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

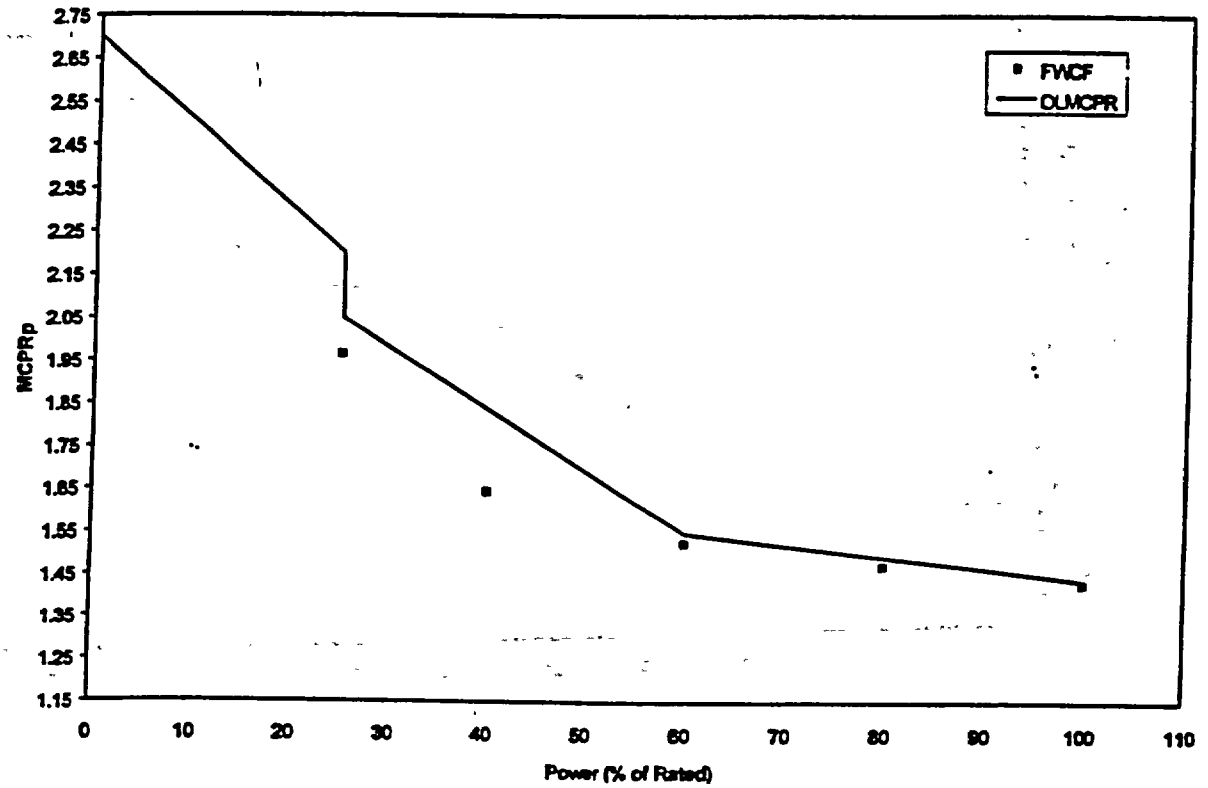
Event	Power / Flow (% rated / % rated)	ATRIUM		GE9
		ΔCPR	$LHGRFAC_p$	ΔCPR
LRNB	100 / 105	0.39	0.92	0.41
LRNB	80 / 105	0.38	0.94	0.44
LRNB	60 / 105	0.40	0.92	0.41
FWCF	100 / 105	0.32	0.97	0.34
FWCF	80 / 105	0.36	0.98	0.41
FWCF	60 / 105	0.43	0.96	0.46
FWCF	40 / 105	0.56	0.91	0.56
FWCF	25 / 105	1.10	0.95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

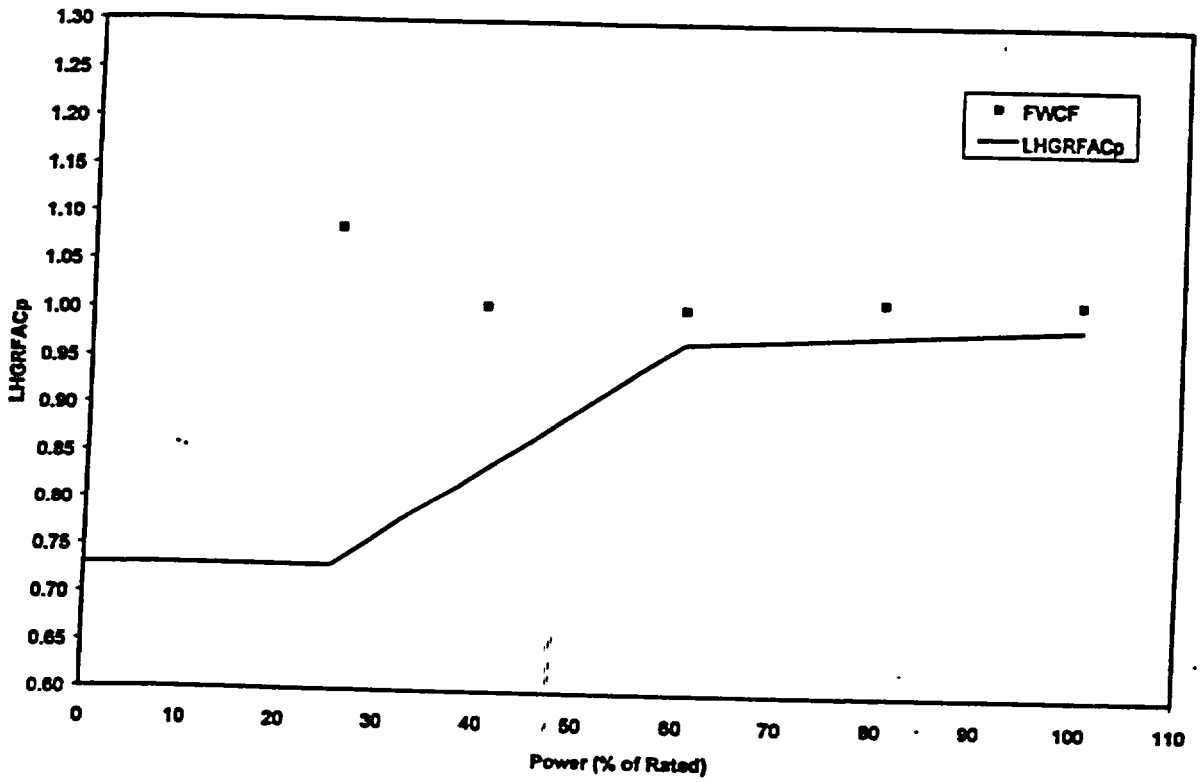
* Scram initiated by high-neutron flux.

† Scram initiated by high dome pressure



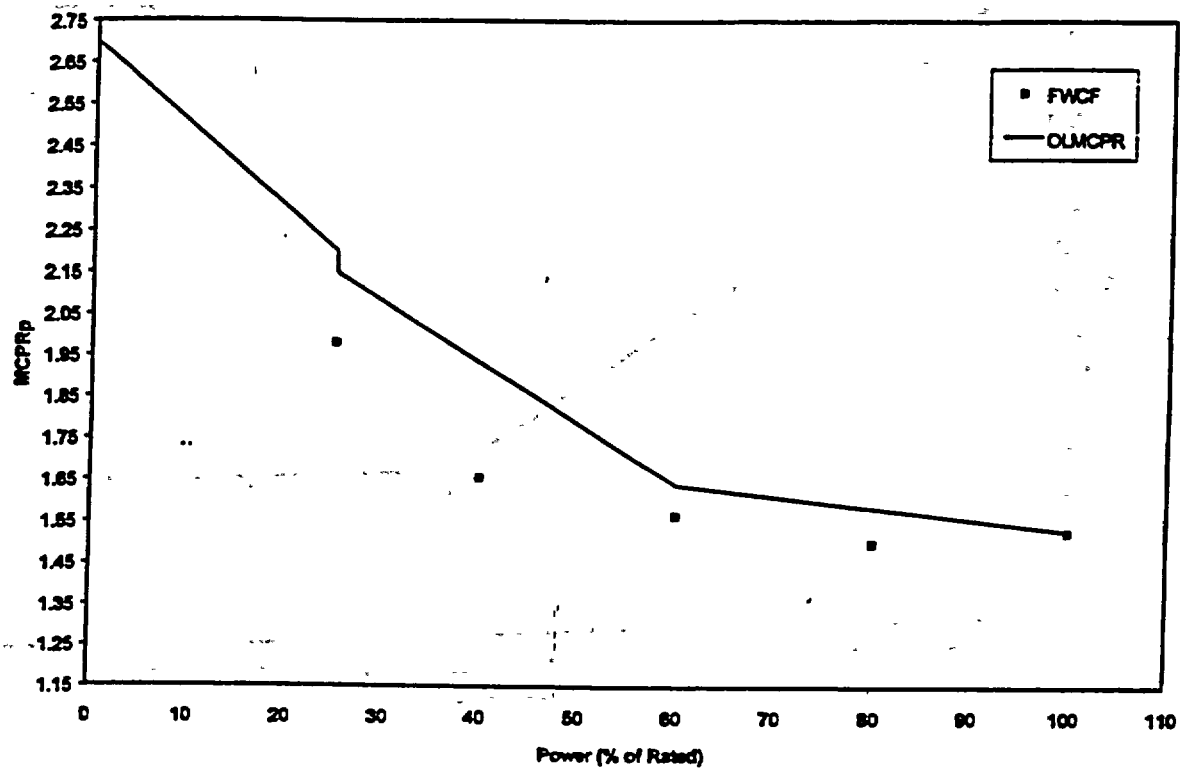
Power (%)	$MCPR_p$ Limit
100	1.44
60	1.55
25	2.05
25	2.20
0	2.70

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



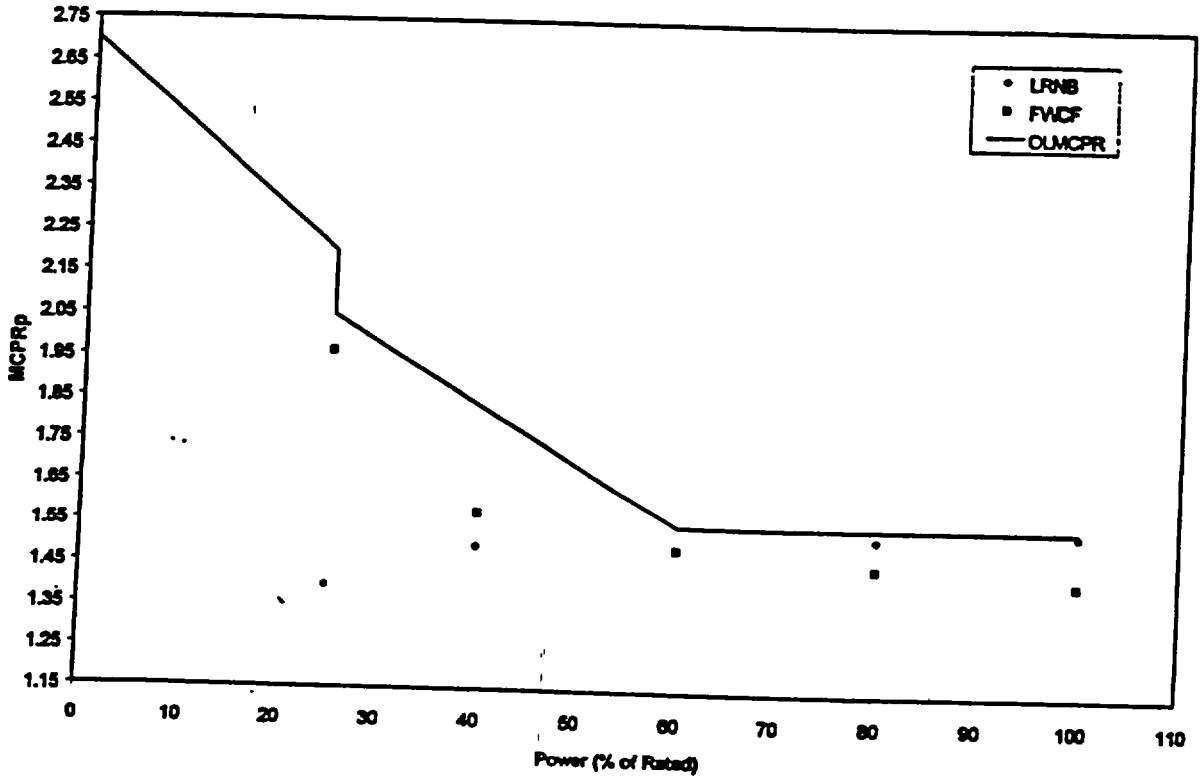
Power (%)	$LHGRFAC_p$ Multiplier
100	0.99
60	0.97
25	0.73
25	0.73
0	0.73

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



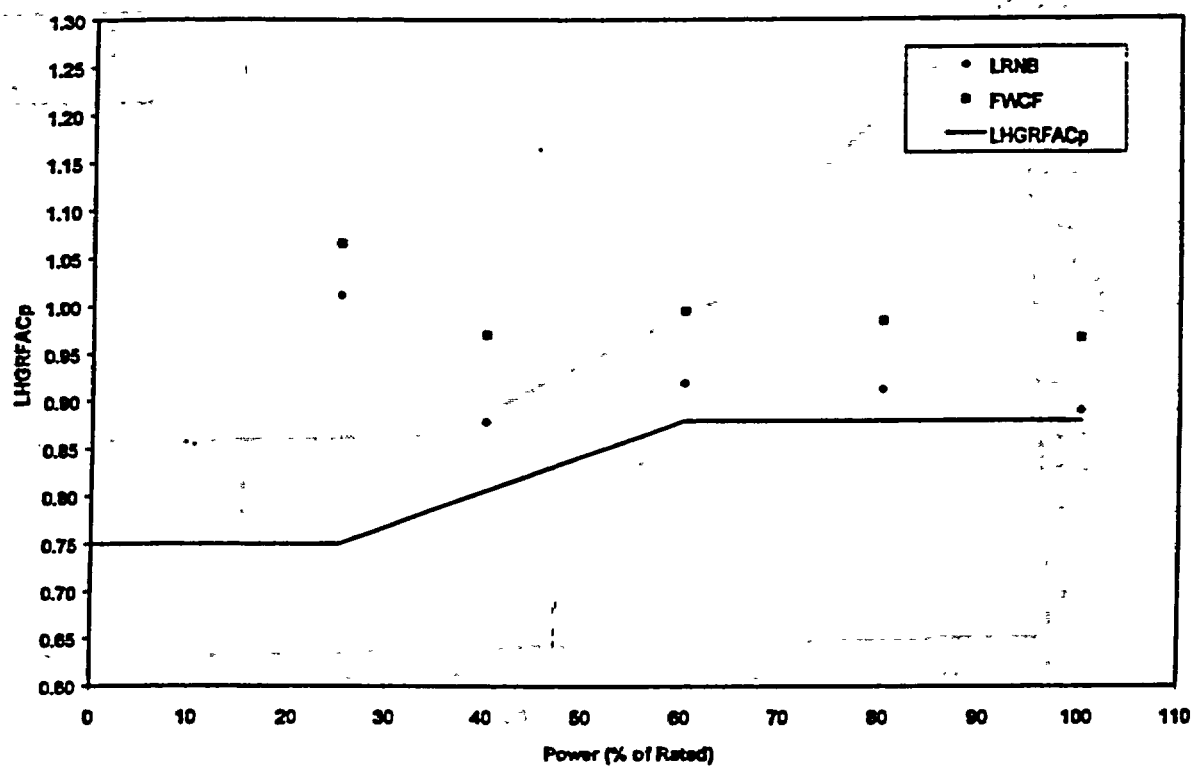
Power (%)	$MCPR_p$ Limit
100	1.53
60	1.64
25	2.15
25	2.20
0	2.70

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



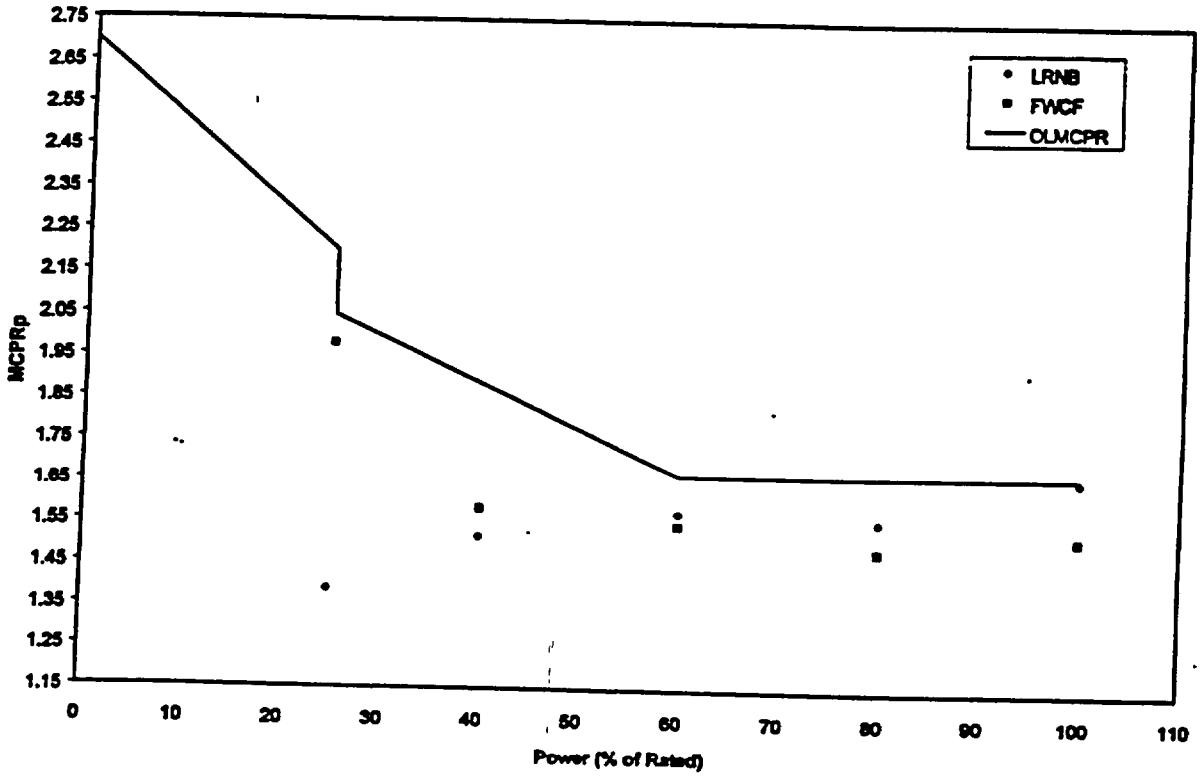
Power (%)	$MCPR_p$ Limit
100	1.55
60	1.55
25	2.05
25	2.20
0	2.70

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



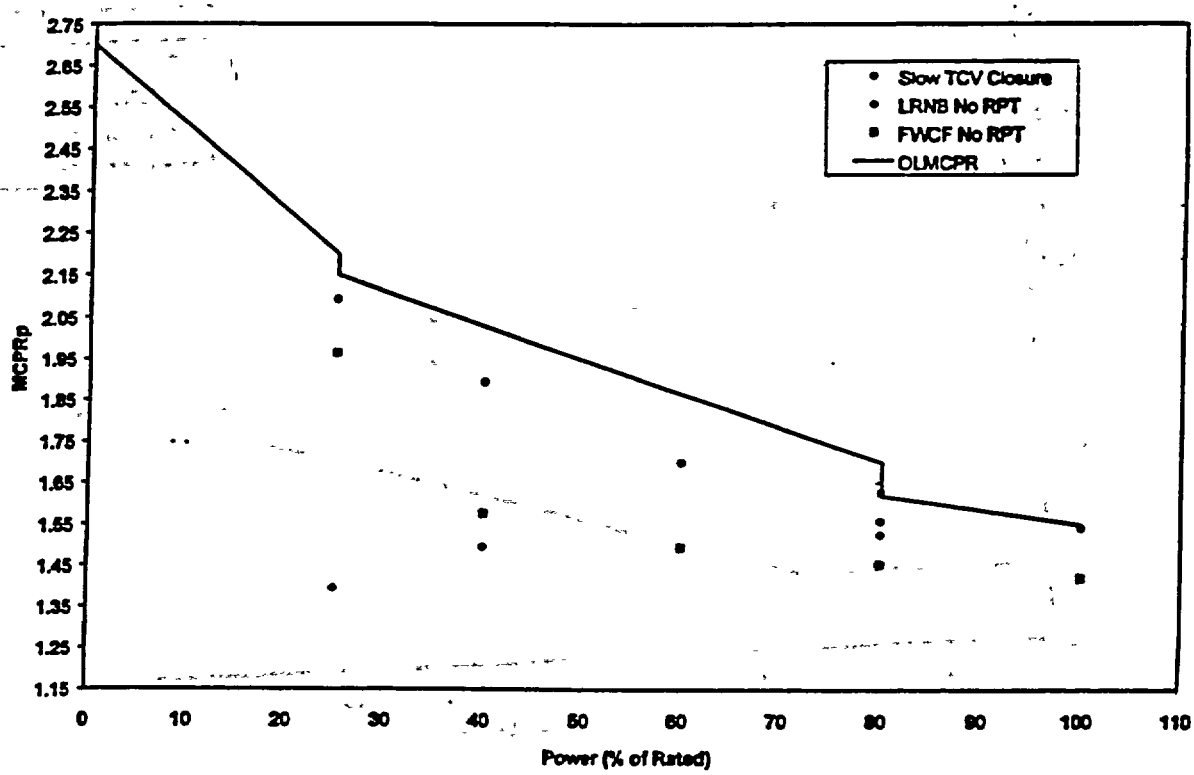
Power (%)	$LHGRFAC_p$ Multiplier
100	0.88
60	0.88
25	0.75
25	0.75
0	0.75

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



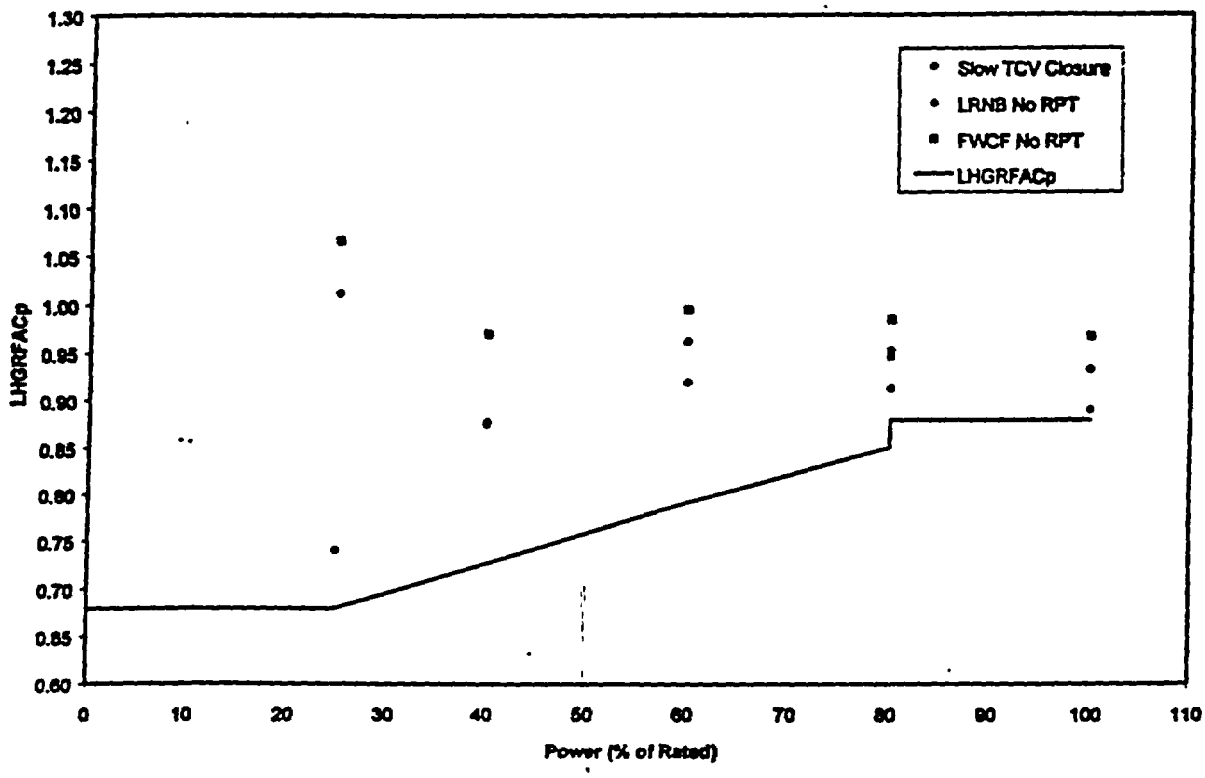
Power (%)	$MCPR_p$ Limit
100	1.67
60	1.67
25	2.05
25	2.20
0	2.70

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



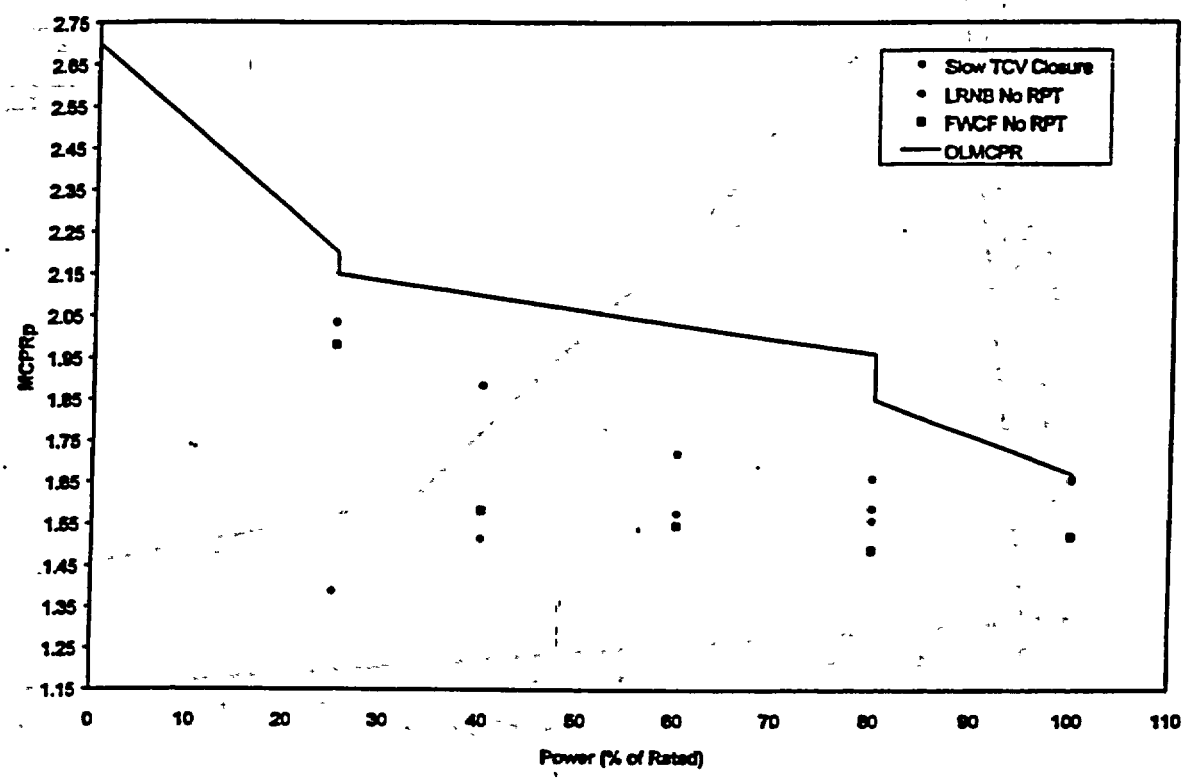
Power (%)	$MCPR_p$ Limit
100	1.55
80	1.62
80	1.70
25	2.15
25	2.20
0	2.70

