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TS 6.9.1.12

March 2, 2006

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555

Limerick Generating Station, Unit 1
Facility Operating License No. NPF-39
NRC Docket No. 50-352

Subject: Issuance of the Core Operating Limits Report
For Reload 10, Cycle 11, Revision 4

Dear Sir/Madam:

Enclosed is a copy of the Core Operating Limits Report (COLR) for Limerick Generating Station, Unit 1, Reload 10, Cycle 11, Revision 4. Revision 4 of this report incorporates changes associated with the implementation of the PANAC11 based 3D Monicore core monitoring system.

This COLR is being submitted to the NRC in accordance with LGS, Unit 1 Technical Specifications (TS) Section 6.9.1.12.

If you have any questions, please do not hesitate to contact us.

Very truly yours,

Pamela B. Cowan
Director, Licensing and Regulatory Affairs
Exelon Generation Company, LLC

Enclosure

cc: S. J. Collins, Regional Administrator, Region I, USNRC
S. Hansell, USNRC Senior Resident Inspector, LGS
T. Valentine, Project Manager [LGS], USNRC

CORE OPERATING LIMITS REPORT

FOR

LIMERICK GENERATING STATION UNIT 1

RELOAD 10, CYCLE 11

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1.0 TERMS AND DEFINITIONS

ARTS	APRM and RBM Technical Specification Analysis
DTSP	Rod Block Monitor Downscale trip setpoint
End of Rated (EOR)	The cycle exposure at which reactor power is equal to 3458 MWth with recirculation system flow equal to 100%, all control rods fully withdrawn, all feedwater heating in service and equilibrium Xenon.
FFWTR	Final Feedwater Temperature Reduction
FWHOOS	Feedwater Heaters Out of Service
HTSP	Rod Block Monitor High trip setpoint
ICF	Increased Core Flow
ITSP	Rod Block Monitor Intermediate trip setpoint
LHGR	Linear Heat Generation Rate
LTSP	Rod Block Monitor Low trip setpoint
MAPFAC(F)	ARTS MAPLHGR thermal limit flow dependent adjustments and multipliers
MAPFAC(P)	ARTS MAPLHGR thermal limit power dependent adjustments and multipliers
MAPLHGR	Maximum Average Planar Linear Heat Generation Rate
MCPR	Minimum Critical Power Ratio
MCPR(P)	ARTS MCPR thermal limit power dependent adjustments and multipliers
MCPR(F)	ARTS MCPR thermal limit flow dependent adjustments and multipliers
MELLLA	Maximum Extended Load Line Limit Analysis
OPRM PBDA	Oscillation Period Range Monitor Period Based Detection Algorithm
RCF	Rated Core Flow
RPTOOS	Recirculation Pump Trip Out of Service
SLMCPR	Safety Limit Minimum Critical Power Ratio
SLO	Single Loop Operation
TBVOOS	Turbine Bypass Valves Out of Service

2.0 REFERENCES

1. "Technical Specifications and Bases for Limerick Generating Station Unit 1", Docket No. 50-352, License No. NPF-39.

2. "Supplemental Reload Licensing Report for Limerick Generating Station Unit 1 Reload 10 Cycle 11", Global Nuclear Fuel Document No. 0000-0018-2410-SRLR, Revision 0, January 2004.

3. "Lattice Dependent MAPLHGR Report for Limerick Generating Station Unit 1 Reload 10 Cycle 11", Global Nuclear Fuel Document No. 0000-0018-2410-MAPLHGR, Revision 0, February 2004.

4. "Lattice Dependent MAPLHGR Report for Limerick Generating Station Unit 1 Reload 9 Cycle 10", Global Nuclear Fuel Document No. J11-03984MAPL, Revision 0, January 2002.

5. "GE14 Fuel Design Cycle-Independent Analyses for Limerick Generating Station Units 1 and 2", GE-NE-L12-00884-00-01P, March 2001.

6. "OPL-3 Transient Protection Parameters Verification for Reload Licensing Analyses for Limerick 1 Reload 10 Cycle 11", Resolved as documented in DRF 20111 (L1C11 Reload Licensing DRF).

7. "Limerick Generating Station Units 1 and 2 ECCS-LOCA Evaluation for GE14", GE Nuclear Energy Document No. GE-NE-J11-03793-09-01P, February 2001.

8. "ARTS Flow-Dependent Limits with TBVOOS for Peach Bottom Atomic Power Station and Limerick Generating Station", GENE Document NEDC-32847P, June 1998.

9. "General Electric Standard Application for Reactor Fuel", NEDE-24011-P-A-14, June 2000 and U.S. Supplement NEDE-24011-P-A-14-US, June 2000.

10. "Power Range Neutron Monitoring System Setpoint Calculations Limerick Generating Station, Units 1 &2 Mod. No. P00224", LE-0107, Rev. 0, March 2000.

11. "Fuel Bundle Information Report for Limerick Generating Station Unit 1 Reload 10 Cycle 11", Global Nuclear Fuel Document No. 0000-0018-2410-FBIR, January 2004.

12. deleted

13. "Limerick 1 and 2 Off-Rated Analyses Below the PLU Power Level", GE Nuclear Document No. GE-NE-0000-0037-3253-R0, March 2005

14. "Limerick 1 Cycle 11 Option III Stability Analysis", GE Nuclear Energy Document No. GENE-0000-0037-0728-R0, March 2005.

3.0 GENERAL INFORMATION

This report provides the following cycle-specific parameter limits for Limerick Generating Station Unit 1 Cycle 11:

- Maximum Average Planar Linear Heat Generation Rate (MAPLHGR)
- Minimum Critical Power Ratio (MCPR)
- Single Loop Operation (SLO) MCPR adjustment
- ARTS MCPR thermal limit adjustments and multipliers (MCPR(P) or MCPR(F))
- ARTS LHGR thermal limit multipliers (LHGRFAC(P) or LHGRFAC(F))
- Rod Block Monitor (RBM) setpoints
- MAPLHGR single loop operation reduction factor
- LHGR single loop operation reduction factor
- Linear Heat Generation Rate (LHGR)
- Turbine Bypass Valve parameters
- Reactor Coolant System Recirculation Flow Upscale Trips
- OPRM Period Based Detection Algorithm (PBDA) trip setpoints

These values have been determined using NRC-approved methodology (Reference 9), and are established such that all applicable limits of the plant safety analysis are met.

