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May 21, 2001

10 CFR 50.4

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

LaSalle County Station, Units 1 and 2  
Facility Operating License Nos. NPF-11 and NPF-18  
NRC Docket Nos. 50-373 and 50-374

Subject: Unit 1 Cycle 9 and Unit 2 Cycle 9 Core Operating Limits Reports  
(COLR)

Reference: Letter from Stewart N. Bailey (NRC) to Oliver D. Kingsley (Exelon),  
"Issuance of Amendments (TAC Nos. MA8388 and MA8390)", dated  
March 30, 2001.

LaSalle County Station Units 1 and 2 have implemented Improved Technical Specifications (ITS), which were approved on March 30, 2001 by the NRC in Amendments 147 and 133 to Facility Operating Licenses NPF-11 and NPF-18, respectively. To support operation with ITS, revisions to the LaSalle County Station Units 1 and 2 Core Operating Limits Reports (COLRs) are necessary to incorporate the results of the cycle-specific analyses for the current operating cycles (L1C9 and L2C9). Included in these cycle specific analyses is resolution of a coding error, identified by Framatome ANP (formerly Siemens), that impacted thermal limit values.

In addition, the Rod Block Monitor (RBM) trip setpoint and allowable value equations in the COLRs are being revised to support operation with Maximum Extended Load Line Limit Analysis (MELLLA). 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 these COLRs to the NRC.

AP01

May 21, 2001  
U.S. Nuclear Regulatory Commission  
Page 2

Should you have any questions concerning this letter, please contact Mr. William Riffer, Regulatory Assurance Manager, at (815) 357-6761, extension 2383.

Respectfully,

A handwritten signature in black ink, appearing to read "Charles G. Pardee", with a large, stylized loop at the end.

Charles G. Pardee  
Site Vice President  
LaSalle County Station

Attachments:        Unit 1 Cycle 9 Core Operating Limits  
                         Unit 2 Cycle 9 Core Operating Limits

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

Technical Requirements Manual

Appendix I

(Amendment 45)

LaSalle Unit 1 Cycle 9

Core Operating Limits Report

and

Reload Transient Analysis Results

May 2001

## **Section 1**

LaSalle Unit 1 Cycle 9

Core Operating Limits Report

May 2001

Technical Requirements Manual - Appendix I  
L1C9 Core Operating Limits Report

Issuance of Changes Summary

Affected Section	Affected Pages	Summary of Changes	Date
All	All	Original Issue (Cycle 9)	10/99
All	All	Incorporated administrative changes (including updating the date to be November 1999)	11/99
All	All	Incorporated changes to thermal limits due to uprate and MELLLA operation, revised LHGR and MAPLHGR limits, CBH penalties, and necessary administrative changes.	5/00
All	All	Incorporated ITS changes, RBM trip setpoint and allowable value equation change for DLO and SLO, TIP symmetry Chi-Squared testing, added information on the use of SUBTIP that allows operation with reduced number of TIPs, incorporated the results of revised thermal limits with correct thermal conductivity and ITS scram times, and other necessary administrative changes.	5/01

# Technical Requirements Manual - Appendix I

## L1C9 Core Operating Limits Report

### Table of Contents

<b>References .....</b>	<b>iii</b>
<b>1. Average Planar Linear Heat Generation Rate (3.2.1) .....</b>	<b>1-1</b>
1.1 Tech Spec Reference .....	1-1
1.2 Description .....	1-1
<b>2. Minimum Critical Power Ratio (3.2.2) .....</b>	<b>2-1</b>
2.1 Tech Spec Reference .....	2-1
2.2 Description .....	2-1
<b>3. Linear Heat Generation Rate (3.2.3) .....</b>	<b>3-1</b>
3.1 Tech Spec Reference .....	3-1
3.2 Description .....	3-1
<b>4. Control Rod Withdrawal Block Instrumentation (3.3.2.1) .....</b>	<b>4-1</b>
4.1 Tech Spec Reference .....	4-1
4.2 Description .....	4-1
<b>5. Allowed Modes of Operation (B 3.2.2, B 3.2.3) .....</b>	<b>5-1</b>
<b>6. Traversing In-Core Probe System (3.2.1, 3.2.2, 3.2.3) .....</b>	<b>6-1</b>
6.1 Tech Spec Reference .....	6-1
6.2 Description .....	6-1
6.3 Bases .....	6-1

# Technical Requirements Manual - Appendix I

## L1C9 Core Operating Limits Report

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# Technical Requirements Manual - Appendix I

## L1C9 Core Operating Limits Report

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# Technical Requirements Manual - Appendix I

## L1C9 Core Operating Limits Report

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# Technical Requirements Manual - Appendix I

## L1C9 Core Operating Limits Report

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

1.1 Tech Spec Reference:  
Tech Spec 3.2.1

1.2 Description:

1.2.1 GE Fuel

The MAPLHGR Limit is determined using the applicable Lattice-Type MAPLHGR limits from Tables 1.2-1, 1.2-2, 1.2-3, and 1.2-4. For Single Reactor Recirculation Loop Operation, the MAPLHGR limits in Tables 1.2-1, 1.2-2, 1.2-3, and 1.2-4 are multiplied by the MAPFAC multipliers provided in Figures 1.2-1 and 1.2-2.

Table for Fuel-Type MAPLHGR Limits	Fuel Type (Reference 3)	Cycle First Inserted
1.2-1	GE9B-P8CWB322-11GZ-100M-150-T	7
1.2-2	GE9B-P8CWB320-9GZ-100M-150-T	7
1.2-3	GE9B-P8CWB343-12GZ-80M-150-T	8
1.2-4	GE9B-P8CWB342-10GZ-80M-150-T	8

1.2.2 SPC Fuel

The MAPLHGR Limit is the Lattice-Type MAPLHGR Limit. The Lattice-Type Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) limits are determined from the table given below:

Fuel Type (References 3 and 4)	Cycle First Inserted
SPCA9-393B-16GZ-100M	9
SPCA9-396B-12GZB-100M	9
SPCA9-384B-11GZ6-80M	9
SPCA9-396B-12GZC-100M	9

Planar Average Exposure (GWd/MTU) (References 4 and 7)	MAPLHGR (kW/ft) (all Siemens fuel types)
0.0	13.5
20.0	13.5
61.1	9.39

For single loop operation (or Abnormal Idle Loop Startup, UFSAR 15.4.4), the MAPLHGR multiplier for SPC fuel is 0.90. (References 4, 6 and 7)

# Technical Requirements Manual - Appendix I

## L1C9 Core Operating Limits Report

Table 1.2-1

Maximum Average Planar Linear Heat Generation Rate (MAPLHGR)

vs.

Average Planar Exposure for Fuel Type  
GE9B-P8CWB322-11GZ-100M-150-T

(References 11 and 24)

Exposure (MWD/ST)	Lattice Specific MAPLHGR limit (KW/ft)					
0	12.74	12.09	11.65	11.25	12.11	12.74
200	12.67	12.13	11.70	11.32	12.15	12.67
1000	12.48	12.22	11.83	11.46	12.25	12.48
2000	12.42	12.35	12.00	11.61	12.39	12.42
3000	12.41	12.48	12.14	11.77	12.54	12.41
4000	12.44	12.62	12.28	11.94	12.70	12.44
5000	12.46	12.77	12.43	12.11	12.86	12.46
6000	12.49	12.90	12.58	12.29	13.02	12.49
7000	12.51	13.03	12.73	12.46	13.19	12.51
8000	12.54	13.16	12.88	12.64	13.33	12.54
9000	12.55	13.30	13.01	12.82	13.43	12.55
10000	12.57	13.42	13.12	12.98	13.44	12.57
12500	12.41	13.41	13.08	13.04	13.40	12.41
15000	12.04	13.05	12.78	12.77	13.06	12.04
20000	11.27	12.38	12.16	12.16	12.40	11.27
25000	10.49	11.74	11.51	11.51	11.76	10.49
27215.6	12.314	12.314	12.314	12.314	12.314	12.314
48080.8	10.800	10.800	10.800	10.800	10.800	10.800
58967.1	6.000	6.000	6.000	6.000	6.000	6.000
Lattice No.	733	1817	1818	1819	1820	1821

Technical Requirements Manual - Appendix I  
L1C9 Core Operating Limits Report

Table 1.2-2

Maximum Average Planar Linear Heat Generation Rate (MAPLHGR)

vs.

Average Planar Exposure for Fuel Type

GE9B-P8CWB320-9GZ-100M-150-T

(References 11 and 24)

Exposure (MWD/ST)	Lattice Specific MAPLHGR limit (kw/ft)					
0	12.74	12.05	11.62	11.10	12.09	12.74
200	12.67	12.09	11.64	11.15	12.14	12.67
1000	12.48	12.19	11.73	11.27	12.25	12.48
2000	12.42	12.32	11.86	11.44	12.39	12.42
3000	12.41	12.44	11.99	11.62	12.53	12.41
4000	12.44	12.57	12.13	11.80	12.67	12.44
5000	12.46	12.70	12.27	11.96	12.81	12.46
6000	12.49	12.83	12.42	12.09	12.89	12.49
7000	12.51	12.97	12.54	12.23	12.98	12.51
8000	12.54	13.07	12.62	12.37	13.07	12.54
9000	12.55	13.15	12.70	12.51	13.15	12.55
10000	12.57	13.20	12.77	12.66	13.22	12.57
12500	12.41	13.19	12.70	12.67	13.20	12.41
15000	12.04	12.89	12.40	12.40	12.90	12.04
20000	11.27	12.29	11.82	11.82	12.30	11.27
25000	10.49	11.69	11.25	11.25	11.70	10.49
27215.6	12.314	12.314	12.314	12.314	12.314	12.314
48080.8	10.800	10.800	10.800	10.800	10.800	10.800
58967.1	6.000	6.000	6.000	6.000	6.000	6.000
Lattice No.	733	1812	1813	1814	1815	1816

Technical Requirements Manual - Appendix I  
L1C9 Core Operating Limits Report

Table 1.2-3

Maximum Average Planar Linear Heat Generation Rate (MAPLHGR)

vs.