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



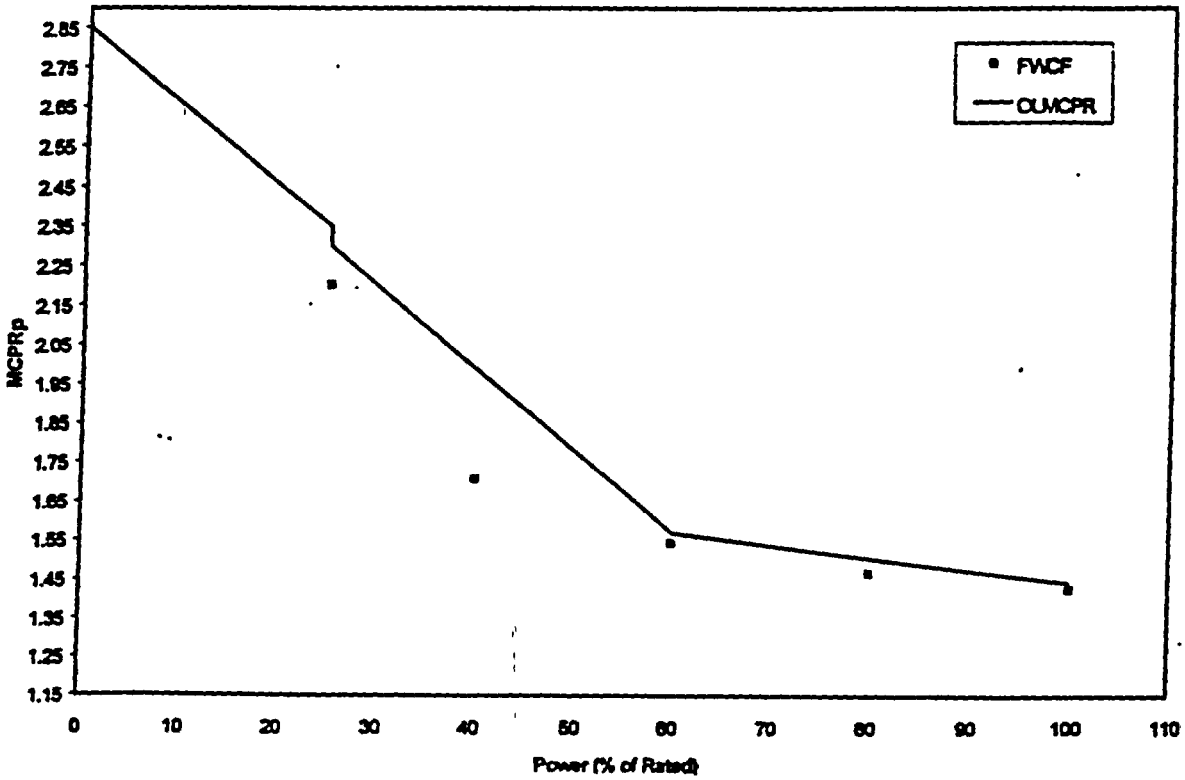
Power (%)	$LHGRFAC_p$ Multiplier
100	0.88
80	0.88
80	0.85
25	0.68
25	0.68
0	0.68

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



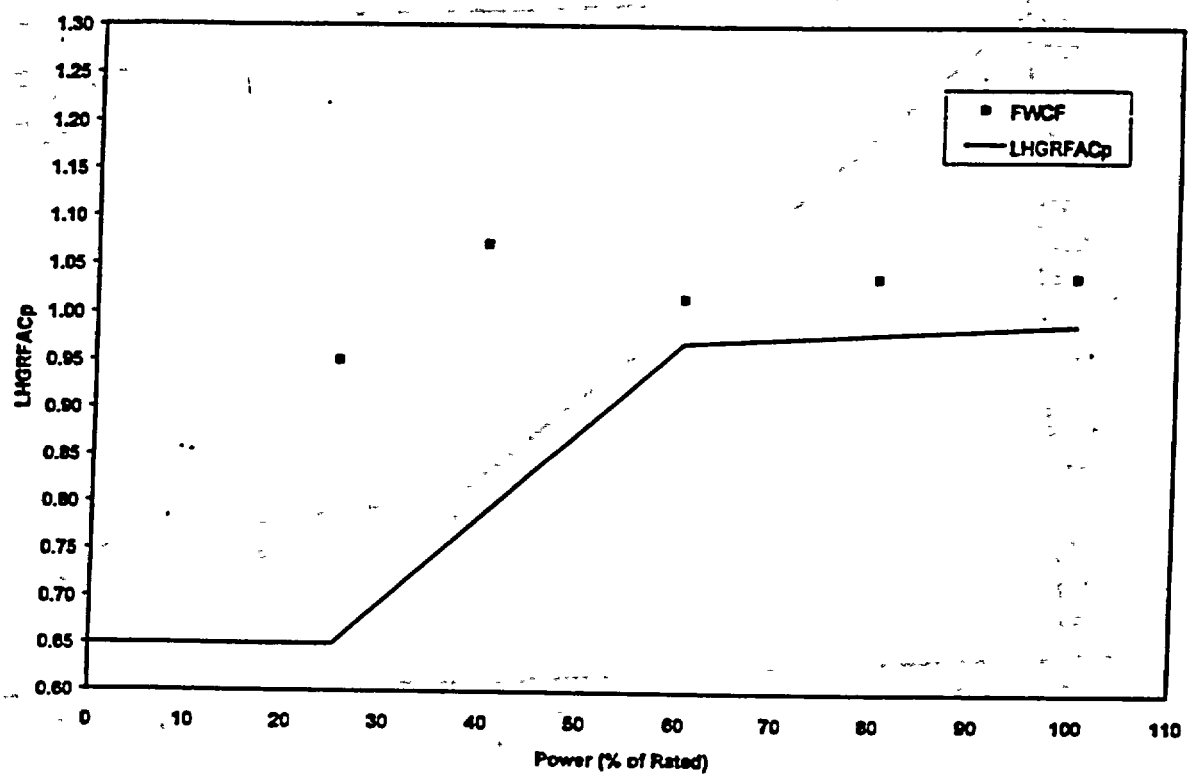
Power (%)	$MCPR_p$ Limit
100	1.67
80	1.85
80	1.96
25	2.15
25	2.20
0	2.70

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



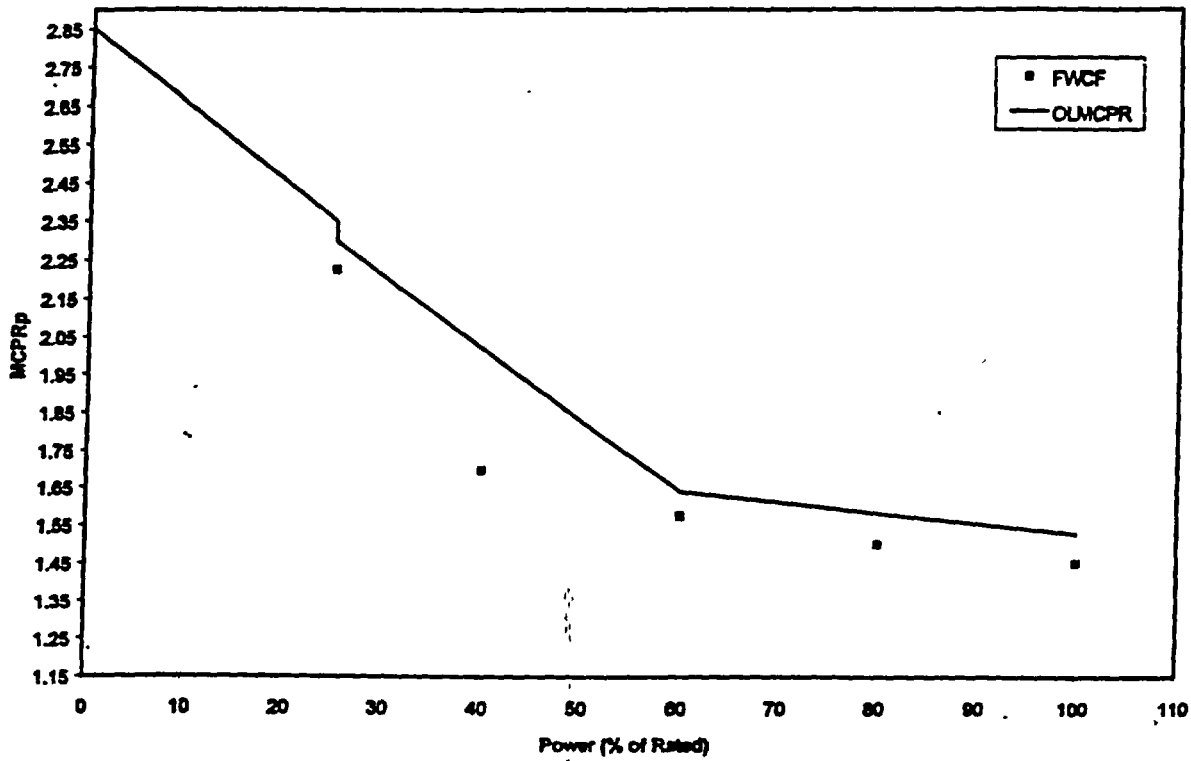
Power (%)	$MCPR_p$ Limit
100	1.44
60	1.57
25	2.30
25	2.35
0	2.85

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



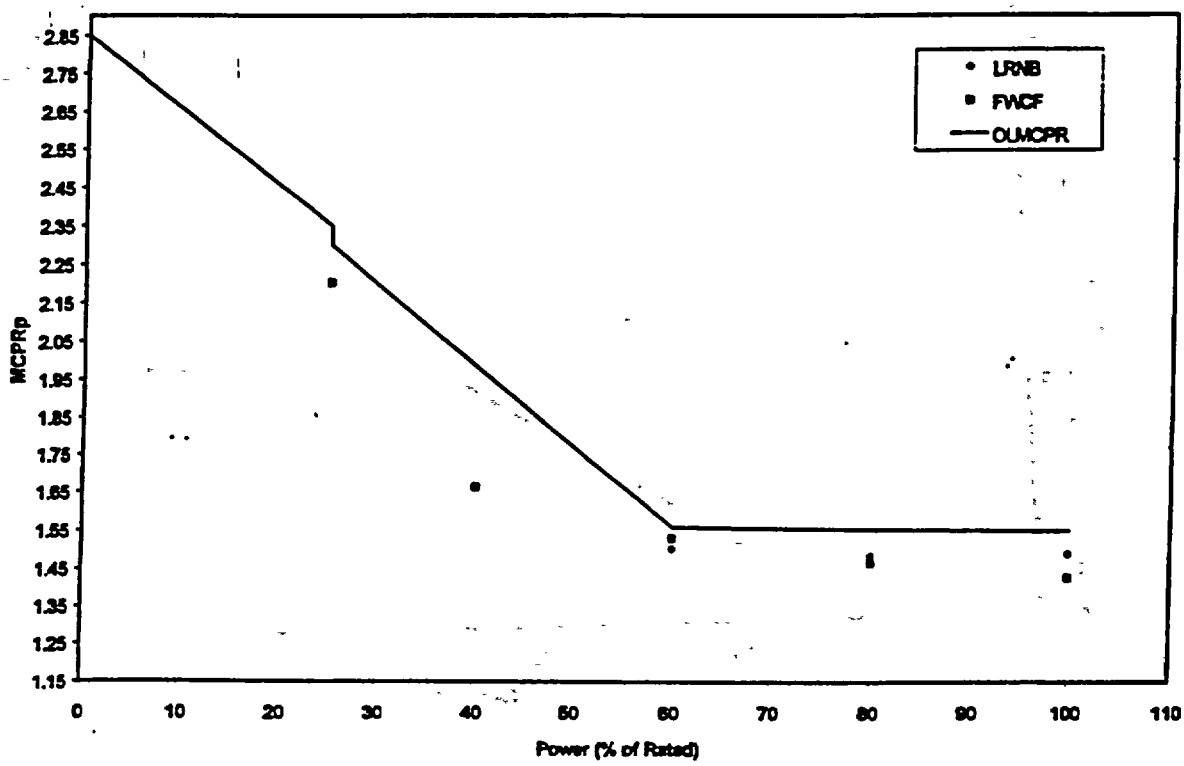
Power (%)	$LHGRFAC_p$ Multiplier
100	0.99
60	0.97
25	0.65
25	0.65
0	0.65

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



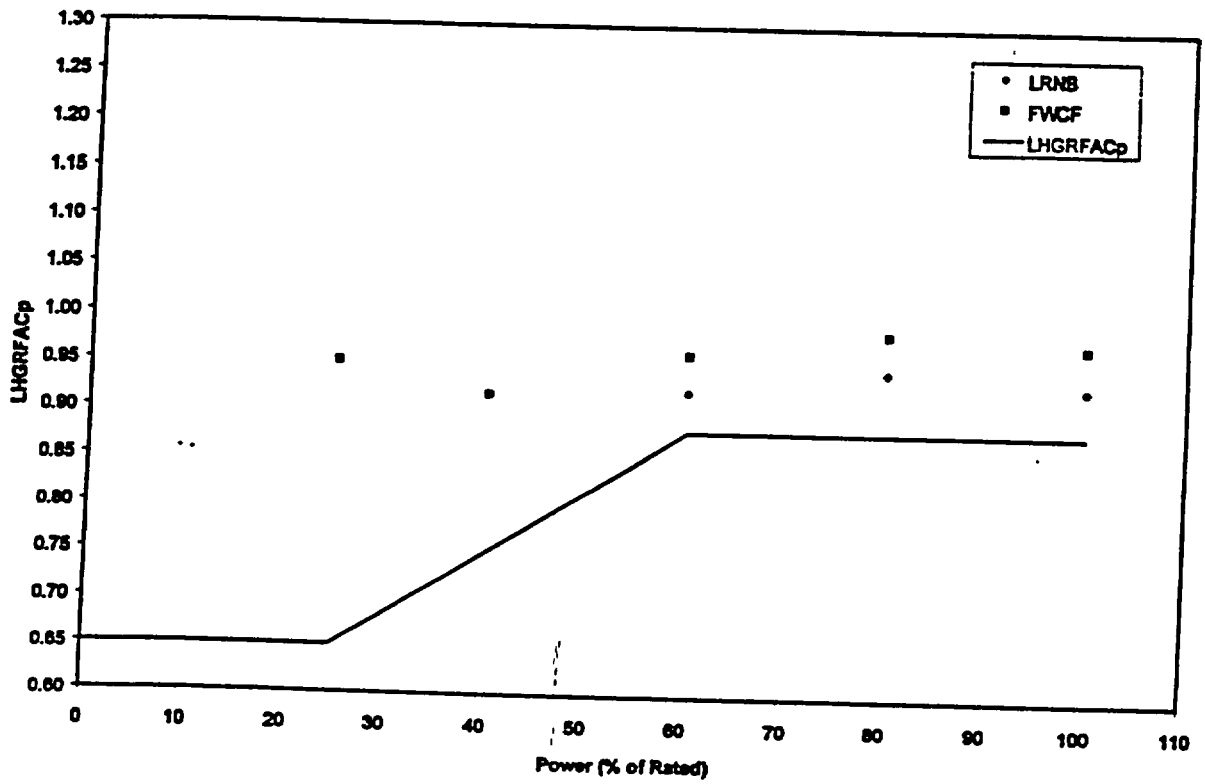
Power (%)	$MCPR_p$ Limit
100	1.53
60	1.64
25	2.30
25	2.35
0	2.85

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



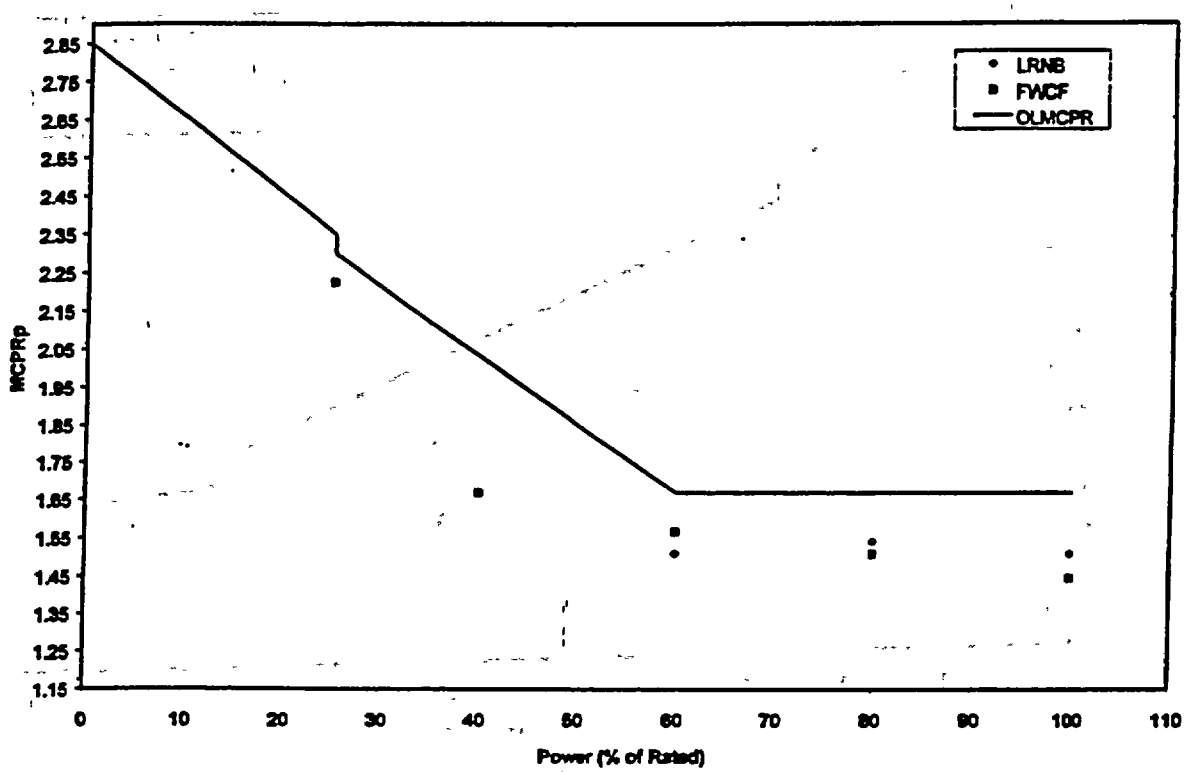
Power (%)	$MCPR_p$ Limit
100	1.55
60	1.56
25	2.30
25	2.35
0	2.85

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



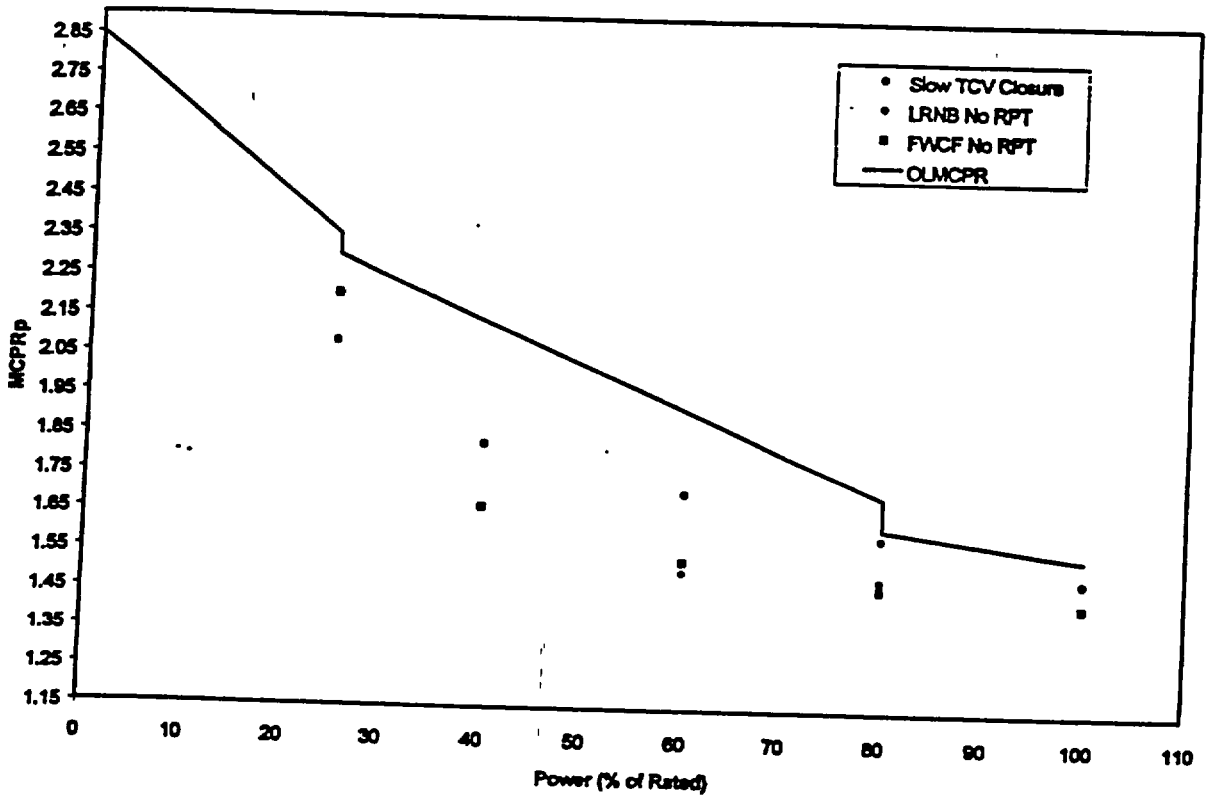
Power (%)	$LHGRFAC_p$ Multiplier
100	0.88
60	0.88
25	0.65
25	0.65
0	0.65

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



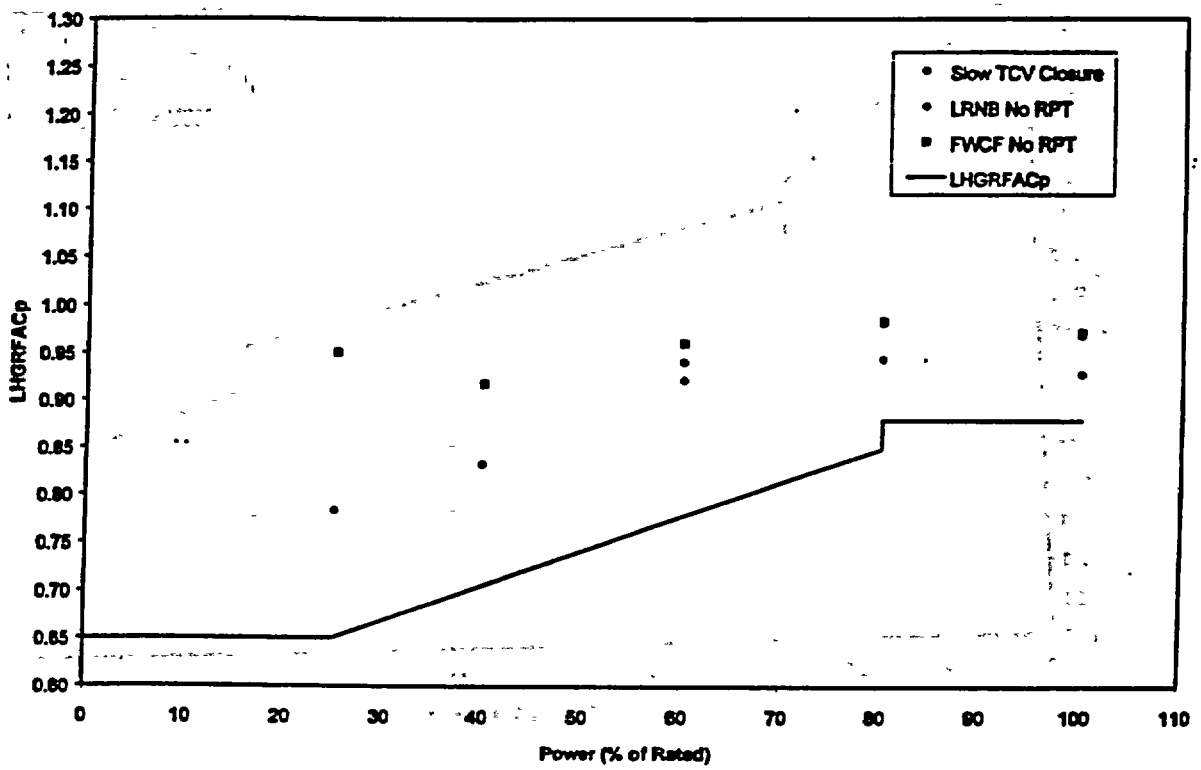
Power (%)	$MCPR_p$ Limit
100	1.67
60	1.67
25	2.30
25	2.35
0	2.85