This report is prepared in accordance with Technical Specification 6.9.1.9 of Reference 1. Preparation of this report was performed in accordance with Exelon Nuclear, Nuclear Fuel Management T&RM NF-AB-120-3600.

The data presented in this report is valid for all licensed operating domains on the operating map, including:

- Maximum Extended Load Line Limit down to 81% of rated core flow during full power operation
- Increased Core Flow (ICF) up to 110% of rated core flow
- Final Feedwater Temperature Reduction (FFWTR) up to 105°F during cycle extension operation
- Feedwater Heater Out of Service (FWHOOS) up to 60°F feedwater temperature reduction at any time during the cycle prior to cycle extension.

Further information on the cycle specific analyses for Limerick 1 Cycle 11 and the associated operating domains discussed above is available in Reference 2.

4.0 MAPLHGR LIMITS

The MAPLHGR limits provided in Tables 4-1 through 4-8 are referenced in Technical Specifications 3.2.1. The limiting MAPLHGR value for the most limiting lattice (excluding natural uranium) of each fuel type as a function of average planar exposure is given in Tables 4-1 through 4-7 (References 3 and 4). Tables 4-1 through 4-7 are used when hand calculations are required as specified in Technical Specification 3.2.1. For single loop operation, a reduction factor is used which is shown in Table 4-8 (Reference 2).

Table 4-1

MAPLHGR Versus Average Planar Exposure
Bundle Type GE13-P9CTB417-13GZ-100T-146-T (GE13)
(Reference 4)

Avg. Plan Exposure (GWd/ST)	MAPLHGR (kW/ft)	Avg. Plan Exposure (GWd/ST)	MAPLHGR (kW/ft)	Avg. Plan Exposure (GWd/ST)	MAPLHGR (kW/ft)
0.0	10.46	7.0	11.53	25.0	12.01
0.2	10.54	8.0	11.69	30.0	11.59
1.0	10.65	9.0	11.85	35.0	10.96
2.0	10.79	10.0	12.02	40.0	10.32
3.0	10.93	12.5	12.26	45.0	9.66
4.0	11.08	15.0	12.45	50.0	8.97
5.0	11.22	17.5	12.44	55.0	7.43
6.0	11.37	20.0	12.32	58.03	6.29

Table 4-2

MAPLHGR Versus Average Planar Exposure
Bundle Type GE13-P9CTB417-11GZ-100T-146-T (GE13)
(Reference 4)

Avg. Plan Exposure (GWd/ST)	MAPLHGR (kW/ft)	Avg. Plan Exposure (GWd/ST)	MAPLHGR (kW/ft)	Avg. Plan Exposure (GWd/ST)	MAPLHGR (kW/ft)
0.0	10.79	7.0	11.75	25.0	12.00
0.2	10.85	8.0	11.91	30.0	11.60
1.0	10.93	9.0	12.06	35.0	10.96
2.0	11.05	10.0	12.21	40.0	10.33
3.0	11.17	12.5	12.43	45.0	9.67
4.0	11.31	15.0	12.55	50.0	8.98
5.0	11.45	17.5	12.47	55.0	7.49
6.0	11.59	20.0	12.32	58.2	6.29

Table 4-3

MAPLHGR Versus Average Planar Exposure
Bundle Type GE14-P10CNAB417-7G8.0/8G7.0-100T-150-T-2527 (GE14C)
(Reference 4)

Avg. Plan Exposure (GWd/ST)	MAPLHGR (kW/ft)	Avg. Plan Exposure (GWd/ST)	MAPLHGR (kW/ft)	Avg. Plan Exposure (GWd/ST)	MAPLHGR (kW/ft)
0.0	10.00	7.0	10.81	25.0	10.34
0.2	10.01	8.0	10.91	30.0	9.87
1.0	10.03	9.0	10.99	35.0	9.39
2.0	10.11	10.0	11.07	40.0	8.91
3.0	10.22	12.0	11.17	45.0	8.40
4.0	10.34	15.0	11.04	50.0	7.87
5.0	10.49	17.0	10.95	55.0	5.89
6.0	10.64	20.0	10.76	57.06	4.86

Table 4-4

MAPLHGR Versus Average Planar Exposure
Bundle Type GE14-P10CNAB417-13GZ-100T-150-T-2528 (GE14C)
(Reference 4)

Avg. Plan Exposure (GWd/ST)	MAPLHGR (kW/ft)	Avg. Plan Exposure (GWd/ST)	MAPLHGR (kW/ft)	Avg. Plan Exposure (GWd/ST)	MAPLHGR (kW/ft)
0.0	10.17	7.0	10.92	25.0	10.34
0.2	10.22	8.0	11.02	30.0	9.86
1.0	10.26	9.0	11.09	35.0	9.38
2.0	10.32	10.0	11.15	40.0	8.90
3.0	10.42	12.0	11.25	45.0	8.40
4.0	10.53	15.0	11.09	50.0	7.86
5.0	10.66	17.0	10.98	55.0	5.91
6.0	10.81	20.0	10.78	57.12	4.85

Table 4-5

MAPLHGR Versus Average Planar Exposure
Bundle Type GE14-P10CNAB417-7G8.0/8G7.0-80U45R-150-T-2531 (GE14C)
(Reference 4)

Avg. Plan Exposure (GWd/ST)	MAPLHGR (kW/ft)	Avg. Plan Exposure (GWd/ST)	MAPLHGR (kW/ft)	Avg. Plan Exposure (GWd/ST)	MAPLHGR (kW/ft)
0.0	10.08	7.0	10.86	25.0	10.36
0.2	10.09	8.0	10.95	30.0	9.88
1.0	10.10	9.0	11.02	35.0	9.40
2.0	10.18	10.0	11.10	40.0	8.91
3.0	10.28	12.0	11.21	45.0	8.40
4.0	10.40	15.0	11.07	50.0	7.86
5.0	10.54	17.0	10.98	55.0	5.91
6.0	10.70	20.0	10.79	57.13	4.85

