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TS 6.9.1.12

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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 12, Cycle 13, Revision 7

Enclosed is a copy of the Core Operating Limits Report (COLR) for Limerick Generating Station, Unit 1, Reload 12, Cycle 13, Revision 7. Revision 7 of this report incorporates the revised cycle specific parameters resulting from the new core configuration implemented during the LGS, Unit 1 (1R12) refueling outage. (Note: Revision 6 of the COLR was generated, but was superceded prior to Cycle 13 startup and is therefore not being submitted (i.e., Revision 6 is obsolete as of the date of this submittal)).

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,

D. P. Helker

David P. Helker
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Enclosure

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CORE OPERATING LIMITS REPORT

FOR

LIMERICK GENERATING STATION

UNIT 1 RELOAD 12 CYCLE 13

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List of Tables

1.0 Terms and Definitions

ARTS	APRM and RBM Technical Specification Analysis
BASE CASE	A case analyzed with Turbine Bypass System in service and Recirculation Pump Trip in service and Feedwater Temperature Reduction allowed (FFWTR includes feedwater heater OOS or final feedwater temperature reduction) at any point in the cycle operation in Dual Loop mode.
DTSP	Rod Block Monitor Downscale Trip Setpoint
EOOS	Equipment Out of Service
EOR	End of Rated. 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at which reactor power is equal to 3458 MWth with recirculation system flow equal to 100%, all control rods fully withdrawn, all feedwater heating in service and equilibrium Xenon.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
LHGRFAC(F)	ARTS LHGR thermal limit flow dependent adjustments and multipliers
LHGRFAC(P)	ARTS LHGR thermal limit power dependent adjustments and multipliers
LTSP	Rod Block Monitor Low Trip Setpoint
MAPLHGR	Maximum Average Planar Linear Heat Generation Rate
MCPR	Minimum Critical Power Ratio
MCPR(F)	ARTS MCPR thermal limit flow dependent adjustments and multipliers
MCPR(P)	ARTS MCPR thermal limit power dependent adjustments and multipliers
MELLLA	Maximum Extended Load Line Limit Analysis
OLMCPR	Operating Limit Minimum Critical Power Ratio
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 General Information

This report is prepared in accordance with Technical Specification 6.9.1.9 of Reference 1. Power and flow dependent limits are listed for various power and flow levels. Linear interpolation is to be used to find intermediate values.

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.

3.0 MAPLHGR Limits

3.1 Technical Specification

Section 3.2.1

3.2 Description

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 Table 3-1. The limiting MAPLHGR value is the same for all fuel types in Limerick Unit 1 Cycle 13. For single loop operation, a reduction factor is used which is shown in Table 3-2. The power and flow dependent multipliers for MAPLHGR have been removed and replaced with LHGRFAC(P) and LHGRFAC(F), therefore MAPLHGR(P) and MAPLHGR(F) are equal to 1.

Table 3-1
MAPLHGR Versus Average Planar Exposure
All Fuel Types
(Reference 2)

Average Planar Exposure (GWD/ST)	MAPLHGR Limit (kW/ft)
0.0	12.82
14.51	12.82
19.13	12.82
57.61	8.00
63.50	5.00

Table 3-2
MAPLHGR Single Loop Operation (SLO) Reduction Factor
(Reference 2)

SLO Reduction Factor	0.80

4.0 MCPR Limits

4.1 Technical Specification

Section 3.2.3

4.2 Description

Table 4-1 is derived from the Reference 2 analyses and is valid for all Cycle 13 fuel types and operating domains. Table 4-1 includes treatment of these MCPR limits for all conditions listed in Section 9.0, Mode of Operations. The cycle exposure that represents EOR is given in the latest verified and approved Cycle Management Report or an 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) and power-dependent adjustment MCPR(P) are sufficiently generic to apply to all fuel types and operating domains. The MCPR(P) curves are independent of recirculation pump trip operability (Reference 3). MCPR(F) and MCPR(P) are independent of Scram Time Option. These adjustments are provided in Table 4-2 and 4-3. The OLMCPR is determined for a given power and flow condition by evaluating the power-dependent MCPR and the flow-dependent MCPR and selecting the greater of the two.

When the actual Scram speed falls between Option B (Tau = 0) and Option A (Tau = 1), linear interpolation shall be used to determine MCPR limits.

Table 4-1
Operating Limit Minimum Critical Power Ratio (OLMCPR)
All Fuel Types
(Reference 2)

EOOS Combination	SCRAM Time Option	Cycle Exposure	
		< EOR – 2675 MWd/ST	≥ EOR – 2675 MWd/ST
BASE	B	1.34	1.39
	A	1.37	1.42
BASE SLO	B	1.44[1]	1.44[1]
	A	1.44[1]	1.44
TBVOOS	B	1.37	1.42
	A	1.40	1.45
TBVOOS SLO	B	1.44[1]	1.44
	A	1.44[1]	1.47
RPTOOS	B	1.40	1.46
	A	1.51	1.63
RPTOOS SLO	B	1.44[1]	1.48
	A	1.53	1.65

[1] OLMCPR limit set by the Single Loop Operation Recirculation Pump Seizure Analysis (Reference 2).