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



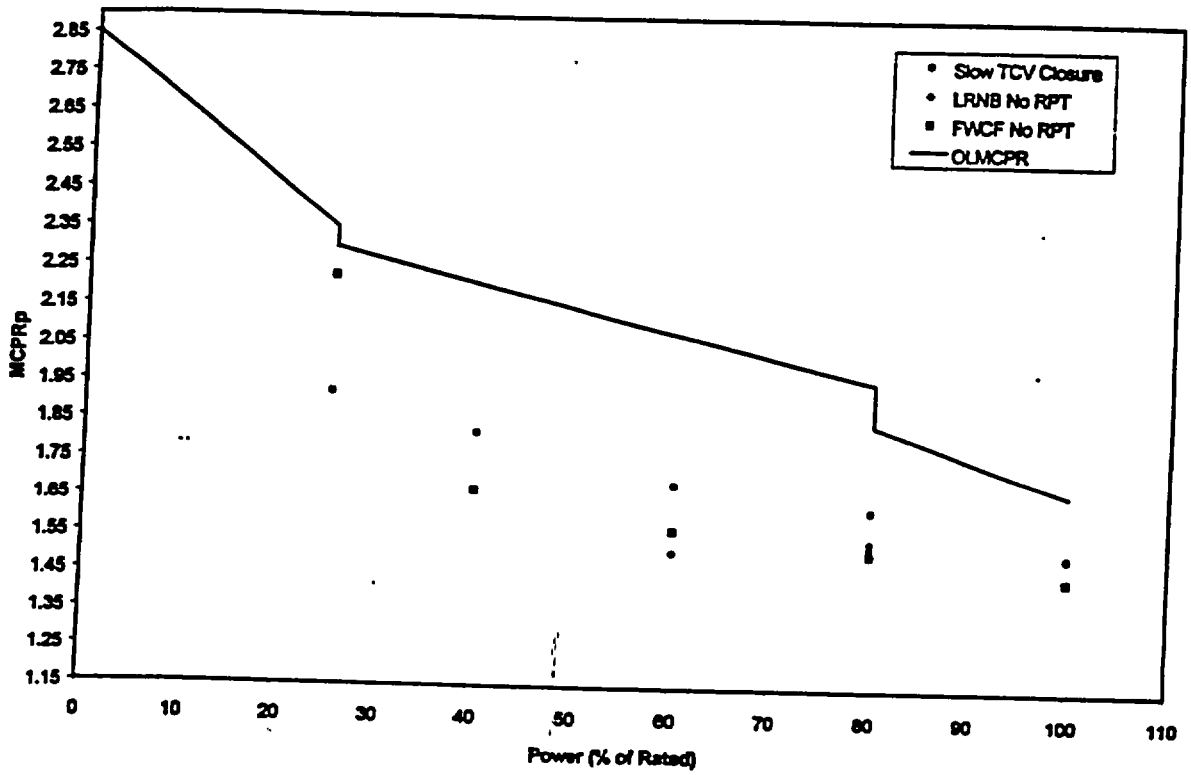
Power (%)	$MCPR_p$ Limit
100	1.55
80	1.62
80	1.70
25	2.30
25	2.35
0	2.85

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

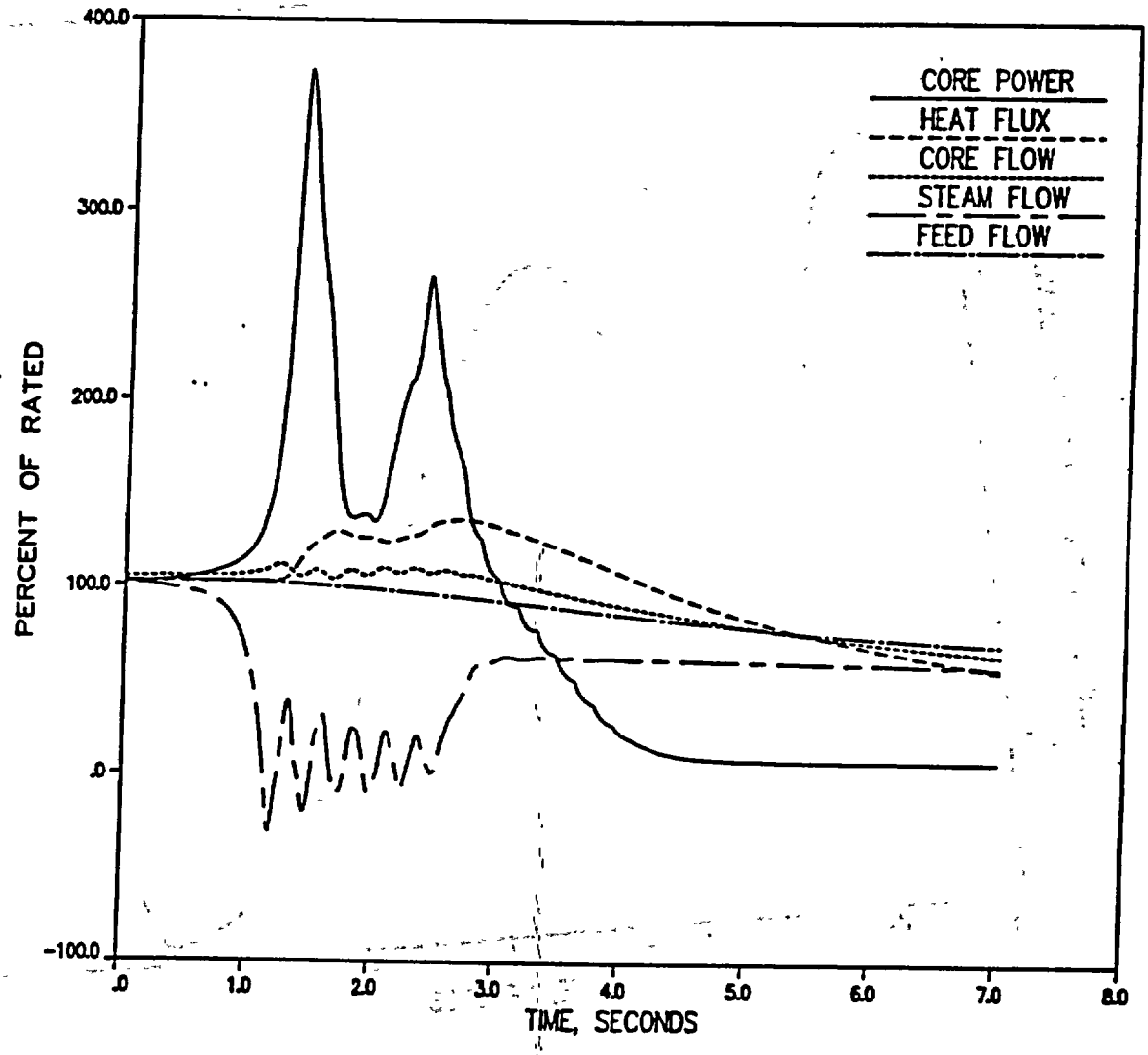


Figure 7.1 Overpressurization Event at 102/105 - MSIV Closure Key Parameters

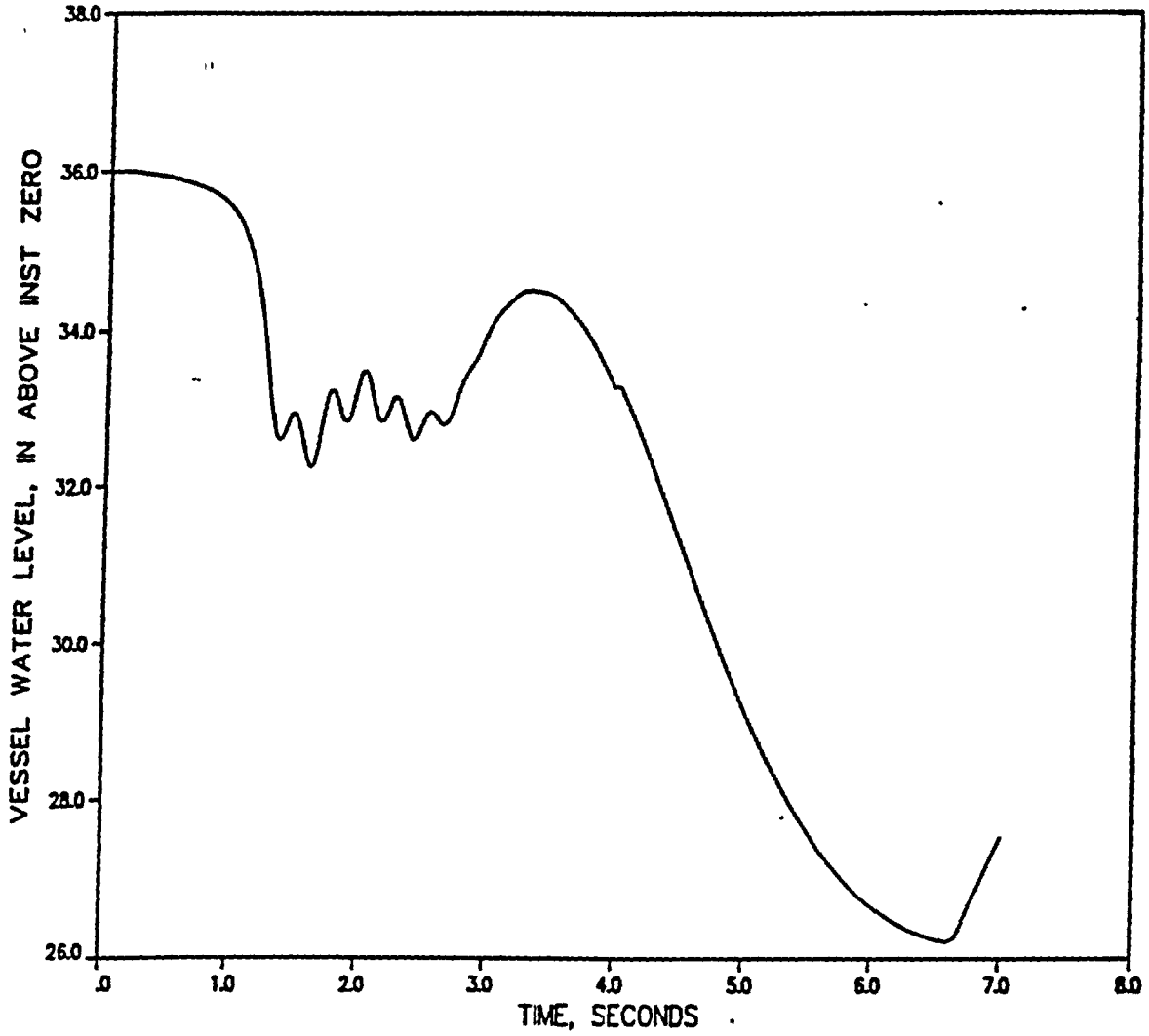


Figure 7.2 Overpressurization Event at 102/105 - MSIV Closure Vessel Water Level

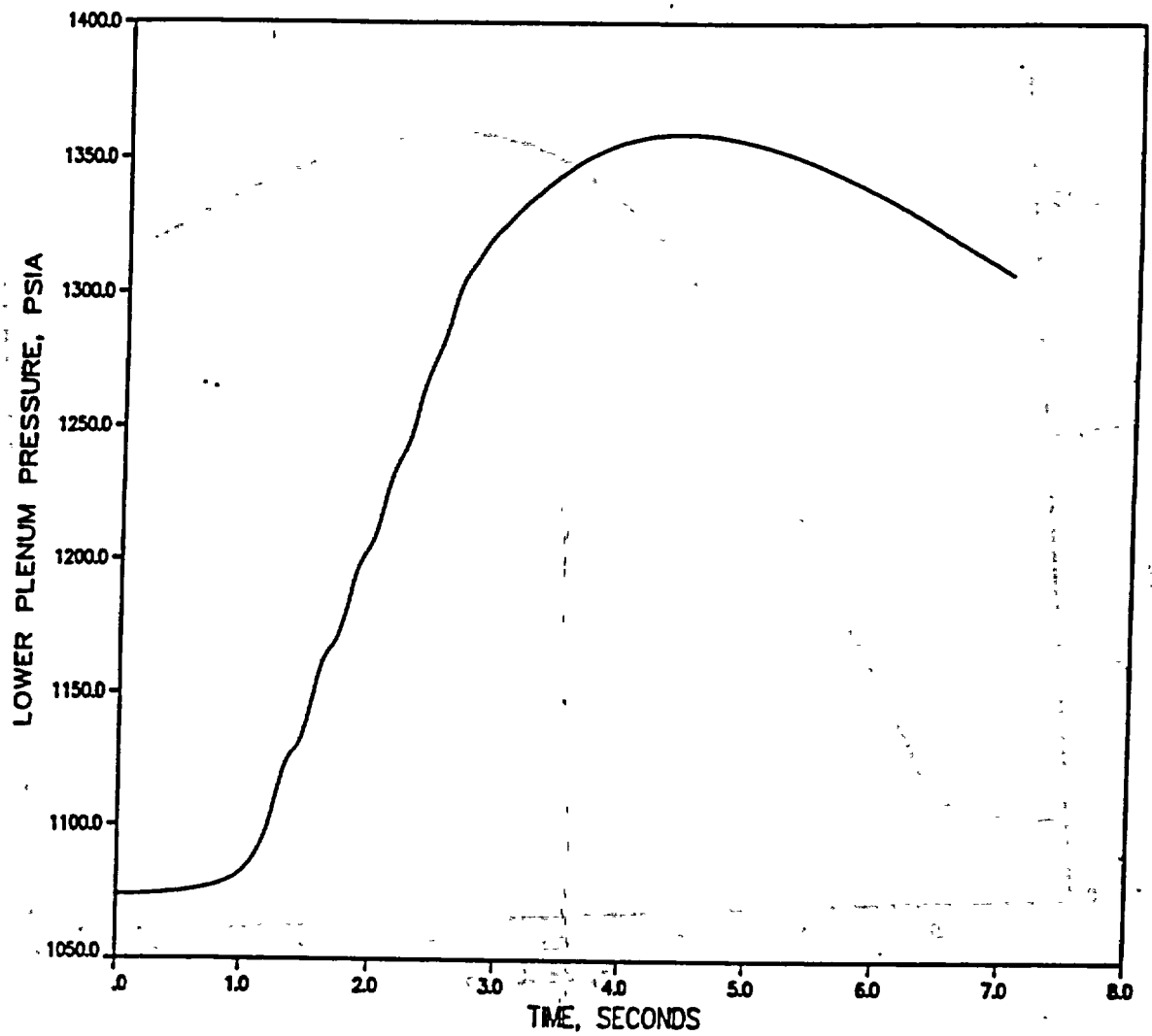


Figure 7.3 Overpressurization Event at 102/105 - MSIV Closure Lower-Plenum Pressure

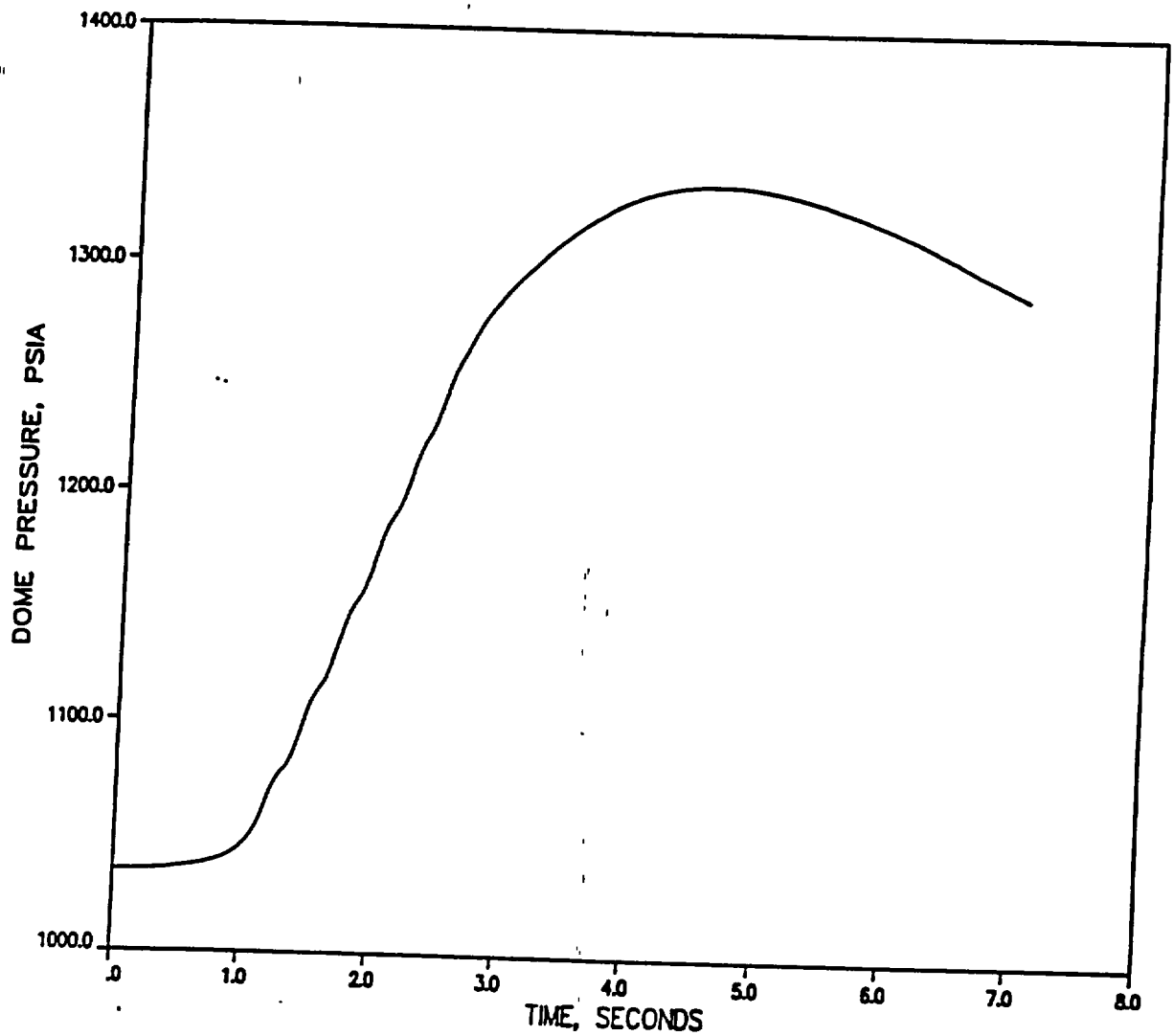
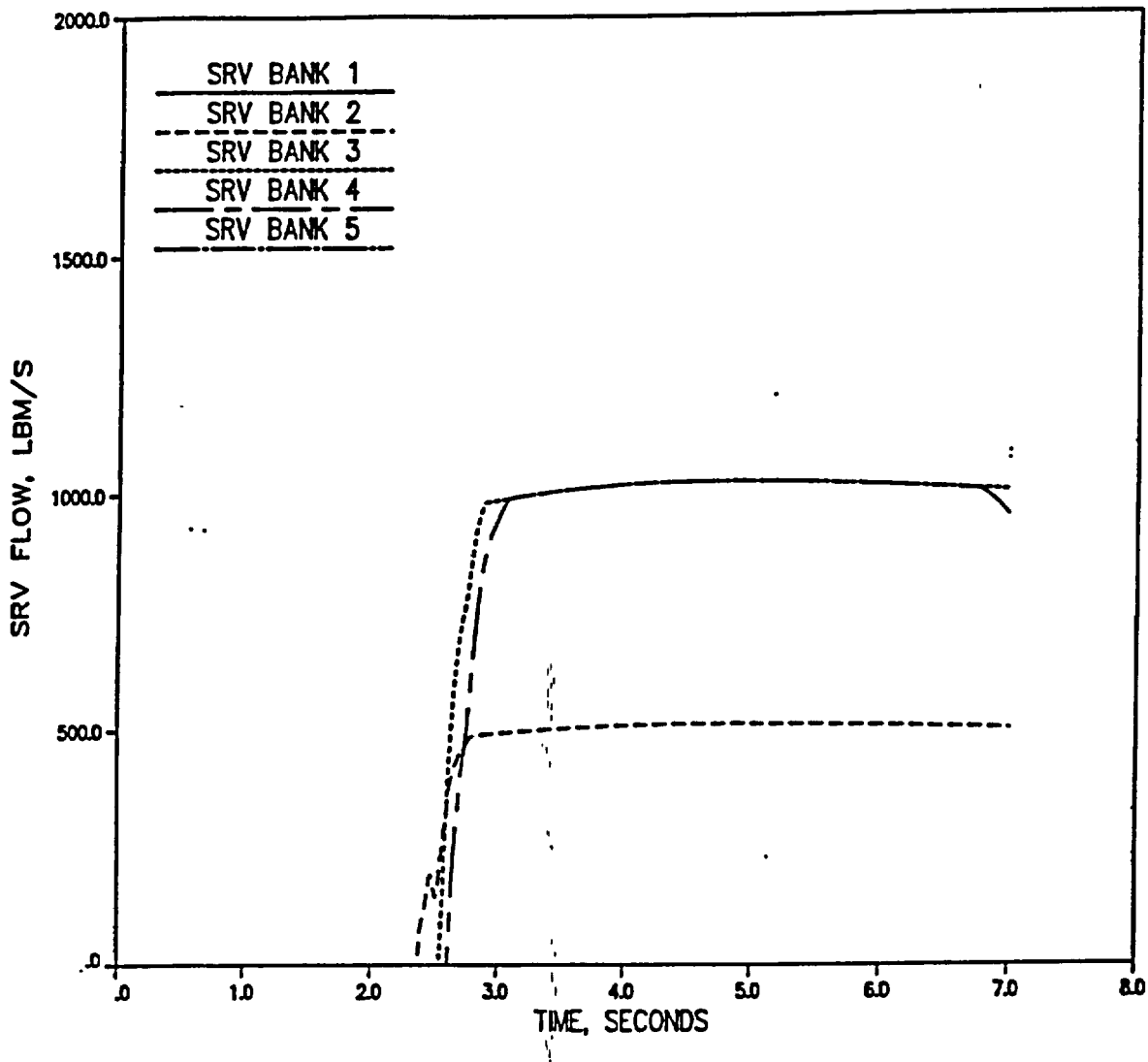


Figure 7.4 Overpressurization Event at 102/105 - MSIV Closure Dome Pressure



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.

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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.

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8. EMF-2323 Revision 0, *LaSalle Unit 2 Cycle 9 Principal Transient Analysis Parameters*, Siemens Power Corporation, March 2000.

9. 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.

10. EMF-95-049(P), *Application of the ANFB Critical Power Correlation to Coresident GE Fuel at the Quad Cities and LaSalle Nuclear Power Stations*, Siemens Power Corporation, October 1995.

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8.0 References *(Continued)*

14. *LaSalle County Nuclear Station Unit 2 Technical Specifications*, as amended.

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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.

20. Letter, D. E. Garber (SPC) to R. J. Chin (ComEd), "LaSalle Unit 2 Cycle 8 Abnormal Idle Recirculation Loop Startup Analysis," DEG:99:070, March 8, 1999.

21. Letter, D. E. Garber (SPC) to R. J. Chin (ComEd), "Description of Measured Power Uncertainty for POWERPLEX® Operation Without Calibrated LPRMs," DEG:00:061, March 7, 2000.

22. Letter, J. H. Riddle (SPC) to R. J. Chin (ComEd), "Scram Surveillance Requirements for MCPR Operating Limits," JHR:96:397, October 8, 1996.

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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:

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

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 $MAPFAC_P$	Generic $MAPFAC_P$
LRNBP	100	No EOOS	24.9	25.2	1.0	1.0
LRNBP	100	RPT OOS	30.3	30.6	1.0	1.0
FWCF	100	TBV OOS	28.7	30.0	1.0	1.0
FWCF	25	No EOOS	50.1	52.0	0.83	0.61
FWCF	25	RPT OOS	57.1	59.0	0.83	0.61
FWCF	25	TBV OOS	62.7	64.5	0.79	0.61