Table 4-6

MAPLHGR Versus Average Planar Exposure
Bundle Type GE14-P10CNAB417-15GZ-100T-150-T-2592 (GE14C)
(Reference 3)

Avg. Plan Exposure (GWd/ST)	MAPLHGR (kW/ft)	Avg. Plan Exposure (GWd/ST)	MAPLHGR (kW/ft)	Avg. Plan Exposure (GWd/ST)	MAPLHGR (kW/ft)
0.0	10.00	8.0	10.91	20.0	10.76
0.2	10.01	9.0	10.99	25.0	10.34
1.0	10.03	10.0	11.07	30.0	9.87
2.0	10.11	11.0	11.14	35.0	9.39
3.0	10.22	12.0	11.17	40.0	8.91
4.0	10.34	13.0	11.13	45.0	8.40
5.0	10.49	14.0	11.08	50.0	7.87
6.0	10.64	15.0	11.04	55.0	5.89
7.0	10.81	17.0	10.95	57.06	4.86

Table 4-7

MAPLHGR Versus Average Planar Exposure
Bundle Type GE14-P10CNAB414-14GZ-100T-150-T-2701 (GE14C)
(Reference 3)

Avg. Plan Exposure (GWd/ST)	MAPLHGR (kW/ft)	Avg. Plan Exposure (GWd/ST)	MAPLHGR (kW/ft)	Avg. Plan Exposure (GWd/ST)	MAPLHGR (kW/ft)
0.0	10.03	8.0	10.99	20.0	10.76
0.2	10.08	9.0	11.12	25.0	10.30
1.0	10.16	10.0	11.2	30.0	9.79
2.0	10.24	11.0	11.25	35.0	9.24
3.0	10.35	12.0	11.28	40.0	8.72
4.0	10.47	13.0	11.21	45.0	8.24
5.0	10.61	14.0	11.14	50.0	7.76
6.0	10.73	15.0	11.08	55.0	5.86
7.0	10.86	17.0	10.96	57.02	4.85

Table 4-8

MAPLHGR Single Loop Operation (SLO) Reduction Factor
(Reference 2)

SLO reduction factor	**0.79**

5.0 MCPR LIMITS

The MCPR values provided in Table 5-1 are referenced in Technical Specification 3.2.3. Table 5-1 is derived from the Reference 2 analyses and is valid for all Cycle 11 fuel types and operating domains. Table 5-1 includes treatment of these MCPR limits for SLO. Bounding MCPR values are also provided for inoperable Recirculation Pump Trip or inoperable Steam Bypass System. These two options represent the Equipment Out of Service conditions. The cycle exposure, which represents EOR, is given in the latest verified and approved Cycle Management Report or associated Engineering Change Request.

ARTS provides for power- and flow-dependent thermal limit adjustments and multipliers, which allow for a more reliable administration of the MCPR thermal limit. The flow-dependent adjustment MCPR(F) is sufficiently generic to apply to all fuel types and operating domains (References 2 and 8). In addition, there are also two sets of power-dependent MCPR multipliers for use with the Turbine Bypass Valves in service and TBVOOS conditions (Reference 13). Section 8.0 contains the conditions for Turbine Bypass Valve Operability. These adjustments and multipliers are shown in Figures 5-1 through 5-3 and are referred to by Technical Specification 3.2.3. The MCPR(P) curves are independent of recirculation pump trip operability (Reference 13).

TABLE 5-1

Operating Limit Minimum Critical Power Ratio (OLMCPR)
(References 2 and 5)

		TBV In Service and RPT In Service		TBV out of Service (TBVOOS)		RPT Out of Service (RPTOOS)	
		OPT. B (τ=0)[1]	OPT. A (τ=1)[1]	OPT. B (τ=0)[1]	OPT. A (τ=1)[1]	OPT. B (τ=0)[1]	OPT. A (τ=1)[1]
Two Loop Operation	BOC to EOR - 2000 MWd/ST	1.33	1.36	1.38	1.41	1.40	1.51
Two Loop Operation	EOR - 2000 MWd/ST to EOC	1.38	1.41	1.43	1.46	1.46	1.63
Single Loop Operation	BOC to EOR - 2000 MWd/ST	1.43[2]	1.43[2]	1.43[2]	1.43[2]	1.43[2]	1.52
Single Loop Operation	EOR - 2000 MWd/ST to EOC	1.43[2]	1.43[2]	1.44	1.47	1.47	1.64

Notes:

1. When Tau does not equal 0 or 1, determine OLMCPR via linear interpolation.
2. OLMCPR limit set by the Single Loop Operation Recirculation Pump Seizure Analysis (Reference 2.)
3. This table is valid for all Cycle 11 fuel types.

FIGURE 5-1

Power Dependent MCPR Limit Adjustments And Multipliers

This Figure Is Valid For All Operating Domains except TBVOOS (References 2 and 13)