Average Planar Exposure for Fuel Type

GE9B-P8CWB343-12GZ-80M-150-T

(References 10 and 24)

Exposure (MWD/ST)	Lattice Specific MAPLHGR limit (kw/ft)				
0	12.66	11.69	11.37	10.92	12.66
200	12.59	11.71	11.43	10.99	12.59
1000	12.40	11.78	11.55	11.13	12.40
2000	12.34	11.95	11.72	11.33	12.34
3000	12.34	12.16	11.91	11.54	12.34
4000	12.37	12.40	12.11	11.76	12.37
5000	12.40	12.67	12.32	12.00	12.40
6000	12.43	12.90	12.53	12.24	12.43
7000	12.46	13.05	12.76	12.49	12.46
8000	12.48	13.21	12.98	12.75	12.48
9000	12.50	13.37	13.13	13.01	12.50
10000	12.51	13.54	13.30	13.22	12.51
12500	12.35	13.75	13.60	13.57	12.35
15000	11.98	13.48	13.23	13.21	11.98
20000	11.20	12.71	12.40	12.37	11.20
25000	10.42	11.92	11.60	11.57	10.42
27215.6	12.314	12.314	12.314	12.314	12.314
48080.8	10.800	10.800	10.800	10.800	10.800
58967.1	6.000	6.000	6.000	6.000	6.000
Lattice No.	732	2083	2084	2085	2086

Technical Requirements Manual - Appendix I  
L1C9 Core Operating Limits Report

Table 1.2-4

Maximum Average Planar Linear Heat Generation Rate (MAPLHGR)

vs.

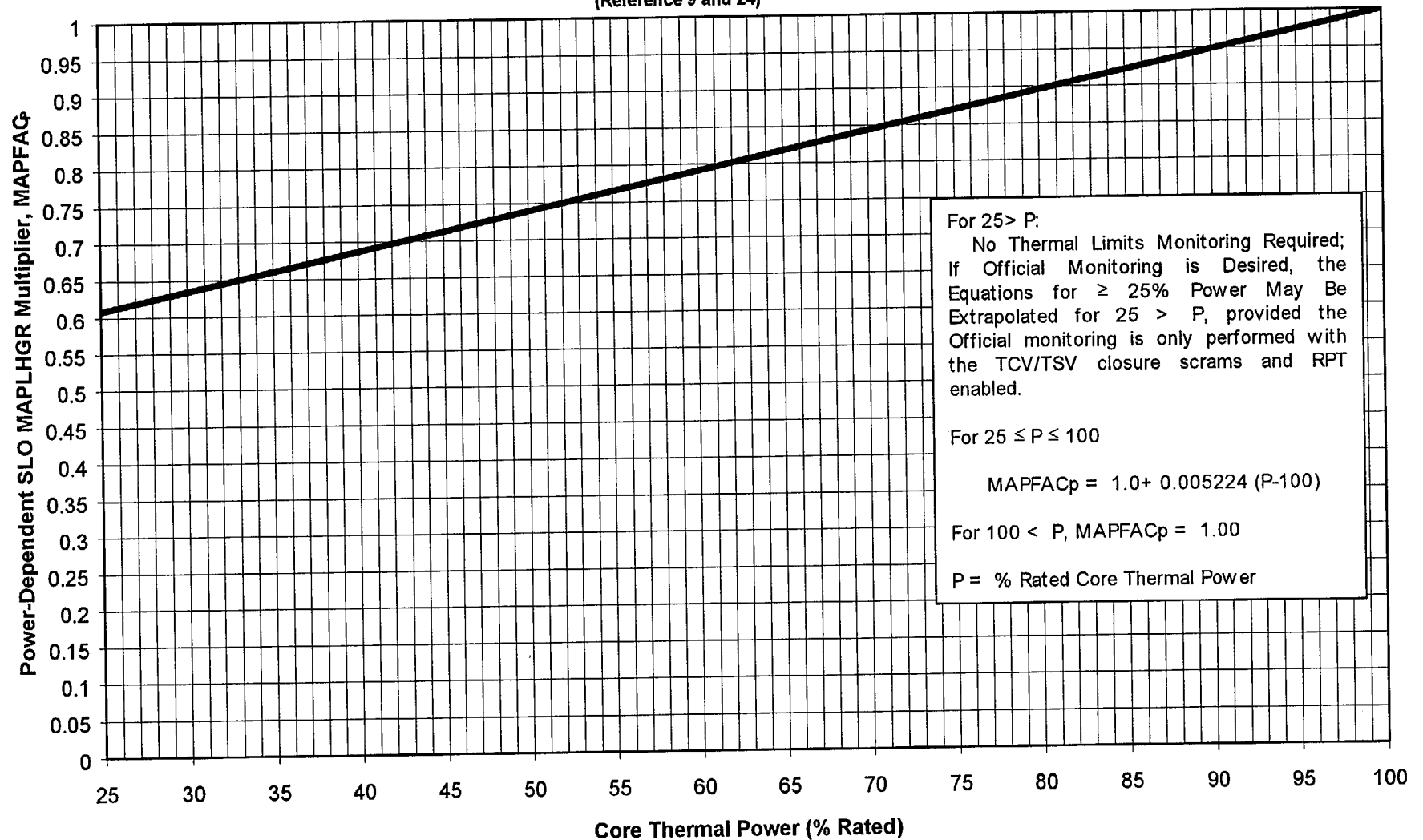
Average Planar Exposure for Fuel Type  
GE9B-P8CWB342-10GZ-80M-150-T

(References 10 and 24)

Exposure (MWD/ST)	Lattice Specific MAPLHGR limit (kw/ft)					
0	12.66	12.04	12.25	11.72	12.09	12.66
200	12.59	12.08	12.28	11.77	12.12	12.59
1000	12.40	12.16	12.35	11.87	12.22	12.40
2000	12.34	12.28	12.45	12.00	12.37	12.34
3000	12.34	12.42	12.55	12.13	12.53	12.34
4000	12.37	12.57	12.65	12.27	12.70	12.37
5000	12.40	12.73	12.76	12.41	12.88	12.40
6000	12.43	12.89	12.87	12.56	13.07	12.43
7000	12.46	13.06	12.98	12.72	13.27	12.46
8000	12.48	13.24	13.10	12.88	13.47	12.48
9000	12.50	13.42	13.21	13.05	13.65	12.50
10000	12.51	13.61	13.31	13.21	13.76	12.51
12500	12.35	13.79	13.35	13.31	13.82	12.35
15000	11.98	13.50	13.06	13.05	13.51	11.98
20000	11.20	12.79	12.47	12.45	12.79	11.20
25000	10.42	11.95	11.67	11.63	11.95	10.42
27215.6	12.314	12.314	12.314	12.314	12.314	12.314
48080.8	10.800	10.800	10.800	10.800	10.800	10.800
58967.1	6.000	6.000	6.000	6.000	6.000	6.000
Lattice No.	732	2087	2088	2089	2090	2091

Technical Requirements Manual - Appendix I  
L1C9 Core Operating Limits Report

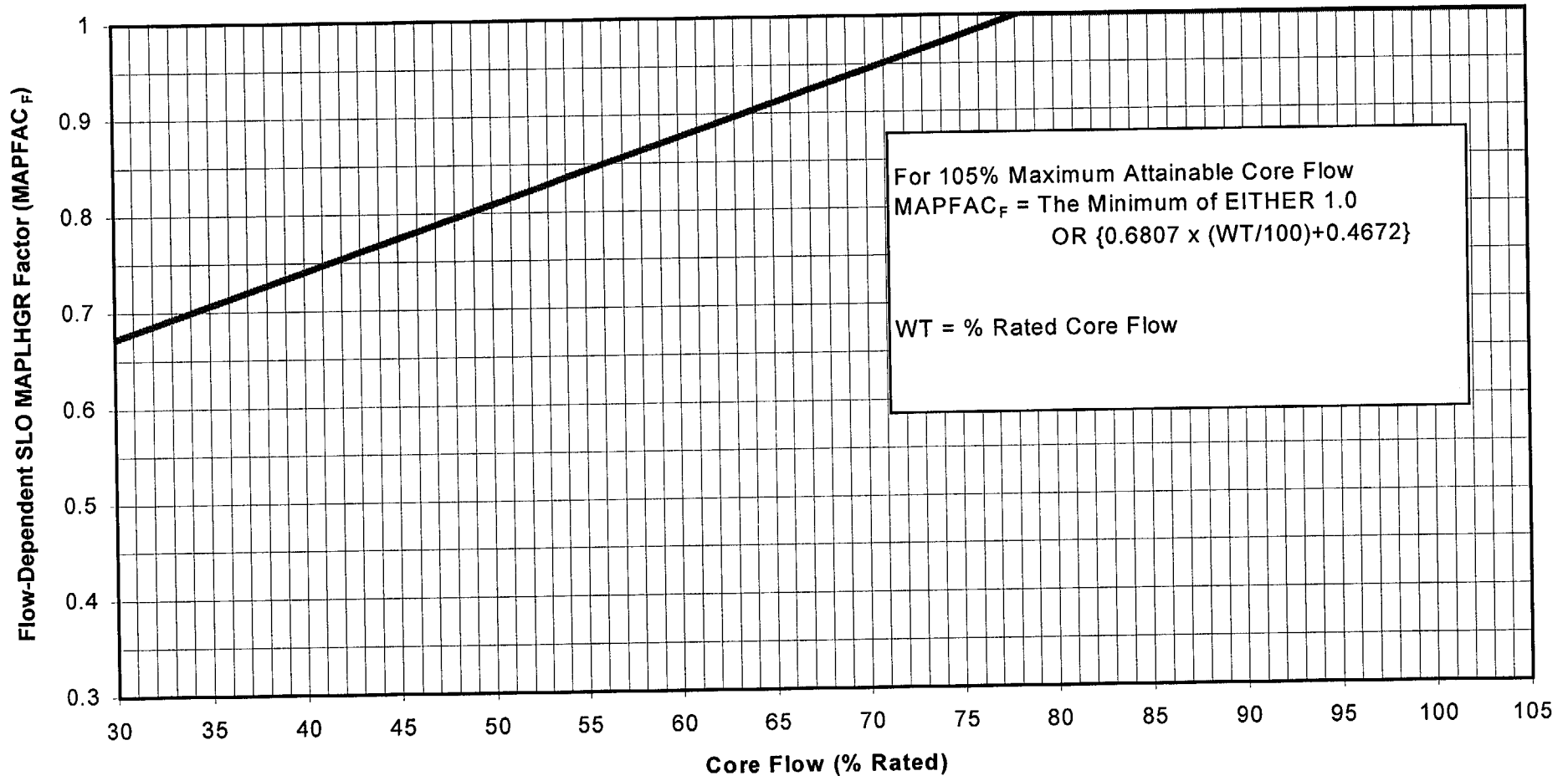
Figure 1.2-1 Power-Dependent SLO and Abnormal Idle Loop Startup MAPLHGR Multipliers  
for GE Fuel, MAPFAC<sub>P</sub>  
(Reference 9 and 24)