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

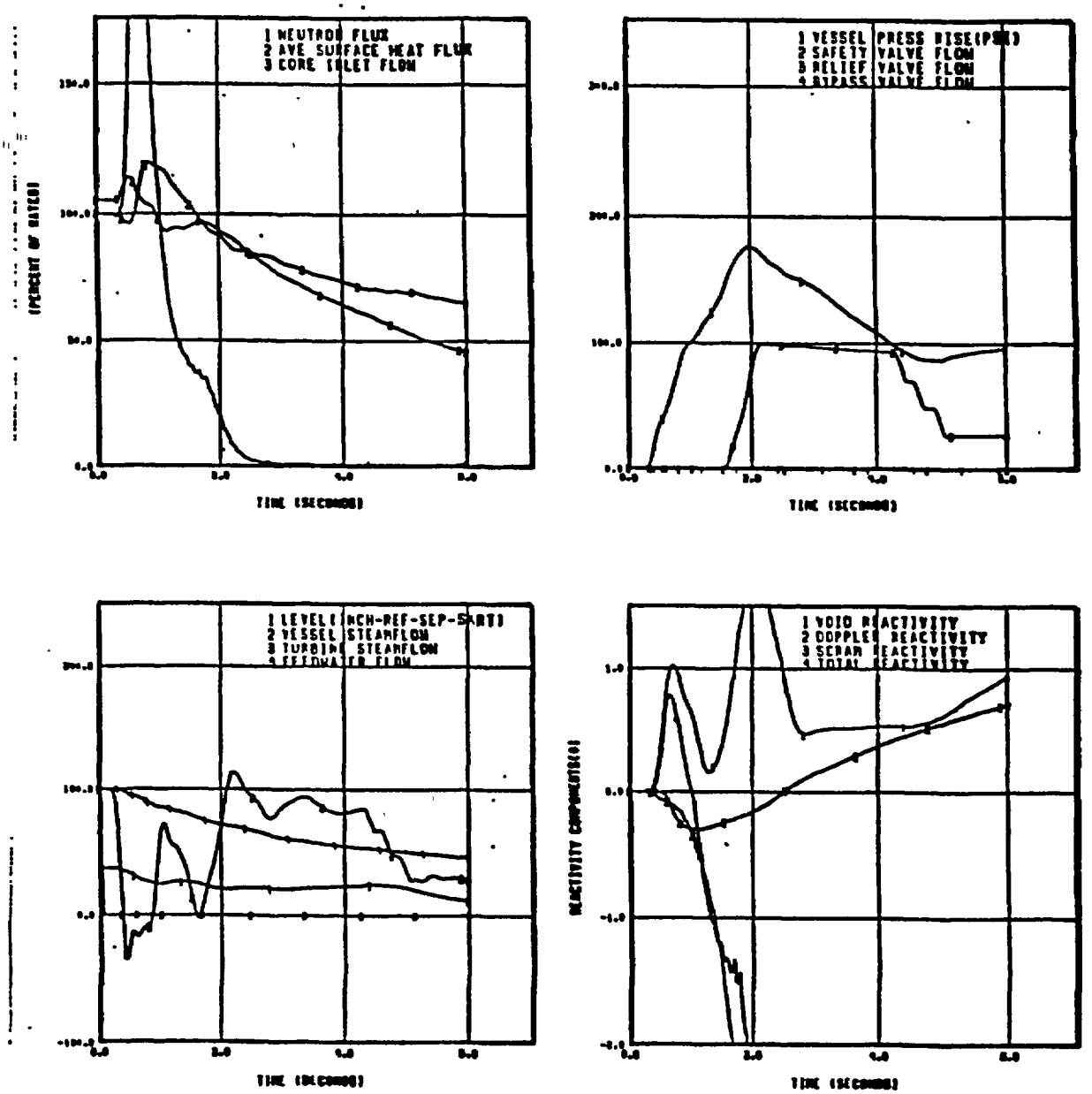


Figure 1. LRNBP from Rated Power, All TCV Fast Closure, Direct Scram, EOC-RPT

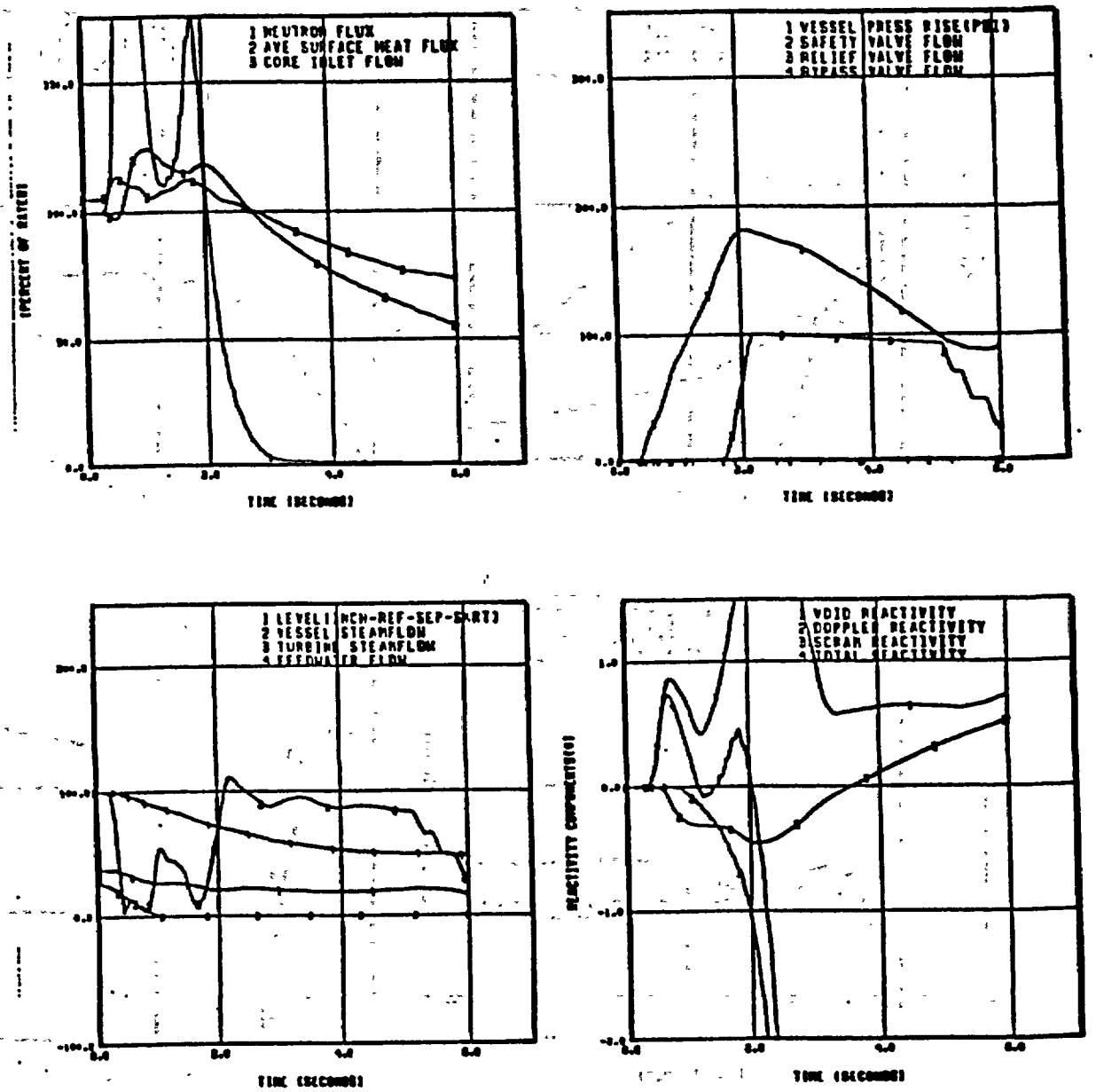


Figure 2. LRNBP from Rated Power, One TCV Slow Closure(50%/second)/Three TCV Fast Closure, Flux Scram, EOC-RPT OOS

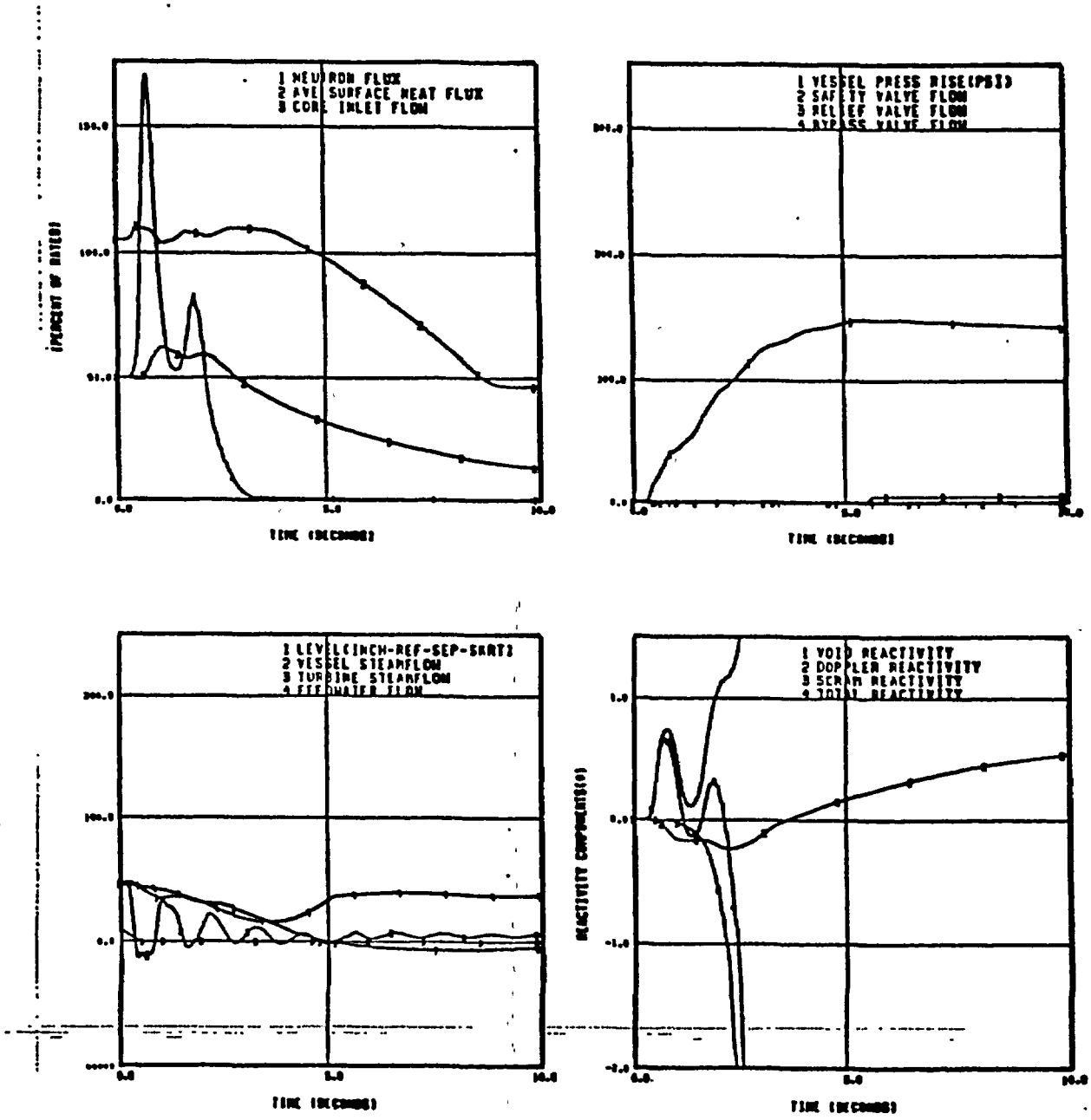


Figure 3. LRNBP from 50% Power, One TCV Slow Closure(50%/second)/Three TCV Fast Closure, Flux Scram

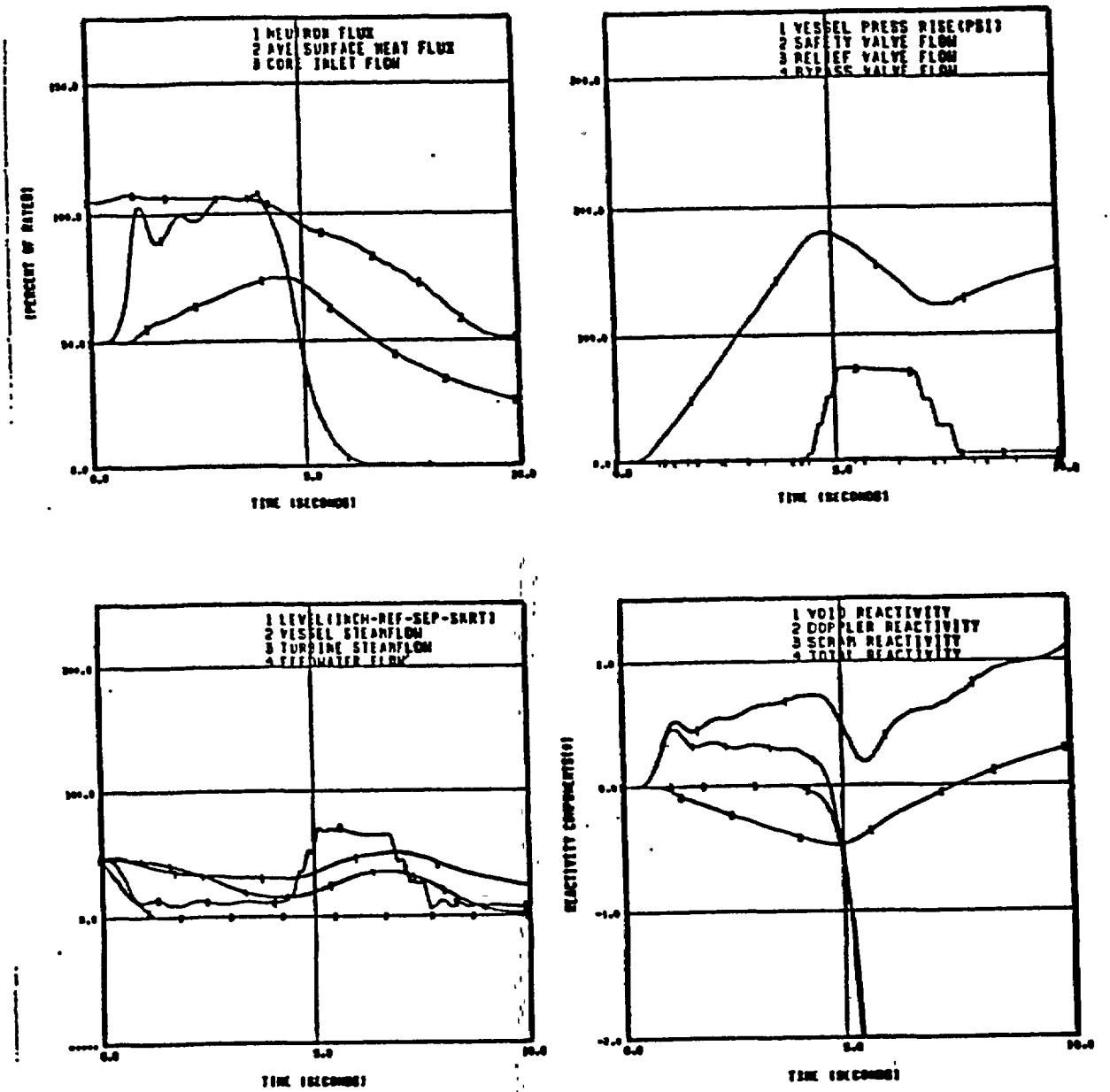


Figure 4. LRNBP from 50% Power, All TCV Closure at 19%/second, Pressure Scram

Technical Requirements Manual - Appendix J
L2C9A Reload Transient Analysis Results

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.

Framatome ANP Richland, Inc.

2101 Horn Rapids Road
Richland, WA 99352

Tel: (509) 375-8100
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.

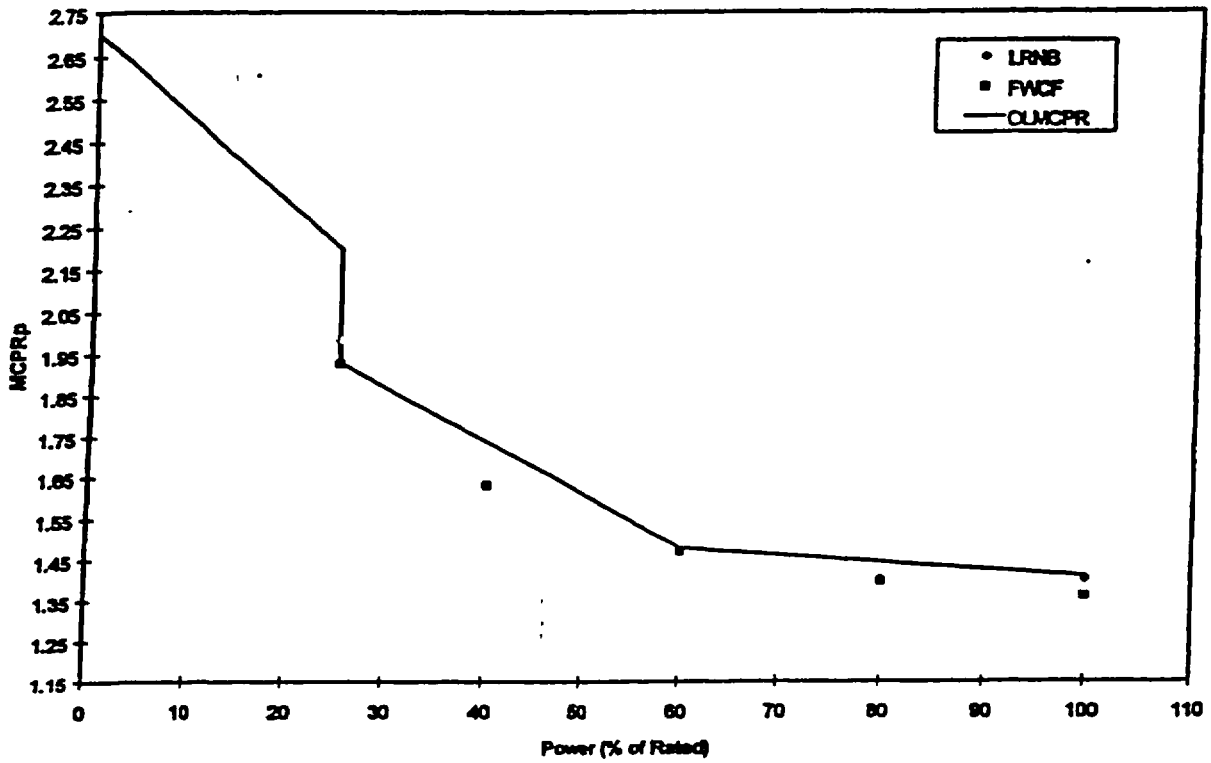
Table 3 EOOS Transient Analysis Results With Proposed ITS Scram Times and Corrected Fuel Thermal Conductivity

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.

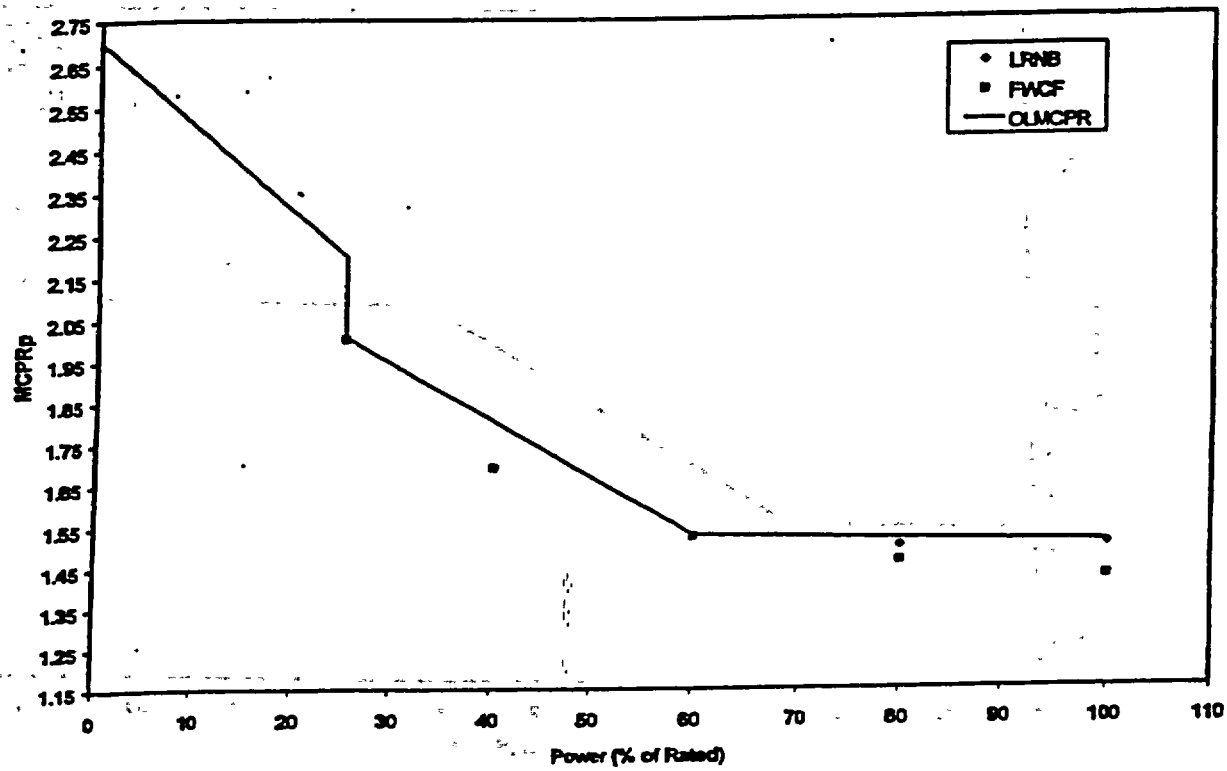
† Scram initiated by high dome pressure.

‡ 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.



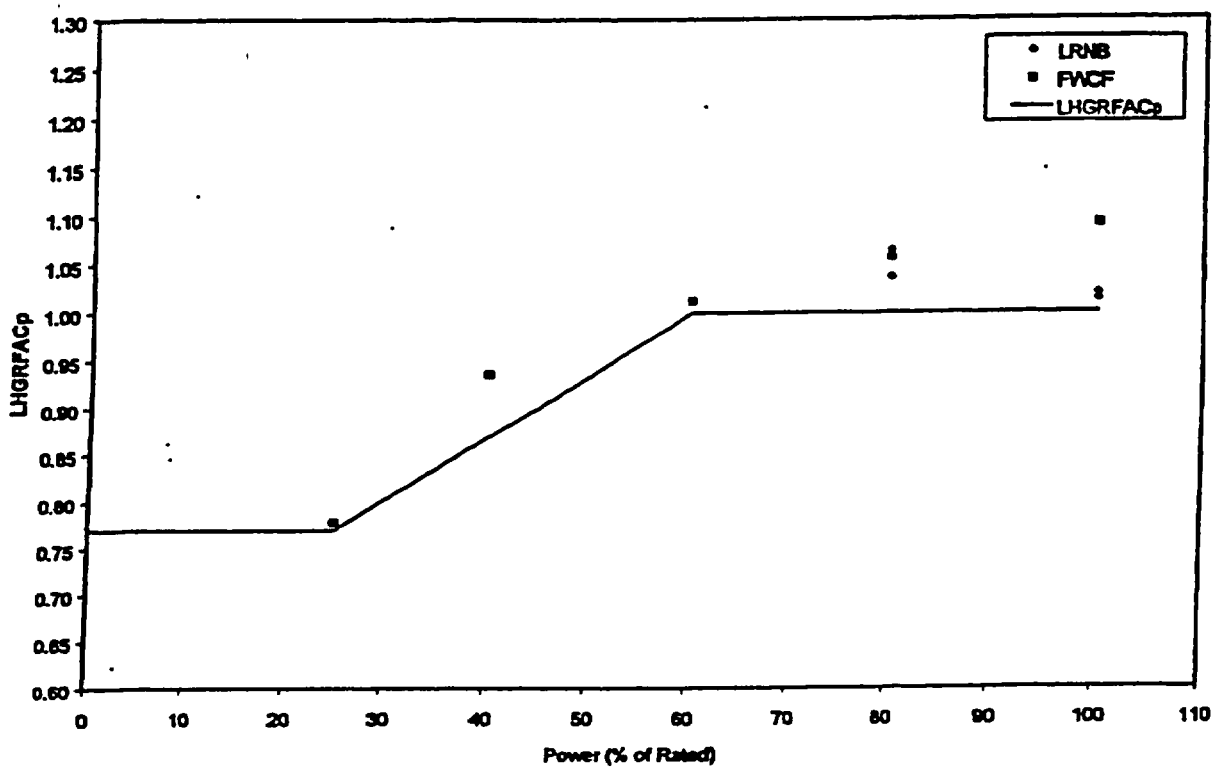
Power (%)	$MCPR_p$ Limit
100	1.41
60	1.48
25	1.93
25	2.20
0	2.70

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



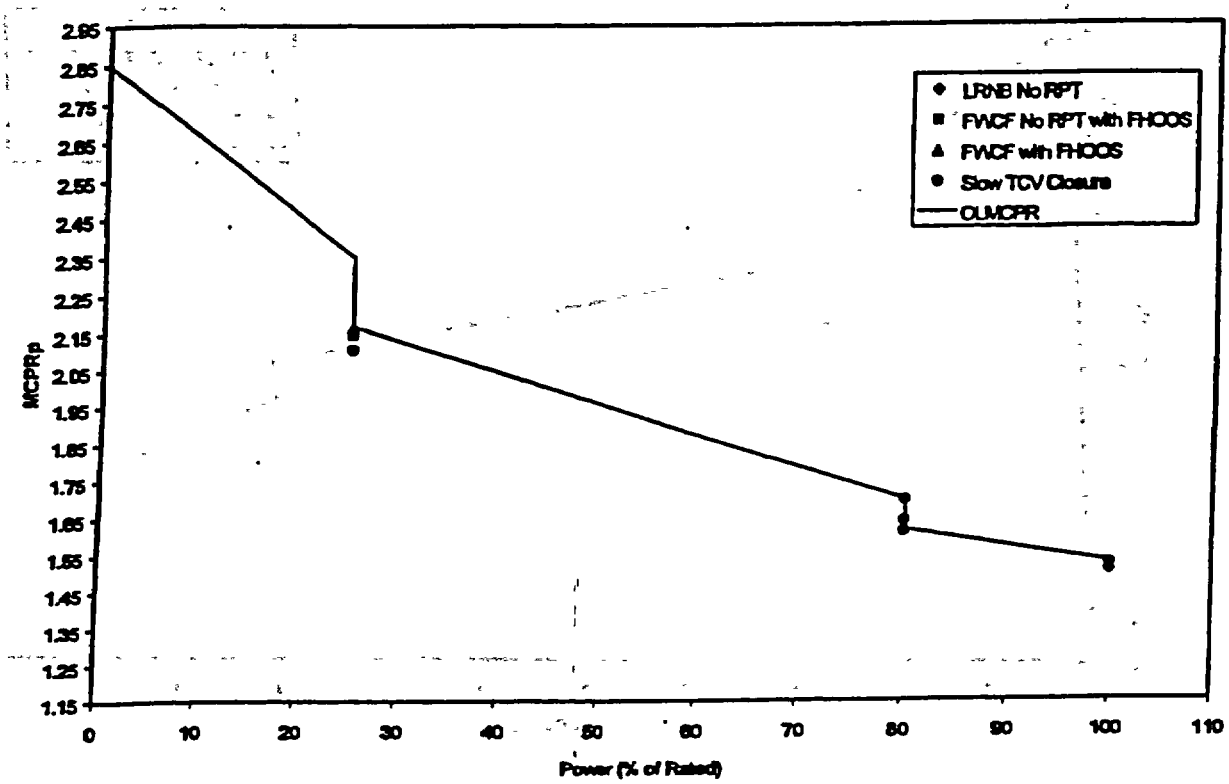
Power (%)	$MCPR_p$ Limit
100	1.51
60	1.53
25	2.01
25	2.20
0	2.70

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



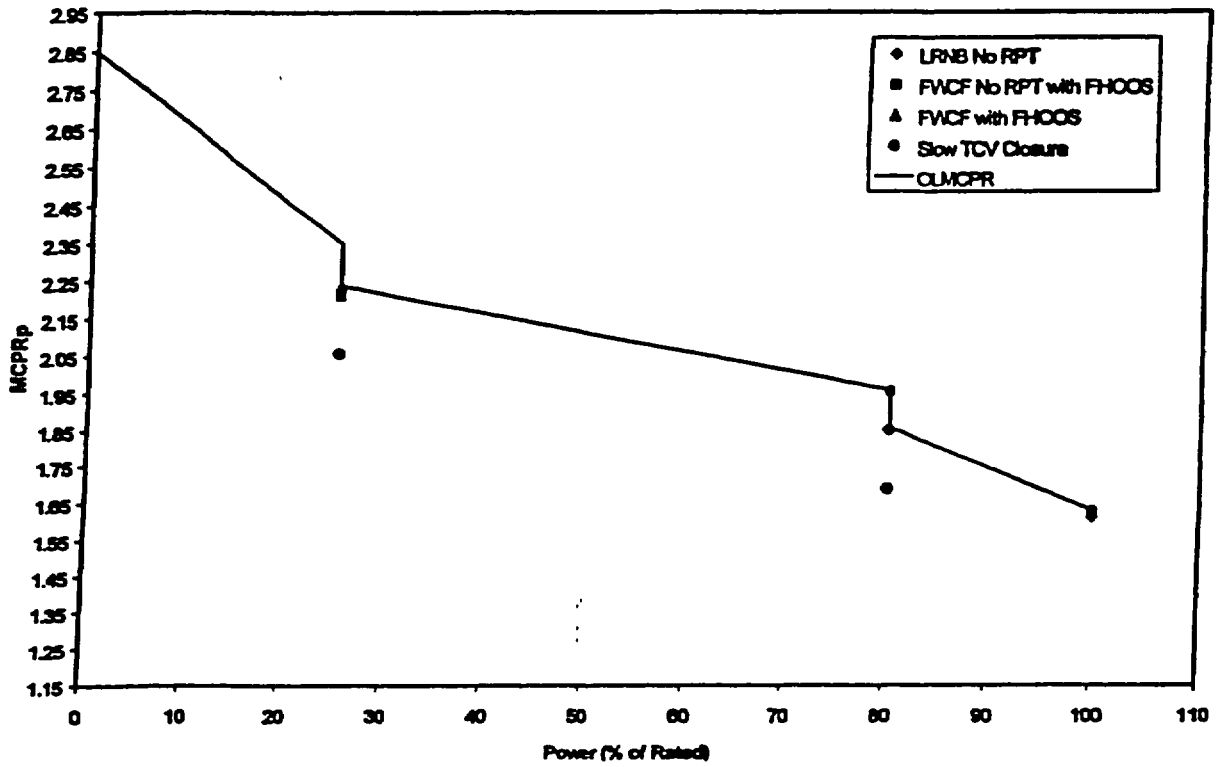
Power (%)	$LHGRFAC_p$ Multiplier
100	1.00
60	1.00
25	0.77
25	0.77
0	0.77