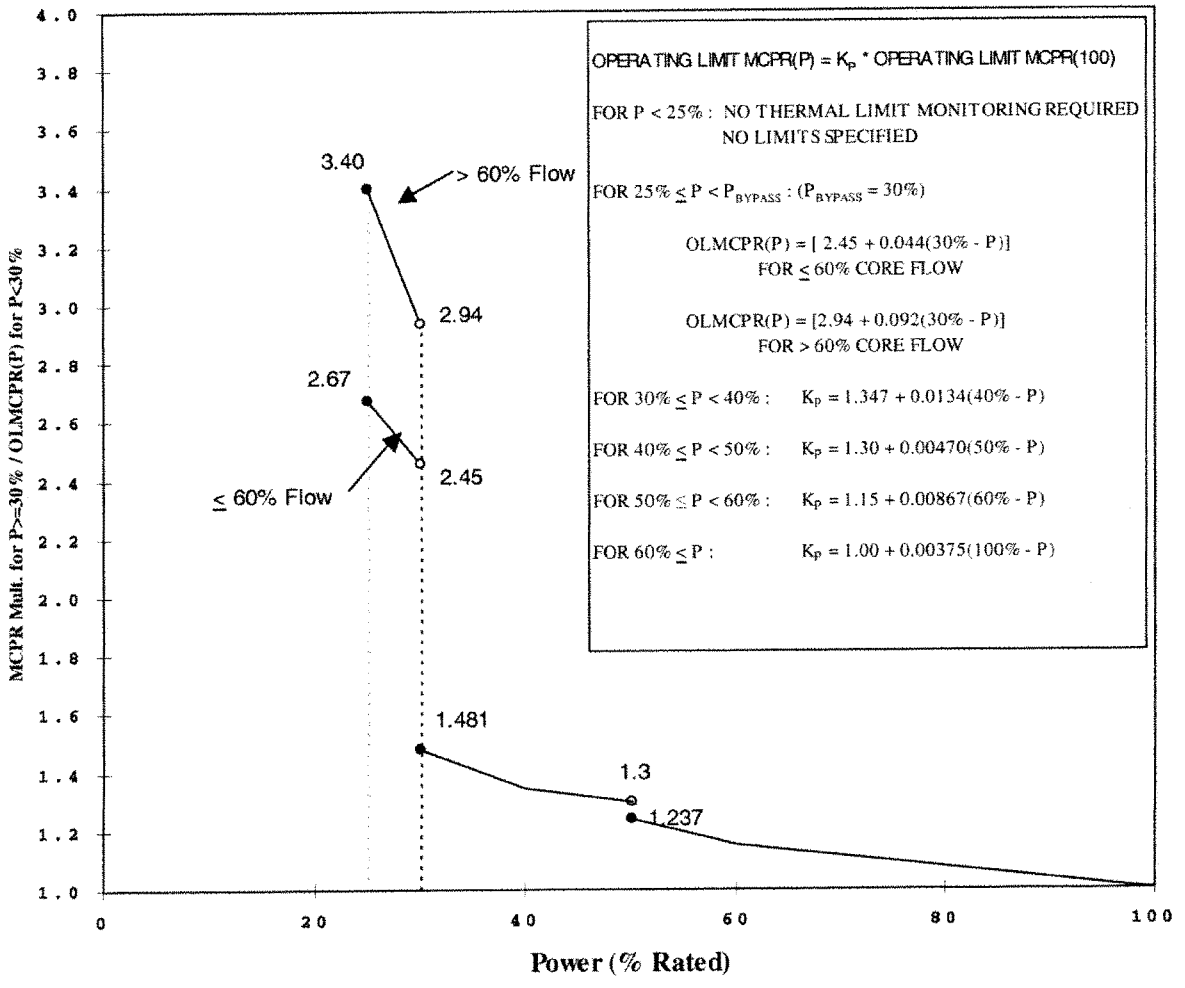


FIGURE 5-2

Power Dependent MCPR Limit Adjustments And Multipliers - TBVOOS

This Figure Is Valid For The TBVOOS Operating Domain (References 2 and 13)