TABLE 4-2
Power Dependent MCPR Limit Adjustments And Multipliers
(References 2, 3, and 9)

EOOS Combination	Core Flow (% of rated)	Core Thermal Power (% of Rated)						
		0	25	< 30	≥ 30	45	60	100
		Operating Limit MCPR			Operating Limit MCPR Multiplier, Kp			
Base	≤ 60	2.66	2.66	2.44	1.481	1.280	1.150	1.000
	> 60	3.39	3.39	2.93				
Base SLO	≤ 60	2.68	2.68	2.46	1.481	1.280	1.150	1.000
	> 60	3.41	3.41	2.95				
RPTOOS	≤ 60	2.66	2.66	2.44	1.481	1.280	1.150	1.000
	> 60	3.39	3.39	2.93				
RPTOOS SLO	≤ 60	2.68	2.68	2.46	1.481	1.280	1.150	1.000
	> 60	3.41	3.41	2.95				
TBVOOS	≤ 60	3.07	3.07	2.63	1.481	1.280	1.150	1.000
	> 60	4.54	4.54	3.77				
TBVOOS SLO	≤ 60	3.09	3.09	2.65	1.481	1.280	1.150	1.000
	> 60	4.56	4.56	3.79				

TABLE 4-3
Flow Dependent MCPR Limits MCPR(F)
(References 2, 3 and 5)

Flow (% rated)	MCPR(F) Limit
0.0	1.7073
79.06	1.25
110.0	1.25

5.0 Linear Heat Generation Rate Limits

5.1 Technical Specification

Section 3.2.4

5.2 Description

The LHGR is an exposure dependent value. Table 5-1 provides the exposure dependent LHGR limit for all UO_2 pins for all bundles in the Cycle 13 core. Table 5-2 provides the exposure dependent LHGR limit for Gad pins in the Cycle 13 core. The LHGR SLO multiplier is shown in Table 5-3.

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, 3, and 5). In addition, there are also two sets of power-dependent LHGR multipliers for use with the Turbine Bypass Valves in service and TBVOOS conditions (References 3 and 10). Section 7.0 contains the conditions for Turbine Bypass Valve Operability. 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 3 and 10).

TABLE 5-1
Linear Heat Generation Rate Limits - UO_2
All Fuel Types
(Reference 8)

Peak Pellet Exposure (GWD/ST)	LHGR Limit (kW/ft)
0.00	13.40
14.51	13.40
57.61	8.00
63.50	5.00

TABLE 5-2
Linear Heat Generation Rate Limits – Gad Rods
All Fuel Types
(Reference 8)

Peak Pellet Exposure (GWD/ST)	LHGR Limit (kW/ft)
0	11.76
12.08	11.76
54.21	7.02
59.98	4.39

TABLE 5-3
LHGR Single Loop Operation (SLO) Reduction Factor
(Reference 2)

SLO Reduction Factor[1]	0.80

TABLE 5-4
Power Dependent LHGR Multiplier LHGRFAC(P)
(References 2, 3, and 9)

EOOS Combination	Core Flow (% of rated)	Core Thermal Power (% of rated)				
		0	25	< 30	≥ 30	100
		LHGRFAC(P) Multiplier				
Base	≤ 60	0.485	0.485	0.490	0.6340	1.0000
	> 60	0.434	0.434	0.473		
Base SLO	≤ 60	0.485	0.485	0.490	0.6340	1.0000
	> 60	0.434	0.434	0.473		
RPTOOS	≤ 60	0.485	0.485	0.490	0.6340	1.0000
	> 60	0.434	0.434	0.473		
RPTOOS SLO	≤ 60	0.485	0.485	0.490	0.6340	1.0000
	> 60	0.434	0.434	0.473		
TBVOOS	≤ 60	0.463	0.463	0.490	0.6340	1.0000
	> 60	0.352	0.352	0.386		
TBVOOS SLO	≤ 60	0.463	0.463	0.490	0.6340	1.0000
	> 60	0.352	0.352	0.386		

TABLE 5-5
Flow Dependent LHGR Multiplier LHGRFAC(F)
(References 2, 3 and 5)

EOOS Combination	Core Flow (% of rated)				
	0	44.07	70	80	110
	LHGRFAC(F) Multiplier				
Dual Loop	0.5055		0.9732	1.00	1.00
Single Loop	0.5055	0.80	0.80	0.80	0.80

[1] Applied through Table 5-5

6.0 Control Rod Block Setpoints

6.1 Technical Specification

Section 3.3.6

6.2 Description

Technical Specification Limiting Condition for Operation number 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 6-2 of this COLR. Table 6-2 lists the Nominal Trip Setpoints and Allowable Values, consistent with a HTSP analytical limit of 114%. 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 6-1.