Technical Requirements Manual - Appendix I  
L1C9 Core Operating Limits Report

Figure 1.2-2 Flow-Dependent SLO and Abnormal Idle Loop Startup MAPLHGR Multiplier  
for GE Fuel, MAPFAC<sub>F</sub>

(References 9, 17, 22, and 24)





# Technical Requirements Manual - Appendix I

## L1C9 Core Operating Limits Report

### 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 to be 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 29,439 MWd/MTU (which is the licensing basis exposure used by SPC). (Reference 4)

#### 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 ( $MCPR_P$ )\* (Reference 3, 4, and 23)

###### 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 Speeds.

###### 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 Speeds.

Note that the 10B rods are defined by the control cell locations 14-39, 22-15, 46-23, 38-47, 14-23, 38-15, 46-39, and 22-47.

##### 2.2.1.2 Flow-Dependent MCPR ( $MCPR_F$ ) (Reference 4)

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 L1C9.

\* For thermal limit monitoring cases at greater than 100%P, the 100% power  $MCPR_P$  limits should be applied.

# Technical Requirements Manual - Appendix I

## L1C9 Core Operating Limits Report

Table 2-1

### MCPR<sub>p</sub> for GE Fuel

(References 3, 4, 5 and 54)

#### Operation from BOC to Coastdown\*\*

EOOS Combination	Percent Core Thermal Power*						
	0	25	25 (25.1)	60	80	80 (80.1)	100
No EOOS	2.70	2.20	2.10	1.57	1.53		1.50
Single RR Loop only	2.71	2.21	2.11	1.58	1.54		1.51
EOOS***	2.85	2.35	2.35		1.71	1.69	1.58
EOOS***/Single RR Loop	2.86	2.36	2.36		1.72	1.70	1.59

\* 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.

# Technical Requirements Manual - Appendix I

## L1C9 Core Operating Limits Report

Table 2-2

### MCPR<sub>P</sub> for Siemens Fuel

(References 3, 4, 5, 23 and 54)

#### **FOR OPERATION AT EXPOSURES OF 11000 MWD/MTU TO COASTDOWN\*\***

All SPC fuel except fuel type 36 in 10B cell locations and fuel type 46 and 47 in A1 cell locations

Percent Core Thermal Power\*

EOOS Combination	0	25	25 (25.1)	60	80	80 (80.1)	100
No EOOS	2.70	2.20	2.05	1.56	1.51		1.46
Single RR Loop only	2.71	2.21	2.06	1.57	1.52		1.47
EOOS***	2.85	2.35	2.35		1.67	1.64	1.54
EOOS***/Single RR Loop	2.86	2.36	2.36		1.68	1.65	1.55

SPC fuel that is fuel type 36 in 10B cell locations and fuel type 46 and 47 in A1 cell locations

Percent Core Thermal Power\*

EOOS Combination	0	25	25 (25.1)	60	80	80 (80.1)	100
No EOOS	2.74	2.24	2.09	1.60	1.55		1.48
Single RR Loop only	2.75	2.25	2.10	1.61	1.56		1.49
EOOS***	2.89	2.39	2.39		1.71	1.66	1.56
EOOS***/Single RR Loop	2.90	2.40	2.40		1.72	1.67	1.57

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

\*\* Coastdown thermal limits are not provided on this COLR.

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

Technical Requirements Manual - Appendix I  
L1C9 Core Operating Limits Report

Table 2-3

$MCPR_F$  for GE and Siemens Fuel

(References 4 & 5)

$MCPR_f$  limits for 105% Maximum Attainable Core Flow

<u>Flow (% rated)</u>	<u><math>MCPR_f</math> ATRIUM-9B</u>	<u><math>MCPR_f</math> GE9</u>
0	1.93	1.93
30	1.93	1.93
102.5	1.14	1.14
105	1.11	1.11

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

# Technical Requirements Manual - Appendix I

## L1C9 Core Operating Limits Report

### 3. Linear Heat Generation Rate (3.2.3)

#### 3.1 Tech Spec Reference:

Tech Spec 3.2.3.

#### 3.2 Description:

##### 3.2.1 GE Fuel

a. 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<sub>P</sub> or the flow dependent LHGR Factor, LHGRFAC<sub>F</sub>. The LHGR Factors (LHGRFAC<sub>P</sub> and LHGRFAC<sub>F</sub>) for the GE fuel is determined from Figures 3.2-1 through 3.2-3. The following LHGR limits apply for the entire cycle exposure range: (References 9, 14 and 24)

#### 1. GE9B-P8CWB322-11GZ-100M-150-T (bundle 3861 in Reference 24)

Nodal Exposure (GWd/MT)	LHGR Limit (KW/ft)
0.00	14.40
12.34	14.40
26.80	12.31
33.07	11.82
38.58	11.35
44.09	10.94
49.11	10.80
60.89	6.00

#### 2. GE9B-P8CWB320-9GZ-100M-150-T (bundle 3860 in Reference 24)

Nodal Exposure (GWd/MT)	LHGR Limit (KW/ft)
0.00	14.40
12.14	14.40
26.19	12.31
48.16	10.80
59.93	6.00

#### 3. GE9B-P8CWB343-12GZ-80M-150-T (bundle 3866 in Reference 24)

Nodal Exposure (GWd/MT)	LHGR Limit (KW/ft)
0.00	14.40
12.33	14.40
27.86	12.31
49.76	10.80
61.18	6.00

#### 4. GE9B-P8CWB342-10GZ-80M-150-T (bundle 3867 in Reference 24)

Nodal Exposure (GWd/MT)	LHGR Limit (KW/ft)
0.00	14.40
12.71	14.40
27.52	12.31
49.54	10.80
60.95	6.00

# Technical Requirements Manual - Appendix I

## L1C9 Core Operating Limits Report

### 3.2.2 Siemens Fuel

The LHGR Limit is the product of the Steady-State LHGR Limit and the minimum of either the power dependent LHGR Factor\*, LHGRFAC<sub>P</sub> or the flow dependent LHGR Factor, LHGRFAC<sub>F</sub>. The Steady-State LHGR limits are given below (Reference 4). LHGRFAC<sub>P</sub> is determined from Table 3-1. LHGRFAC<sub>F</sub> is determined from Table 3-2. SPC LHGRFAC multipliers in this COLR are applicable up to a core average exposure of 29,439 MWd/MTU (which is the licensing basis exposure used by SPC). (Reference 4)

Siemens Fuel Steady-State LHGR Limits for the following fuel types:

1. SPCA9-393B-16GZ-100M
2. SPCA9-396B-12GZB-100M
3. SPCA9-384B-11GZ6-80M
4. SPCA9-396B-12GZC-100M

#### **LHGR limits for all SPC fuel from BOC to Coastdown**

(excluding fuel type 36 in 10B locations from rod pattern targeted for approximately 9000 MWD/MTU to rod pattern targeted approximately for 12,000MWD/MTU)

Planar Average Exposure (GWd/MTU) (Reference 4)	LHGR limit (kW/ft)
0.0	14.4
15.0	14.4
61.1	8.32

#### **LHGR limits for SPC fuel type 36 in 10B locations**

(from rod pattern targeted at approximately 9000 MWD/MTU to rod pattern targeted at approximately 12,000 MWD/MT)