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



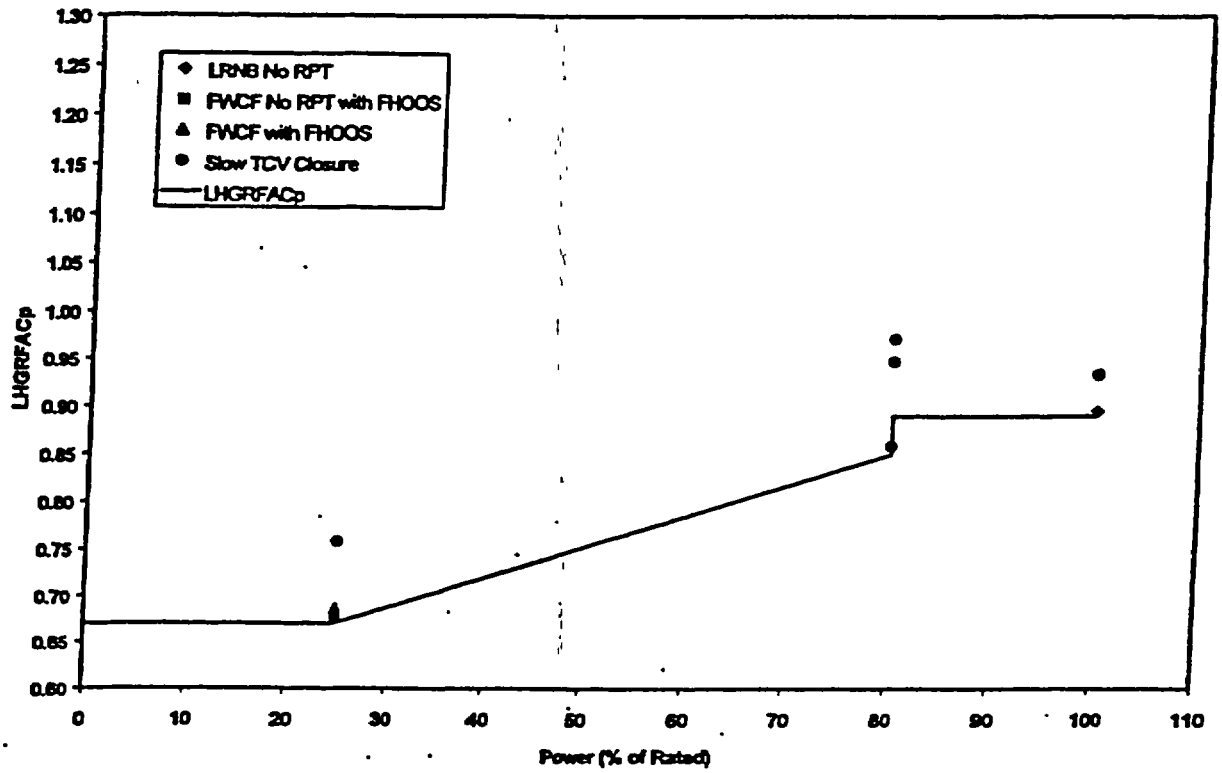
Power (%)	$MCPR_p$ Limit
100	1.53
80	1.62
80	1.70
25	2.17
25	2.35
0	2.85

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

Attachment 7

LaSalle Unit 2 Cycle 9
Equipment Out-of-Service Operating Limits
Using Nominal Scram Speed
And
Exposure Limited to 14,000 MWd/MTU

FRAMATOME ANP

January 10, 2002
DEG:02:009

Mr. F. W. Trikur
Exelon Nuclear
Nuclear Fuel Management
4300 Winfield Road
Warrenville, IL 60555

Dear Mr. Trikur:

LaSalle Unit 2 Cycle 9 Equipment Out-of-Service Operating Limits Using Nominal Scram Speed and Exposure Limited to 14,000 MWd/MTU

Reference: 1) Letter, D. E. Garber (FRA-ANP) to R. J. Chin (Exelon), *LaSalle Unit 2 Cycle 9 Operating Limits for Proposed ITS Scram Times and Corrected Fuel Thermal Conductivity*," DEG:01:046, March 22, 2001.

2) Exelon Task Order, *L2C9 TCV Slow Closure Analysis with NSS Insertion Times*, NFM-MW-B040, Exelon, November 29, 2001.

Turbine control valve (TCV) testing at LaSalle Unit 2 indicated that some of the turbine control valves do not meet the fast closure criteria. Due to TCV slow closure, the plant must be operated using the more restrictive TCV slow closure equipment out-of-Service (EOOS) $MCPR_p$ limits provided in Reference 1. Based on the Reference 1 EOOS $MCPR_p$ limits, Exelon expects to run into MCPR margin problems in February 2002. Exelon requested FRA-ANP (Reference 2) to provide revised ATRIUM™-9B EOOS limits that will improve MCPR margin to support continued operation until a mid-cycle outage to correct the TCV closure rate.

The attachment provides the L2C9 TCV slow closure/FHOOS and/or no RPT transient analysis results and operating limits based on nominal scram speed and a maximum cycle exposure of 14,000 MWd/MTU. The operating limits in the attachment provide significant additional margin as noted by comparison of the 100% power $MCPR_p$ limit of 1.42 versus 1.53 provided in Reference 1. The GE9 operating limits presented in Reference 1 remain applicable.

Please forward the attachment to Exelon at your earliest convenience.

Very truly yours,

D. E. Garber
Project Manager

LaSalle Unit 2 Cycle 9 Equipment Out-of-Service Operating Limits for Nominal Scram Speed and Exposure Limited to 14,000 MWd/MTU

Turbine control valve (TCV) testing at LaSalle Unit 2 indicated that some of the turbine control valves do not meet the fast closure criteria. Due to TCV slow closure, the plant must be operated using the more restrictive TCV slow closure equipment out-of-service (EOOS) $MCPR_p$ limits provided in Reference 1. Based on the Reference 1 EOOS $MCPR_p$ limits, Exelon expects to run into MCPR margin problems in February 2002. Exelon requested Framatome ANP, Inc. (FRA-ANP) (Reference 2) to provide revised ATRIUM™-9B* EOOS limits that will improve MCPR margin to support continued operation until a mid-cycle outage to correct the TCV closure rate.

MCPR margin was gained in the EOOS operating limits by reanalyzing TCV slow closure/FHOOS and/or no RPT analyses based on nominal scram speed (NSS) and limiting the cycle exposure over which the limits are applicable to BOC - 14,000 MWd/MTU.

Scram times corresponding to NSS were taken from the LaSalle Unit 2 plant transient analysis parameters document (Reference 3). The scram times used are presented in Table 1 for informational purposes.

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 4 have been reanalyzed. The subset of analyses reanalyzed is similar to the subset presented in Reference 1 and is based on results presented in Reference 4. Review of Figures 5.16, 5.17, and 5.18 in Reference 4 shows 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. FWCF with FHOOS cases were included in this analysis resulting in a slightly more limiting case at 25% power than the FWCF no RPT with FHOOS cases.

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* ATRIUM is a trademark of Framatome ANP.

Cases at power levels of 40% and 60% were included in this analysis for completeness even though Reference 4 shows considerable margin to the limits at these power levels.

Table 2 presents the analysis results used to establish the slow TCV closure/FHOOS and/or no RPT limits. Figure 1 presents the revised slow TCV closure/FHOOS and/or no RPT $MCPR_p$ limits for the ATRIUM-9B fuel. The sum of the L2C9 safety limit MCPR (1.11 per Reference 4) and the ΔCPR results from Table 2 are also presented in Figure 1.

Figure 2 presents the revised slow TCV closure/FHOOS and/or no RPT $LHGRFAC_p$ multipliers for the ATRIUM-9B fuel.

The ATRIUM-9B $MCPR_p$ limits and $LHGRFAC_p$ multipliers provided in Figures 1 and 2 protect operation with any combination of up to four TCVs closing slowly, EOC RPT OOS, and FHOOS up to a cycle exposure of 14,000 MWd/MTU (NEOC). The only equipment out-of-service scenarios provided in Reference 4 not explicitly protected by the slow TCV closure/FHOOS and/or no RPT limits are single-loop operation (discussed below), turbine bypass valves OOS (discussed below), and startup of an idle loop. The limits support scram speeds at least as fast as the NSS insertion times presented in Table 1; the slower technical specification scram speed (TSSS) insertion times are not supported by these limits.

Comparison of turbine bypass valves OOS and the TCV slow closure/FHOOS and/or no RPT limits in Table 2.1 of Reference 4 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 revise limits for startup of an idle loop.

Single-Loop Operation

Figures 1 and 2 provide the two-loop operation (TLO) $MCPR_p$ limits and $LHGRFAC_p$ multipliers. Reference 5 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. 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. Reference 4 indicates the L2C9 TLO safety limit MCPR is 1.11 and the SLO safety limit MCPR is 1.12. 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 Figure 1 to account for the increase in safety limit MCPR. The Figure 2 TCV slow closure/FHOOS and/or no RPT $LHGRFAC_p$ multipliers remain applicable for SLO.

References

1. Letter, D. E. Garber (FRA-ANP) to R. J. Chin (Exelon), *LaSalle Unit 2 Cycle 9 Operating Limits for Proposed ITS Scram Times and Corrected Fuel Thermal Conductivity,"* DEG:01:046, March 22, 2001.

2. Exelon Task Order, *L2C9 TCV Slow Closure Analysis with NSS Insertion Times,* NFM-MW-B040, Exelon, November 29, 2001

3. EMF-2323 Revision 0, *LaSalle Unit 2 Cycle 9 Principal Transient Analysis Parameters,* Siemens Power Corporation, March 2000.

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

5. 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.

Table 1 Nominal Scram Insertion Times (Reference 3)

Position (notch)	NSS Time (sec)
48	0.00
48	0.200*
45	0.380
39	0.680
25	1.680
5	2.680
0	2.804

* 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

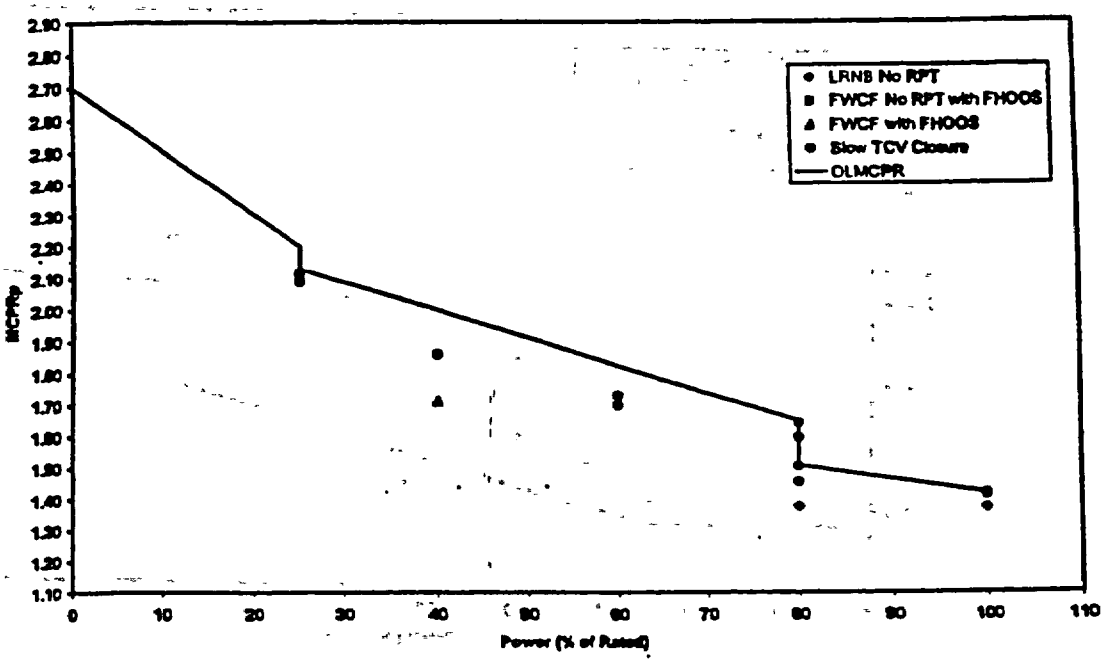
Table 2 EOOS Transient Analysis Results With Nominal Scram Speed and Exposure Limited to 14,000 MWd/MTU

Power / Flow	Slow Valve Characteristics	ATRIUM-9B ΔCPR	ATRIUM-9B $LHGRFAC_p$
	Slow TCV Closure		
100 / 105*	1 TCV closing in 2.0 seconds	0.31	0.98
100 / 81*	1 TCV closing in 2.0 seconds	0.31	1.00
80 / 105*	1 TCV closing in 2.0 seconds	0.35	0.97
80 / 57.2*	1 TCV closing in 2.0 seconds	0.40	1.00
80 / 105†	1 TCV closing in 2.0 seconds	0.54	0.85
80 / 57.2†	1 TCV closing in 2.0 seconds	0.49	0.92
60 / 105†	1 TCV closing in 2.0 seconds	0.62	0.83
60 / 35.1†	1 TCV closing in 2.0 seconds	0.59	0.95
40 / 105†	1 TCV closing in 2.0 seconds	0.75	0.78
25 / 105†,‡	1 TCV closing in 2.0 seconds	0.98	0.70
	LRNB No RPT		
100 / 105	NA	0.27	0.99
80 / 105	NA	0.27	1.00
	FWCF With FHOOS		
40 / 105	NA	0.61	0.88
25 / 105‡	NA	1.02	0.69
	FWCF No RPT With FHOOS		
25 / 105‡	NA	1.01	0.68

* Scram initiated by high neutron flux.

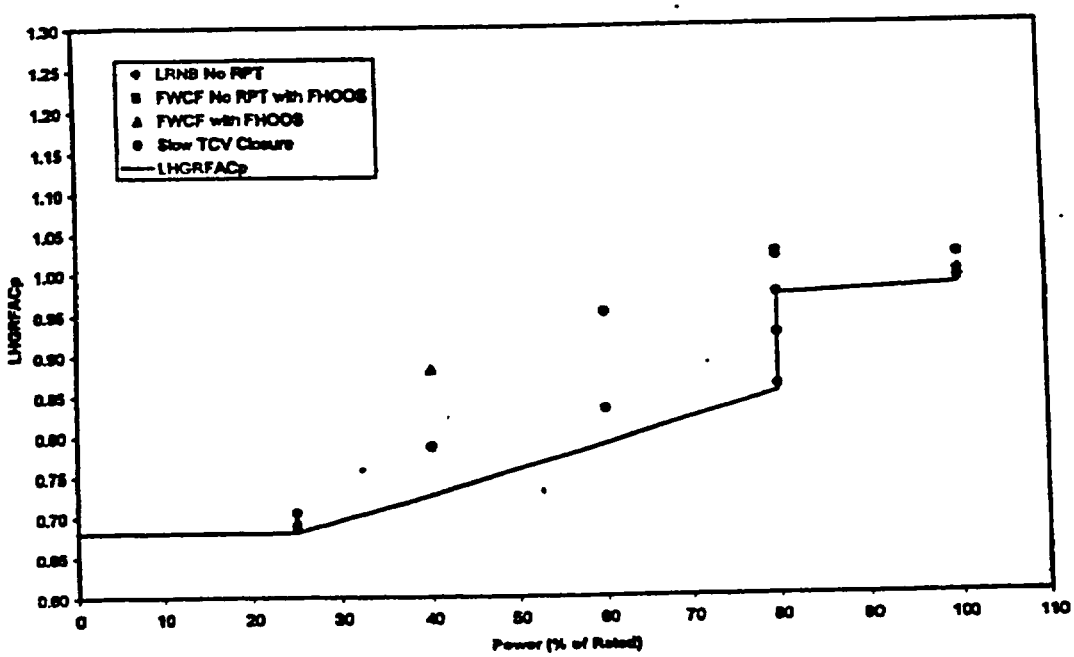
† Scram initiated by high dome pressure.

‡ [illegible] result in from an exposure prior to NEOC (14,000 MWd/MTU). The ΔCPR and $LHGRFAC_p$ [illegible]



Power (%)	$MCPR_p$ Limit
100	1.42
80	1.51
80	1.65
25	2.13
25	2.20
0	2.70

Figure 1 NEOC (14,000 MWd/MTU) Slow TCV Closure/FHOOS and/or No RPT Power-Dependent MCPR Limits for ATRIUM-9B Fuel With NSS Insertion Times



Power (%)	$LHGRFAC_p$ Multiplier
100	0.98
80	0.97
80	0.85
25	0.68
25	0.68
0	0.68

Figure 2 NEOC (14,000 MWd/MTU) Slow TCV Closure/FHOOS and/or No RPT Power-Dependent LHGR Multipliers for ATRIUM-9B Fuel With NSS Insertion Times

Technical Requirements Manual - Appendix J
L2C9A Reload Transient Analysis Results

Attachment 8

LaSalle Unit 2 Cycle 9 Operating Limits for Cycle Extension to 19,300 MWd/MTU

FRAMATOME ANP

An AREVA and Siemens company

FRAMATOME ANP, Inc.

August 9, 2002
DEG:02:125

Mr. F. W. Trikur
Exelon Nuclear
Nuclear Fuel Management
4300 Winfield Road
Warrenville, IL 60555

Dear Mr. Trikur:

LaSalle Unit 2 Cycle 9 Operating Limits for Cycle Extension to 19,300 MWd/MTU

Reference: 1) Exelon task order NFM-MW-B080, LaSalle 2 Cycle 9 Coastdown Analysis, July 9, 2002

2) Contract for Fuel Fabrication and Related Components and Services dated as of October 24, 2000 between Siemens Power Corporation and Commonwealth Edison Company for LaSalle Nuclear Plant.

In response to Reference 1 analyses have been performed to support extending operation at LaSalle Unit 2 Cycle 9 out to 19,300 MWd/MTU. Limits are established for base case operation and three equipment out-of-service scenarios. The analysis results and operating limits are presented in the attachment.

Very truly yours,

D. E. Garber
Project Manager

FRAMATOME ANP, Inc.
2101 Horn Rapids Road - Richland WA 99352
Tel.: 509-375-8100 Fax: 509-375-8402 www.us.framatome-anp.com

LaSalle Unit 2 Cycle 9 Operating Limits for Cycle Extension to 19,300 MWd/MTU With Technical Specification Scram Speeds

Exelon has determined that LaSalle Unit 2 Cycle 9 (L2C9) will exceed the current EOC licensing exposure of 18,458.2 MWd/MTU and requested (Reference 3) Framatome ANP, Inc. (FRA-ANP) to perform additional analyses to support operation to an exposure of 19,300 MWd/MTU for the following scenarios:

- Base case operation with TSSS.
- FHOOS operation with TSSS.
- Operation with no bypass and FHOOS with TSSS.
- Operation with any combination of TCV slow closure, no RPT or FHOOS with TSSS.

The current EOC operating limits for LaSalle Unit 2 Cycle 9 were provided in References 1 and 2, and support operation to a cycle exposure of 18,458.2 MWd/MTU. The limiting analyses from References 1 and 2 were analyzed to determine the operating limits for the cycle extension to 19,300 MWd/MTU. Additional power/flow state points were analyzed for certain events to ensure completeness in determining the operating limits. The analyses were performed with the Reference 4 parameters with the exceptions noted in Reference 3; FFTR/FHOOS temperature reduction, steam line pressure drop, and recirculation pump torque. This letter report summarizes the transient analysis results and operating limits to support the L2C9 cycle extension.

Cycle Extension

L2C9 was originally licensed to an EOC cycle exposure of 18,458.2 MWd/MTU. Recent discussions with Exelon indicate that L2C9 is expected to begin coastdown operation at approximately 17,300 MWd/MTU. Data provided by Exelon indicates that the cycle will extend coastdown operation to an exposure of approximately 19,020 MWd/MTU. In order to provide some conservatism and flexibility, additional full power capability was included. L2C9 is conservatively modeled to operate at rated power to a cycle exposure of 19,300 MWd/MTU.

TSSS Base Case Operation

The base case limits consider transient analysis results from the load rejection with no bypass (LRNB) and feedwater controller failure (FWCF) events. Reference 1 provided the EOC base case operating limits for TSSS scram times.

Table 1 presents the analysis results used to establish the TSSS base case limits for the cycle extension. Figures 1 and 2 present TSSS $MCPR_p$ limits to support base case operation for ATRIUM™-9B* and GE9 fuel, respectively. The sum of the L2C9 safety limit MCPR (1.11 per Reference 5) and the ΔCPR results from Table 1 are also presented in the figures. Figure 3 presents the base case $LHGRFAC_p$ multipliers for ATRIUM-9B fuel and the $LHGRFAC_p$ results from Table 1.

TSSS FHOOS Operation

Exelon requested that FRA-ANP provide a set of operating limits to protect operation for FHOOS. This set of limits considers transient analysis results from the FWCF with FHOOS and the LRNB with FHOOS events.

Table 2 presents the analysis results used to establish limits to protect operation in the FHOOS scenario for the cycle extension. Figures 4 and 5 present TSSS $MCPR_p$ limits to support operation with FHOOS for ATRIUM-9B and GE9 fuel, respectively. The sum of the L2C9 safety limit MCPR (1.11 per Reference 5) and the ΔCPR results from Table 2 are also presented in the figures. Figure 6 presents the FHOOS $LHGRFAC_p$ multipliers for ATRIUM-9B fuel and the $LHGRFAC_p$ results from Table 2.

TSSS FHOOS and TBVOOS Operation

Exelon requested that FRA-ANP provide a set of operating limits to protect operation in the FHOOS and TBVOOS scenario. This set of limits considers transient analysis results from the FWCF with TBVOOS, FWCF FHOOS with TBVOOS, FWCF with FHOOS and LRNB with FHOOS events. Reference 2 provided the EOC TBVOOS or FHOOS operating limits for TSSS scram times.

Table 2 presents the analysis results used to establish limits to protect operation in the FHOOS and TBVOOS scenario for the cycle extension. Figures 7 and 8 present TSSS $MCPR_p$ limits to support operation in the FHOOS and TBVOOS scenario for ATRIUM-9B and GE9 fuel, respectively. The sum of the L2C9 safety limit MCPR (1.11 per Reference 5) and the ΔCPR results from Table 2 are also presented in the figures. Figure 9 presents the FHOOS and TBVOOS $LHGRFAC_p$ multipliers for ATRIUM-9B fuel and the $LHGRFAC_p$ results from Table 2.

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* ATRIUM is a trademark of Framatome ANP.

TSSS TCV Slow Closure, No RPT or FHOOS Operation

Limits to support operation ~~with any combination of TCV slow closure,~~ no RPT or FHOOS consider transient analysis results for 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.) Reference 1 provided the EOC TSSS operating limits for the same EOOS scenarios.

Table 3 presents the analysis results used to establish the cycle extension limits for any combination of TCV slow closure, no RPT or FHOOS. Figures 10 and 11 present TSSS $MCPR_p$ limits to support operation with any combination of TCV slow closure, no RPT or FHOOS for ATRIUM-9B and GE9 fuel, respectively. The sum of the L2C9 safety limit MCPR (1.11 per Reference 5) and the ΔCPR results from Table 3 are also presented in the figures. Figure 12 presents the any combination of TCV slow closure, no RPT or FHOOS $LHGRFAC_p$ multipliers for ATRIUM-9B fuel and the $LHGRFAC_p$ results from Table 3.

Single-Loop Operation

Figures 1–12 provide the two-loop operation (TLO) $MCPR_p$ limits and $LHGRFAC_p$ multipliers for the L2C9 cycle extension. 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. 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 SLO have not been performed, FRA-ANP expects the TLO operation ΔCPR results would remain applicable in SLO for all scenarios. Reference 5 indicates the L2C9 TLO safety limit MCPR is 1.11 and the SLO safety limit MCPR is 1.12. Therefore, SLO $MCPR_p$ limits for base case, FHOOS, FHOOS and TBVOOS, and any combination of TCV slow closure, no RPT or FHOOS can be determined by adding 0.01 to the appropriate $MCPR_p$ limits reported in the above figures to account for the increase in safety limit MCPR. The ATRIUM-9B $LHGRFAC_p$ multipliers in Figures 3, 6, 9, and 12 remain applicable for SLO.

GE9 Mechanical Limits

References 8 and 9 provided the initial evaluations of the GE9 mechanical limits for L2C9. These evaluations were updated in References 1 and 2. An evaluation of the GE9 mechanical limits for the

rated power analyses reported in Tables 1–3 was performed. The cycle extension analysis results are bound by the previous limiting L2C9 GE9 1% strain results presented in References 8 and 9. Therefore, the adjustments (if any) currently applied to the GE9 fuel limits remain applicable for the cycle extension.

Licensing Applicability

References 5 and 6 provided the original L2C9 licensing analyses and limits for which FRA-ANP was responsible to a cycle exposure of 18,458.2 MWd/MTU. References 1 and 2 updated portions of the licensing analyses and limits for proposed ITS scram speeds and corrected fuel thermal conductivity. FRA-ANP has performed additional evaluations to determine the applicability of the current licensing analyses and limits to the L2C9 cycle extension. The evaluations demonstrated that the current analysis results and limits remain applicable for the L2C9 cycle extension with the exception of the $MCPR_p$ limits and $LHGRFAC_p$ multipliers.

The L2C9 operating limits provided in References 1 and 2 remain applicable to a cycle exposure of 18,458.2 MWd/MTU (core exposure of 30,266.2 MWd/MTU). The $MCPR_p$ limits and $LHGRFAC_p$ multipliers presented in Figures 1–12 must be used for operation beyond a cycle exposure of 18,458.2 MWd/MTU, and are applicable to a cycle exposure of 19,300 MWd/MTU. The base case $MCPR_p$ limits and $LHGRFAC_p$ multipliers are valid for any feedwater temperature within the upper and lower bounds defined by Reference 4, Item 3.12. The other limits support operation with up to a 120°F decrease in feedwater temperature from the nominal value.

Core Hydrodynamic Stability Analysis

The L2C9 stability analysis was updated for the extended cycle exposure of 19,300 MWd/MTU. For each power/flow point, decay ratios were calculated to determine the highest expected decay ratio throughout the cycle. Table 4 provides the updated results for the stability decay ratio analysis. Reference 6 provided the current stability analysis decay ratios. The cycle extension analysis was based on an updated STAIF methodology previously utilized for LaSalle Unit 1 Cycle 10.

For reactor operation under conditions of 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.