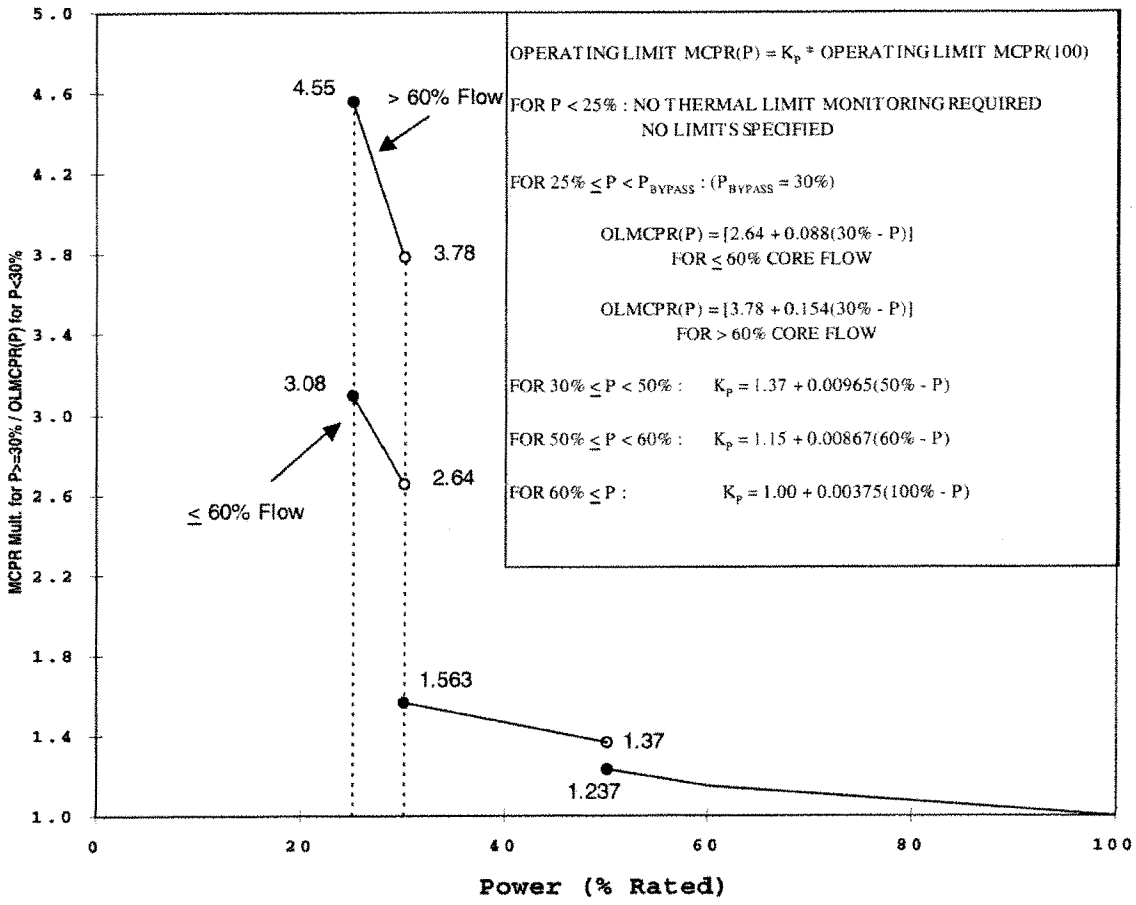
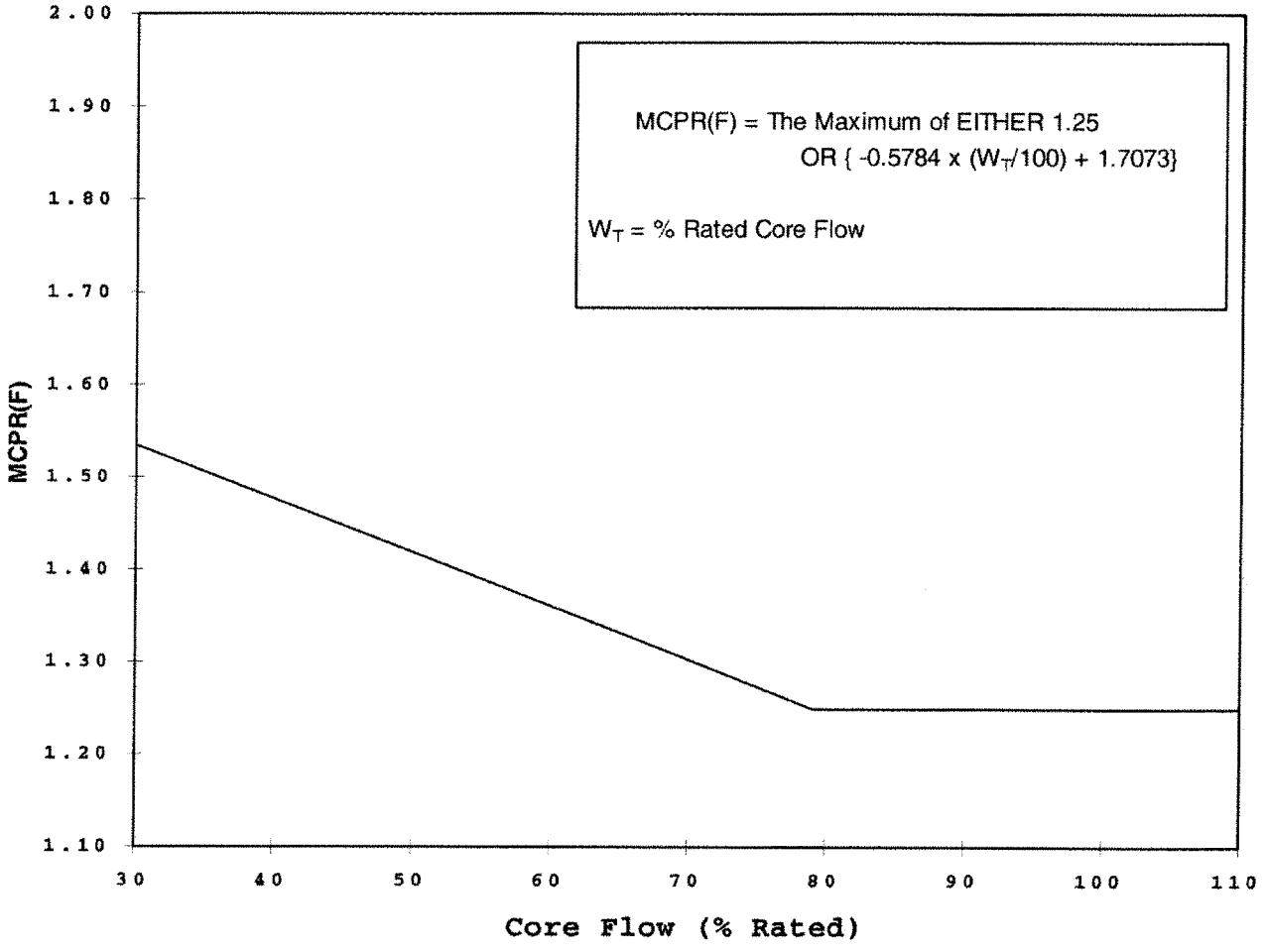


FIGURE 5-3

Flow Dependent MCPR Limits MCPR(F)

This Figure Is Valid For All Operating Domains
(References 2 and 8)



6.0 LINEAR HEAT GENERATION RATE LIMITS

The maximum LHGR value for each fuel type for use in Technical Specification 3.2.4 is given in Table 6-1 below. The LHGR is an exposure dependent value. Due to the proprietary nature of these values only the maximum LHGR for each fuel type is listed in Table 6-1.

ARTS provides for power- and flow-dependent thermal limit multipliers, which allow for a more reliable administration of the LHGR thermal limits. There are two sets of flow-dependent LGHR multipliers for dual-loop and single-loop operation (References 2, 5 and 8). In addition, there are also two sets of power-dependent LHGR multipliers for use with the Turbine Bypass Valves in service and TBVOOS conditions (Reference 13). Section 8.0 contains the conditions for Turbine Bypass Valve Operability. The LHGR multipliers are shown in Figures 6-1 through 6-4 and are referred to by Technical Specification 3.2.4. Thermal limit monitoring must be performed with the more limiting LHGR limit resulting from the power- and flow-biased calculation. The LHGRFAC(P) curves are independent of recirculation pump trip operability (Reference 13). For single loop operation, a reduction factor is used which is shown in Table 6-2 (Reference 2).

