Attachment 1 Contains Proprietary Information
Withhold From Public Disclosure Under 10 CFR 2.390(a)(4).
When Separated From Attachment 1, Cover Letter is Decontrolled.

ATTACHMENT 2
Core Operating Limits Report for Clinton Power Station Unit 1, Cycle 15
(Non-Proprietary Version)

Attachment 1 Contains Proprietary Information
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CORE OPERATING LIMITS REPORT

FOR

CLINTON POWER STATION UNIT 1 CYCLE 15

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Table of Contents

List of Tables

1.0 Terms and Definitions

ADSOOS	Automatic Depressurization System Valve Out of Service
Base Case	A case analyzed with two (2) Safety-Relief Valves Out-of-Service (OOS), one (1) Automatic Depressurization System valve OOS, one (1) Turbine Control Valve stuck closed, one (1) Turbine Stop Valve stuck closed, one (1) Turbine Bypass Valve OOS, and up to a 50°F feedwater temperature reduction (FWTR includes feedwater heater OOS or final feedwater temperature reduction) at any point in the cycle operation in Dual Loop mode (Reference 3).
Coastdown	The reactor condition where thermal power gradually decreases due to fuel depletion while the following conditions are met: 1) all operable control rods are fully withdrawn and 2) all cycle extension techniques have been exhausted including FFWTR and ICF.
DLO	Dual Reactor Recirculation Loop Operation
FFWTR	Final Feedwater Temperature Reduction
FWHOOS	Feedwater Heaters Out of Service
ICF	Increased Core Flow
LHGR	Linear Heat Generation Rate
LHGRFAC(F)	LHGR thermal limit flow dependent multipliers
LHGRFAC(P)	LHGR thermal limit power dependent multipliers
MAPLHGR	Maximum Average Planar Linear Heat Generation Rate
MCPR	Minimum Critical Power Ratio
MCPR(F)	MCPR thermal limit flow dependent adjustments and multipliers
MCPR(P)	MCPR thermal limit power dependent adjustments and multipliers
MELLLA	Maximum Extended Load Line Limit Analysis
MSIV	Main Steam Isolation Valve
OLMCPR	Operating Limit Minimum Critical Power Ratio
OPRM	Oscillation Power Range Monitor
PROOS	Pressure Regulator Out of Service

SLO	Single Reactor Recirculation Loop Operation
SRVOOS	Safety Relief Valve Out of Service
TBVOOS	Turbine Bypass Valve(s) Out of Service – valves are not credited for fast opening or for normal pressure control
TCV	Turbine Control Valve
TSV	Turbine Stop Valve

2.0 General Information

This report is prepared in accordance with Technical Specification 5.6.5 of Reference 1. Power and flow dependent limits and multipliers are listed for various power and flow levels. Linear interpolation is to be used to find intermediate values.

These values have been determined using NRC-approved methodologies presented in Section 10 and are established such that all applicable limits of the plant safety analysis are met.

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 99% of rated core flow during full power operation
- Increased Core Flow (ICF) up to 107% of rated core flow
- Final Feedwater Temperature Reduction (FFWTR) up to 50°F during cycle extension operation
- Feedwater Heater Out of Service (FWHOOS) up to 50°F feedwater temperature reduction at any time during the cycle prior to cycle extension.

3.0 MAPLHGR Limits

3.0 Technical Specification Reference:

Sections 3.2.1 and 3.4.1.

3.1 Description:

Table 3-1 is used to determine the maximum average planar linear heat generation rate (MAPLHGR) limit for GE14C and GE14I fuel. Table 3-2 is used to determine the maximum average planar linear heat generation rate (MAPLHGR) limit for GNF2 fuel. Limits listed in Table 3-1 and Table 3-2 are for dual reactor recirculation loop operation (DLO).

For single reactor recirculation loop operation (SLO), the MAPLHGR limits given in Table 3-1 and Table 3-2 must be multiplied by a SLO MAPLHGR multiplier provided in Table 3-3. The SLO MAPLHGR multiplier for all fuel types is 0.76 (Reference 3).

For Loss of 'FULL' Feedwater Heating (±10 °F outside design NORMAL temperature, meaning changes in feedwater temperature greater than 10 °F and less than or equal to 50 °F), the MAPLHGR limits given in Table 3-1 and 3-2 must be multiplied by a LHGR multiplier provided in Table 3-4. The Loss of 'FULL' Feedwater Heating LHGR multiplier for all fuel types is 0.99 (Reference 7).

Table 3-1
MAPLHGR Versus Average Planar Exposure – GE14C/GE14I[1]
(Reference 3)

Avg. Planar Exposure (GWd/ST)	MAPLHGR Limit (kW/ft)
0.00	12.82
19.13	12.82
57.61	8.00
63.50	5.00

Table 3-2
MAPLHGR Versus Average Planar Exposure – GNF2[1]
(Reference 3)

Avg. Planar Exposure (GWd/ST)	MAPLHGR Limit (kW/ft)
0.00	13.78
17.15	13.78
60.78	6.87
63.50	5.50

[1] Linear interpolation should be used for points not listed in the table.

Table 3-3
MAPLHGR Single Loop Operation (SLO) Multiplier
(Reference 3)

Fuel Type	MAPLHGR SLO Multiplier
All Fuel Types	0.760

Table 3-4
MAPLHGR Multiplier for Loss of 'FULL' Feedwater Heating
(Reference 7)

Fuel Type	MAPLHGR Multiplier
All Fuel Types	0.990

4.0 MCPR Limits

4.0 Technical Specification Reference:

Sections 3.2.2, 3.4.1, and 3.7.6.

4.1 Description:

The various MCPR limits are described below.

