review of the Reference 2 limits shows that the most limiting two-loop operation EOOS scenario is TCV slow closure/FHOOS and/or no RPT.

The TCV slow closure/FHOOS and/or no RPT limits consider transient analysis results from the following scenarios: TCV slow closure (up to all four valves), EOC RPT OOS, FHOOS, and a combination of FHOOS and EOC RPT OOS. (Note: TCV slow closure analyses with FHOOS are bound by TCV slow closure analyses at nominal feedwater temperature, and therefore, no specific analyses are required for this scenario.) In order to reduce the workscope required to establish new limits, only a subset of the analyses reported in Reference 2 have been reanalyzed. Review of Figures 5.16, 5.17 and 5.18 in Reference 2 show that the TCV slow closure analyses are limiting for all power levels above 25% power; the FWCF no RPT with FHOOS is limiting at 25% power. Additionally, these figures show that there is considerable margin between the analysis results and the limits at power levels of 40% and 60%.

Table 5.5 of Reference 2 was reviewed to determine which specific TCV slow closure analyses required reanalysis to establish the limits. Tables 5.1 (FHOOS) and 5.4 (EOC RPT OOS) of Reference 2 were also reviewed since the limits are applicable for EOC RPT OOS or FHOOS only. Table 3 presents the analysis results required to adequately establish the slow TCV closure/FHOOS and/or no RPT limits.

Figures 4 and 5 present the revised slow TCV closure/FHOOS and/or no RPT $MCPR_p$ limits for the ATRIUM-9B and GE9 fuel, respectively. The sum of the L2C9 safety limit MCPR (1.11 per Reference 2) and the ΔCPR results from Table 3 are also presented in Figures 4 and 5.

---

* ATRIUM is a trademark of Framatome ANP.

Figure 6 presents the revised slow TCV closure/FHOOS and/or no RPT LHGRFAC$_p$ multipliers for the ATRIUM-9B fuel.

The MCPR$_p$ limits and LHGRFAC$_p$ multipliers provided in Figures 4–6 protect operation with up to four TCVs closing slowly, EOC RPT OOS, FHOOS and any combination of up to four TCVs closing slowly, EOC RPT OOS and FHOOS. The only equipment out-of-service scenarios provided in Reference 2 not explicitly protected by the slow TCV closure/FHOOS and/or no RPT limits are single-loop operation (discussed below), turbine bypass valves OOS, and abnormal startup of an idle loop.

Comparison of turbine bypass valves OOS and the TCV slow closure/FHOOS and/or no RPT limits in Table 2.2 of Reference 3 shows the TCV slow closure/FHOOS and/or no RPT limits clearly bound the turbine bypass valves OOS limits. Consequently, applying the TCV slow closure/FHOOS and/or no RPT limits will protect operation with the turbine bypass OOS.

No analyses were performed to address the abnormal startup of an idle loop limits with ITS scram times and the corrected fuel thermal conductivity.

Single-Loop Operation

Figures 1–3 provide the two-loop operation (TLO) MCPR$_p$ limits and LHGRFAC$_p$ multipliers for base case operation. Reference 7 indicates that the consequences of base case pressurization transients in single-loop operation (SLO) are bound by the consequences of the same transient initiated from the same power/flow conditions in TLO and that the TLO base case ΔCPRs and the LHGRFAC$_p$ multipliers remain applicable for SLO. Reference 2 indicates the L2C9 TLO safety limit MCPR is 1.11 and the SLO safety limit MCPR is 1.12. Since the TLO ΔCPR results are applicable to SLO, the SLO ATRIUM-9B and GE9 MCPR$_p$ limits can be determined by adding 0.01 to the base case operation MCPR$_p$ limits provided in Figures 1 and 2 to account for the increase in safety limit MCPR. The base case LHGRFAC$_p$ multipliers shown in Figure 3 remain applicable for SLO.

The conclusion that TLO ΔCPR results generally bound SLO results has been demonstrated for both base case operation and some equipment out-of-service scenarios for other BWRs. Although specific L2C9 analyses for a combination of TCV slow closure/FHOOS and/or no RPT in SLO have not been performed, FRA-ANP expects the TLO operation ΔCPR results would remain applicable in SLO for this scenario. Therefore, SLO MCPR$_p$ limits for TCV slow closure/FHOOS and/or no RPT can be determined by adding 0.01 to the TCV slow closure/FHOOS and/or no RPT MCPR$_p$ limits reported in Figures 4 and 5 to account for the increase in safety limit MCPR. The Figure 6 TCV slow closure/FHOOS and/or no RPT $LHGRFAC_p$ multipliers remain applicable for SLO.