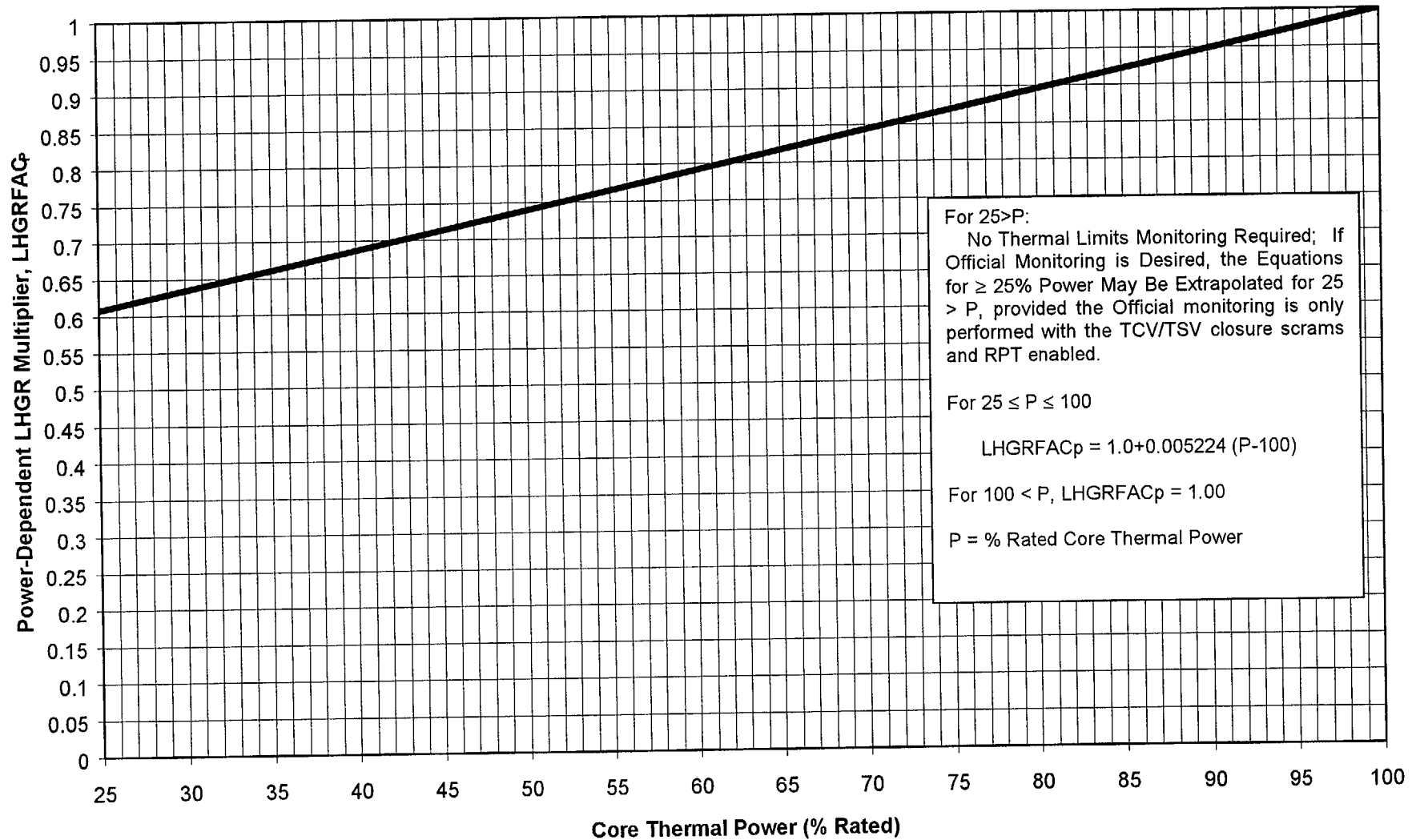
Planar Average Exposure (GWd/MTU) (References 4 and 23)	LHGR limit (kW/ft)
0.0	14.05
15.0	14.05
61.1	7.97

Note that the 10B rods are defined by the control cell locations 14-39, 22-15, 46-23, 38-47, 14-23, 38-15, 46-39, and 22-47.

\* For thermal limit monitoring cases at greater than 100%P, the 100% power LHGRFAC<sub>P</sub> limits should be applied.

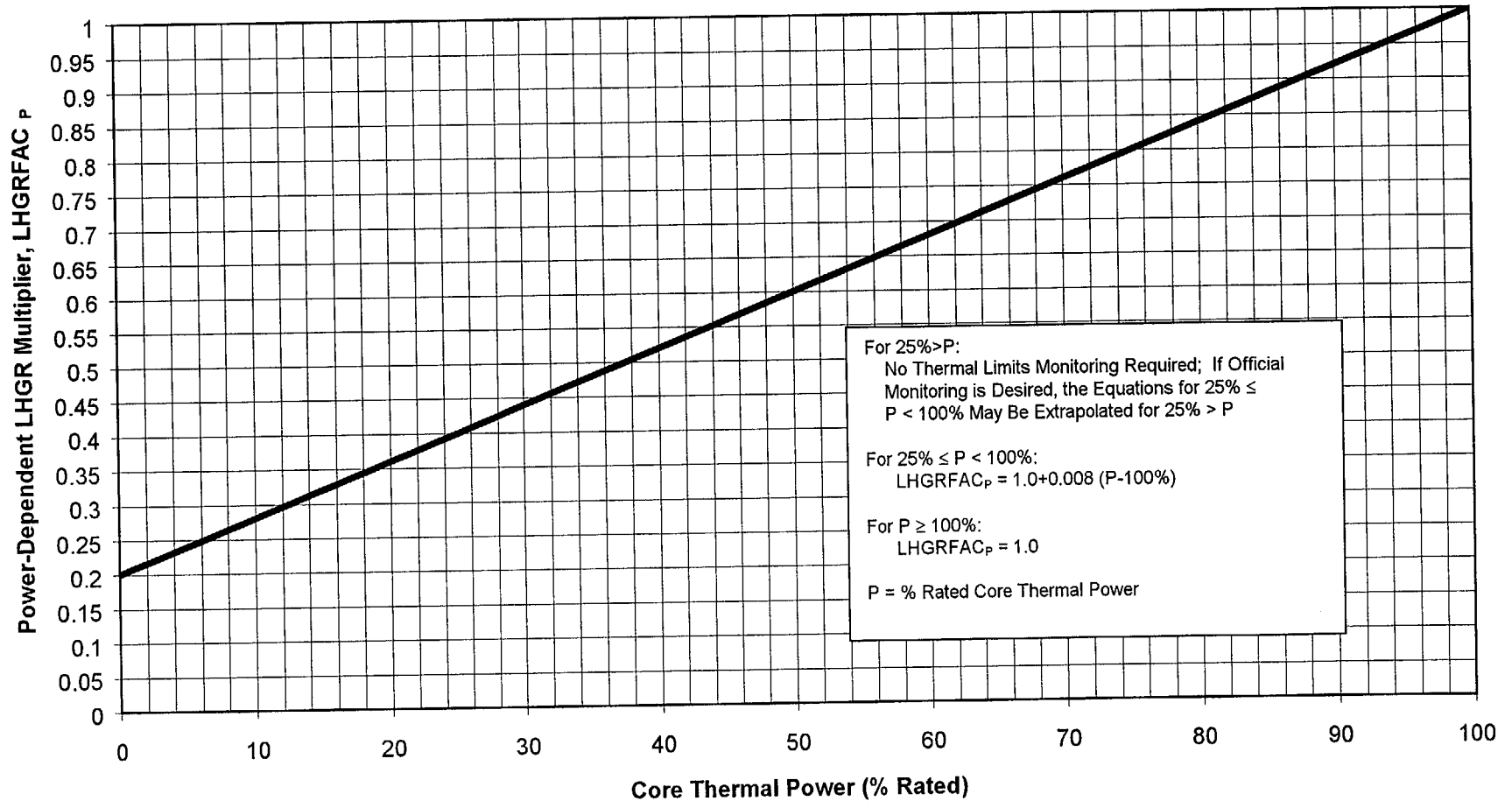
Technical Requirements Manual - Appendix I  
L1C9 Core Operating Limits Report

Figure 3.2-1 Power-Dependent LHGR Multipliers for GE fuel (formerly MAPFAC<sub>P</sub>)  
(Reference 9 and 24)



Technical Requirements Manual - Appendix I  
L1C9 Core Operating Limits Report

Figure 3.2-2 Power-Dependent LHGR Multiplier for GE Fuel  
(TCV(s) Slow Closure) (formerly MAPFAC<sub>P</sub>)  
(Reference 15 and 24)



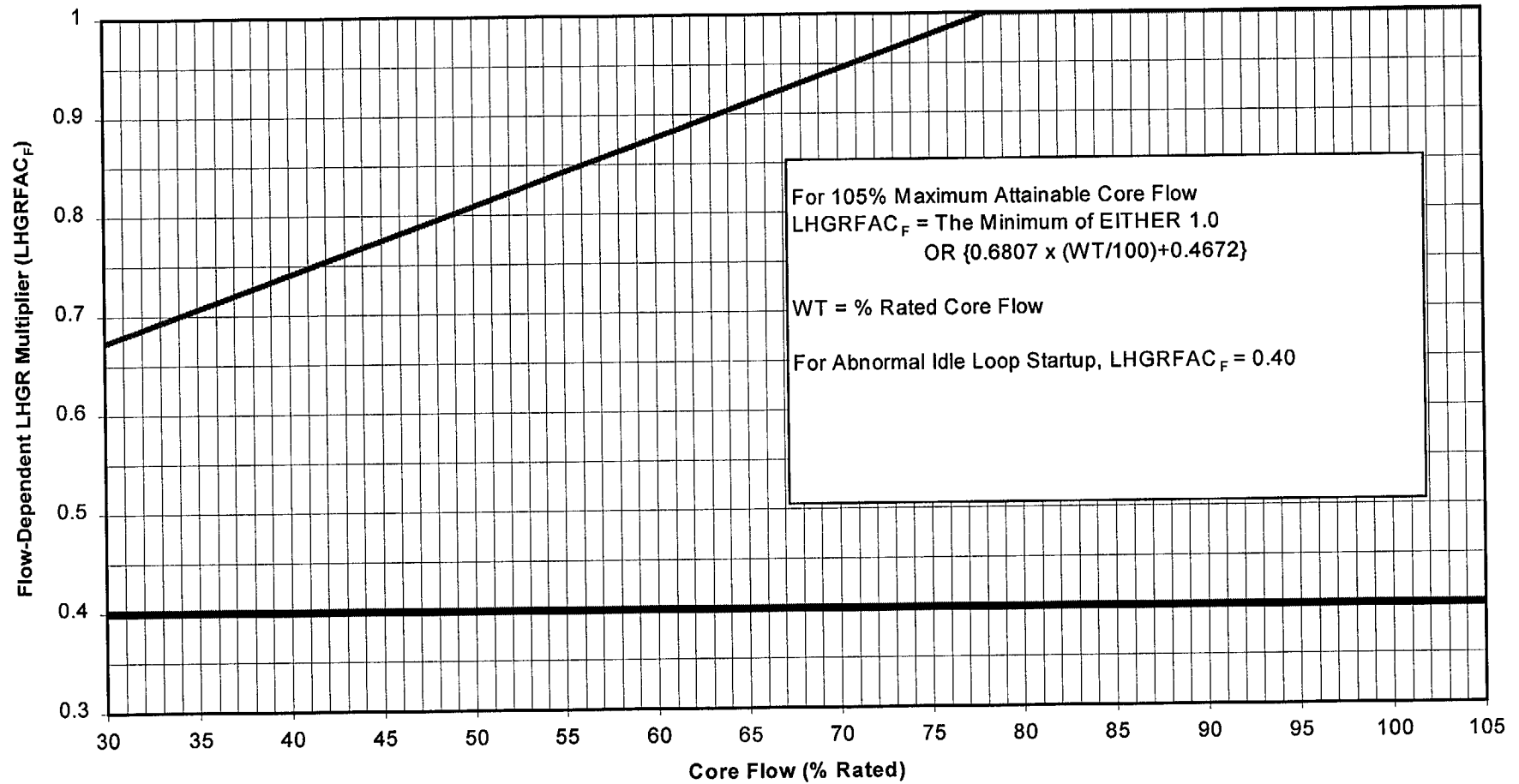


# Technical Requirements Manual - Appendix I

## L1C9 Core Operating Limits Report

**Figure 3.2-3 Flow-Dependent LHGR Multiplier for GE Fuel (formerly MAPFAÇ )**

(Reference 9 and 17, 22, and 24)



