ENCLOSURE 1

NON-PROPRIETARY INFORMATION

UNIT 1 COLR for Cycle 15 Rev. 9

CORE OPERATING LIMITS REPORT

FOR

LIMERICK GENERATING STATION

UNIT 1 RELOAD 14 CYCLE 15

(This is a complete re-write; no annotations are used.)

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1.0 Terms and Definitions

ARTS	APRM and RBM Technical Specification Analysis
BASE	A case analyzed with Turbine Bypass System in service, Recirculation Pump Trip in service, Feedwater Temperature Reduction allowed (FFWTR includes feedwater heater OOS or final feedwater temperature reduction) and PLUOOS allowed at any point in the cycle operation in Dual Loop mode.
DLO	Dual Loop Operation
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reactor power is equal to rated thermal power with recirculation system flow equal to 100%, all control rods fully withdrawn, all feedwater heating in service and equilibrium Xenon.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
Kp	Off-rated power dependent OLMCPR multiplier
LHGR	Linear Heat Generation Rate
LHGRFAC(F)	ARTS LHGR thermal limit flow dependent multipliers
LHGRFAC(P)	ARTS LHGR thermal limit power dependent multipliers
LTSP	Rod Block Monitor Low Trip Setpoint
MAPFAC(F)	Off-rated flow dependent MAPLHGR multiplier
MAPFAC(P)	Off-rated power dependent MAPLHGR multiplier
MAPLHGR	Maximum Average Planar Linear Heat Generation Rate
MCPR	Minimum Critical Power Ratio
MCPR(F)	ARTS MCPR flow dependent thermal limit
MCPR(P)	ARTS MCPR power dependent thermal limit

MELLLA	Maximum Extended Load Line Limit Analysis
OLMCPR	Operating Limit Minimum Critical Power Ratio
OPRM	Oscillation Power Range Monitor
PBDA	Period Based Detection Algorithm
PLUOOS	Power Load Unbalance Out of Service
RBM	Rod Block Monitor
RPTIS	Recirculation Pump Trip in Service
RPTOOS	Recirculation Pump Trip Out of Service
SLO	Single Loop Operation
TBVIS	Turbine Bypass Valves in Service
TBVOOS	Turbine Bypass Valves Out of Service

2.0 General Information

This report provides the following cycle-specific parameter limits for Limerick Generating Station Unit 1 Cycle 15:

- 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
- Oscillation Power Range Monitor Period Based Detection Algorithm (OPRM PBDA) Trip Setpoints

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 the minimum licensed core flow during full power operation
- Increased Core Flow (ICF) up to 110% of rated core flow
- Final Feedwater Temperature Reduction (FFWTR) up to 105.0°F during cycle extension operation
- Feedwater Heater Out of Service (FWHOOS) up to 60.0°F feedwater temperature reduction at any time during the cycle prior to cycle extension.

Further information on the cycle-specific analyses for Limerick Unit 1 Cycle 15 and the associated operating domains discussed above is available in Reference 2.

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 Tables 3-1 and 3-2. For single loop operation, a reduction factor is used, which is shown in Table 3-3. The power and flow dependent multipliers for MAPLHGR have been removed and replaced with LHGRFAC(P) and LHGRFAC(F); therefore, MAPFAC(P) and MAPFAC(F) are equal to 1.0 for all power and flow conditions (Reference 2). LHGRFAC(P) and LHGRFAC(F) are addressed in Section 5.0.

Table 3-1
MAPLHGR Versus Average Planar Exposure – GE14
(Reference 2)

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

Table 3-2
MAPLHGR Versus Average Planar Exposure – GNF2
(Reference 2)

Average Planar Exposure (GWD/ST)	MAPLHGR Limit (kW/ft)
0.0	13.78
17.52	13.78
60.78	7.50
63.50	6.69

Table 3-3
MAPLHGR SLO Reduction Factor – All Fuel Types
(Reference 2)

SLO Reduction Factor	0.80

4.0 MCPR Limits

4.1 Technical Specification

Section 3.2.3

4.2 Description

Tables 4-1 and 4-2 are derived from Reference 2 and are valid for all Cycle 15 operating domains. Table 4-1 is valid for GE14 fuel and Table 4-2 is valid for GNF2 fuel. Tables 4-1 and 4-2 include treatment of these MCPR limits for all conditions listed in Section 9.0, Modes of Operation. Limerick Unit 1 Cycle 15 was analyzed with no mid-cycle MCPR breakpoint.