GE9 Mechanical Limits

Reference 6 provides an evaluation of the GE9 mechanical limits for L2C9. An evaluation of the GE9 mechanical limits for the rated power analyses reported in Tables 2 and 3 was performed. It has been demonstrated that the maximum nodal power ratio history curve for the analyses are bound by the previously approved L2C9 curve. Therefore, it is FRA-ANP's position that no further evaluation of the GE9 mechanical limits is required.

References

1. LaSalle County Nuclear Station Unit 2 Technical Specifications, as amended.
2. EMF-2440 Revision 0, *LaSalle Unit 2 Cycle 9 Plant Transient Analysis*, Siemens Power Corporation, October 2000.
3. EMF-2437 Revision 0, *LaSalle Unit 2 Cycle 9 Reload Analysis,* Siemens Power Corporation, October 2000.
4. Letter, D. E. Garber (FRA-ANP) to R. J. Chin (Exelon), "LaSalle Unit 2 Cycle 9 Base Case Operating Limits for Proposed ITS Scram Times," DEG:01:014, January 18, 2001.
5. Letter, D. E. Garber (FRA-ANP) to R. J. Chin (Exelon), "Transmittal of Condition Report 9191," DEG:01:038, February 27, 2001.
6. Letter, D. E. Garber (SPC) to R. J. Chin (ComEd), "LaSalle Unit 2 Cycle 9 Transient Power History Data for Confirming Mechanical Limits for GE9 Fuel," DEG:00:185, August 3, 2000.
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.
8. EMF-2323 Revision 0, *LaSalle Unit 2 Cycle 9 Principal Transient Analysis Parameters*, Siemens Power Corporation, March 2000.
9. Letter D. E. Garber (SPC) to R. J. Chin (ComEd), "Evaluation of Improved Technical Specification Scram Times at Dresden, LaSalle and Quad Cities Station," DEG:99:195, July 26, 1999.

Table 1 Proposed ITS Scram Insertion Times

Position (notch)	TS Limit (sec)	Slow Rods (sec)	Analytical (sec)
48	0.00	0.00	0.00
48	0.20*	0.20*	0.20*
45	0.52	0.67	0.53
39	0.80	1.62	0.85
25	1.77	3.84	1.90
5	3.20	7.00	3.45
0	3.56	7.79	3.83

---

* The 0.20-second delay is considered a nominal value that cannot be verified by the plant. Therefore, the transient analysis calculations are performed to bound a range of no delay (linear insertion from start signal to notch 45) to a delay value just before notch 45. This is consistent with the information provided in Reference 8.

Table 2 Base Case Transient Analysis Results With Proposed ITS Scram Times and Corrected Fuel Thermal Conductivity

Power / Flow	ATRIUM-9B ΔCPR	ATRIUM-9B $LHGRFAC_p$	GE9 ΔCPR	Peak Neutron Flux (% rated)	Peak Heat Flux (% rated)
			LRNB		
100 / 105	0.30	1.01	0.40	424	127
100 / 81	0.30	1.01	0.40	427	127
80 / 105	0.30	1.03	0.40	342	100
80 / 57.2	0.30	1.06	0.40	246	95
			FWCF		
100 / 105	0.26	1.09	0.32	301	123
80 / 105	0.29	1.05*	0.36	268	101
60 / 105	0.37*	1.01*	0.42	173*	77*
40 / 105	0.53*	0.93	0.59*	112*	58*
25 / 105	0.82*	0.77	0.90*	73*	45*

---

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

Table 3 EOOS Transient Analysis Results With Proposed ITS Scram Times and Corrected Fuel Thermal Conductivity