TABLE 6-1
Rod Block Monitor Setpoints[1]
(References 2 and 7)

Power Level	Nominal Trip Setpoint	Allowable Value
LTSP	121.5%	121.5%
ITSP	116.5%	116.5%
HTSP	111.0%	111.7%
DTSP	5.0%	2.0%

TABLE 6-2
Reactor Coolant System Recirculation Flow Upscale Trip
(Reference 7)

Nominal Trip Setpoint	113.4%
Allowable Value	115.6%

[1] Based on a cycle-specific rated RWE MCPR limit less than or equal to the minimum cycle OLMCPR. The values provided assume the Rod Block Monitor filter time constant between 0.1 seconds and 0.55 seconds is used.

7.0 Turbine Bypass Valve Parameters

7.1 Technical Specification

Section 3.7.8 and 4.7.8.C

7.2 Description

The operability requirements for the steam bypass system are found in Tables 7-1 and 7-2. If these requirements cannot be met, the MCPR, MCPR(P) and LHGRFAC(P) limits for inoperable Steam Bypass System, known as Turbine Bypass Valve Out Of Service (TBVOOS), must be used.

TABLE 7-1
Turbine Bypass System Response Time
(Reference 4)

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 7-2
Minimum Required Bypass Valves To Maintain System Operability
(Reference 4)

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

8.0 Stability Protection Setpoints

8.1 Technical Specification

Section 2.2.1.2.F

8.2 Description

The Limerick 1 Cycle 13 OPRM Period Based Detection Algorithm (PBDA) Trip Setpoints for the OPRM System are found in Table 8-1. These values are based on the cycle specific analysis documented in Reference 2. The Cycle 13 OPRM PBDA trip setpoints specified in Table 8-1 require a minimum OLMCPR value of 1.34 (See Section 4.0 MCPR Limits). The setpoints provided in Table 8-1 are bounding for all modes of operation shown in Table 9-1.

TABLE 8-1
OPRM PBDA Trip Setpoints[1]
(Reference 2)

PBDA Trip Amplitude	Corresponding Maximum Confirmation Count Trip Setting
≤1.14	16

9.0 Modes Of Operation

TABLE 9-1
Modes of Operation
(Reference 2, 3 and 5)

EOOS Options	Operating Region[2]
Base, Option A or B	Yes
Base SLO, Option A or B	Yes
TBVOOS, Option A or B	Yes
TBVOOS SLO, Option A or B	Yes
RPTOOS, Option A or B	Yes
RPTOOS SLO, Option A or B	Yes
TBVOOS and RPTOOS, Option A or B	No
TBVOOS and RPTOOS SLO, Option A or B	No

[1] The station has conservatively decided to maintain the PDBA Trip Amplitude at 1.12 with a Corresponding Maximum Confirmation Count Trip Setting of 14 until such time where these changes do not introduce a Unit difference at Limerick. Operations and Site Engineering agreed upon this decision.
[2] Operating Region refers to operation on the Power to Flow map with or without FFWTR.

10.0 Methodology

The analytical methods used to determine the core operating limits shall be those previously reviewed and approved by the NRC, specifically those described in the following document:

1. "General Electric Standard Application for Reactor Fuel", NEDE-24011-P-A-15, September 2005 and U.S. Supplement NEDE-24011-P-A-15-US, September 2005.

11.0 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 12 Cycle 13", Global Nuclear Fuel Document No. 0000-0069-5237-SRLR, Revision 1, February 2008.

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

4. "OPL-3 Transient Protection Parameters Verification for Reload Licensing Analyses for Limerick 1 Reload 12 Cycle 13", TODI NF0700207.

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

6. "General Electric Standard Application for Reactor Fuel", NEDE-24011-P-A-15, September 2005 and U.S. Supplement NEDE-24011-P-A-15-US, September 2005.

7. "Power Range Neutron Monitoring System Setpoint Calculations Limerick Generating Station, Units 1 & 2 Mod. No. P00224", LE-0107, Rev. 0, March 2000. Including Minor Revision 0B, March 1, 2008.

8. "Fuel Bundle Information Report for Limerick Generating Station Unit 1 Reload 12 Cycle 13", Global Nuclear Fuel Document No. 0000-0069-5237-FBIR, January 2008.

9. "Limerick Units 1 and 2 Off-Rated Analysis Below PLU Power Level With Credit for Backup Trip", GE-NE-0000-0053-9467-R1, August 2006.