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. The power dependent adjustment MCPR(P) is independent of recirculation pump trip operability. MCPR(P) and MCPR(F) are independent of Scram Time Option. In addition, there are six sets of power dependent MCPR multipliers (Kp) for use with the BASE, TBVOOS, RPTOOS, DLO and SLO conditions. The PLUOOS condition is included in the BASE MCPR(P) and MCPR(F) limits and Kp multipliers and is bounded by the TBVOOS limits and multipliers; therefore, no additional adjustments are required for PLUOOS in those operating conditions. The PLUOOS condition has not been analyzed concurrent with the RPTOOS operating condition. Operation in the PLUOOS condition concurrent with the RPTOOS condition requires core thermal power < 55% of rated (Reference 3). Section 7.0 contains the conditions for Turbine Bypass Valve Operability. MCPR(P) and MCPR(F) adjustments for all fuel types are provided in Table 4-3 and 4-4, respectively. 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.

Table 4-1
Operating Limit Minimum Critical Power Ratio (OLMCPR) – GE14
(Reference 2)

EOOS Combination	SCRAM Time Option[1]	All Cycle Exposures
BASE	B	1.37
	A	1.45
BASE SLO[2]	B	1.46
	A	1.48
TBVOOS	B	1.43
	A	1.52
TBVOOS SLO[2]	B	1.46
	A	1.55
RPTOOS	B	1.42
	A	1.59
RPTOOS SLO[2]	B	1.46
	A	1.62

Table 4-2
Operating Limit Minimum Critical Power Ratio (OLMCPR) – GNF2
(Reference 2)

EOOS Combination	SCRAM Time Option[1]	All Cycle Exposures
BASE	B	1.37
	A	1.45
BASE SLO[2]	B	1.58
	A	1.58
TBVOOS	B	1.43
	A	1.52
TBVOOS SLO[2]	B	1.58
	A	1.58
RPTOOS	B	1.42
	A	1.59
RPTOOS SLO[2]	B	1.58
	A	1.62

[1] When Tau does not equal 0 or 1, determine OLMCPR via linear interpolation.
[2] For single-loop operation, the MCPR operating limit is 0.03 greater than the analyzed two loop value. However, a minimum value of 1.46 for GE14 fuel and 1.58 for GNF2 fuel is required to obtain an OLMCPR limit set by the Single Loop Operation Recirculation Pump Seizure Event (Reference 2).

Table 4-3
Power Dependent MCPR Limits and Multipliers MCPR(P) and Kp – All Fuel Types
(Reference 2)

EOOS Combination	Core Flow (% of rated)	Core Thermal Power (% of Rated)						
		0	25	< 30	≥ 30	65	85	100
		Operating Limit MCPR, MCPR(P)			Operating Limit MCPR Multiplier, Kp			
BASE	≤ 60	2.50	2.50	2.40	1.340	1.131	1.067	1.000
	> 60	2.75	2.75	2.55				
BASE SLO	≤ 60	2.53	2.53	2.43	1.340	1.131	1.067	1.000
	> 60	2.78	2.78	2.58				
TBVOOS	≤ 60	3.25	3.25	2.75	1.340	1.131	1.067	1.000
	> 60	3.75	3.75	3.25				
TBVOOS SLO	≤ 60	3.28	3.28	2.78	1.340	1.131	1.067	1.000
	> 60	3.78	3.78	3.28				
RPTOOS	≤ 60	2.50	2.50	2.40	1.340	1.131	1.067	1.000
	> 60	2.75	2.75	2.55				
RPTOOS SLO	≤ 60	2.53	2.53	2.43	1.340	1.131	1.067	1.000
	> 60	2.78	2.78	2.58				

Table 4-4
Flow Dependent MCPR Limits MCPR(F) – All Fuel Types
(Reference 2)

Flow (% rated)	MCPR(F) Limit
0.0	1.70
30.0	1.53
79.0	1.25
110.0	1.25

5.0 LHGR Limits

5.1 Technical Specification

Section 3.2.4

5.2 Description

The LHGR limit is the product of the exposure dependent LHGR limit (from Table 5-1 for UO2 fuel rods and Table 5-2 for Gadolinia fuel rods) and the minimum of: the power dependent LHGR Factor, LHGRFAC(P), and the flow dependent LHGR Factor, LHGRFAC(F). For single loop operation, a reduction factor is used, which is shown in Table 5-3 and applied in Table 5-5. No further Single Loop Operating reduction factors need to be applied to the values in Tables 5-4 and 5-5.