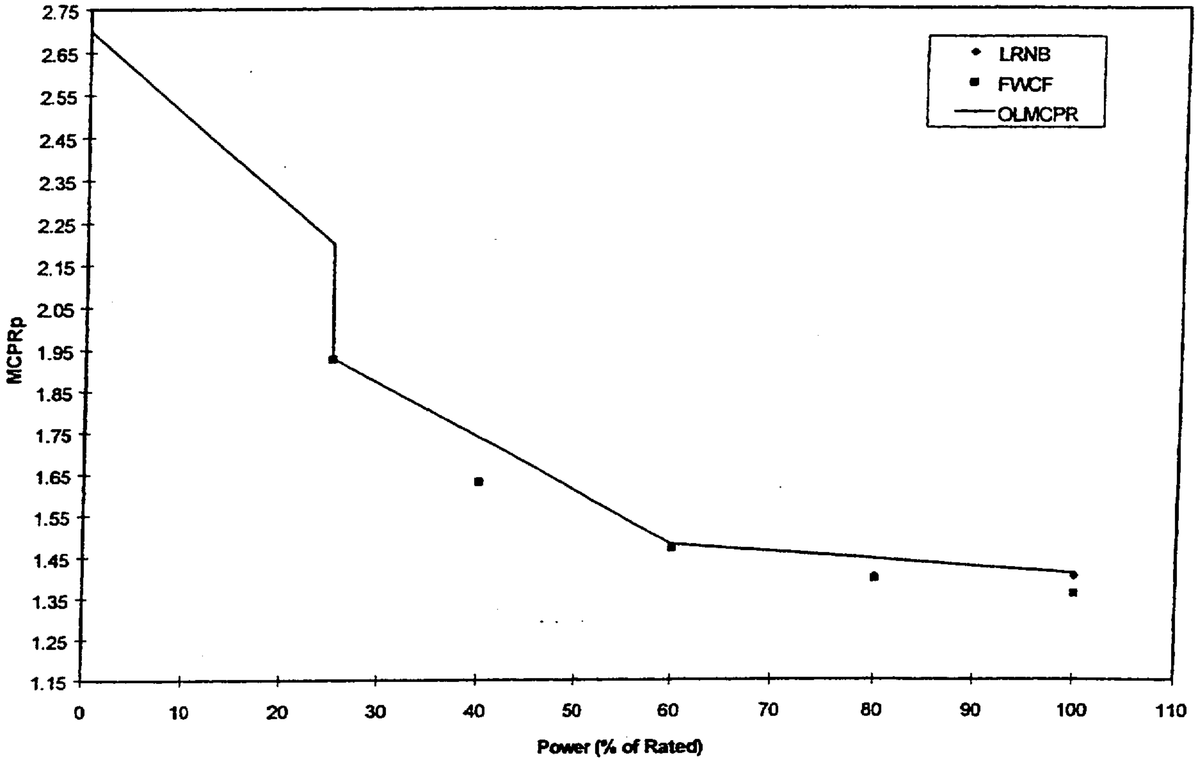
Power / Flow	Slow Valve Characteristics	ATRIUM-9B ΔCPR	ATRIUM-9B LHGRFAC$_p$	GE9 ΔCPR
Slow TCV Closure				
100 / 105[*]	1 TCV closing in 2.0 seconds	0.42	0.93	0.52
80 / 57.2[*]	1 TCV closing in 2.0 seconds	0.51	0.97	0.75
80 / 105[†]	2 TCV closing in 2.0 seconds	0.54[‡]	0.94	0.58[‡]
80 / 57.2[†]	2 TCV closing in 2.0 seconds	0.59	0.85	0.85
25 / 105[†]	1 TCV closing in 2.0 seconds	1.00	0.75	0.95
LRNB No RPT				
100 / 105	NA	0.40	0.89	0.51
FWCF With FHOOS				
25 / 105	NA	1.06[‡]	0.68[‡]	1.13[‡]
FWCF No RPT With FHOOS				
25 / 105	NA	1.04[‡]	0.67[‡]	1.11[‡]

---

[*] Scram initiated by high neutron flux.