# Technical Requirements Manual - Appendix I L1C9 Core Operating Limits Report

Table 3-1

## LHGRFAC<sub>P</sub> for Siemens Fuel

(References 4, 5 and 54)

### Operation from BOC to Coastdown\*\*

EOOS Combination	Percent Core Thermal Power*						
	0	25	25	60	80	80	100
No EOOS	0.67	0.67	0.67	0.94	0.98		1.00
Single RR Loop only	0.67	0.67	0.67	0.94	0.98		1.00
EOOS***	0.64	0.64	0.64		0.86	0.86	0.86
EOOS***/Single RR Loop	0.64	0.64	0.64		0.86	0.86	0.86

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

\*\* Coastdown thermal limits are not provided in this COLR.

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

Technical Requirements Manual - Appendix I  
L1C9 Core Operating Limits Report

Table 3-2

LHGRFAC<sub>F</sub> for Siemens Fuel

(References 4 & 5)

Values Applicable for up to 105% Maximum Attainable Core Flow

Flow (% rated)	LHGRFAC <sub>F</sub> ATRIUM-9B
0	0.69
30	0.69
76	1.00
105	1.00

These LHGRFAC<sub>F</sub> multipliers apply from BOC through coastdown and in all EOOS scenarios.

# Technical Requirements Manual - Appendix I

## L1C9 Core Operating Limits Report

### 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:

<u>ROD BLOCK MONITOR UPSCALE TRIP FUNCTION</u>	<u>TRIP SETPOINT</u>	<u>ALLOWABLE VALUE</u>
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%.

# Technical Requirements Manual - Appendix I

## L1C9 Core Operating Limits Report

### 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 <sup>1</sup>	Standard	MELLLA	ICF <sup>7</sup>	Coastdown <sup>9</sup>
None	Yes	Yes	Yes	No
Feedwater Heaters <sup>2</sup> (Reference 9)	Yes	No <sup>3</sup>	Yes	No
Single RR Loop <sup>10</sup> (Reference 9)	Yes	No <sup>8</sup>	N/A	No
Turbine Bypass Valves (Reference 9)	Yes	Yes	Yes	No
EOC Recirculation Pump Trip (Reference 9)	Yes	Yes	Yes	No
TCV Slow Closure/EOC Recirculation Pump Trip (Reference 15)	Yes	Yes	Yes	No
TCV Slow Closure/EOC Recirculation Pump Trip / Feedwater Heaters <sup>2</sup> (Reference 15, 20 and 21)	Yes	No <sup>3</sup>	Yes	No
Turbine Bypass Valves / Feedwater Heaters <sup>2</sup> (Reference 9)	No	No	No <sup>5</sup>	No
EOC Recirculation Pump Trip / Feedwater Heaters <sup>2</sup> (Reference 9)	Yes <sup>4</sup>	No <sup>3</sup>	Yes <sup>4</sup>	No
TCV Stuck Closed <sup>6</sup> (Reference 16)	Yes	Yes	Yes	No

- 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.
- 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.
- 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.
- 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.
- Only when operating in coastdown, otherwise this combination is not allowed.
- 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.
- ICF is analyzed for up to 105% core flow.
- 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 25)
- Coastdown is defined to begin at a core average exposure of 29,439 MWd/MTU (which is the licensing basis exposure used by SPC). (Reference 4).
- Single Loop Operation is allowed with any of the EOOS options listed in this table.

# Technical Requirements Manual - Appendix I

## L1C9 Core Operating Limits Report

### 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 18, 52 and 53) 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 1 Cycle 9

Reload Transient Analysis Results

May 2001





# Technical Requirements Manual - Appendix I

## L1C9 Reload Transient Analysis Results

### Table of Contents

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

Technical Requirements Manual - Appendix I  
L1C9 Reload Transient Analysis Results

Attachment 1

LaSalle Unit 1 Cycle 9

Neutronics Licensing Report

NUCLEAR FUEL MANAGEMENT DEPARTMENT  
NUCLEAR DESIGN INFORMATION TRANSMITTAL

- ☒ SAFETY RELATED  
☐ NON-SAFETY RELATED  
☐ REGULATORY RELATED

Originating Organization  
☒ Nuclear Fuel Management  
☐ Other (specify) \_\_\_\_\_

NDIT No. NFM9900149  
Seq. No. 00  
Page 1 of 27

Station LaSalle Unit 1 Cycle 9 Generic \_\_\_\_\_

To: Deborah A. Laughton

Subject LaSalle 1 Cycle 9 Neutronics Licensing Report (NLR)

Theodore P. Shannon  
Preparer

Theodore P. Shannon  
Preparer's Signature

10/7/99  
Date

John K. Wheeler  
Reviewer

John K. Wheeler  
Reviewer's Signature

10/7/99  
Date

Adelmo S. Pallotta  
NFM Supervisor

Adelmo S. Pallotta  
NFM Supervisor's Signature

10/8/99  
Date

Status of Information:

- ☒ Verified  
☐ Unverified  
☐ Engineering Judgement

Method and Schedule of Verification for Unverified NDITs: \_\_\_\_\_

Description of Information: Results and bases of neutronics licensings calculations for LaSalle 1 Cycle 9. These calculations cover operation with a rated core power up to 3489 MWt.

Purpose of Information: Provide LaSalle County Station and NFM BSS group with neutronics licensing results.

Source of Information: NFM Calculation Note BNDL:99-050, Revision 0.

Supplemental Distribution: E.A. McVey (LaSalle), Jeff Nugent (LaSalle), Norha Plumey (LaSalle), Adelmo S. Pallotta, Robert W. Tsai, Randall H. Jacobs, LaSalle Central File, DG Central File

### Licensing Basis

This document, in conjunction with References 1, 3 and 4 in Section VIII, provides the licensing basis for LaSalle County Station Unit 1 Reload 8, Cycle 9.

### Table of Contents

I. Nuclear Design	3
I.1 New Reload Fuel Assembly Nuclear Design	3
I.1.1 Assembly Average Enrichment	3
I.1.2 Axial Enrichment and Burnable Poison Distribution	3
I.1.3 Radial Enrichment and Burnable Poison Distribution	3
I.2 Core Nuclear Design	4
I.2.1 Core Configuration and Licensing Exposure Limits	4
I.2.2 Core Reactivity Characteristics	5
II. Control Rod Withdrawal Error	5
III. Fuel Loading Error	6
IV. Control Rod Drop Accident	6
V. Loss of Feedwater Heating	7
VI. Maximum Exposure Limit Compliance	7
VII. Spent Fuel Pool and Fresh Fuel Vault Criticality Compliance	8
VII.1 Fresh Fuel Vault Criticality Compliance	8
VII.2 L1 Spent Fuel Pool Criticality Compliance	8
VII.3 L2 Spent Fuel Pool Criticality Compliance	8
VIII. References	9

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I. Nuclear Design

I.1 New Reload Fuel Assembly Nuclear Design

I.1.1 Assembly Average Enrichment

<u>Assembly Name</u>	<u>Batch Identifier</u>	<u>Enrichment (w/o U-235)</u>
SPCA9-393B-16GZ-100M	19A	3.93
SPCA9-396B-12GZB-100M	19B	3.96
SPCA9-396B-12GZC-100M	19C	3.96
SPCA9-384B-11GZ6-80M	28B	3.84

I.1.2 Axial Enrichment and Burnable Poison Distribution

<u>Assembly Name</u>	<u>Batch Identifier</u>	<u>Figure</u>
SPCA9-393B-16GZ-100M	19A	1
SPCA9-396B-12GZB-100M	19B	1
SPCA9-396B-12GZC-100M	19C	1
SPCA9-384B-11GZ6-80M	28B	2

I.1.3 Radial Enrichment and Burnable Poison Distribution

<u>Lattice Name</u>	<u>Batch Found In</u>	<u>Figure</u>
SPCA9-4.56L-12G8.0/4G3.0-100M	19A	3
SPCA9-4.56L-12G8.0-100M	19A	4
SPCA9-3.91L-12G8.0-100M	19A	5
SPCA9-3.90L-8G5.0-100M	19A	6
SPCA9-4.59L-12G8.0-100M	19B	7
SPCA9-4.59L-12G7.0-100M	19B	8
SPCA9-3.96L-8G7.0/4G8.0-100M	19B	9
SPCA9-3.96L-8G5.0-100M	19B and 19C	10
SPCA9-4.58L-8G6.0/4G3.0-100M	19C	11
SPCA9-4.58L-8G6.0-100M	19C	12
SPCA9-4.06L-11G6.0-80M	28B	13
SPCA9-4.34L-10G6.0-80M	28B	14

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JKW 10/6/99

## I.2 Core Nuclear Design

### I.2.1 Core Configuration and Licensing Exposure Limits

<u>Assembly Name</u>	<u>Cycle Loaded</u>	<u>Number in Core</u>
GE9B-P8CWB322-11GZ-100M-150-CECO	7	56
GE9B-P8CWB320-9GZ-100M-150-CECO	7	89
GE9B-P8CWB343-12GZ-80M-150-CECO	8	104
GE9B-P8CWB342-10GZ-80M-150-CECO	8	143
SPCA9-384B-11GZ6-80M	9	36
SPCA9-393B-16GZ-100M	9	208
SPCA9-396B-12GZB-100M	9	88
SPCA9-396B-12GZC-100M	9	40

	<u>Core Average Exposure</u>	<u>Core Incremental Exposure</u>
Exposure at EOC 8 (Cycle N-1)		
Nominal EOC 8 (MWD/MT)	27966.9	12511.0
Short EOC 8 (MWD/MT) [for shutdown consideration]	27455.9	12000.0

Cycle 9 (Cycle N) neutronics analyses are valid for EOC 8 (Cycle N-1) exposures greater than 12000 MWD/MT. The exposure window that validates the pressurization transients can be found in the L1C9 reload analysis document (Reference 3).