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 LHGR multipliers for dual-loop and single-loop operation. In addition, there are six sets of power dependent LHGR multipliers for use with the BASE, TBVOOS, RPTOOS, DLO and SLO conditions. The PLUOOS condition is included in the BASE LHGRFAC(P) and LHGRFAC(F) multipliers and is bounded by the TBVOOS multipliers; therefore, no additional adjustments are required for PLUOOS in those operating conditions. The PLUOOS condition has not been analyzed concurrent with the RPTOOS operating condition. Operation in the PLUOOS condition concurrent with the RPTOOS condition requires core thermal power < 55% of rated (Reference 3). Tables 5-4 and 5-5 for LHGRFAC(P) and LHGRFAC(F), respectively, are applicable to both GE14 and GNF2 fuel types. Section 7.0 contains the conditions for Turbine Bypass Valve Operability. Linear interpolation should be used for points not listed in Appendix A.

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.

Table 5-1
Linear Heat Generation Rate Limits – UO_2 Rods
(Reference 5)

Fuel Type	LHGR
GE14	See Appendix A
GNF2	See Appendix A

Table 5-2
Linear Heat Generation Rate Limits – Gad Rods
(Reference 5)

Fuel Type	LHGR
GE14	See Appendix A
GNF2	See Appendix A

Table 5-3
LHGR Single Loop Operation (SLO) Multiplier – All Fuel Types
(Reference 2)

SLO Multiplier[1]	0.80

Table 5-4
Power Dependent LHGR Multiplier LHGRFAC(P) – All Fuel Types
(Reference 2)

EOOS Combination	Core Flow (% of rated)	Core Thermal Power (% of rated)						
		0	25	< 30	≥ 30	65	85	100
		LHGRFAC(P) Multiplier						
BASE	≤ 60	0.485	0.485	0.490	0.750	0.817	0.922	1.000
	> 60	0.434	0.434	0.473				
BASE SLO	≤ 60	0.485	0.485	0.490	0.750	0.817	0.922	1.000
	> 60	0.434	0.434	0.473				
TBVOOS	≤ 60	0.463	0.463	0.490	0.750	0.817	0.922	1.000
	> 60	0.352	0.352	0.386				
TBVOOS SLO	≤ 60	0.463	0.463	0.490	0.750	0.817	0.922	1.000
	> 60	0.352	0.352	0.386				
RPTOOS	≤ 60	0.485	0.485	0.490	0.750	0.817	0.922	1.000
	> 60	0.434	0.434	0.473				
RPTOOS SLO	≤ 60	0.485	0.485	0.490	0.750	0.817	0.922	1.000
	> 60	0.434	0.434	0.473				

Table 5-5
Flow Dependent LHGR Multiplier LHGRFAC(F) – All Fuel Types
(Reference 2)

EOOS Combination	Core Flow (% of rated)					
	0	30	44.082	70	80	110
	LHGRFAC(F) Multiplier					
Dual Loop	0.506	0.706		0.973	1.000	1.000
Single Loop	0.506	0.706	0.800			0.800

[1] Applied through Table 5-5

6.0 Control Rod Block Setpoints

6.1 Technical Specification

Sections 3.1.4.3 and 3.3.6

6.2 Description

The ARTS Rod Block Monitor provides for power dependent RBM trips. Technical Specification 3.3.6 states 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 trip setpoints/allowable values and applicable RBM signal filter time constant data are shown in Table 6-1. The Reactor Coolant System Recirculation Flow Upscale Trip is shown in Table 6-2. These setpoints are set high enough to allow full utilization of the enhanced ICF domain up to 110% of rated core flow.

Table 6-1
Rod Block Monitor Setpoints[1]
(References 2 and 4)

Power Level	Analytical Limit	Allowable Value	Nominal Trip Setpoint	MCPR Limit
LTSP	123.0%	121.5%	121.5%	
ITSP	118.0%	116.5%	116.5%	< 1.70 [(2)]
HTSP	113.2%	111.7%	111.0%	< 1.40 [(3)]
DTSP	No Limitation	2.0%	5.0%	

Table 6-2
Reactor Coolant System Recirculation Flow Upscale Trip
(Reference 4)

Analytical Limit	N/A
Allowable Value	115.6%
Nominal Trip Setpoint	113.4%

[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 of 1.32, which is less than the minimum cycle OLMCPR.
[2] This is the MCPR limit (given THERMAL POWER is $\geq$ 28.4% and < 90%) below which the RBM is required to be OPERABLE (see Reference 2 and TS Table 3.3.6-2).
[3] This is the MCPR limit (given THERMAL POWER is $\geq$ 90%) below which the RBM is required to be OPERABLE (see Reference 2 and TS Table 3.3.6-2).