References

1. Letter, D. E. Garber (FRA-ANP) to R. J. Chin (Exelon), "LaSalle Unit 2 Cycle 9 Operating Limits for Proposed ITS Scram Times and Corrected Fuel Thermal Conductivity," DEG:01:046, March 22, 2001.

2. Letter, D. E. Garber (FRA-ANP) to R. J. Chin (Exelon), "LaSalle Unit 2 Cycle 9 NSS Base Case and TBVOOS or FHOOS Operating Limits for Proposed ITS Scram Times with Corrected Fuel Thermal Conductivity," DEG:01:076, May 15, 2001.

3. Exelon Task Order, LaSalle 2 Cycle 9 Coastdown Analysis, NFM-MW-B080, July 9, 2002.

4. EMF-2323 Revision 0, *LaSalle Unit 2 Cycle 9 Principal Transient Analysis Parameters*, Siemens Power Corporation, March 2000.

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

6. EMF-2437 Revision 0, *LaSalle Unit 2 Cycle 9 Reload Analysis*, Siemens Power Corporation, October 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. Letter, D. E. Garber (FRA-ANP) to R. J. Chin (Exelon), "LaSalle Unit 2 Cycle 9 Transient Power History Data for Confirming Mechanical Limits for GE9 Fuel," DEG:00:185, August 3, 2000.

9. Letter, D. E. Garber (FRA-ANP) to R. J. Chin (Exelon), "Additional Analysis for LaSalle Unit 2 Cycle 9 1% Plastic Strain Compliance for GE9 Fuel," DEG:00:213, September 6, 2000.

Table 1 Base Case Transient Analysis Results

Power / Flow	ATRIUM-9B ΔCPR	ATRIUM-9B $LHGRFAC_p$	GE9 ΔCPR
LRNB			
100 / 105	0.33	1.000	0.41
80 / 105	0.32	1.000	0.40*
60 / 105	0.31	1.023	0.37
FWCF			
100 / 105	0.26	1.055	0.32*
80 / 105	0.30	1.055*	0.36*
60 / 105	0.37	1.007*	0.42*
40 / 105	0.53*	0.931*	0.59*
25 / 105	0.82*	0.776*	0.90*

* The analysis results are from an exposure prior to 19,300 MWd/MTU. The ΔCPR and $LHGRFAC_p$ results are conservatively used to establish the thermal limits.

Table 2 TBVOOS and FHOOS Transient Analysis Results

Power / Flow	ATRIUM-9B ΔCPR	ATRIUM-9B $LHGRFAC_p$	GE9 ΔCPR
FWCF With TBVOOS			
100 / 105	0.35	0.971	0.42
80 / 105	0.38	1.000	0.46*
60 / 105	0.45	0.964*	0.52*
40 / 105	0.55	0.957	0.61
25 / 105	0.74	0.865	0.79
FWCF FHOOS With TBVOOS			
100 / 105	0.33	1.015	0.38
80 / 105	0.39	1.031	0.44
60 / 105	0.49	1.007	0.53
40 / 105	0.65	0.925	0.70
25 / 105	0.94	0.789	1.00
FWCF With FHOOS			
100 / 105	0.26	1.089	0.29
80 / 105	0.33	1.098	0.35
60 / 105	0.43*	0.964*	0.46*
40 / 105	0.59	0.957	0.62
25 / 105	1.06*	0.685*	1.13*
LRNB With FHOOS			
100 / 105	0.26	1.015	0.31
80 / 105	0.26	1.038	0.30

* The analysis results presented are from an exposure prior to 19,300 MWd/MTU. The ΔCPR and $LHGRFAC_p$ results are conservatively used to establish the thermal limits.

Table 3 EOOS Transient Analysis Results

Power / Flow	ATRIUM-9B ΔCPR	ATRIUM-9B $LHGRFAC_p$	GE9 ΔCPR
TCV Slow Closure			
100 / 105*	0.49	0.828	0.62
80 / 105*	0.45	0.894	0.54
80 / 57.2*	0.51‡	0.971‡	0.75‡
80 / 105†	0.57	0.854‡	0.66
80 / 57.2†	0.59‡	0.944‡	0.85‡
60 / 105†	0.50	0.944	0.58
40 / 105†	0.80	0.818	0.87
25 / 105†	1.00‡	0.754	1.00
LRNB No RPT			
100 / 105	0.46	0.799	0.61
80 / 105	0.39	0.871	0.49
FWCF No RPT			
40 / 105	0.50	0.964	0.57
25 / 105	0.68	0.871	0.75
FWCF No RPT With FHOOS			
40 / 105	0.61	0.925	0.67
25 / 105	1.04‡	0.675‡	1.11‡

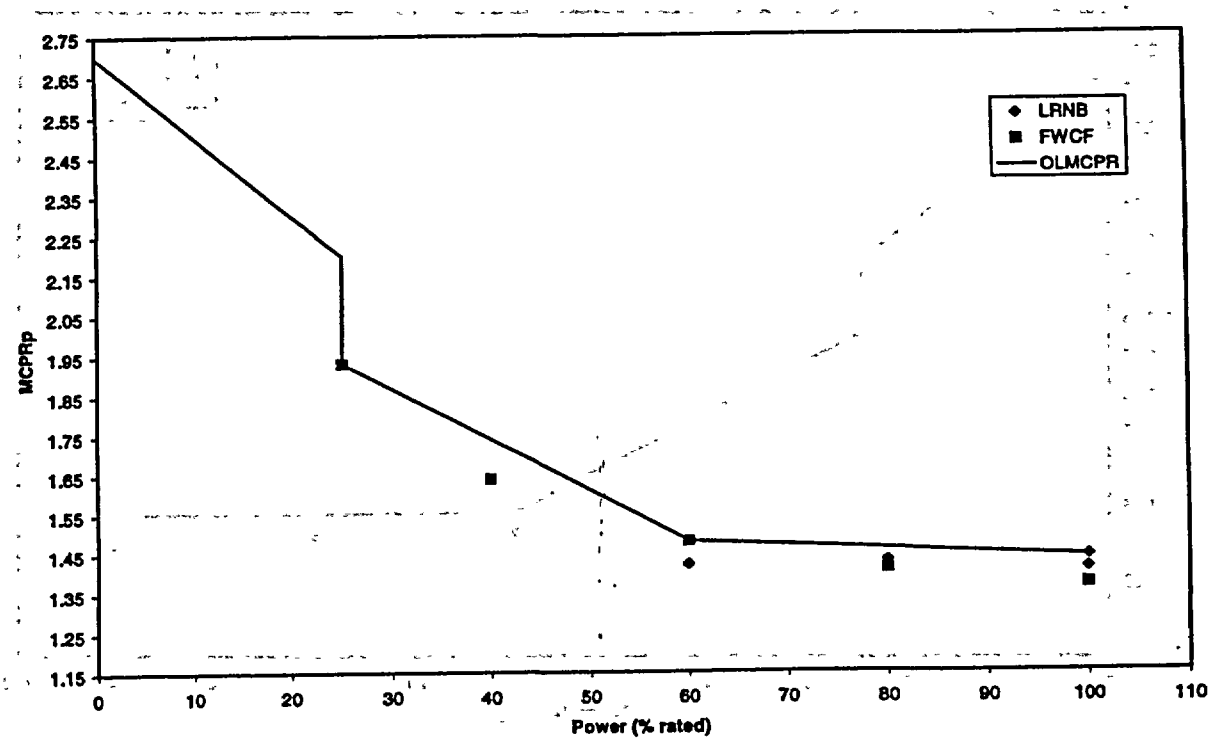
* Scram initiated by high neutron flux.

† Scram initiated by high dome pressure.

‡ The analysis results presented are from an exposure prior to 19,300 MWd/MTU. The ΔCPR and $LHGRFAC_p$ results are conservatively used to establish the thermal limits.

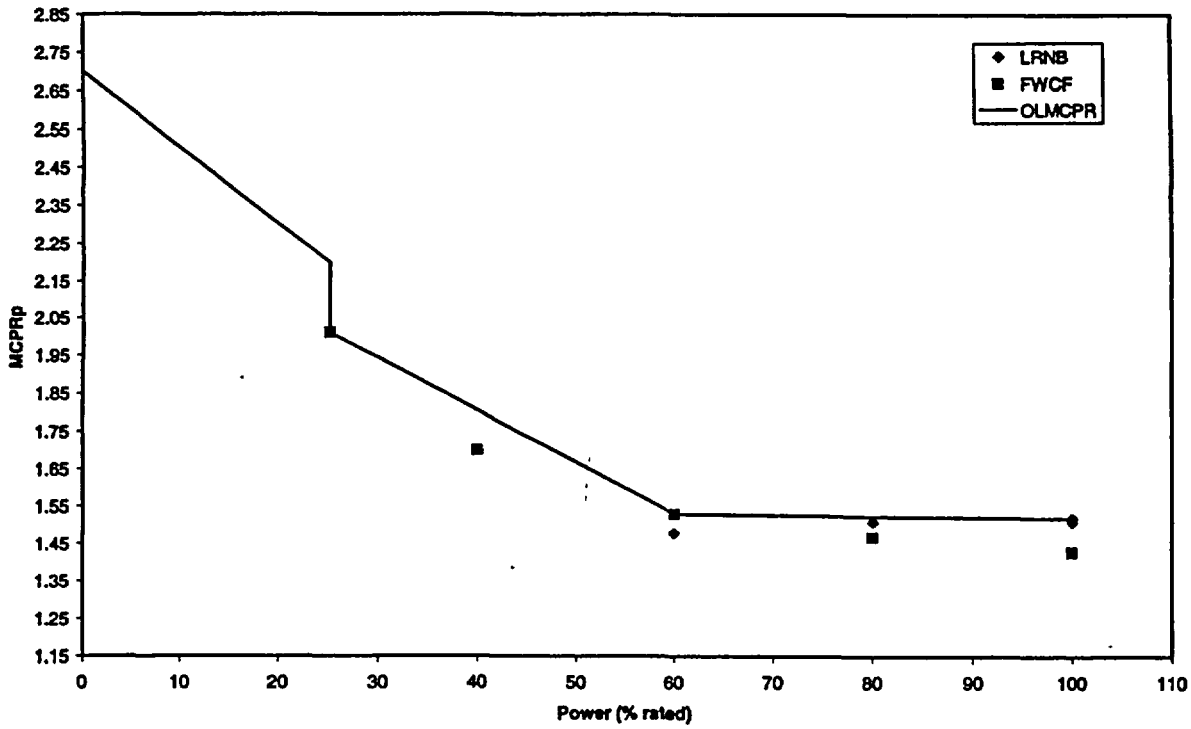
~~Table 4: Stability Analysis Decay Ratio Results~~

Power / Flow (%)	Maximum Global	Maximum Regional
30.1 / 26.6	0.59	0.53
31.6 / 29.2	0.42	0.50
61.9 / 45.0	0.67	0.88
73.6 / 50.0	0.73	0.95
78.2 / 60.0	0.52	0.63
82.4 / 60.0	0.57	0.72



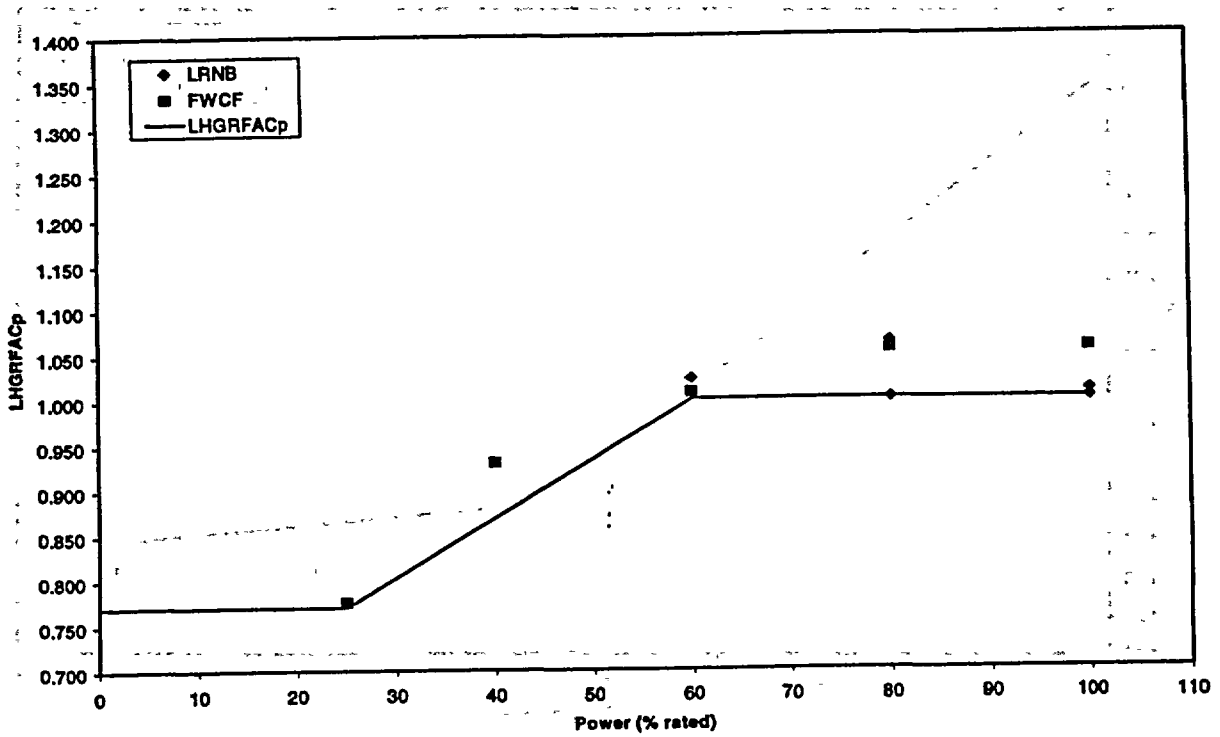
Power (%)	$MCPR_p$ Limit
100	1.44
60	1.48
25	1.93
25	2.20
0	2.70

Figure 1 Coastdown (19,300 MWd/MTU) Base Case Power-Dependent MCPR Limits for ATRIUM-9B Fuel with TSSS Insertion Times



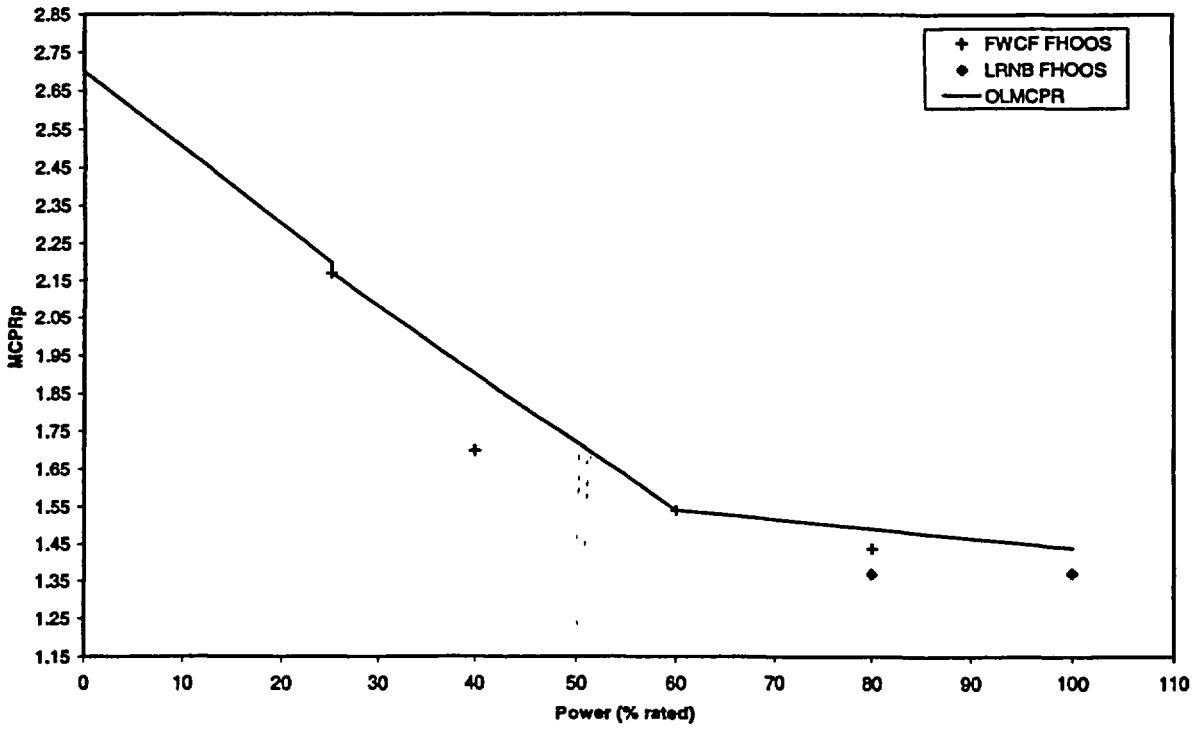
Power (%)	$MCPR_p$ Limit
100	1.52
60	1.53
25	2.01
25	2.20
0	2.70

Figure 2 Coastdown (19,300 MWd/MTU) Base Case Power-Dependent MCPR Limits for GE9 Fuel with TSSS Insertion Times



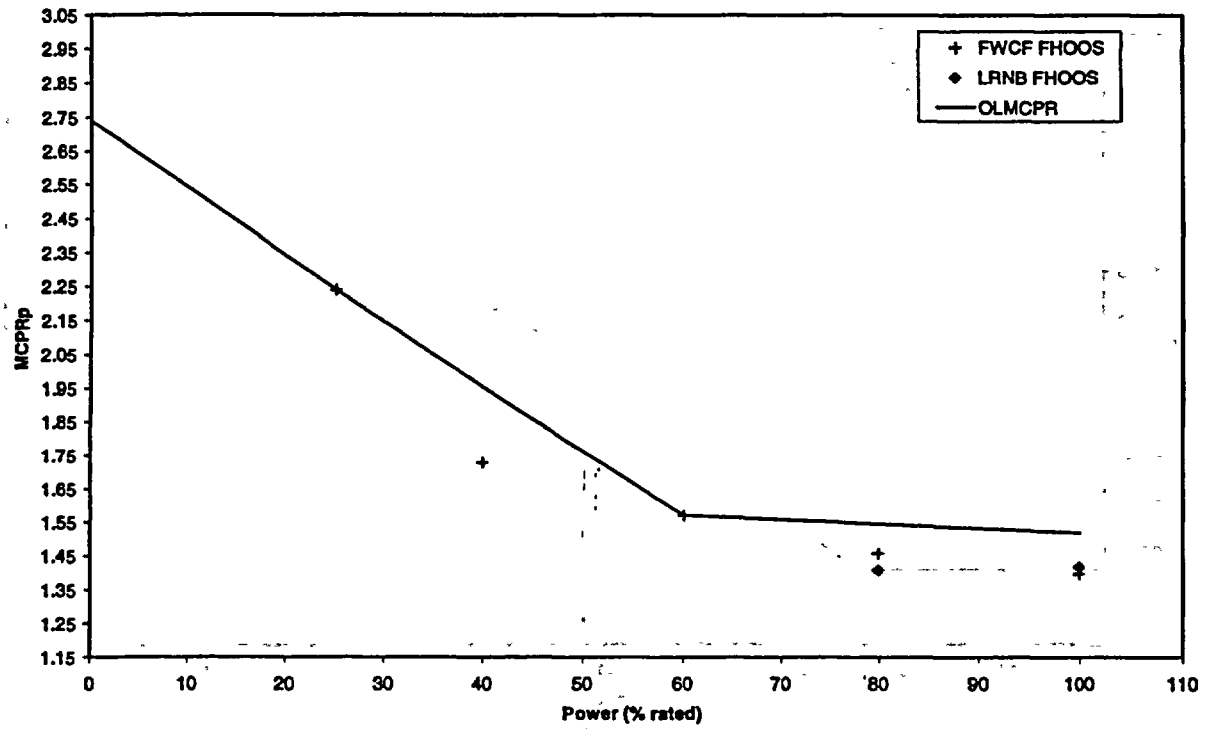
Power (%)	$LHGRFAC_p$ Multiplier
100	1.00
60	1.00
25	0.77
25	0.77
0	0.77

Figure 3 Coastdown (19,300 MWd/MTU)
Base Case Power-Dependent LHGR Multipliers
for ATRIUM-9B Fuel with TSSS Insertion Times



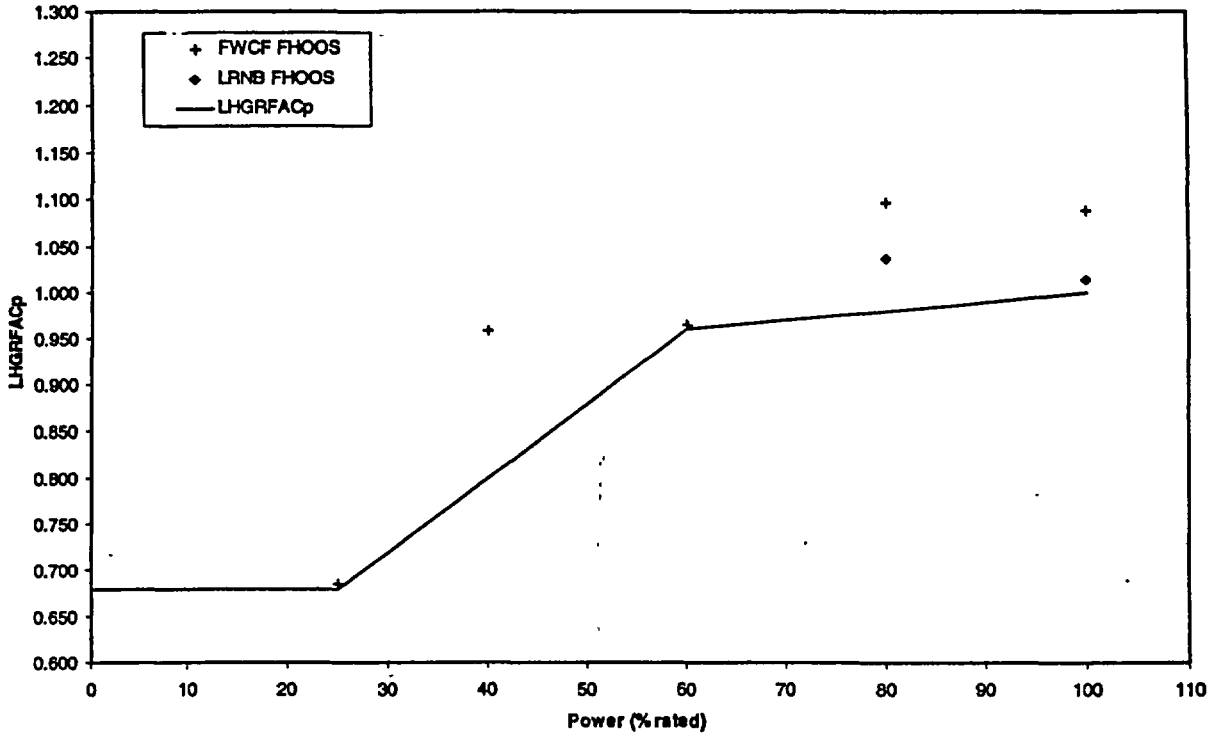
Power (%)	$MCPR_p$ Limit
100	1.44
60	1.54
25	2.17
25	2.20
0	2.70

Figure 4 Coastdown (19,300 MWd/MTU) FHOOS Power-Dependent MCPR Limits for ATRIUM-9B Fuel with TSSS Insertion Times



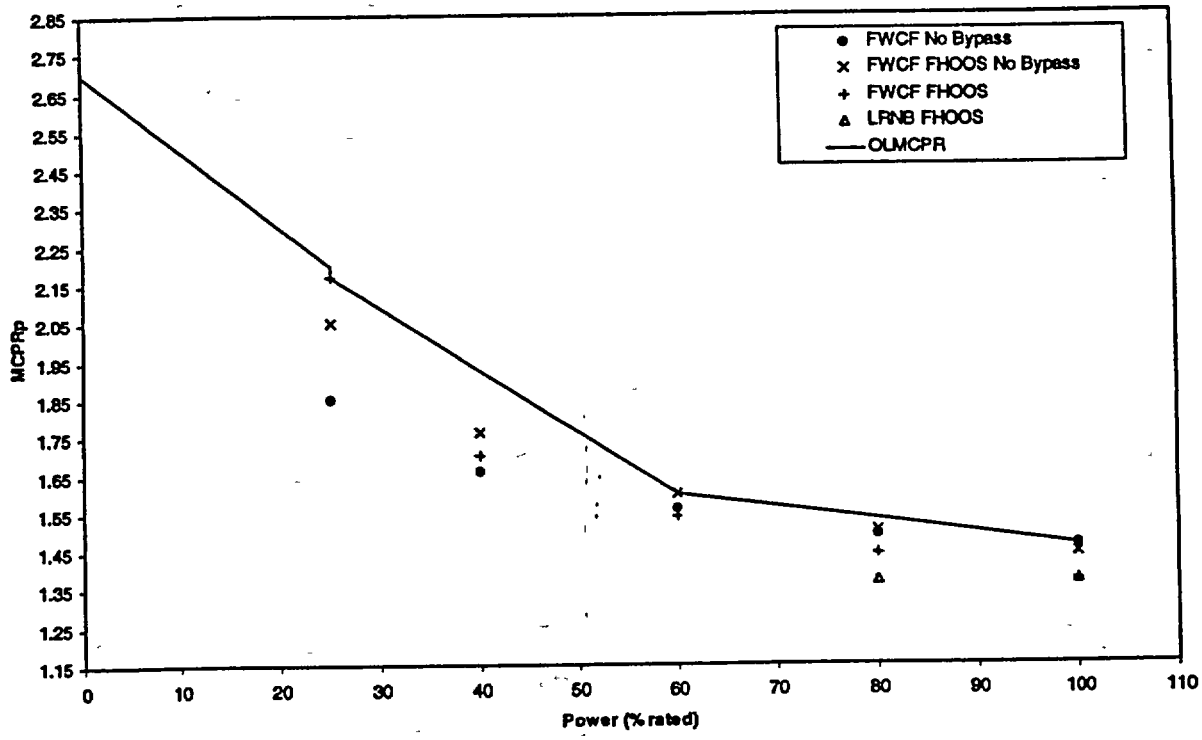
Power (%)	$MCPR_p$ Limit
100	1.52
60	1.57
25	2.24
25	2.24
0	2.74

Figure 5 Coastdown (19,300 MWd/MTU) FHOOS Power-Dependent MCPR Limits for GE9 Fuel with TSSS Insertion Times