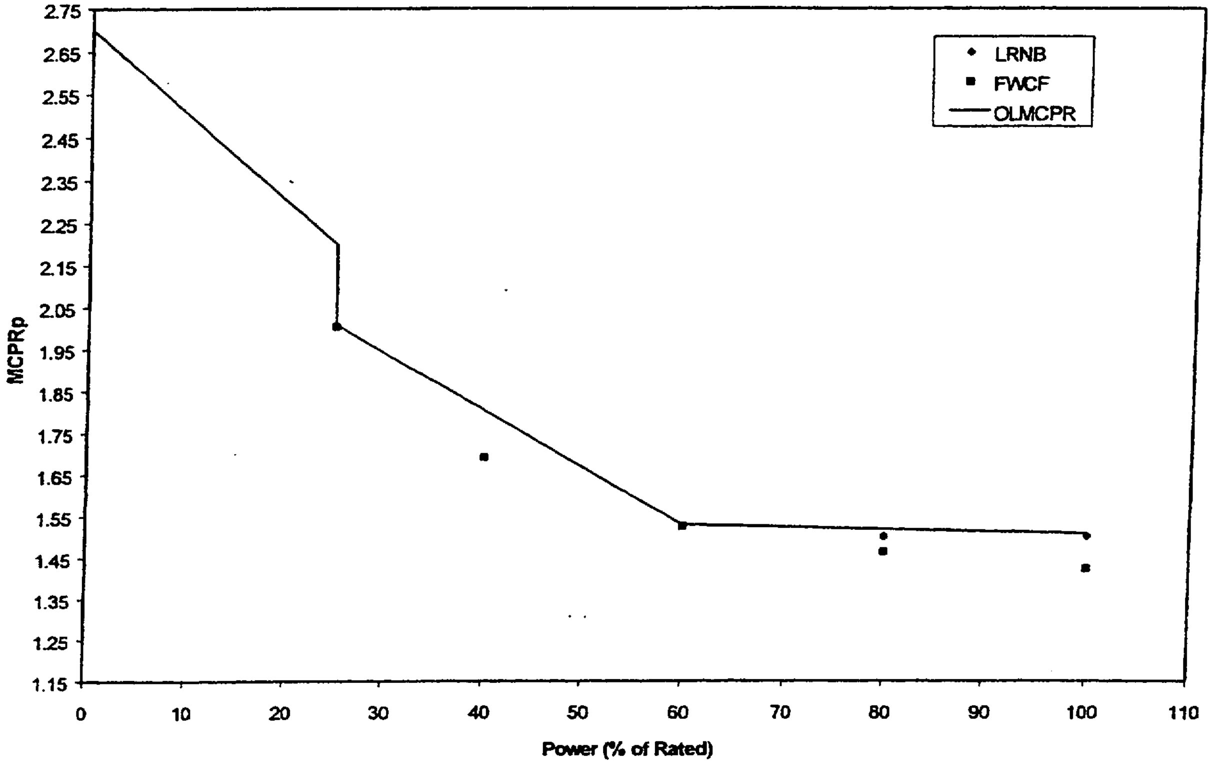
[†] Scram initiated by high dome pressure.

[‡] The analysis results presented are from an exposure prior to EOC. The ΔCPR and LHGRFAC$_p$ results are conservatively used to establish the thermal limits.