7.0 Turbine Bypass Valve Parameters

7.1 Technical Specification

Sections 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. Additional information on the operability of the turbine bypass system can be found in Reference 6.

Table 7-1
Turbine Bypass System Response Time
(Reference 3)

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 3)

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

8.0 Stability Protection Setpoints

8.1 Technical Specification

Section 2.2.1

8.2 Description

The Limerick Unit 1 Cycle 15 OPRM 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 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
(Reference 2)

PBDA Trip Amplitude	Corresponding Maximum Confirmation Count Trip Setting
≤ 1.12	≤ 14

9.0 Modes of Operation

Table 9-1
Modes of Operation
(Reference 2)

EOOS Options	Operating Region[1]
BASE, Option A or B	Yes[2]
BASE SLO, Option A or B	Yes[2]
TBVOOS, Option A or B	Yes[2]
TBVOOS SLO, Option A or B	Yes[2]
RPTOOS, Option A or B	Yes[3]
RPTOOS SLO, Option A or B	Yes[3]
TBVOOS and RPTOOS, Option A or B	No
TBVOOS and RPTOOS SLO, Option A or B	No

[1] Operating Region refers to operation on the Power to Flow map with or without FFWTR.
[2] The PLUOOS condition is supported in this mode of operation with no power reduction required.
[3] The PLUOOS condition requires core thermal power level < 55% of rated (Reference 3).

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 documents:

1. "General Electric Standard Application for Reactor Fuel," NEDE-24011-P-A-18, April 2011 and U.S. Supplement NEDE-24011-P-A-18-US, April 2011.

2. "Reactor Stability Detect and Suppress Solutions Licensing Basis Methodology for Reload Applications," NEDO-32465-A, Rev. 0, August 1996.

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 1 Reload 14 Cycle 15", Global Nuclear Fuel Document No. 0000-0131-9339-SRLR, Revision 1, January 2012.

3. "Final Resolved OPL-3 Parameters for Limerick Unit 1 Cycle 15", Exelon TODI ES1100022 Rev. 0, September 9, 2011.

4. "GE NUMAC PRNM Setpoint Study", Exelon Design Analysis LE-0107, Rev. 2, February 23, 2012.

5. "Fuel Bundle Information Report for Limerick 1 Reload 14 Cycle 15", Global Nuclear Fuel Document No. 0000-0131-9339-FBIR-NP, Revision 0, January 2012.

6. "Tech Eval Stop Valve Load Limit Documentation", Exelon Document IR 917231 Assignment 7, November 11, 2009.

Appendix A

Global Nuclear Fuel

A Joint Venture of GE,Toshiba, & Hitachi

Global Nuclear Fuel

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Non-Proprietary Information – Class I (Public)

Fuel Bundle Information Report
for
Limerick 1
Reload 14 Cycle 15

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1. Introduction and Summary

This report, which supplements the *Supplemental Reload Licensing Report*, contains thermal-mechanical linear heat generation rate (LHGR) limits for the GNF-A fuel designs to be loaded into Limerick 1 for Cycle 15. These LHGR limits are obtained from thermal-mechanical considerations only. Approved GNF-A calculation models documented in Reference 1 were used in performing this analysis.

LHGR limits as a function of exposure for each bundle of the core design are given in Appendix A. The LHGR values provided in Appendix A provide upper and lower exposure dependent LHGR boundaries which envelope the actual gadolinia dependent LHGR limits. The LHGRs reported have been rounded to two places past the decimal.

Appendix B contains a description of the fuel bundles. Table B-1 contains a summary of bundle-specific information, and the figures provide the enrichment distribution and gadolinium distribution for the fuel bundles included in this appendix. These bundles have been approved for use under the fuel licensing acceptance criteria of Reference 1.

2. References

1. *General Electric Standard Application for Reactor Fuel*, NEDE-24011-P-A-18, April 2011; and the U.S. Supplement, NEDE-24011-P-A-18-US, April 2011.

Appendix A
UO_2/Gd Thermal-Mechanical LHGR Limits

Bundle Type: GE14-P10CNAB415-15GZ-120T-150-T6-3035 (GE14C)

Bundle Number: 3035

Peak Pellet Exposure	UO_2 LHGR Limit
GWd/MT (GWd/ST)	kW/ft
0.00 (0.00)	13.40
16.00 (14.51)	13.40
63.50 (57.61)	8.00
70.00 (63.50)	5.00

Peak Pellet Exposure	Most Limiting Gadolinia LHGR Limit [1]
GWd/MT (GWd/ST)	kW/ft
0.00 (0.00)	11.76
13.31 (12.08)	11.76
59.76 (54.21)	7.02
66.12 (59.98)	4.39

[1] Bounding gadolinia LHGR limit for all gadolinium concentrations occurring in this bundle design (8.0% Gd).