TABLE 6-1
Linear Heat Generation Rate Limits
(Reference 11)

FUEL TYPE	MAXIMUM VALUE
GE13	14.4 kW/ft
GE14	13.4 kW/ft

Table 6-2
LHGR Single Loop Operation (SLO) Reduction Factor
(Reference 2)

SLO reduction factor	0.79

FIGURE 6-1
Power Dependent LHGR Multiplier LHGRFAC(P)

This Figure Is Valid For the All Operating Domains except TBVOOS)
(Reference 13)

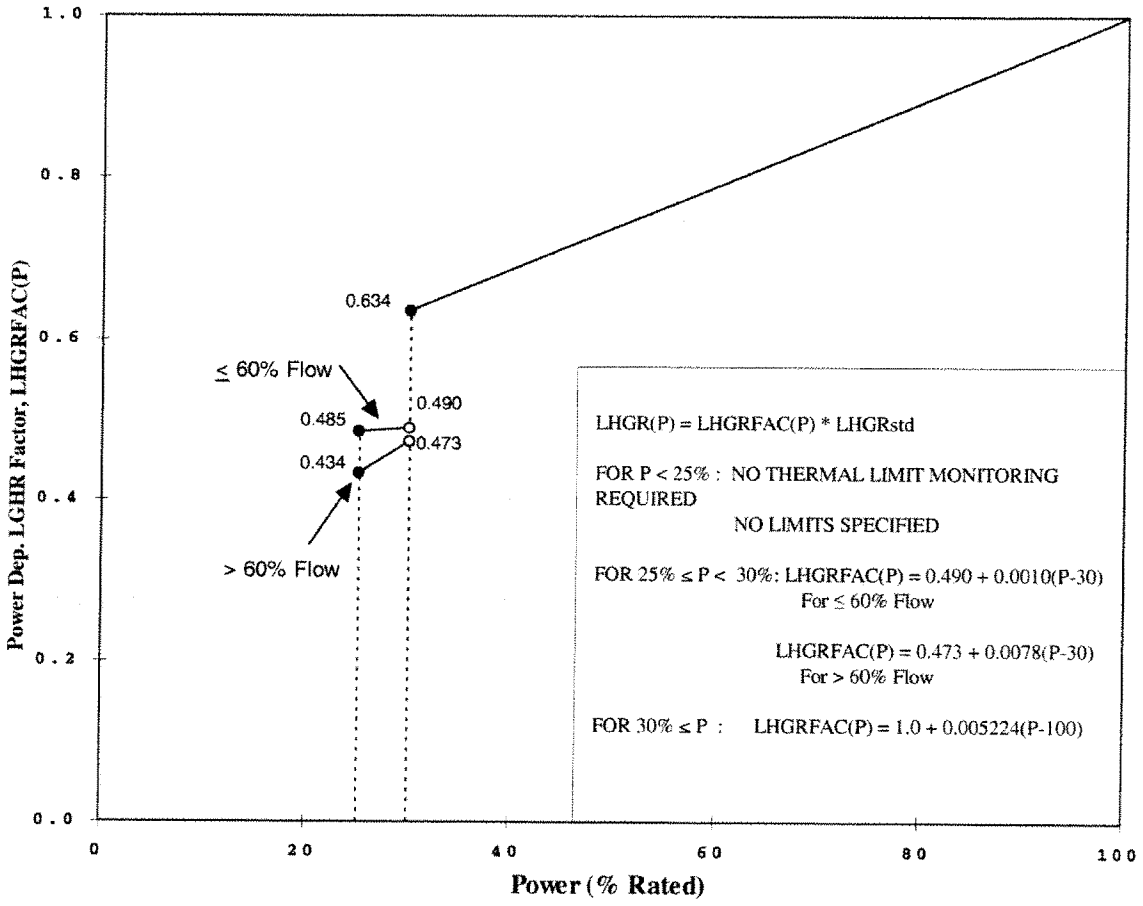


FIGURE 6-2
Power Dependent LHGR Multiplier LHGRFAC(P) - TBVOOS

This Figure Is Valid For The TBVOOS Operating Domain (Reference 13)

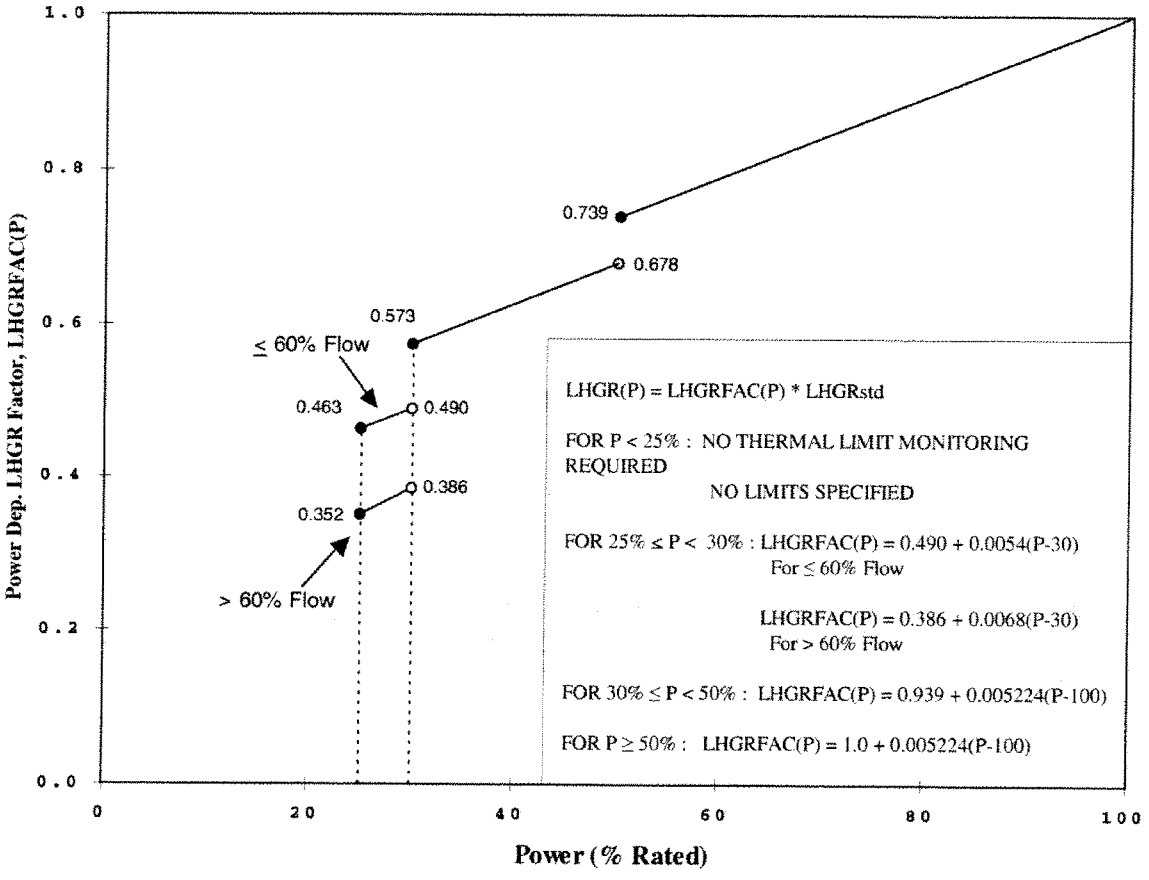


FIGURE 6-3
Flow Dependent LHGR Multiplier LHGRFAC(F)