	<u>Core Average Exposure</u>
Exposure at BOC 9 (Cycle N)	
With Nominal EOC 8 (MWD/MT)	10961.0
With Short EOC 8 (MWD/MT)	10634.9

The Cycle 9 incremental exposure to LFPC is 18000.0 MWD/MT (incremental energy to LFPC of 2418.0 GWD) based on a nominal EOC 8.

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### 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 K-effective bias is 1.0050 (Reference 11). The shutdown margin calculations are based on the short cycle 8 exposure given in Section I.2.1.

BOC Cold K-Effective, All Rods Out	1.11710
BOC Cold K-Effective, All Rods In	0.96354
BOC Cold K-Effective, Strongest Rod Out	0.99407
BOC Shutdown Margin, % $\Delta K$	1.09
Minimum Shutdown Margin, % $\Delta K$	1.01
Cycle Exposure(s) of Minimum Shutdown Margin, MWD/MT	250.0 & 15000.0
Reactivity Defect (R-value) Total, % $\Delta K$	0.08
Standby Liquid Control System (SLCS) Shutdown Margin, Cold Condition, 660 ppm enriched Boron, % $\Delta K$	17.81

Note that the SLCS analysis results credit a B-10 enrichment of 45% at LaSalle.

### II. Control Rod Withdrawal Error

Analysis was performed at a core power of 3489 MWt, 100% core flow (108.5 Mlbm/hr), unblocked (RBM not credited) conditions only. Figure 15 is the initial rod pattern for the case that set the limit for the ATRIUM-9B fuel in the core. Figure 16 is initial rod pattern for the case that set the limit for the GE9B fuel in the core. These results bound operation with 3323 MWt as the rated power for the core.

Distance Withdrawn (ft)	ATRIUM-9B $\Delta CPR$	GE9B $\Delta CPR$
12	0.29	0.31

The design complies with the SPC 1% plastic strain 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 updated GE mechanical overpower protection (MOP) criteria during a control rod withdrawal error event.

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### 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  $\Delta$ CPR value that is less than that of the limiting transient, the AOO requirements and hence the off-site dose requirements are met for the fuel loading error.

The values reported below bound all fuel types found in the core.

<u>Event</u>	<u><math>\Delta</math>CPR</u>
Mislocated Bundle	0.31
Misoriented Bundle	0.17

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

### IV. Control Rod Drop Accident

LaSalle is a Banked Position Withdrawal Sequence (BPWS) plant. In order to allow the site the option of shutting down the reactor by inserting control rods using the simplified control rod sequences shown in Table 1, the 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 280 cal/g Technical Specification limit for a control rod drop accident is not exceeded. Note that the 0.32% $\Delta$ k adder mentioned below is included in this analysis to account for possible rod mispositioning errors as well as clumping effects.

Dropped Control Rod Worth without 0.32 % $\Delta$ k adder, % $\Delta$ k	0.722
Dropped Control Rod Worth with 0.32 % $\Delta$ k adder, % $\Delta$ k	1.042
Doppler Coefficient used, ( $\Delta$ k/k)/°F	-9.50E-06
Effective Delayed Neutron Fraction used	0.0052
Four-Bundle Local Peaking Factor	1.358
Maximum Deposited Fuel Rod Enthalpy with 0.32 % $\Delta$ k adder, (cal/gm)	184.1
Number of Rods Greater than 170 cal/gm with 0.32% $\Delta$ k adder	134

Note that the limit on maximum deposited fuel rod enthalpy is 280 cal/gm and the (conservative) limit on the number of rods greater than 170 cal/gm (failed rods) is 770.

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#### V. Loss of Feedwater Heating

The loss of feedwater heating event is analyzed at a core power of 3489 MWt for 81%, 100% and 105% rated flow with an assumed inlet temperature decrease of 145°F. These results bound operation with 3323 MWt as the rated power for the core.

<u>Event</u>	<u>ATRIUM-9B</u> <u>ΔCPR</u>	<u>GE9B</u> <u>ΔCPR</u>
Loss of Feedwater Heating	0.19	0.18

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 1% plastic strain criteria via conformance to the mechanical overpower protection (MOP) limit. The design complies with the GE centerline melt criteria via conformance to the thermal overpower protection (TOP) limits. The analyses did not take credit for the thermal power scram function at the site.

#### VI. Maximum Exposure Limit Compliance

Note that the exposures listed below are based on the nominal Cycle 8 (Cycle N-1) exposure, 12511 MWD/MT, and the licensing basis (Reference 3) Cycle 9 (Cycle N) core average exposure of 29439 MWD/MT.

<u>Exposure Criteria</u>	<u>GE9B</u> <u>Projected Exposure</u> <u>(GWD/MT)</u>	<u>GE9B</u> <u>Exposure Limit</u> <u>(GWD/MT)</u>	<u>ATRIUM-9B</u> <u>Projected Exposure</u> <u>(GWD/MT)</u>	<u>ATRIUM-9B</u> <u>Exposure Limit*</u> <u>(GWD/MT)</u>
Peak Fuel Assembly	44.9	48.0**	23.8	48.0
Peak Fuel Batch	40.4	42.0	N/A	N/A
Peak Fuel Rod	N/A	N/A	26.4	55.0
Peak Fuel Pellet	58.4	60.0	35.6	66.0

\* 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.

\*\* There is no peak fuel assembly exposure limit for GE9B fuel. The limit reported above is based on the maximum channel exposure assumption used in developing the safety limit MCPR for LaSalle I Cycle 9.

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*JKW* 10/7/99

## VII. Spent Fuel Pool and Fresh Fuel Vault Criticality Compliance

For the L1C9 reload, there are three new SPC ATRIUM-9B assembly types consisting of 10 unique enriched lattices as well as one SPC ATRIUM-9B assembly type with 2 unique enriched lattices which was initially manufactured for use in L2C8. These four (total) assembly and twelve (total) enriched lattice types are identified in I.1 New Reload Fuel Assembly Nuclear Design. For the purpose of the following sections all four assembly types will be referred to as "new (ATRIUM-9B) assemblies".

### VII.1 Fresh Fuel Vault Criticality Compliance

The fuel storage vault criticality analysis that is detailed in Reference 6 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<sub>2</sub>O<sub>3</sub>.

### VII.2 L1 Spent Fuel Pool Criticality Compliance

The LaSalle Unit 1 spent fuel pool criticality analysis that is detailed in Reference 7 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<sub>2</sub>O<sub>3</sub>.

### VII.3 L2 Spent Fuel Pool Criticality Compliance

The LaSalle Unit 2 spent fuel pool criticality analysis that is detailed in Reference 8 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  $k_{\text{eff}} < 0.95$ .

Lattice Type	Maximum $k_{\text{inf}}^*$	Maximum in-Rack $k_{\text{eff}}^{**}$	Spent Fuel Pool $k_{\text{eff}}$ Limit
SPCA9-4.56L-12G8.0/4G3.0-100M	1.182	< 0.85	0.95
SPCA9-4.56L-12G8.0-100M	1.187	< 0.85	0.95
SPCA9-3.91L-12G8.0-100M	1.168	< 0.85	0.95
SPCA9-3.90L-8G5.0-100M	1.233	< 0.86	0.95
SPCA9-4.59L-12G8.0-100M	1.191	< 0.85	0.95
SPCA9-4.59L-12G7.0-100M	1.210	< 0.85	0.95
SPCA9-3.96L-8G7.0/4G8.0-100M	1.186	< 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
SPCA9-4.06L-11G6.0-80M	1.213	< 0.85	0.95
SPCA9-4.34L-10G6.0-80M	1.227	< 0.86	0.95

\* From 68 °F, uncontrolled CASMO-3G results.

\*\* From Figure 6.1 of Reference 8.

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JKW 10/7/99

VIII. References

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12. "LaSalle 1 Cycle 9 Final Licensing Loading Pattern (FLLP)", NFM Calculation Note, BNDL:99-029, Revision 0, April 29, 1999.
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15. "LaSalle 1 Cycle 9 MOPs/TOPs RWE", NFM Calculation Note, BNDL:99-037, Revision 0, July 7, 1999.

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VIII. References

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18. "LaSalle Unit 1 Cycle 9 Bundle Misorientation Analysis", NFM Calculation Note, BNDL:99-054, Revision 0, August 20, 1999.
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20. "LaSalle 1 Cycle 9 - L1C8 Data for GE Plastic Strain Analysis", NFM Calculation Note, BNDL:99-057, Revision 0, August 20, 1999.
21. "LaSalle 1 Cycle 9 - L1C9 Data for GE Plastic Strain Analysis", NFM Calculation Note, BNDL:99-058, Revision 0, August 18, 1999.
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24. "LaSalle 1 Cycle 9 RWE Clad Strain Compliance", GE Proprietary Letter WHC:99-031 from William H. Hetzel to Dr. R.J. Chin, dated September 27, 1999.
25. "LaSalle 1 Cycle 9 NLR", NFM Calculation Note, BNDL:99-050, Revision 0, October 1999.