UO_2/Gd Thermal-Mechanical LHGR Limits

Bundle Type: GE14-P10CNAB415-15GZ-120T-150-T6-3038 (GE14C)

Bundle Number: 3038

Peak Pellet Exposure	UO_2 LHGR Limit
GWd/MT (GWd/ST)	kW/ft
0.00 (0.00)	13.40
16.00 (14.51)	13.40
63.50 (57.61)	8.00
70.00 (63.50)	5.00

Peak Pellet Exposure	Most Limiting Gadolinia LHGR Limit [2]
GWd/MT (GWd/ST)	kW/ft
0.00 (0.00)	11.76
13.31 (12.08)	11.76
59.76 (54.21)	7.02
66.12 (59.98)	4.39

[2] Bounding gadolinia LHGR limit for all gadolinium concentrations occurring in this bundle design (8.0% Gd).

UO_2/Gd Thermal-Mechanical LHGR Limits

Bundle Type: GE14-P10CNAB415-15GZ-120T-150-T6-3041 (GE14C)

Bundle Number: 3041

Peak Pellet Exposure	UO_2 LHGR Limit
GWd/MT (GWd/ST)	kW/ft
0.00 (0.00)	13.40
16.00 (14.51)	13.40
63.50 (57.61)	8.00
70.00 (63.50)	5.00

Peak Pellet Exposure	Most Limiting Gadolinia LHGR Limit [3]
GWd/MT (GWd/ST)	kW/ft
0.00 (0.00)	11.76
13.31 (12.08)	11.76
59.76 (54.21)	7.02
66.12 (59.98)	4.39

[3] Bounding gadolinia LHGR limit for all gadolinium concentrations occurring in this bundle design (8.0% Gd).

UO_2/Gd Thermal-Mechanical LHGR Limits

Bundle Type: GE14-P10CNAB394-15GZ-120T-150-T6-3271 (GE14C)

Bundle Number: 3271

Peak Pellet Exposure	UO_2 LHGR Limit
GWd/MT (GWd/ST)	kW/ft
0.00 (0.00)	13.40
16.00 (14.51)	13.40
63.50 (57.61)	8.00
70.00 (63.50)	5.00

Peak Pellet Exposure	Most Limiting Gadolinia LHGR Limit [4]
GWd/MT (GWd/ST)	kW/ft
0.00 (0.00)	12.00
13.42 (12.17)	12.00
60.17 (54.59)	7.16
66.57 (60.39)	4.48

[4] Bounding gadolinia LHGR limit for all gadolinium concentrations occurring in this bundle design (7.0% Gd).

UO_2/Gd Thermal-Mechanical LHGR Limits

Bundle Type: GE14-P10CNAB401-13GZ-120T-150-T6-3273 (GE14C)

Bundle Number: 3273

Peak Pellet Exposure	UO_2 LHGR Limit
GWd/MT (GWd/ST)	kW/ft
0.00 (0.00)	13.40
16.00 (14.51)	13.40
63.50 (57.61)	8.00
70.00 (63.50)	5.00

Peak Pellet Exposure	Most Limiting Gadolinia LHGR Limit [5]
GWd/MT (GWd/ST)	kW/ft
0.00 (0.00)	11.76
13.31 (12.08)	11.76
59.76 (54.21)	7.02
66.12 (59.98)	4.39

[5] Bounding gadolinia LHGR limit for all gadolinium concentrations occurring in this bundle design (8.0% Gd).

UO_2/Gd Thermal-Mechanical LHGR Limits

Bundle Type: GE14-P10CNAB402-13GZ-120T-150-T6-3274 (GE14C)

Bundle Number: 3274

Peak Pellet Exposure	UO_2 LHGR Limit
GWd/MT (GWd/ST)	kW/ft
0.00 (0.00)	13.40
16.00 (14.51)	13.40
63.50 (57.61)	8.00
70.00 (63.50)	5.00

Peak Pellet Exposure	Most Limiting Gadolinia LHGR Limit [6]
GWd/MT (GWd/ST)	kW/ft
0.00 (0.00)	11.76
13.31 (12.08)	11.76
59.76 (54.21)	7.02
66.12 (59.98)	4.39

[6] Bounding gadolinia LHGR limit for all gadolinium concentrations occurring in this bundle design (8.0% Gd).