**This Figure Is Valid For All Operating Domains
Excluding Single Loop Operation
(References 5 and 8)**

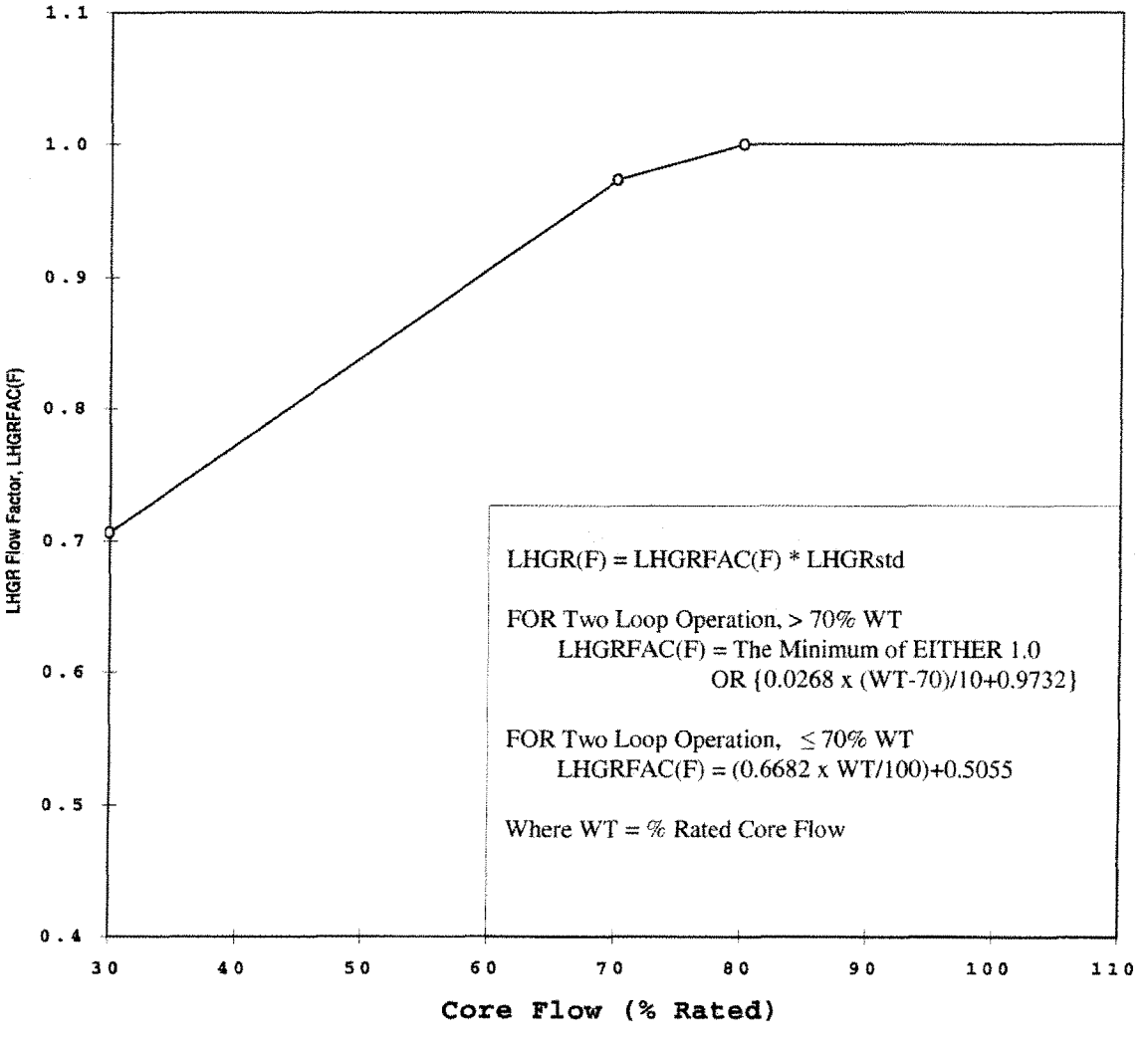
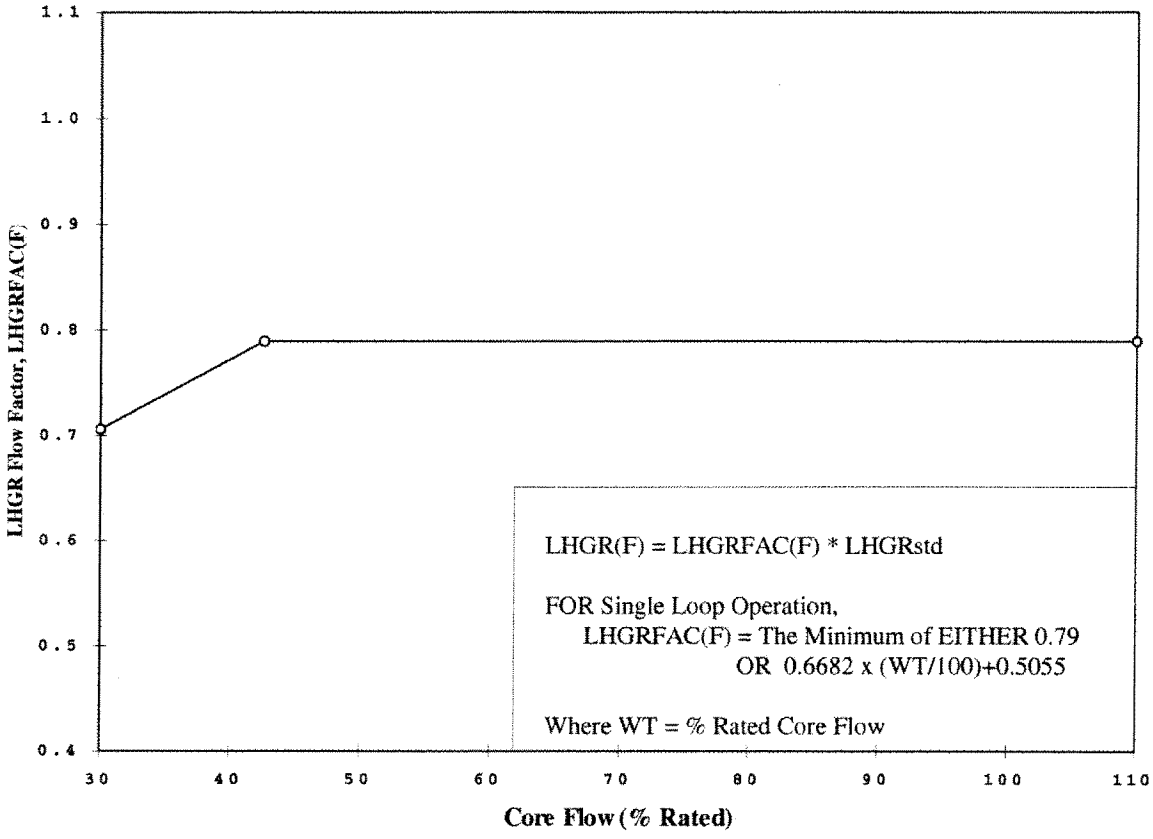