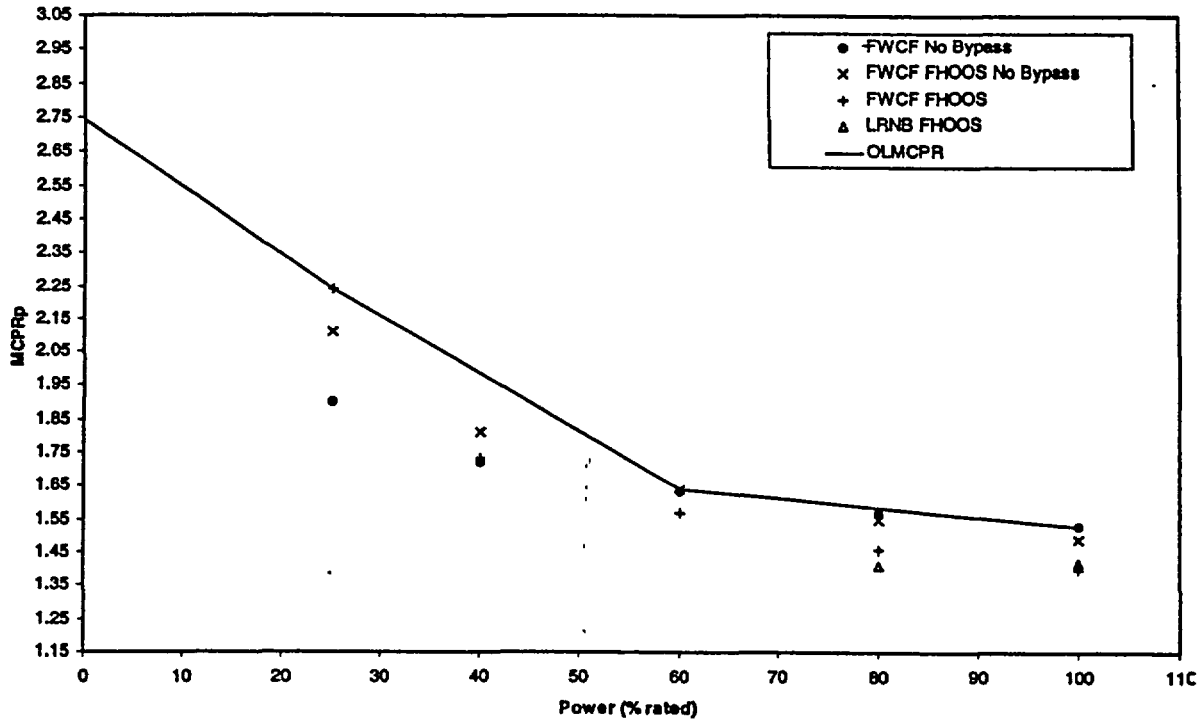
Power (%)	$LHGRFAC_p$ Multiplier
100	1.00
60	0.96
25	0.68
25	0.68
0	0.68

Figure 6 Coastdown (19,300 MWd/MTU) FHOOS Power-Dependent LHGR Multipliers for ATRIUM-9B Fuel with TSSS Insertion Times



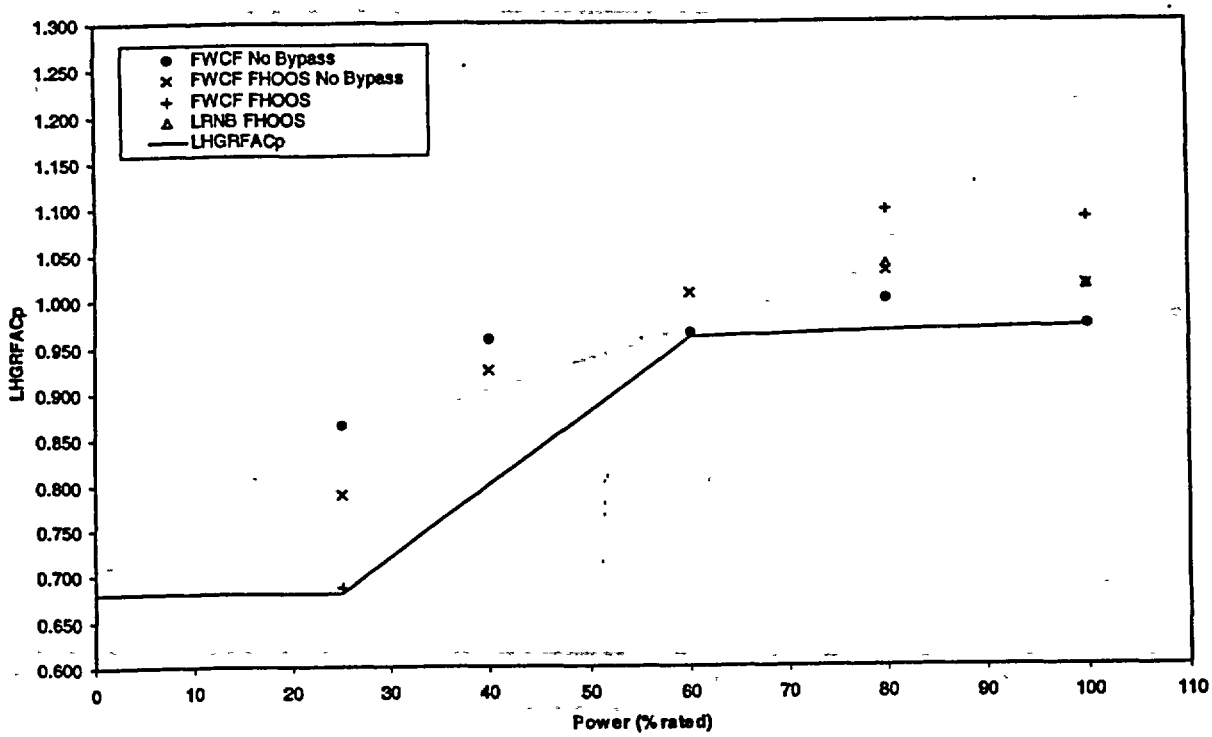
Power (%)	$MCPR_p$ Limit
100	1.46
60	1.60
25	2.17
25	2.20
0	2.70

Figure 7 Coastdown (19,300 MWd/MTU) FHOOS and No Bypass Power-Dependent MCPR Limits for ATRIUM-9B Fuel with TSSS Insertion Times



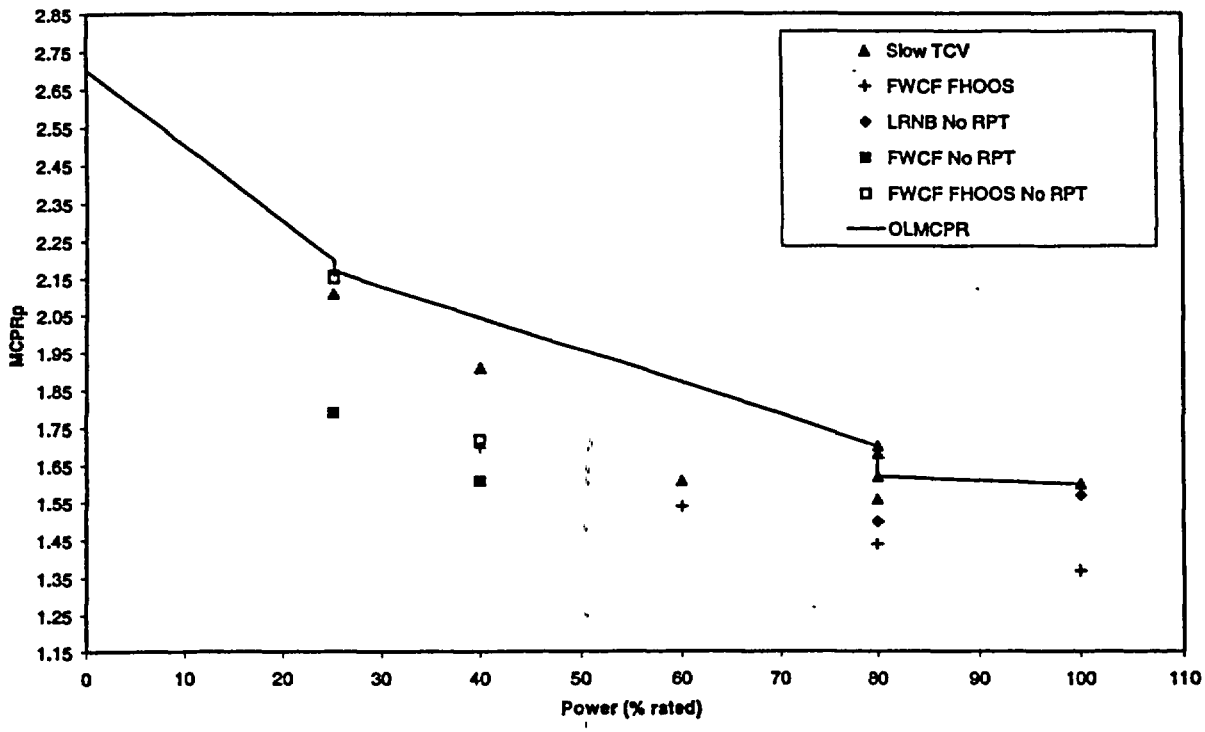
Power (%)	$MCPR_p$ Limit
100	1.53
60	1.64
25	2.24
25	2.24
0	2.74

Figure 8 Coastdown (19,300 MWd/MTU) FHOOS and No Bypass Power-Dependent MCPR Limits for GE9 Fuel with TSSS Insertion Times



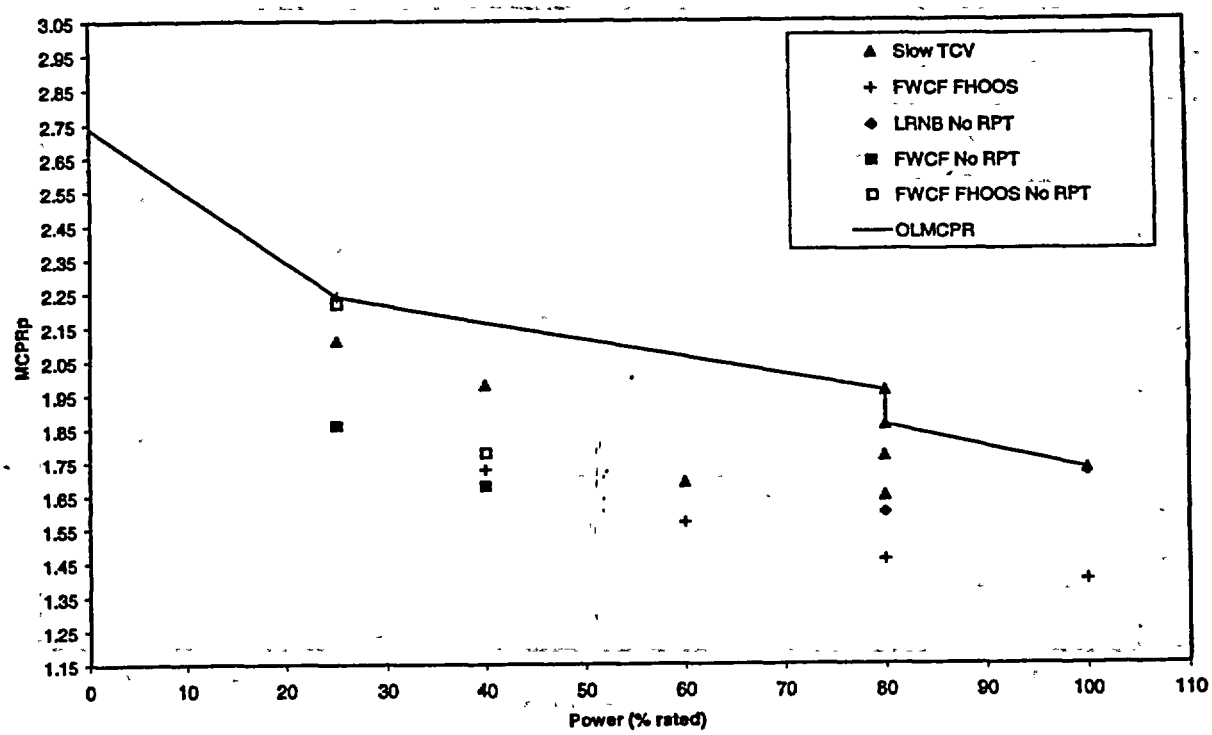
Power (%)	$LHGRFAC_p$ Multiplier
100	0.97
60	0.96
25	0.68
25	0.68
0	0.68

Figure 9 Coastdown (19,300 MWd/MTU) FHOOS and No Bypass Power-Dependent LHGR Multipliers for ATRIUM-9B Fuel with TSSS Insertion Times



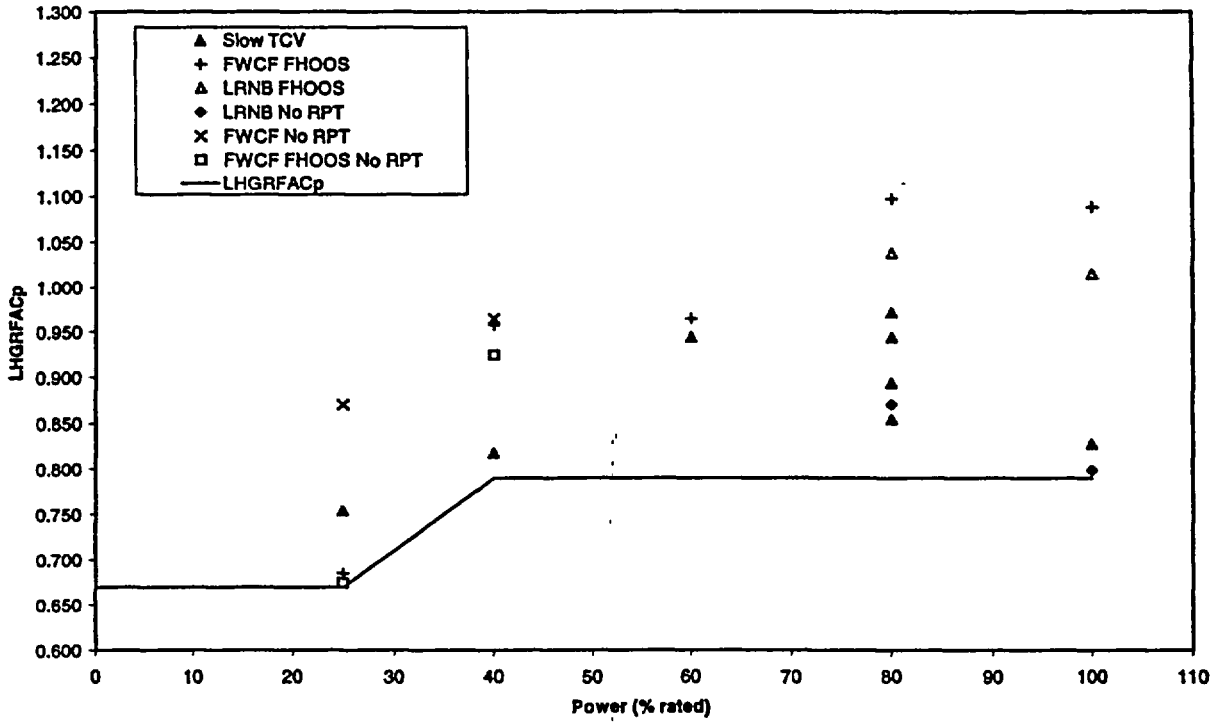
Power (%)	$MCPR_p$ Limit
100	1.60
80	1.62
80	1.70
25	2.17
25	2.20
0	2.70

Figure 10 Coastdown (19,300 MWd/MTU) TCV Slow Closure/FHOOS or No RPT Power-Dependent MCPR Limits for ATRIUM-9B Fuel with TSSS Insertion Times



Power (%)	$MCPR_p$ Limit
100	1.73
80	1.86
80	1.96
25	2.24
25	2.24
0	2.74

Figure 11 Coastdown (19,300 MWd/MTU) TCV Slow Closure/FHOOS or No RPT Power-Dependent MCPR Limits for GE9 Fuel with TSSS Insertion Times



Power (%)	$LHGRFAC_p$ Multiplier
100	0.79
80	0.79
80	0.79
40	0.79
25	0.67
25	0.67
0	0.67

Figure 12 Coastdown (19,300 MWd/MTU) TCV Slow Closure/FHOOS or No RPT Power-Dependent LHGR Multipliers for ATRIUM-9B Fuel with TSSS Insertion Times

Attachment 9

LaSalle Unit 2 Cycle 9 NSS Base Case and TBVOOS or FHOOS Operating Limits for Proposed ITS Scram Times With Corrected Fuel Thermal Conductivity

FRAMATOME ANP

May 15, 2001
DEG:01:076

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 NSS Base Case and TBVOOS or FHOOS Operating Limits for Proposed ITS Scram Times With 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: Letter, D. E. Garber to R. J. Chin (DEG:01:046) dated March 22, 2001. Subject: "LaSalle Unit 2 Cycle 9 Operating Limits for Proposed ITS Scram Times and Corrected Fuel Thermal Conductivity."

Ref: 4: Letter, D. E. Garber to R. J. Chin (DEG:01:038) dated February 27, 2001. Subject: "Transmittal of Condition Report 9191."

Ref: 5: Contract for Fuel Fabrication and Related Components and Services dated as of October 24, 2000 between Siemens Power Corporation and Commonwealth Edison Company for LaSalle Nuclear Plant.

Exelon is replacing the current Technical Specifications (Reference 1) with Improved Technical Specifications (ITS) during LaSalle Unit 1 Cycle 9 (L1C9) operation. The operating limits for L1C9 (Reference 2) were established consistent with the scram times presented in Reference 1 and are not consistent with the proposed ITS surveillance times. Exelon requested that FRA-ANP perform analyses to address a mid-cycle transition to the ITS for the turbine bypass valves out-of-service (TBVOOS) or feedwater heaters out-of-service (FHOOS) scenario. Reference 3 describes the determination of analytical scram times consistent with the ITS. Reference 4 identifies an error in the fuel thermal

Framatome ANP Richland, Inc.

2101 Horn Rapids Road
Richland, WA 99352

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Fax: (509) 375-8402

conductivity used in the transient analyses for LaSalle. A reevaluation of the nominal scram speed (NSS) limits previously provided in Reference 2 with the corrected fuel thermal conductivity is also presented.

The attachment provides L2C9 $MCPR_p$ limits and $LHGRFAC_p$ multipliers that support operation in either the TBVOOS or FHOOS scenarios. The limits are based on transient analyses that used the Reference 3 analytical scram times and the corrected fuel thermal conductivity. Limits are also presented for the base case operation with NSS insertion times.

Results based on the ITS scram speeds and the corrected fuel thermal conductivity that demonstrate compliance with the ASME overpressurization requirements are also presented in the attachment.

Very truly yours,

David Garber
Project Manager

Attachment

bcc:
O. C. Brown, 34
D. G. Carr, 23
R. E. Collingham, 18
M. E. Garrett, 23
A. N. Ham, 23
J. M. Haun, 34
D. B. McBurney, 23
P. D. Wimpy, 34
File: _____
LB

LaSalle Unit 2 Cycle 9 NSS Base Case and TBVOOS or FHOOS Operating Limits for Proposed ITS Scram Times With Corrected Fuel Thermal Conductivity

Reference 2 presents $MCPR_p$ limits and $LHGRFAC_p$ multipliers that protect several equipment-out-of-service (EOOS) scenarios, including turbine bypass valves out-of-service (TBVOOS) and feedwater heaters out-of-service (FHOOS). The Reference 2 limits are based on the limiting EOOS condition (TCV slow closure/FHOOS and/or no RPT) and include the effects of ITS scram speeds and the corrected fuel thermal conductivity (Reference 3). Framatome ANP Richland, Inc. (FRA-ANP) provided proposed ITS surveillance scram times to Exelon in Reference 2, Table 1.

Comparison of the Reference 1 analysis results show the TCV slow closure results are, in general, significantly larger than either the TBVOOS or FHOOS results. Therefore, the limits based on TCV slow closure/FHOOS and/or no RPT have considerable margin for the TBVOOS and FHOOS scenarios. As a result, Exelon has requested that FRA-ANP provide a set of limits that protects the TBVOOS and FHOOS scenarios but is less conservative than the Reference 2 EOOS limits. The maximum overpressurization analysis has also been reevaluated to include the effects of ITS scram speeds and the corrected fuel thermal conductivity.

Additionally, the limiting nominal scram speed (NSS) base case transient analyses have been reanalyzed to quantify the effect of the corrected fuel thermal conductivity.

TBVOOS or FHOOS

Exelon requested that FRA-ANP provide a set of operating limits to protect operation in either the TBVOOS or FHOOS scenarios. This set of limits considers transient analysis results from the feedwater controller failure (FWCF) with TBVOOS and FWCF with FHOOS events. In order to reduce the workscope required to establish new limits, only a subset of the analyses reported in Reference 1 has been reanalyzed. Review of Figures 5.1–5.3 and 5.7–5.9 in Reference 1 show that the FWCF with TBVOOS analyses are limiting at 60% power and above. The FWCF with FHOOS scenario is limiting below 60% power. Additionally, these figures show that there is considerable margin between the analysis results and the limits at 40% power.

Tables 5.1 and 5.3 of Reference 1 were reviewed to determine which specific FWCF analyses required reanalysis to establish the limits. Table 1 presents the analysis results required to adequately establish limits to protect operation in the TBVOOS or FHOOS scenarios.

Figures 1 and 2 present the limits to support operation in either TBVOOS or FHOOS scenarios for the ATRIUM™-9B* and GE9 fuel, respectively. The sum of the L2C9 safety limit MCPR (1.11 per Reference 1) and the ΔCPR results from Table 1 are also presented in the figures. Figure 3 presents the ATRIUM-9B LHGRFAC$_p$ multipliers and the LHGRFAC$_p$ results from Table 1.

NSS Base Case Operation

Reference 1 provided base case operating limits for the NSS scram times. After Reference 1 was issued, FRA-ANP informed Exelon of an error in the fuel thermal conductivity used in the COTRANSA2 calculations (Reference 3). The limiting analyses provided in Reference 1 have been reanalyzed using the corrected fuel thermal conductivity. The NSS base case limits consider transient analysis results from the LRNB and FWCF events.

Review of Tables 3.3 and 3.4 of Reference 1 show that the FWCF analyses are limiting for all power levels at or below 60% power; the LRNB event is limiting above 60% power. Additionally, Figures 3.14, 3.15, and 3.17 of Reference 1 show that there is considerable margin between the analysis results and the limits at the 40% power level. Table 2 presents the analysis results required to adequately establish the NSS base case limits.

Figures 4 and 5 present the revised base case NSS MCPR$_p$ limits for the ATRIUM-9B and GE9 fuel, respectively. The sum of the L2C9 safety limit MCPR (1.11 per Reference 1) and the ΔCPR results from Table 2 are also presented in Figures 4 and 5. The NSS base case LHGRFAC$_p$ results from Table 2 and the resulting LHGRFAC$_p$ multipliers are presented in Figure 6.

Single-Loop Operation

Reference 2 states that single-loop operation (SLO) limits are obtained by applying the increase in MCPR safety limit between two-loop operation (TLO) and SLO to the TLO limits. This is applicable for both the ITS EOOS and NSS limits contained herein.

GE9 Mechanical Limits

Reference 4 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 1 and 2 was performed. It was demonstrated that the GE9 mechanical limits criteria have been met for the implementation of ITS for

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* ATRIUM is a trademark of Framatome ANP.

the TBVOOS and FHOOS scenarios. The GE9 mechanical limits criteria have also been met for operation with NSS scram times.

Maximum Overpressure Analysis

The limiting overpressurization event (MSIV closure), as described in Section 7 of Reference 1, was reanalyzed with ITS scram times and the corrected fuel thermal conductivity. The transient response is similar to that presented in Reference 1. The maximum pressure of 1345 psig occurs in the lower plenum. The maximum dome pressure is 1319 psig. The results demonstrate that the maximum vessel pressure limit of 1375 psig and dome pressure limit of 1325 psig are not exceeded.

References

1. EMF-2440 Revision 0, *LaSalle Unit 2 Cycle 9 Plant Transient Analysis,* Siemens Power Corporation, October 2000.
2. Letter, D. E. Garber (FRA-ANP) to R. J. Chin (Exelon), "LaSalle Unit 2 Cycle 9 Operating Limits for Proposed ITS Scram Times and Corrected Fuel Thermal Conductivity," DEG:01:046, March 22, 2001.
3. Letter, D. E. Garber (FRA-ANP) to R. J. Chin (Exelon), "Transmittal of Condition Report 9191," DEG:01:038, February 27, 2001.
4. 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.