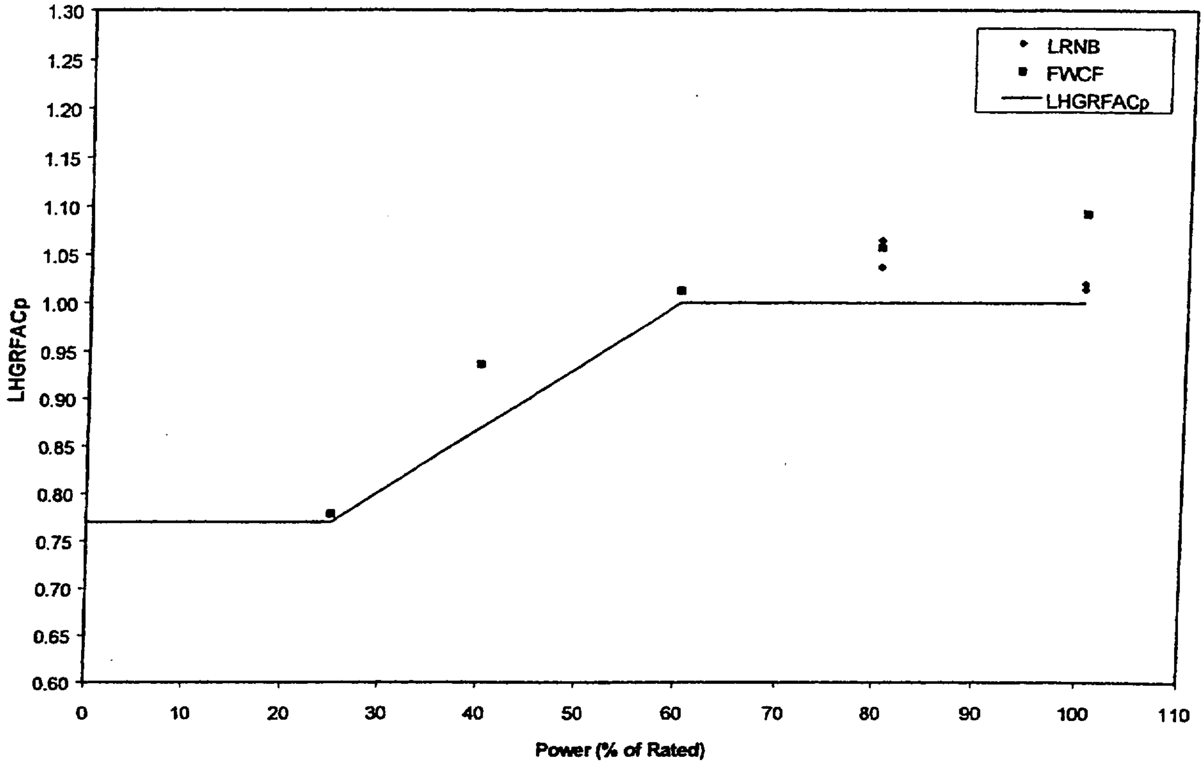
Power (%)	$MCPR_p$ Limit
100	1.41
60	1.48
25	1.93
25	2.20
0	2.70

Figure 1 EOC Base Case Power-Dependent MCPR Limits for ATRIUM-9B Fuel With Proposed ITS Scram Times and Corrected Fuel Thermal Conductivity



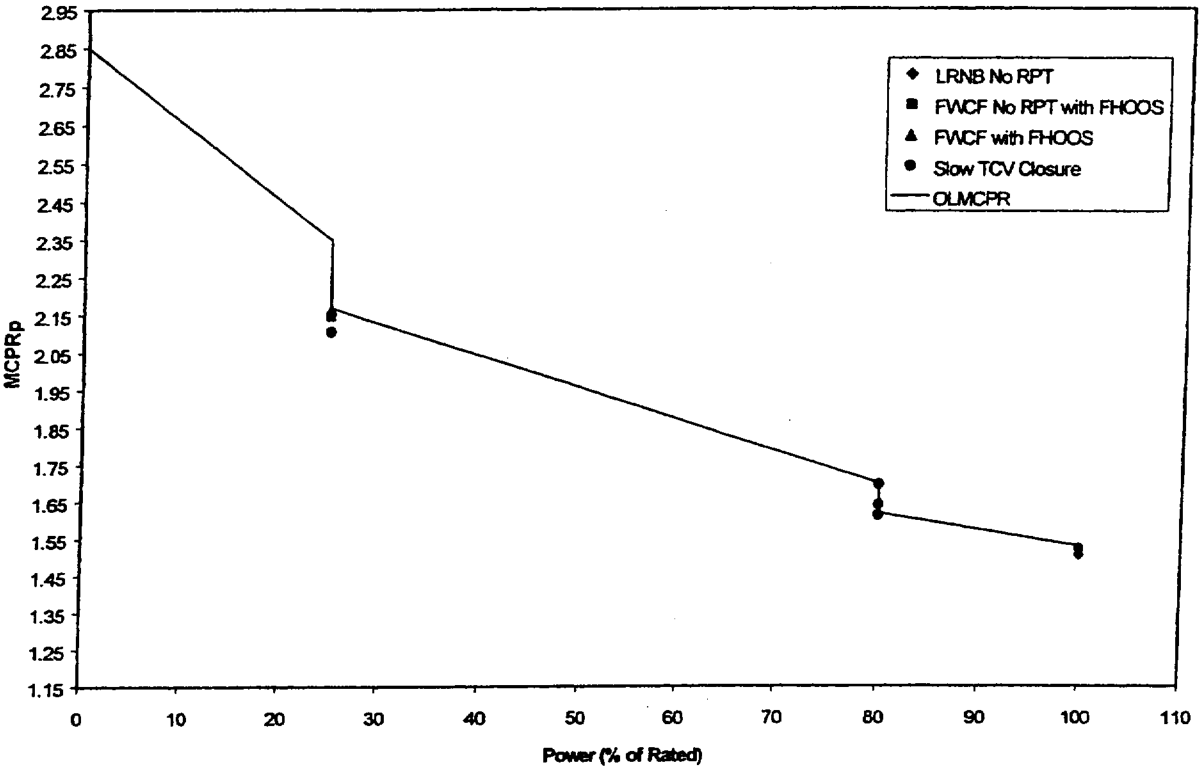
Power (%)	$MCPR_p$ Limit
100	1.51
60	1.53
25	2.01
25	2.20
0	2.70