UO_2/Gd Thermal-Mechanical LHGR Limits

Bundle Type: GE14-P10CNAB416-15GZ-120T-150-T6-3040 (GE14C)

Bundle Number: 3040

Peak Pellet Exposure	UO_2 LHGR Limit
GWd/MT (GWd/ST)	kW/ft
0.00 (0.00)	13.40
16.00 (14.51)	13.40
63.50 (57.61)	8.00
70.00 (63.50)	5.00

Peak Pellet Exposure	Most Limiting Gadolinia LHGR Limit [7]
GWd/MT (GWd/ST)	kW/ft
0.00 (0.00)	11.76
13.31 (12.08)	11.76
59.76 (54.21)	7.02
66.12 (59.98)	4.39

[7] Bounding gadolinia LHGR limit for all gadolinium concentrations occurring in this bundle design (8.0% Gd).

UO_2/Gd Thermal-Mechanical LHGR Limits

Bundle Type: GE14-P10CNAB398-12GZ-120T-150-T6-3275 (GE14C)

Bundle Number: 3275

Peak Pellet Exposure	UO_2 LHGR Limit
GWd/MT (GWd/ST)	kW/ft
0.00 (0.00)	13.40
16.00 (14.51)	13.40
63.50 (57.61)	8.00
70.00 (63.50)	5.00

Peak Pellet Exposure	Most Limiting Gadolinia LHGR Limit [8]
GWd/MT (GWd/ST)	kW/ft
0.00 (0.00)	11.76
13.31 (12.08)	11.76
59.76 (54.21)	7.02
66.12 (59.98)	4.39

[8] Bounding gadolinia LHGR limit for all gadolinium concentrations occurring in this bundle design (8.0% Gd).

UO_2/Gd Thermal-Mechanical LHGR Limits

Bundle Type: GE14-P10CNAB394-15GZ-120T-150-T6-3272 (GE14C)

Bundle Number: 3272

Peak Pellet Exposure	UO_2 LHGR Limit
GWd/MT (GWd/ST)	kW/ft
0.00 (0.00)	13.40
16.00 (14.51)	13.40
63.50 (57.61)	8.00
70.00 (63.50)	5.00

Peak Pellet Exposure	Most Limiting Gadolinia LHGR Limit [9]
GWd/MT (GWd/ST)	kW/ft
0.00 (0.00)	11.76
13.31 (12.08)	11.76
59.76 (54.21)	7.02
66.12 (59.98)	4.39

[9] Bounding gadolinia LHGR limit for all gadolinium concentrations occurring in this bundle design (8.0% Gd).

UO_2/Gd Thermal-Mechanical LHGR Limits

Bundle Type: GE14-P10CNAB415-15GZ-120T-150-T6-3042 (GE14C)

Bundle Number: 3042

Peak Pellet Exposure	UO_2 LHGR Limit
GWd/MT (GWd/ST)	kW/ft
0.00 (0.00)	13.40
16.00 (14.51)	13.40
63.50 (57.61)	8.00
70.00 (63.50)	5.00

Peak Pellet Exposure	Most Limiting Gadolinia LHGR Limit [10]
GWd/MT (GWd/ST)	kW/ft
0.00 (0.00)	11.76
13.31 (12.08)	11.76
59.76 (54.21)	7.02
66.12 (59.98)	4.39

[10] Bounding gadolinia LHGR limit for all gadolinium concentrations occurring in this bundle design (8.0% Gd).

UO_2/Gd Thermal-Mechanical LHGR Limits

Bundle Type: GE14-P10CNAB415-15GZ-120T-150-T6-3039 (GE14C)

Bundle Number: 3039

Peak Pellet Exposure	UO_2 LHGR Limit
GWd/MT (GWd/ST)	kW/ft
0.00 (0.00)	13.40
16.00 (14.51)	13.40
63.50 (57.61)	8.00
70.00 (63.50)	5.00

Peak Pellet Exposure	Most Limiting Gadolinia LHGR Limit [11]
GWd/MT (GWd/ST)	kW/ft
0.00 (0.00)	11.76
13.31 (12.08)	11.76
59.76 (54.21)	7.02
66.12 (59.98)	4.39

[11] Bounding gadolinia LHGR limit for all gadolinium concentrations occurring in this bundle design (8.0% Gd).