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Table 1

LaSalle 1 Cycle 9 Simplified Shutdown Sequences

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	48-10	Groups 7 and 8 must be fully inserted prior to inserting any Group 10 rod.
10	10-00	Group 10 must be at 10 prior to inserting any Group 10 rod to 00.
9	48-10	Group 10 must be fully inserted prior to inserting any Group 9 rod.
9	10-00	Group 9 must be at 10 prior to inserting any Group 9 rod to 00.
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	48-10	Group 4 must be fully inserted prior to inserting any Group 3 rod.
3	10-00	Group 3 must be at 10 prior to inserting any Group 3 rod to 00.
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	48-10	Group 8 must be fully inserted prior to inserting any Group 7 rod.
7	10-00	Group 7 must be at 10 prior to inserting any Group 7 rod to 00.
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	48-10	Group 4 must be fully inserted prior to inserting any Group 3 rod.
3	10-00	Group 3 must be at 10 prior to inserting any Group 3 rod to 00.
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.

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

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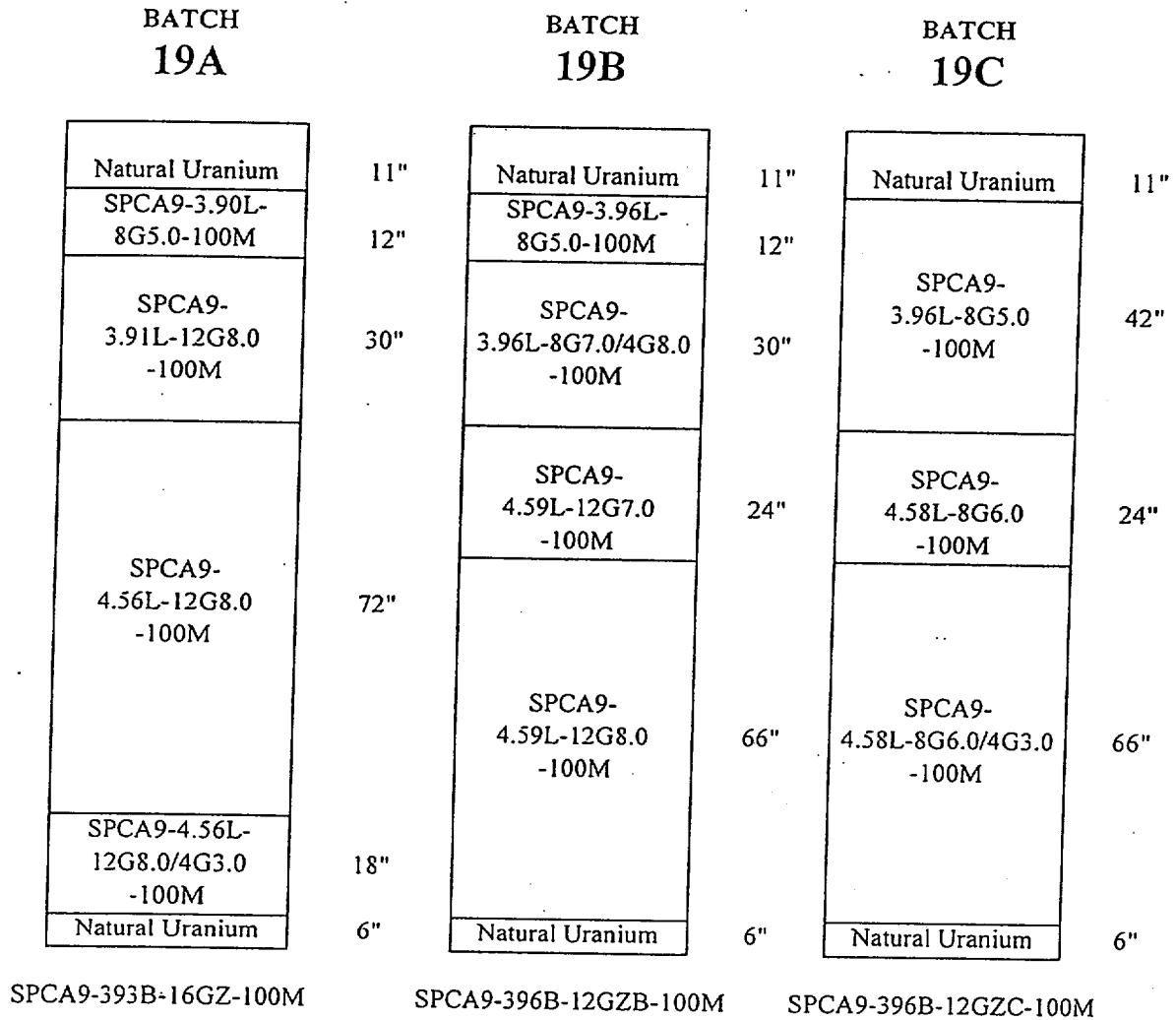
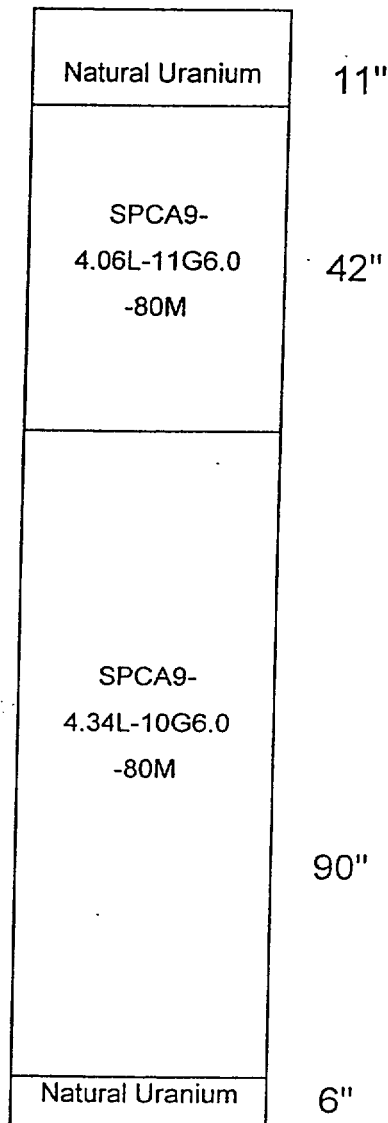


Figure 1

L1C9 ATRIUM-9B Assembly Axial Designs (100M Channels)

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BATCH  
28B



SPCA9-384B-11GZ6-80M

Figure 2

L1C9 ATRIUM-9B Assembly Axial Designs (80M Channels)

*JP* 8/22/99  
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NUCLEAR FUEL MANAGEMENT DEPARTMENT  
NUCLEAR DESIGN INFORMATION TRANSMITTAL

NDIT No. NFM9900149

Seq. No. 00

Page 14 of 27

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	G3 4.00	G2 4.20	4 4.95	G1 4.70	4 4.95	G2 4.20	G3 4.00	2 4.00
3 4.70	G2 4.20	4 4.95	4 4.95	4 4.95	4 4.95	4 4.95	G2 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	G1 4.70	4 4.95				4 4.95	G1 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	G2 4.20	4 4.95	4 4.95	4 4.95	4 4.95	4 4.95	G2 4.20	3 4.70
2 4.00	G3 4.00	G2 4.20	4 4.95	G1 4.70	4 4.95	G2 4.20	G3 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 (36)	4.95 w/o U-235
G1	Rods (4)	4.70 w/o U-235+8.0 w/o Gd2O3
G2	Rods (8)	4.20 w/o U-235+8.0 w/o Gd2O3
G3	Rods (4)	4.00 w/o U-235+3.0 w/o Gd2O3

Figure 3  
SPCA9-4.56L-12G8.0/4G3.0-100M (19A)  
Enrichment Distribution

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

Figure 4  
SPCA9-4.56L-12G8.0-100M (19A)  
Enrichment Distribution

8/20/99  
10/6/99

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	G1 3.40	4 4.40	G1 3.40	4 4.40	G1 3.40	2 3.40	2 3.40
3 3.80	G1 3.40	4 4.40	4 4.40	4 4.40	4 4.40	4 4.40	G1 3.40	3 3.80
4 4.40	4 4.40	4 4.40	Internal Water Channel			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
4 4.40	4 4.40	4 4.40				4 4.40	4 4.40	4 4.40
3 3.80	G1 3.40	4 4.40	4 4.40	4 4.40	4 4.40	4 4.40	G1 3.40	3 3.80
2 3.40	2 3.40	G1 3.40	4 4.40	G1 3.40	4 4.40	G1 3.40	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 (36)	4.40 w/o U-235
G1	Rods (12)	3.40 w/o U-235+8.0 w/o Gd2O3

Figure 5  
SPCA9-3.91L-12G8.0-100M (19A)  
Enrichment Distribution

*RP* 8/20/99  
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NUCLEAR FUEL MANAGEMENT DEPARTMENT  
NUCLEAR DESIGN INFORMATION TRANSMITTAL

NDIT No. NFM9900149  
Seq. No. 00  
Page 17 of 27

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	G1 3.40	4 4.40	2 3.40	4 4.40	G1 3.40	2 3.40	2 3.40
3 3.80	G1 3.40	4 4.40	4 4.40	4 4.40	4 4.40	4 4.40	G1 3.40	3 3.80
4 4.40	4 4.40	4 4.40	Internal Water Channel			4 4.40	4 4.40	4 4.40
4 4.40	2 3.40	4 4.40				4 4.40	2 3.40	4 4.40
4 4.40	4 4.40	4 4.40				4 4.40	4 4.40	4 4.40
3 3.80	G1 3.40	4 4.40	4 4.40	4 4.40	4 4.40	4 4.40	G1 3.40	3 3.80
2 3.40	2 3.40	G1 3.40	4 4.40	2 3.40	4 4.40	G1 3.40	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 (16)	3.40 w/o U-235
3	Rods (8)	3.80 w/o U-235
4	Rods (36)	4.40 w/o U-235
G1	Rods (8)	3.40 w/o U-235+5.0 w/o Gd2O3