Figure 2 EOC Base Case Power-Dependent MCPR Limits for GE9 Fuel With Proposed ITS Scram Times and Corrected Fuel Thermal Conductivity



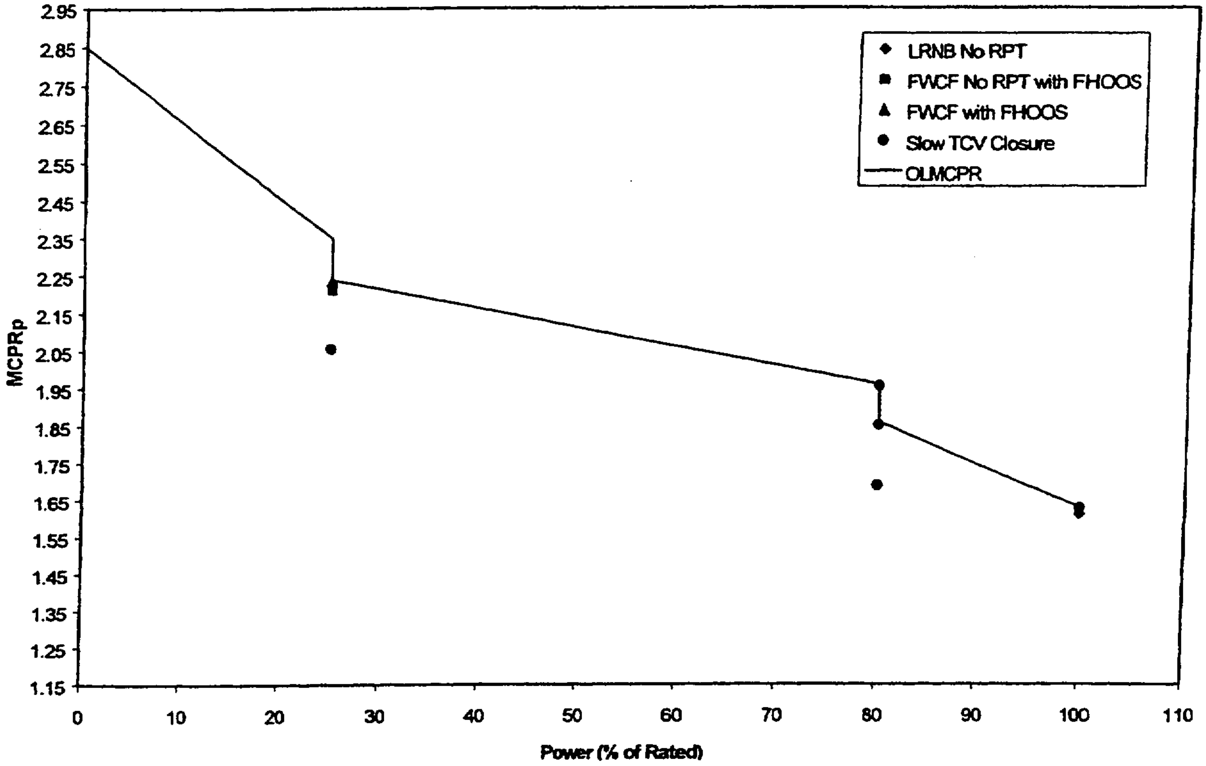
Power (%)	LHGRFAC$_p$ Multiplier
100	1.00
60	1.00
25	0.77
25	0.77
0	0.77