UO_2/Gd Thermal-Mechanical LHGR Limits

Bundle Type: GNF2-P10CG2B393-10G7.0/2G6.0-120T2-150-T6-4048 (GNF2)

Bundle Number: 4048

Peak Pellet Exposure	UO_2 LHGR Limit
GWd/MT (GWd/ST)	kW/ft
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Peak Pellet Exposure	Most Limiting Gadolinia LHGR Limit [12]
GWd/MT (GWd/ST)	kW/ft
[[	
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[12] Bounding gadolinia LHGR limit for all gadolinium concentrations occurring in this bundle design [[ ]].

UO_2/Gd Thermal-Mechanical LHGR Limits

Bundle Type: GNF2-P10CG2B404-12G6.0-100T2-150-T6-4044 (GNF2)

Bundle Number: 4044

Peak Pellet Exposure	UO_2 LHGR Limit
GWd/MT (GWd/ST)	kW/ft
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Peak Pellet Exposure	Most Limiting Gadolinia LHGR Limit [13]
GWd/MT (GWd/ST)	kW/ft
[[	
	]]

[13] Bounding gadolinia LHGR limit for all gadolinium concentrations occurring in this bundle design [[ ]].

UO_2/Gd Thermal-Mechanical LHGR Limits

Bundle Type: GNF2-P10CG2B404-12G6.0-120T2-150-T6-3643 (GNF2)

Bundle Number: 3643

Peak Pellet Exposure	UO_2 LHGR Limit
GWd/MT (GWd/ST)	kW/ft
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Peak Pellet Exposure	Most Limiting Gadolinia LHGR Limit [14]
GWd/MT (GWd/ST)	kW/ft
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[14] Bounding gadolinia LHGR limit for all gadolinium concentrations occurring in this bundle design [[ ]].

UO_2/Gd Thermal-Mechanical LHGR Limits

Bundle Type: GNF2-P10CG2B387-15GZ-120T2-150-T6-4045 (GNF2)

Bundle Number: 4045

Peak Pellet Exposure	UO_2 LHGR Limit
GWd/MT (GWd/ST)	kW/ft
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Peak Pellet Exposure	Most Limiting Gadolinia LHGR Limit [15]
GWd/MT (GWd/ST)	kW/ft
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[15] Bounding gadolinia LHGR limit for all gadolinium concentrations occurring in this bundle design [[ ]].

UO_2/Gd Thermal-Mechanical LHGR Limits

Bundle Type: GNF2-P10CG2B388-13GZ-120T2-150-T6-4046 (GNF2)

Bundle Number: 4046

Peak Pellet Exposure	UO_2 LHGR Limit
GWd/MT (GWd/ST)	kW/ft
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Peak Pellet Exposure	Most Limiting Gadolinia LHGR Limit [16]
GWd/MT (GWd/ST)	kW/ft
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[16] Bounding gadolinia LHGR limit for all gadolinium concentrations occurring in this bundle design [[ ]].

UO_2/Gd Thermal-Mechanical LHGR Limits

Bundle Type: GNF2-P10CG2B392-15GZ-120T2-150-T6-4047 (GNF2)

Bundle Number: 4047

Peak Pellet Exposure	UO_2 LHGR Limit
GWd/MT (GWd/ST)	kW/ft
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Peak Pellet Exposure	Most Limiting Gadolinia LHGR Limit [17]
GWd/MT (GWd/ST)	kW/ft
[[	
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[17] Bounding gadolinia LHGR limit for all gadolinium concentrations occurring in this bundle design [[ ]].

Appendix B
Fuel Bundle Information

Table B-1
Bundle Specific Information

Fuel Bundle	Bundle Number	Enrichment (wt% U-235)	Weight of UO_2 (kg)	Weight of U (kg)	Max k_∞ at 20°C [18]	Exposure at Max k_∞ GWd/MT (GWd/ST)
GE14-P10CNAB415-15GZ-120T-150-T6-3035 (GE14C)	3035	[[				
GE14-P10CNAB415-15GZ-120T-150-T6-3038 (GE14C)	3038					
GE14-P10CNAB415-15GZ-120T-150-T6-3041 (GE14C)	3041					
GE14-P10CNAB394-15GZ-120T-150-T6-3271 (GE14C)	3271					
GE14-P10CNAB401-13GZ-120T-150-T6-3273 (GE14C)	3273					
GE14-P10CNAB402-13GZ-120T-150-T6-3274 (GE14C)	3274					
GE14-P10CNAB416-15GZ-120T-150-T6-3040 (GE14C)	3040					
GE14-P10CNAB398-12GZ-120T-150-T6-3275 (GE14C)	3275					
GE14-P10CNAB394-15GZ-120T-150-T6-3272 (GE14C)	3272					
GE14-P10CNAB415-15GZ-120T-150-T6-3042 (GE14C)	3042					
GE14-P10CNAB415-15GZ-120T-150-T6-3039 (GE14C)	3039					
GNF2-P10CG2B393-10G7.0/2G6.0-120T2-150-T6-4048 (GNF2)	4048					
GNF2-P10CG2B404-12G6.0-100T2-150-T6-4044 (GNF2)	4044					