Figure 6  
SPCA9-3.90L-8G5.0-100M (19A)  
Enrichment Distribution

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NUCLEAR FUEL MANAGEMENT DEPARTMENT  
NUCLEAR DESIGN INFORMATION TRANSMITTAL

NDIT No. NFM9900149

Seq. No. 00

Page 18 of 27

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	G1 4.20	4 4.95	G1 4.20	4 4.95	G1 4.20	4 4.95	G1 4.20	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	G1 4.20	4 4.95	G1 4.20	4 4.95	G1 4.20	4 4.95	G1 4.20	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 (12)	4.20 w/o U-235+8.0 w/o Gd2O3

Figure 7  
SPCA9-4.59L-12G8.0-100M (19B)  
Enrichment Distribution

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NUCLEAR FUEL MANAGEMENT DEPARTMENT  
NUCLEAR DESIGN INFORMATION TRANSMITTAL

NDIT No. NFM9900149  
Seq. No. 00  
Page 19 of 27

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	G1 4.20	4 4.95	G1 4.20	4 4.95	G1 4.20	4 4.95	G1 4.20	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	G1 4.20	4 4.95	G1 4.20	4 4.95	G1 4.20	4 4.95	G1 4.20	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 (12)	4.20 w/o U-235+7.0 w/o Gd2O3

Figure 8  
SPCA9-4.59L-12G7.0-100M (19B)  
Enrichment Distribution

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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	G2 3.40	4 4.40	G1 3.40	4 4.40	G1 3.40	4 4.40	G2 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	G2 3.40	4 4.40	G1 3.40	4 4.40	G1 3.40	4 4.40	G2 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 (8) 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+7.0 w/o Gd2O3  
G2 Rods (4) 3.40 w/o U-235+8.0 w/o Gd2O3

Figure 9  
SPCA9-3.96L-8G7.0/4G8.0-100M (19B)  
Enrichment Distribution

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NUCLEAR FUEL MANAGEMENT DEPARTMENT  
NUCLEAR DESIGN INFORMATION TRANSMITTAL

NDIT No. NFM9900149  
Seq. No. 00  
Page 21 of 27

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 10  
SPCA9-3.96L-8G5.0-100M (19B and 19C)  
Enrichment Distribution

*JKW* 8/20/99  
JKW 10/6/99

NUCLEAR FUEL MANAGEMENT DEPARTMENT  
NUCLEAR DESIGN INFORMATION TRANSMITTAL

NDIT No. NFM9900149  
Seq. No. 00  
Page 22 of 27

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	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	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 11  
SPCA9-4.58L-8G6.0/4G3.0-100M (19C)  
Enrichment Distribution

PS 8/20/99  
JW 10/6/99



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 12  
SPCA9-4.58L-8G6.0-100M(19C)  
Enrichment Distribution

*RS* 8/20/99  
JKW 10/6/99

NUCLEAR FUEL MANAGEMENT DEPARTMENT  
NUCLEAR DESIGN INFORMATION TRANSMITTAL

NDIT No. NFM9900149  
Seq. No. 00  
Page 24 of 27

1 2.72	2 3.53	3 3.94	3 3.94	4 4.53	3 3.94	3 3.94	2 3.53	1 2.72
2 3.53	G 3.69	4 4.53	4 4.53	G 3.69	4 4.53	4 4.53	G 3.69	2 3.53
3 3.94	4 4.53	4 4.53	4 4.53	4 4.53	4 4.53	4 4.53	4 4.53	3 3.94
3 3.94	4 4.53	4 4.53	Internal Water Channel			G 3.69	4 4.53	3 3.94
4 4.53	G 3.69	4 4.53				4 4.53	G 3.69	4 4.53
3 3.94	4 4.53	4 4.53				4 4.53	4 4.53	3 3.94
3 3.94	4 4.53	4 4.53	G 3.69	4 4.53	4 4.53	G 3.69	4 4.53	3 3.94
2 3.53	G 3.69	4 4.53	4 4.53	G 3.69	4 4.53	4 4.53	G 3.69	2 3.53
1 2.72	2 3.53	3 3.94	3 3.94	4 4.53	3 3.94	3 3.94	2 3.53	1 2.72

- 1 Rods ( 4) 2.72 w/o U-235  
2 Rods ( 8) 3.53 w/o U-235  
3 Rods (16) 3.94 w/o U-235  
4 Rods ( 33) 4.53 w/o U-235  
G Rods (11) 3.69 w/o U-235+6.0 w/o Gd2O3

Figure 13  
SPCA9-4.06L-11G6.0-80M (28B)  
Enrichment Distribution

7/2/99 8/22/99  
JKW 10/6/99

1 2.72	2 3.78	3 4.19	3 4.19	4 4.78	3 4.19	3 4.19	2 3.78	1 2.72
2 3.78	G 4.19	4 4.78	4 4.78	G 4.19	4 4.78	4 4.78	G 4.19	2 3.78
3 4.19	4 4.78	4 4.78	4 4.78	4 4.78	4 4.78	4 4.78	4 4.78	3 4.19
3 4.19	4 4.78	4 4.78	Internal Water Channel			G 4.19	4 4.78	3 4.19
4 4.78	G 4.19	4 4.78				4 4.78	G 4.19	4 4.78
3 4.19	4 4.78	4 4.78				4 4.78	4 4.78	3 4.19
3 4.19	4 4.78	4 4.78	G 4.19	4 4.78	4 4.78	4 4.78	4 4.78	3 4.19
2 3.78	G 4.19	4 4.78	4 4.78	G 4.19	4 4.78	4 4.78	G 4.19	2 3.78
1 2.72	2 3.78	3 4.19	3 4.19	4 4.78	3 4.19	3 4.19	2 3.78	1 2.72

- 1 Rods ( 4) 2.72 w/o U-235  
2 Rods ( 8) 3.78 w/o U-235  
3 Rods (16) 4.19 w/o U-235  
4 Rods ( 34) 4.78 w/o U-235  
G Rods (10) 4.19 w/o U-235+6.0 w/o Gd2O3

Figure 14  
SPCA9-4.34L-10G6.0-80M (28B)  
Enrichment Distribution

7/22/99  
JKW 10/6/99

Cycle 9 Exposure 13000.0 MWd/MTU  
1746.3 GWd  
Core Average Exposure 23961.4 MWd/MTU

Delta E: MWd/MTU, (GWd)		.0 ( .00 )	Axial Profile	
Power: MWt		3489.0 (100.00 %)	N	Power Exposure
Core Pressure: psia		1020.1	Top 25	.153 3.961
Inlet Subcooling: Btu/lbm		-18.28	24	.284 6.830
Flow: Mlb/hr		108.50 (100.00 %)	23	.663 16.284
			22	.806 19.848
			21	.874 21.821
			20	.935 23.364
			19	.978 24.366
			18	1.006 25.256
			17	1.010 26.344
			16	1.011 27.653
			15	1.013 28.409
			14	1.030 28.934
			13	1.056 29.323
			12	1.087 29.530
			11	1.128 29.908
			10	1.177 30.365
			9	1.231 30.778*
			8	1.279 30.556
			7	1.347 30.740
			6	1.421 30.648
			5	1.485* 29.817
			4	1.477 27.607
			3	1.308 23.608
			2	.962 17.267
			Bottom 1	.279 4.864
Control Rod Density: %		20.54		
k-effective:		1.00388		
Void Fraction:		.448		
Core Delta-P: psia		21.675	% AXIAL TILT -18.447 -10.750	
Core Plate Delta-P: psia		17.213	AVG BOT 8ft/12ft 1.1042 1.0860	
Coolant Temp: Deg-F		545.8		
In Channel Flow: Mlb/hr		93.26	Active Channel Flow: Mlb/hr 93.26	
Source Convergence		.00008		

Figure 15  
Initial RWE Rod Pattern for Limiting ATRIUM-9B Case  
Error Rod is 34-43

*DP* 8/22/99  
*DLW* 10/6/99

NUCLEAR FUEL MANAGEMENT DEPARTMENT  
NUCLEAR DESIGN INFORMATION TRANSMITTAL

NDIT No. NFM9900149  
Seq. No. 00  
Page 27 of 27

Cycle 9 Exposure .0 MWd/MTU

.0 GWd

Core Average Exposure 10961.0 MWd/MTU

Delta E: MWd/MTU, (GWd)	.0 ( .00 )	Axial Profile	
Power: MWt	3489.0 (100.00 %)	N	Power Exposure
Core Pressure: psia	1020.1	Top 25	.134 1.558
Inlet Subcooling: Btu/lbm	-18.28	24	.242 2.748
Flow: Mlb/hr	108.50 (100.00 %)	23	.614 6.567
		22	.753 8.305
		21	.813 9.766
		20	.885 10.769
		19	.947 11.473
		18	1.008 12.074
		17	1.084 12.760
		16	1.209 13.155
		15	1.271 13.418
		14	1.290 13.606
		13	1.288 13.747
		12	1.256 13.859
		11	1.254 13.965
		10	1.273 14.034*
		9	1.304 14.008
		8	1.326 13.527
		7	1.357 13.424
		6	1.365* 13.358
		5	1.316 13.185
		4	1.164 12.622
		3	.968 11.120
		2	.693 8.223
		Bottom 1	.187 2.308
Control Rod Density: %	15.23	% AXIAL TILT -13.547 -10.296	
k-effective:	1.00250	AVG BOT 8ft/12ft 1.1172 1.0898	
Void Fraction:	.430		
Core Delta-P: psia	21.559		
Core Plate Delta-P: psia	17.096		
Coolant Temp: Deg-F	545.5		
In Channel Flow: Mlb/hr	93.36	Active Channel Flow: Mlb/hr: 93.36	
Source Convergence	.00007		

Figure 16  
Initial RWE Rod Pattern for Limiting GE9B Case  
Error Rod is 30-39

*JS* 8/22/99  
JKW 10/6/99