Figure 3 EOC Base Case Power-Dependent LHGR Multipliers for ATRIUM-9B Fuel With Proposed ITS Scram Times and Corrected Fuel Thermal Conductivity



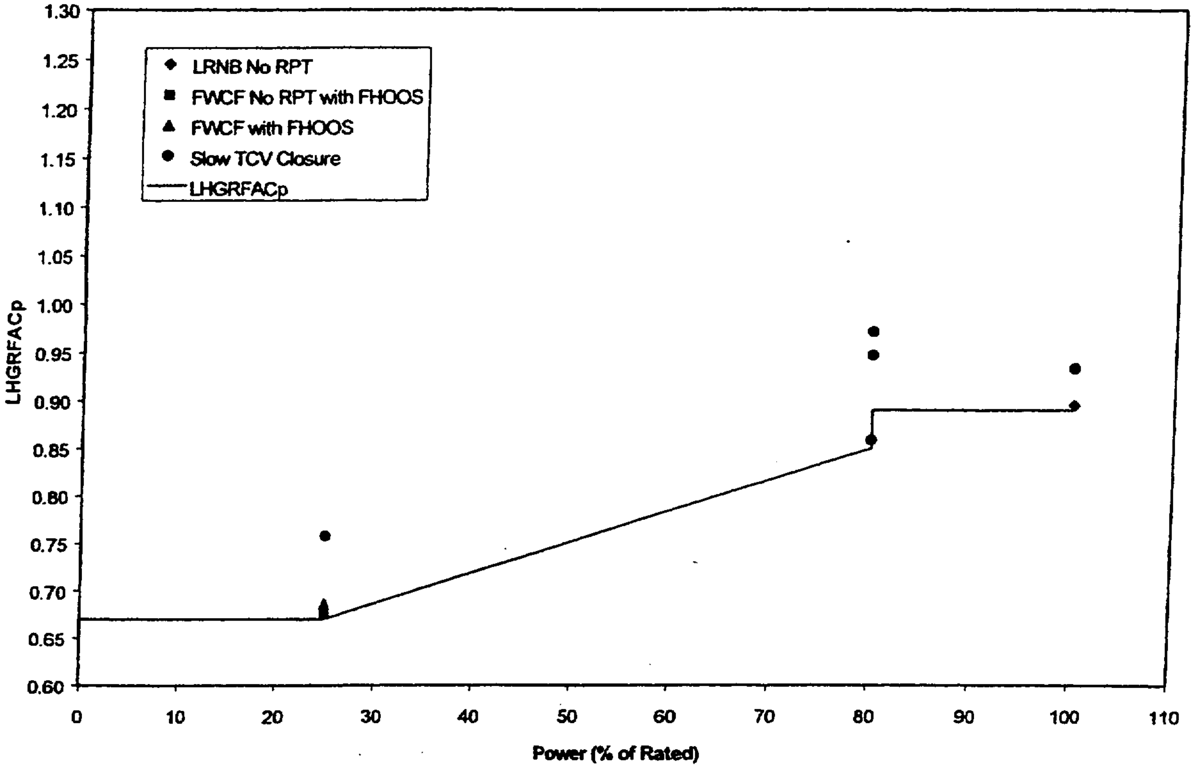
Power (%)	$MCPR_p$ Limit
100	1.53
80	1.62
80	1.70
25	2.17
25	2.35
0	2.85

Figure 4 EOC Slow TCV Closure/FHOOS and/or No RPT Power-Dependent MCPR Limits for ATRIUM-9B Fuel With Proposed ITS Scram Times and Corrected Fuel Thermal Conductivity



Power (%)	$MCPR_p$ Limit
100	1.63
80	1.86
80	1.96
25	2.24
25	2.35
0	2.85

Figure 5 EOC Slow TCV Closure/FHOOS and/or No RPT Power-Dependent MCPR Limits for GE9 Fuel With Proposed ITS Scram Times and Corrected Fuel Thermal Conductivity



Power (%)	LHGRFAC$_p$ Multiplier
100	0.89
80	0.89
80	0.85
25	0.67
25	0.67
0	0.67

Figure 6 EOC Slow TCV Closure/FHOOS and/or No RPT Power-Dependent LHGR Multipliers for ATRIUM-9B Fuel With Proposed ITS Scram Times and Corrected Fuel Thermal Conductivity