Table 1 TBVOOS and FHOOS Transient Analysis Results With Proposed ITS Scram Times and Corrected Fuel Thermal Conductivity

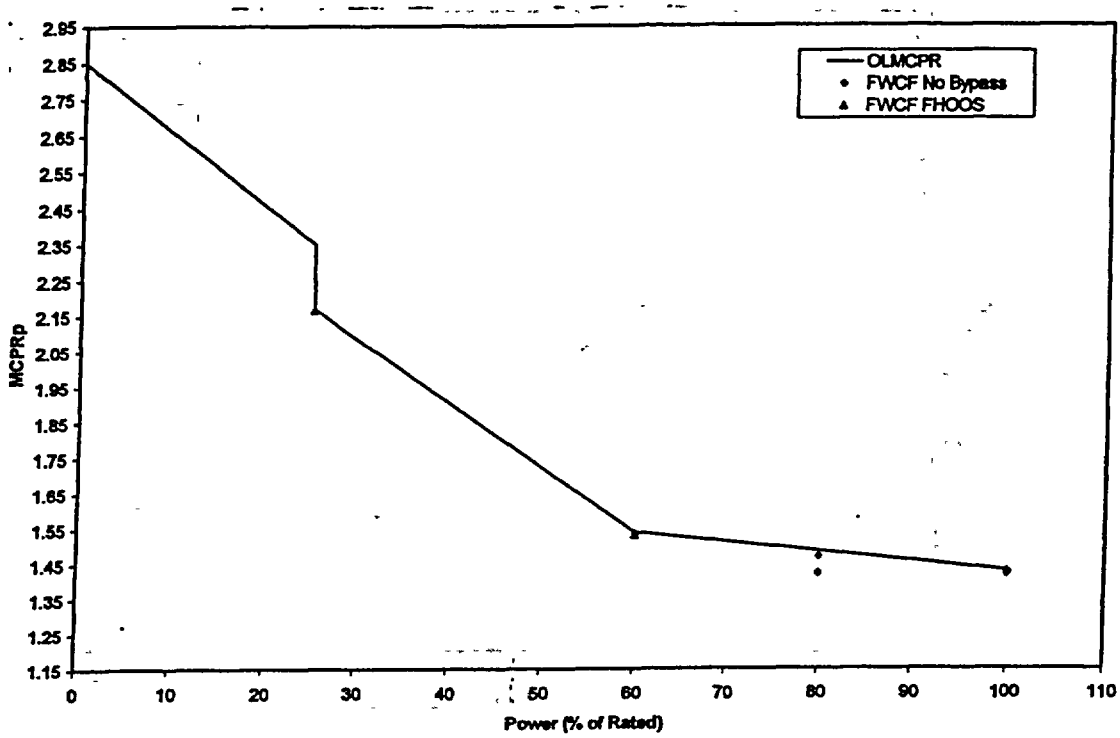
Power / Flow	ATRIUM-9B ΔCPR	ATRIUM-9B $LHGRFAC_p$	GE9 ΔCPR
FWCF With TBVOOS			
100 / 105	0.32	1.02	0.41
100 / 81	0.32	1.00	0.41
80 / 105	0.36	1.02	0.46
80 / 57.2	0.31	1.06	0.41
60 / 105	0.43*	0.96*	0.52
FWCF With FHOOS			
60 / 105	0.43*	0.96*	0.46
25 / 105	1.06*	0.68*	1.13*

* 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 2 NSS Base Case Transient Analysis Results With Corrected Fuel Thermal Conductivity

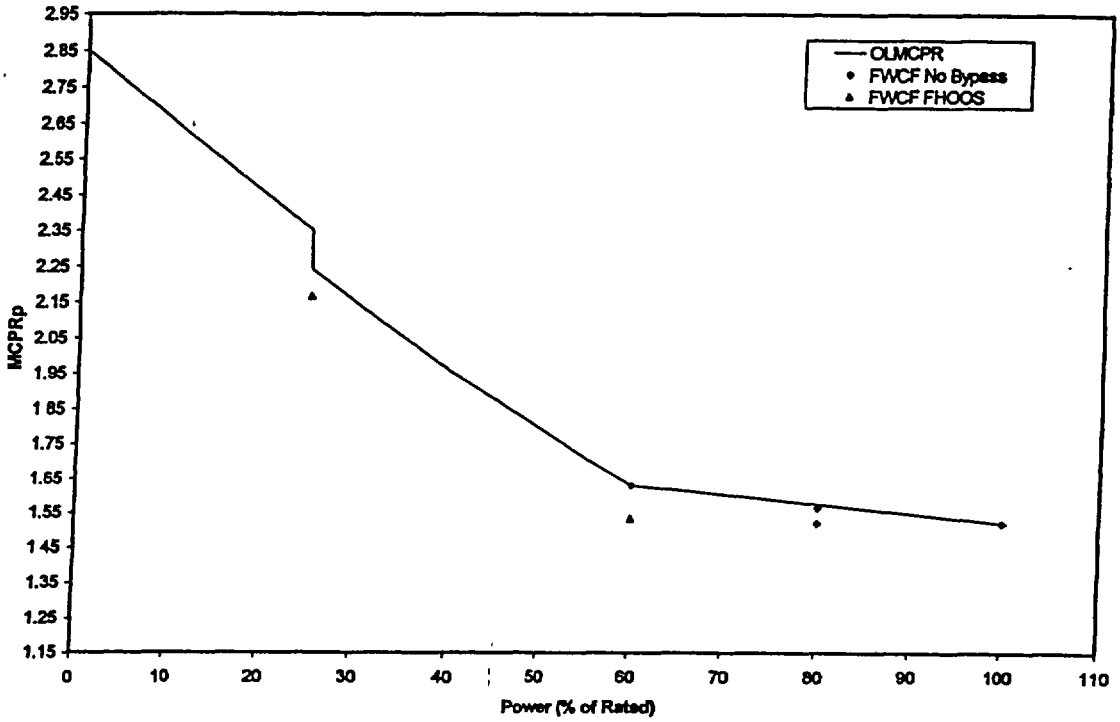
Power / Flow	ATRIUM-9B ΔCPR	ATRIUM-9B $LHGRFAC_p$	GE9 ΔCPR	Peak Neutron Flux (% rated)	Peak Heat Flux (% rated)
LRNB					
100 / 105	0.28	1.02	0.38	388	124
80 / 105	0.28	1.04	0.37	305	98
FWCF					
60 / 105	0.33	1.04*	0.40	189	79
25 / 105	0.80*	0.78*	0.88*	67*	44*

* 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.



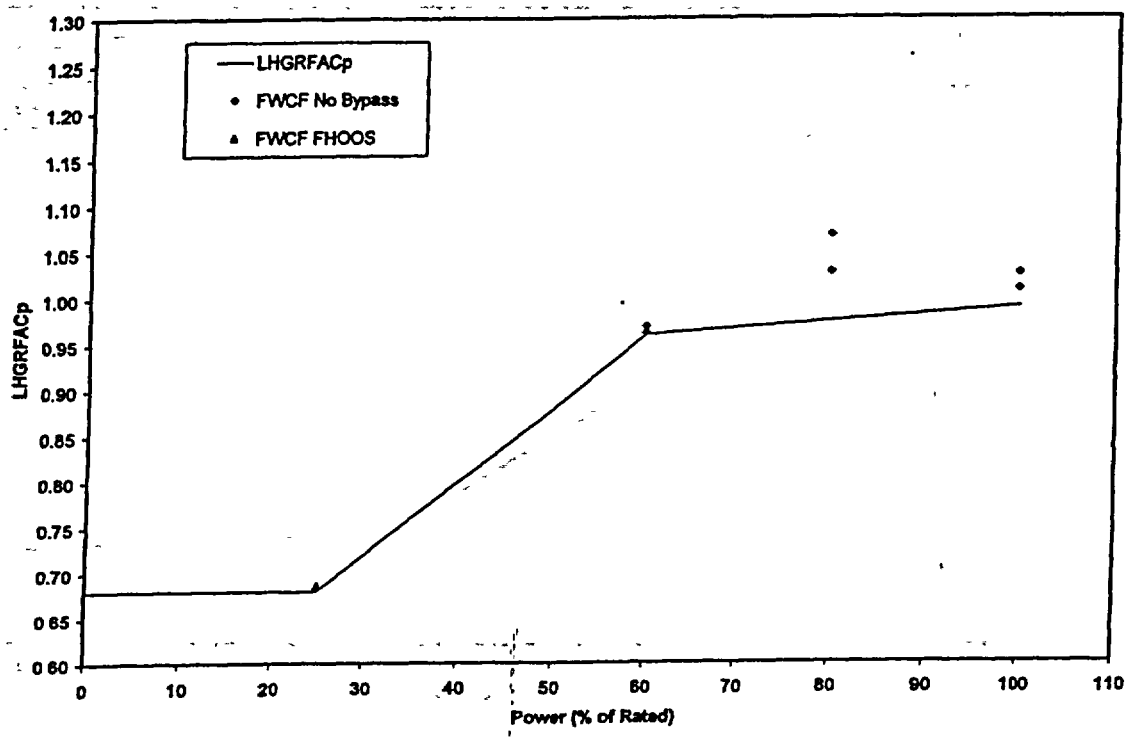
Power (%)	$MCPR_p$ Limit
100	1.43
60	1.54
25	2.17
25	2.35
0	2.85

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



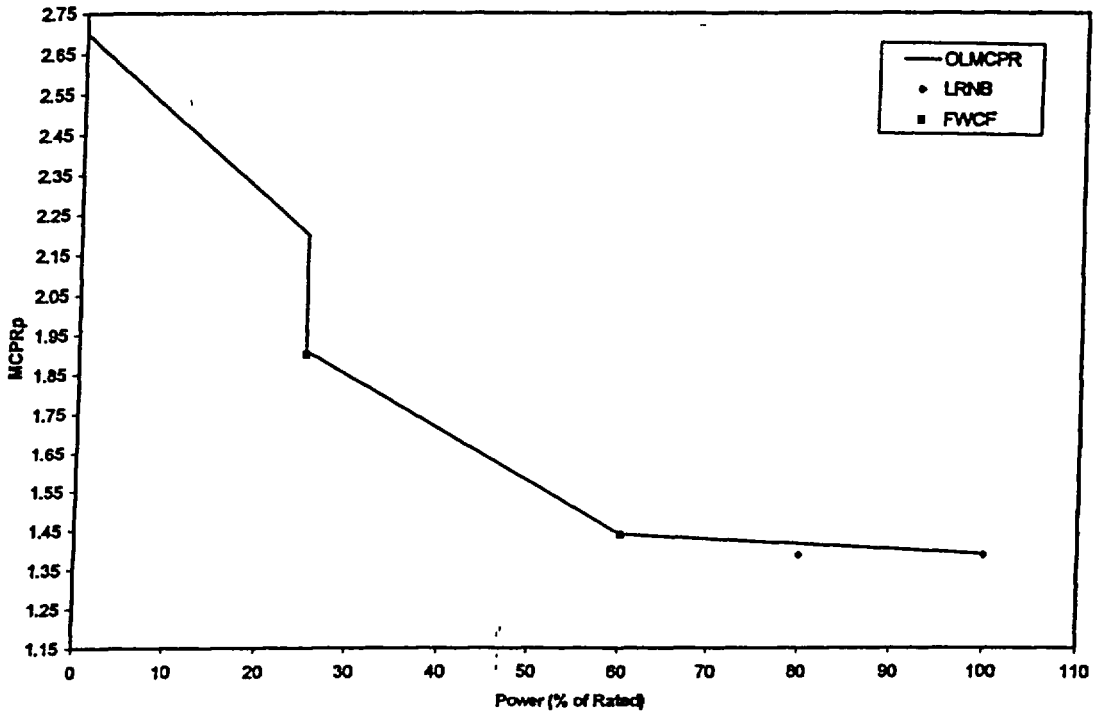
Power (%)	$MCPR_p$ Limit
100	1.52
60	1.63
25	2.24
25	2.35
0	2.85

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



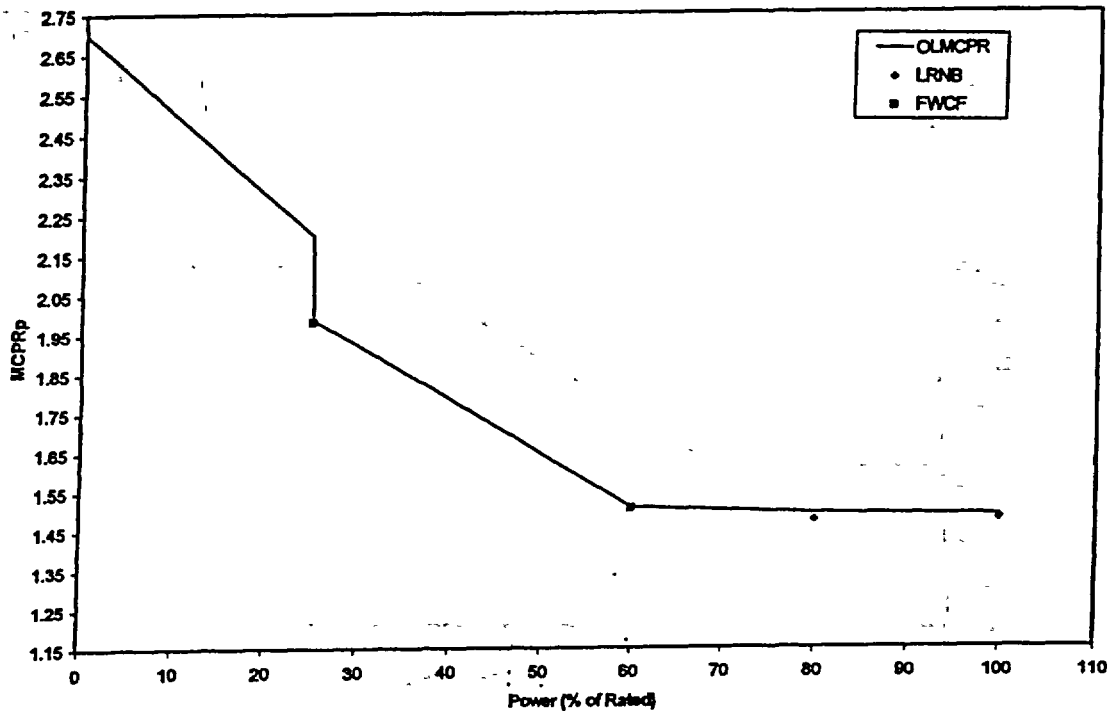
Power (%)	$LHGRFAC_p$ Multiplier
100	0.99
60	0.96
25	0.68
25	0.68
0	0.68

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



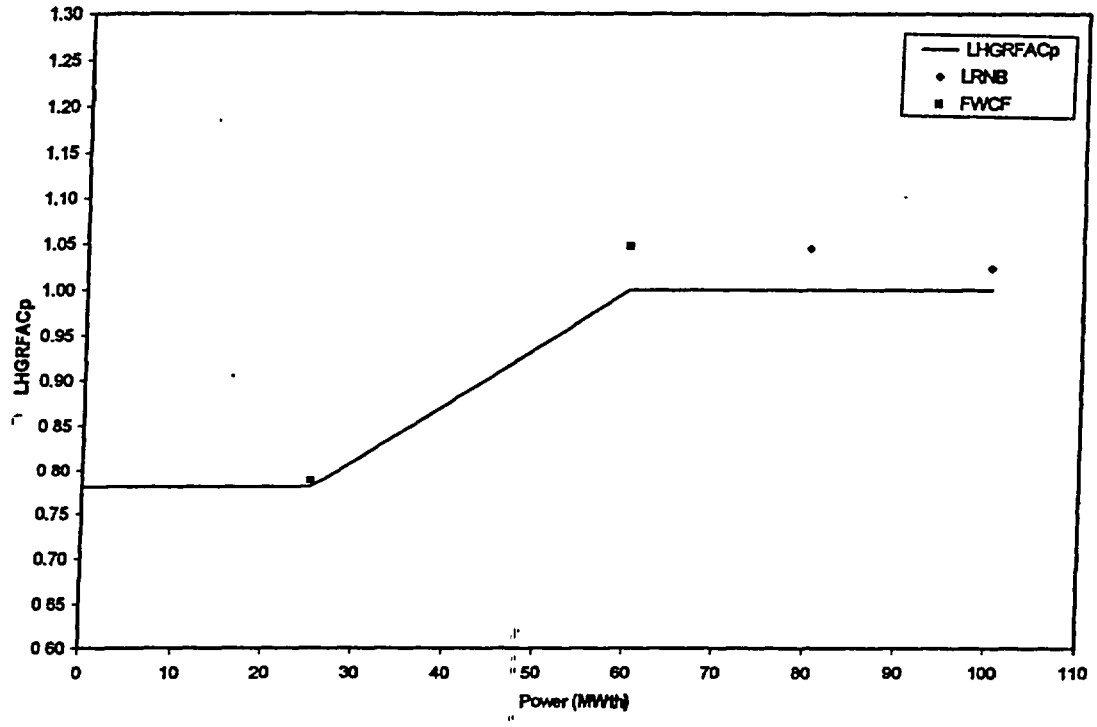
Power (%)	$MCPR_p$ Limit
100	1.39
60	1.44
25	1.91
25	2.20
0	2.70

Figure 4 EOC NSS Base Case Power-Dependent MCPR Limits for ATRIUM-9B Fuel With Corrected Fuel Thermal Conductivity



Power (%)	$MCPR_p$ Limit
100	1.49
60	1.51
25	1.99
25	2.20
0	2.70

Figure 5 EOC NSS Base Case Power-Dependent MCPR Limits for GE9 Fuel With Corrected Fuel Thermal Conductivity



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

Figure 6 EOC NSS Base Case Power-Dependent LHGR Multipliers for ATRIUM-9B Fuel With Corrected Fuel Thermal Conductivity

Attachment 10

Transmittal of Licensing Evaluation for LaSalle Unit 2 Cycle 9A

FRAMATOME ANP

An AREVA and Siemens Company

October 30, 2002
DEG:02:153

Mr. F. W. Trikur
Exelon Generation Company
4300 Winfield Road
Warrenville, IL 60555

Dear Mr. Trikur:

Licensing Evaluation for LaSalle Unit 2 Cycle 9A

Reference: 1) Contract for Fuel Fabrication and Related Components and Services dated as of October 24, 2000 between Siemens Power Corporation and Commonwealth Edison Company for LaSalle Nuclear Plant.

LaSalle Unit 2 was shut down on October 25 to perform in-core fuel sipping to identify the location of failed fuel. Five failed assemblies were replaced. The attached assessment is provided in support of continued core licensing analysis applicability. This assessment is based on the revised core loading provided in the reference.

Relative to startup, FANP recommends Exelon perform the normal tests required for the restart of the reactor from an unplanned mid-cycle shutdown. It has been shown that the revised Cycle 9A core loading behaves globally the same as the original core loading. Hence, FANP does not believe this needs to be treated as a new reload startup, e.g., the χ^2 test is not required.

If Exelon intends to monitor this revised core as a new cycle (resetting the cycle exposure to zero) then the POWERPLEX®-II CMSS* needs to be cleared as described in the POWERPLEX User's Manual, Section 4.1.4, except for the GAF- file. The last LPRM calibration is still valid and will be utilized appropriately as long as the ELPRM and CELPRM arrays are preserved from the original Cycle 9.

Very truly yours,

D. E. Garber
Project Manager

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* POWERPLEX is a registered trademark of Framatome ANP.

Licensing Analysis Evaluation for LaSalle Unit 2 Cycle 9A

Summary

A revised core design for LaSalle Unit 2 Cycle 9 (L2C9A) will result from a late cycle shuffle to discharge and replace assemblies with failed fuel rods. Fuel sipping has determined that there are 5 ATRIUM™-9B* assemblies with failed fuel rods. These 5 ATRIUM-9B assemblies will be discharged from the core and replaced with previously discharged GE9 assemblies. Reference 1 presents the loading plan for the L2C9A core. With the change in core design, a review of the licensing analyses and operating limits is necessary to support operation to the end of Cycle 9A.

References 2 and 3 provided results of the original LaSalle Unit 2 Cycle 9 licensing analysis performed by Framatome ANP (FANP). References 4 and 5 were issued to provide modified operating limits to support the change to ITS scram speeds and correct the thermal conductivity used in the transient analyses. Operating limits to support FFTR/coastdown operation for L2C9 were provided in Reference 6. The purpose of this evaluation is to assess the continued applicability of the operating limits provided in References 2, 4, 5, and 6 for LaSalle Unit 2 Cycle 9A.

Each of the licensing analyses identified below has been reviewed and dispositioned based on the extent of the core loading changes, the sensitivity of the event to the changes and conservatisms in the licensing analyses. It is concluded that the L2C9 operating limits presented in Reference 2 as modified by References 4 and 5 remain applicable for Cycle 9A to a Cycle 9A exposure of 1492.3 MWd/MTU. The operating limits provided in Reference 6 are applicable for Cycle 9A operation to a cycle exposure of 2334.1 MWd/MTU. Exelon should ensure that the axial power shape at end of full power remains in compliance with the licensing basis power shape reported in Reference 2.

Thermal-Hydraulic Design

The fuel designs which make up the revised Cycle 9 core loading are the same as the fuel designs in the original Cycle 9 core loading. The changes in the core loading have negligible impact on the thermal-hydraulic characteristics of the core and are explicitly accounted for in the core monitoring system.

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* ATRIUM is a trademark of Framatome ANP.

Safety Limit

Minimum critical power ratio (MCPR) safety limit is primarily sensitive to core radial power and local peaking distributions. Calculations were performed to evaluate the impact of the Cycle 9A core design on the MCPR safety limit. The results showed that for the same MCPR safety limit, fewer rods are expected to experience boiling transition than in the L2C9 MCPR safety limit analysis reported in Reference 7. Therefore, the L2C9 two-loop operation MCPR safety limit of 1.11 and single-loop operation MCPR safety limit of 1.12 remain applicable for Cycle 9A.

Cold Shutdown Margin

(To be addressed by Exelon.)

Standby Liquid Control System

(To be addressed by Exelon.)

Stability

The changes caused by the shuffle from Cycle 9 to Cycle 9A have a minimal impact on the core parameters e.g., core void coefficient, axial and radial power peaking (see Table 1) that could significantly affect the stability analysis. Therefore, the stability analysis reported in Reference 6 remains applicable for Cycle 9A.

Core-Wide Pressurization Transients

Core-wide pressurization transients occur when a pressurization wave collapses the voids in the reactor core and the resulting reactivity insertion creates a power spike. The results of these events, along with the results of the control rod withdrawal error (CRWE) event are used to set the power-dependent MCPR operating limits. Pressurization transients are sensitive to the core average reactivity characteristics, void coefficient and the core average axial power profile. The L2C9A changes to the core design do not have a significant effect on the core average characteristics. The XLRNOR parameter used in the transient analyses is related to the void coefficient and provides a measure of the change in core reactivity for a given change in pressure. A higher value of XLRNOR makes pressurization events more severe. The XLRNOR value for Cycle 9A is slightly lower than the L2C9 value at the equivalent exposure. A comparison of the L2C9 licensing basis axial power profile and the L2C9A power shape at the equivalent EOFP exposure is presented in Figure 1. The comparison shows that the L2C9 power shape is limiting because there is less power in the bottom third of the core. Since the L2C9 licensing analyses used a more top-peaked axial power shape and a more severe void coefficient (XLRNOR), the L2C9 analyses and power-dependent operating limits remain applicable for L2C9A.

Flow Excursion Transients

A flow excursion transient is a core-wide transient in which there is an unplanned increase in core flow. The maximum attainable core flow and the slope of the runup path impact the magnitude of the power increase. FANP performed cycle-specific flow excursion analyses for LaSalle Unit 2 Cycle 9 and established flow-dependent MCPR operating limits and LHGR multipliers. Evaluation of the L2C9A core design demonstrates that the flow-dependent MCPR operating limits and the flow-dependent LHGR factors established for the original core design remain applicable.

Core Inlet Moderator Temperature Change Excursions (Loss of Feedwater Heating)

(To be addressed by Exelon.)

ASME Overpressurization Event

The ASME event is a core-wide pressurization event and is sensitive to the same phenomenon described for the pressurization transients. Evaluation of the revised core design demonstrates that the results of the ASME analysis for the original core design remain applicable.

Control Rod Withdrawal Error

(To be addressed by Exelon.)

Fuel Loading Error

(To be addressed by Exelon.)

LOCA

The MAPLHGR limits are established based on LOCA analyses performed with conservative core reactivity characteristics and are applicable for mixed core and equilibrium core designs. Therefore, the ATRIUM-9B MAPLHGR limits presented in Reference 2 remain applicable for Cycle 9A.

Control Rod Drop

(To be addressed by Exelon.)

References

1. Exelon TODI NF0200148, "LaSalle Unit 2 Cycle 9A Design Basis Loading Plan," October 29, 2002.

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

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

4. Letter, D. E. Garber (FRA-ANP) to R. J. Chin (Exelon), "LaSalle Unit 2 Cycle 9 Operating Limits for Proposed ITS Scram Times and Corrected Fuel Thermal Conductivity," DEG:01:046, March 22, 2001.

5. Letter, D. E. Garber (FRA-ANP) to R. J. Chin (Exelon), "LaSalle Unit 2 Cycle 9 NSS Base Case and TBVOOS or FHOOS Operating Limits for Proposed ITS Scram Times With Corrected Fuel Thermal Conductivity," DEG:01:076, May 15, 2001.

6. Letter, D. E. Garber (FRA-ANP) to F. W. Trikur (Exelon), "LaSalle Unit 2 Cycle 9 Operating Limits for Cycle Extension to 19,300 MWd/MTU," DEG:02:125, August 9, 2002.

7. Letter, D. E. Garber (SPC) to R. J. Chin (Exelon), "MCPR Safety Limit Results for LaSalle Unit 2 Cycle 9," DEG:00:135, June 1, 2000.

Table 1 Comparison of LaSalle Unit 2 Cycle 9 and LaSalle Unit 2 Cycle 9A Core Parameters at Equivalent EOC Licensing Exposure

	LaSalle Unit 2 Cycle 9	LaSalle Unit 2 Cycle 9A
Radial power peaking	1.37	1.40
Axial power peaking	1.43 (node 20)	1.35 (node 20)
Void coefficient (XLRNOR)	0.0105	0.0104

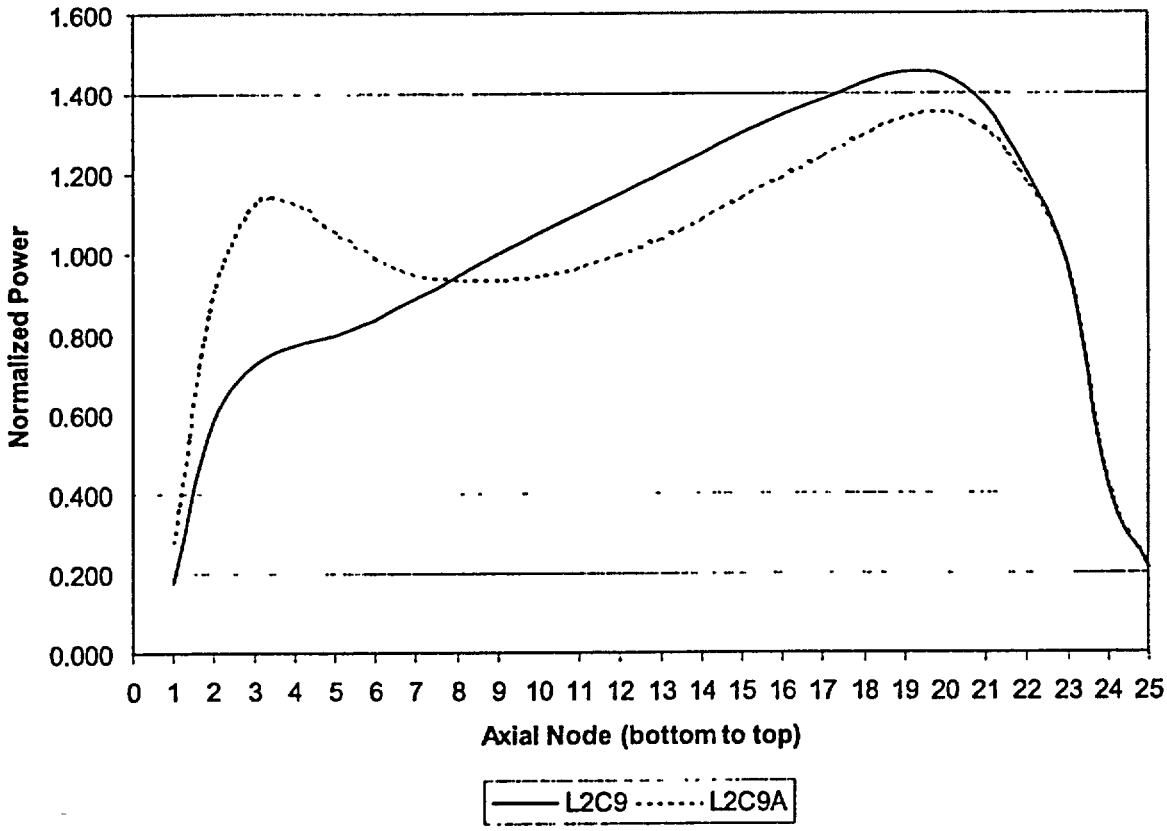

Figure 1 Comparison of LaSalle Unit 2 Cycle 9 and LaSalle Unit 2 Cycle 9A Licensing Axial Power Profiles