FIGURE 6-4
Flow Dependent LHGR Multiplier LHGRFAC(F) - SLO

This Figure Is Valid For Single Loop Operation
(References 2 and 8)



7.0 CONTROL ROD BLOCK SETPOINTS

Technical Specification Limiting Condition for Operation 3.3.6 requires control rod block instrumentation channels shall be OPERABLE with their trip setpoints consistent with the values shown in the Trip Setpoint column of Technical Specification Table 3.3.6-2. The Reactor Coolant System Recirculation Flow Upscale Trip is a cycle-specific value and as such is found in Table 7-2 of this COLR. Table 7-2 lists the Nominal Trip Setpoint and Allowable Value. These setpoints are set high enough to allow full utilization of the enhanced ICF domain up to 110% of rated core flow. Additionally, the ARTS Rod Block Monitor provides for power-dependent RBM trips. The trip setpoints/allowable values and applicable RBM signal filter time constant data are shown in Table 7-1. These values are for use with Technical Specification 3.3.6.

TABLE 7-1
Rod Block Monitor Setpoints
(References 2 and 10)

	Nominal Trip Setpoint	Allowable Value
LTSP[1]	121.5%	121.5%
ITSP[1]	116.5%	116.5%
HTSP[1]	111.0%	111.7%
DTSP[1]	92.0%	89.0%

Notes:

1. These setpoints (with Rod Block Monitor filter time constant between 0.1 seconds and 0.55 seconds) are based on a cycle-specific rated RWE MCPR limit which is less than or equal to the minimum cycle OLMCPR (see COLR references 2 and 10).

TABLE 7-2
Reactor Coolant System Recirculation Flow Upscale Trip
(Reference 10)

Nominal Trip Setpoint	113.4%
Allowable Value	115.6%

8.0 TURBINE BYPASS VALVE PARAMETERS

The operability requirements for the steam bypass system for use in Technical Specifications 3.7.8 and 4.7.8.C are found in Tables 8-1 and 8-2. If these requirements cannot be met, the MCPR, MCPR(P) and MAPFAC(P) limits for inoperable Steam Bypass System, known as Turbine Bypass Valve Out Of Service, must be used.

TABLE 8-1
Turbine Bypass System Response Time
(Reference 6)

Maximum delay time before start of bypass valve opening following generation of the turbine bypass valve flow signal	0.11 sec
Maximum time after generation of a turbine bypass valve flow signal for bypass valve position to reach 80% of full flow (includes the above delay time)	0.31 sec

TABLE 8-2
Minimum Required Bypass Valves To Maintain System Operability
(References 6 and 13)

Reactor Power	No. of Valves in Service
$P \geq 25\%$	7

9.0 STABILITY PROTECTION SETPOINTS

The Limerick 1 Cycle 11 Oscillation Power Range Monitor (OPRM) Period Based Detection Algorithm (PBDA) Trip Setpoints for the OPRM System for use in Technical Specification 2.2.1 are found in Table 9-1. These values are based on the cycle specific analysis documented in Reference 14.

Any change to the OLMCPR value and/or ARTS-based power dependent MCPR limits should be evaluated for potential impact on the OPRM PBDA Trip Setpoints.

TABLE 9-1
OPRM PBDA Trip Setpoints

PBDA Trip Amplitude	Corresponding Maximum Confirmation Count Trip Setpoint
1.12	14

10.0 MODES OF OPERATION

Limerick Generating Station has been analyzed to operate with a number of operational flexibility features, including Increased Core Flow, Maximum Extended Load Line Limit, Coastdown, EOC Recirculation Pump Trip and Option A/B MCPR Limits. Limerick Generating Station has also been analyzed to operate with a number of equipment out-of-service conditions, including Turbine Bypass Valves OOS, Single Loop Operation, Feedwater Heating OOS, Final Feedwater Temperature Reduction and Safety/Relief Valves OOS (up to 2 of 14 safety/relief valves OOS). Operation is allowed in any combination of these operational flexibility features and equipment out-of-service conditions, with one **EXCEPTION**, which is that Limerick may **NOT** operate with EOC-Recirculation Pump Trip out-of-service in conjunction with Turbine Bypass Valves OOS.