[18] Maximum lattice k_∞ for the most reactive uncontrolled state plus a [[ ]] adder for uncertainties.

GNF2-P10CG2B404-12G6.0-120T2-150-T6-3643 (GNF2)	3643					
GNF2-P10CG2B387-15GZ-120T2-150-T6-4045 (GNF2)	4045					
GNF2-P10CG2B388-13GZ-120T2-150-T6-4046 (GNF2)	4046					
GNF2-P10CG2B392-15GZ-120T2-150-T6-4047 (GNF2)	4047					]]

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Figure B-1 Enrichment and Gadolinium Distribution for EDB No. 3035 Fuel Bundle GE14-P10CNAB415-15GZ-120T-150-T6-3035 (GE14C)

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Figure B-2 Enrichment and Gadolinium Distribution for EDB No. 3038 Fuel Bundle GE14-P10CNAB415-15GZ-120T-150-T6-3038 (GE14C)

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Figure B-3 Enrichment and Gadolinium Distribution for EDB No. 3041 Fuel Bundle GE14-P10CNAB415-15GZ-120T-150-T6-3041 (GE14C)

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Figure B-4 Enrichment and Gadolinium Distribution for EDB No. 3271 Fuel Bundle GE14-P10CNAB394-15GZ-120T-150-T6-3271 (GE14C)

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Figure B-5 Enrichment and Gadolinium Distribution for EDB No. 3273 Fuel Bundle GE14-P10CNAB401-13GZ-120T-150-T6-3273 (GE14C)

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Figure B-6 Enrichment and Gadolinium Distribution for EDB No. 3274 Fuel Bundle GE14-P10CNAB402-13GZ-120T-150-T6-3274 (GE14C)

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Figure B-7 Enrichment and Gadolinium Distribution for EDB No. 3040 Fuel Bundle GE14-P10CNAB416-15GZ-120T-150-T6-3040 (GE14C)

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Figure B-8 Enrichment and Gadolinium Distribution for EDB No. 3275 Fuel Bundle GE14-P10CNAB398-12GZ-120T-150-T6-3275 (GE14C)

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Figure B-9 Enrichment and Gadolinium Distribution for EDB No. 3272 Fuel Bundle GE14-P10CNAB394-15GZ-120T-150-T6-3272 (GE14C)

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Figure B-10 Enrichment and Gadolinium Distribution for EDB No. 3042 Fuel Bundle GE14-P10CNAB415-15GZ-120T-150-T6-3042 (GE14C)

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Figure B-11 Enrichment and Gadolinium Distribution for EDB No. 3039 Fuel Bundle GE14-P10CNAB415-15GZ-120T-150-T6-3039 (GE14C)

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Figure B-12 Enrichment and Gadolinium Distribution for EDB No. 4048
Fuel Bundle GNF2-P10CG2B393-10G7.0/2G6.0-120T2-150-T6-4048 (GNF2)

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Figure B-13 Enrichment and Gadolinium Distribution for EDB No. 4044 Fuel Bundle GNF2-P10CG2B404-12G6.0-100T2-150-T6-4044 (GNF2)

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Figure B-14 Enrichment and Gadolinium Distribution for EDB No. 3643 Fuel Bundle GNF2-P10CG2B404-12G6.0-120T2-150-T6-3643 (GNF2)

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Figure B-15 Enrichment and Gadolinium Distribution for EDB No. 4045 Fuel Bundle GNF2-P10CG2B387-15GZ-120T2-150-T6-4045 (GNF2)

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Figure B-16 Enrichment and Gadolinium Distribution for EDB No. 4046 Fuel Bundle GNF2-P10CG2B388-13GZ-120T2-150-T6-4046 (GNF2)

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Figure B-17 Enrichment and Gadolinium Distribution for EDB No. 4047 Fuel Bundle GNF2-P10CG2B392-15GZ-120T2-150-T6-4047 (GNF2)