4.1.1 Manual Flow Control MCPR Limits

The Operating Limit MCPR (OLMCPR) is determined from either section 4.1.1.1 or 4.1.1.2, whichever is greater at any given power and flow condition.

4.1.1.1 Power-Dependent MCPR

For operation less than 33.3% core thermal power and with the pressure regulator in service, the MCPR(P) as a function of core thermal power is shown in Table 4-2. For operation less than 33.3% core thermal power and with the pressure regulator out of service, the MCPR(P) as a function of core thermal power is shown in Table 4-3.

For operation at greater than or equal to 33.3% core thermal power, the OLMCPR as a function of core thermal power is determined by multiplying the applicable rated condition OLMCPR limit shown in Table 4-1 by the applicable MCPR multiplier K(P) given in Table 4-2 or Table 4-3.

4.1.1.2 Flow-Dependent MCPR

Tables 4-4 through 4-7 give the MCPR(F) as a function of flow based on the applicable plant condition. The limits for dual loop operation are listed in Tables 4-4 and 4-6. The limits for single loop operation are listed in Tables 4-5 and 4-7. The MCPR(F) determined from these tables is the flow dependent OLMCPR.

4.1.2 Automatic Flow Control MCPR Limits

Automatic Flow Control MCPR Limits are not provided.

4.1.3 Option A and Option B

Option A and Option B refer to use of scram speeds for establishing MCPR operating limits.

Option A scram speed is the BWR/6 Technical Specification scram speed. The Technical Specification scram speeds must be met to utilize the Option A MCPR limits. Reload analyses performed by GNF for Cycle 15 Option A MCPR limits utilized a 20% core average insertion time of 0.516 seconds (Reference 6).

To utilize the MCPR limits for the Option B scram speed, the cycle average scram insertion time for 20% insertion must satisfy equation 2 in Reference 5 Section 4. If the cycle average scram insertion time does not meet the Option B criteria, the appropriate MCPR value may be determined from a linear interpolation between the Option A and B limits as specified by equation 4 in Reference 5 Section 4.

4.1.4 Recirculation Flow Control Valve Settings

Cycle 15 was analyzed with a maximum core flow runout of 109%; therefore the recirculation flow control valve must be set to maintain core flow less than 109% (92.105 Mlb/hr) for all runout events (Reference 3).

Table 4-1
Operating Limit Minimum Critical Power Ratio
(Reference 3)

EOOS Combination	GE14C and GNF2 Fuel[2] Option A All Exposures	GE14C and GNF2 Fuel[2] Option B All Exposures
Base Case DLO[4]	1.43[1]	1.43[1]
Base Case SLO[3,4]	1.43	1.43
PROOS DLO[4]	1.43[1]	1.43[1]
PROOS SLO[3,4]	1.43	1.43
Two or More TBVOOS DLO	1.43	1.43[1]
Two or More TBVOOS SLO[3]	1.46	1.43

Notes for Table 4-1:

1. Value is adjusted to obtain an OPRM amplitude setpoint of 1.10.
2. GE14I OLMCPR is the GE14C OLMCPR shown plus 0.07, per Reference 3.
3. SLO Option A(B) OLMCPR is the transient DLO Option A(B) OLMCPR plus 0.03 or the OPRM OLMCPR value, whichever is highest.
4. Includes TCV and/or TSV stuck closed, 1 TBVOOS.

Table 4-2
Power Dependent MCPR Limits MCPR(P) and Multipliers K(P)[1,2]
(Reference 3)

EOOS Combination	Core Flow (% of Rated)	Core Thermal Power (%)						
		0.0	21.6	<33.3	≥33.3	≤70.0	>70.0	100.0
		MCPR(P)			K(P)			
Base Case[4] DLO GNF2/GE14C[3]	≤ 50	2.31	2.31	2.10	1.351	1.212	1.163	1.000
	> 50	2.46	2.46	2.17				
Base Case[4] SLO GNF2/GE14C[3]	≤ 50	2.34	2.34	2.13	1.351	1.212	1.163	1.000
	> 50	2.49	2.49	2.20				
Two or More TBVOOS DLO GNF2/GE14C[3]	≤ 50	2.31	2.31	2.10	1.351	1.212	1.163	1.000
	> 50	2.46	2.46	2.17				
Two or More TBVOOS SLO GNF2/GE14C[3]	≤ 50	2.34	2.34	2.13	1.351	1.212	1.163	1.000
	> 50	2.49	2.49	2.20				

Notes for Table 4-2:

1. Values are interpolated between relevant power levels.
2. Allowable EOOS conditions are listed in Section 9.0.
3. An adder of 0.07 is applied to the GE14C MCPR(P) values for GE14I, per Reference 3. GE14C MCPR(P) limits are bounding for GNF2.
4. Includes TCV and/or TSV stuck closed, 1 TBVOOS.

Table 4-3
PROOS Power Dependent MCPR Limits MCPR(P) and Multipliers K(P)[1,2]
(Reference 3)

EOOS Combination	Core Flow (% of Rated)	Core Thermal Power (%)							
		0.0	21.6	<33.3	≥33.3	60.0	≤85.0	>85.0	100.0
		MCPR(P)			K(P)				
PROOS[4] DLO GNF2/GE14C[3]	≤ 50	2.31	2.31	2.10	1.558	1.436	1.309	1.084	1.000
	> 50	2.46	2.46	2.17					
PROOS[4] SLO GNF2/GE14C[3]	≤ 50	2.34	2.34	2.13	1.558	1.436	1.309	1.084	1.000
	> 50	2.49	2.49	2.20					

Notes for Table 4-3:

1. Values are interpolated between relevant power levels.
2. Allowable EOOS conditions are listed in Section 9.0.
3. An adder of 0.07 is applied to the GE14C MCPR(P) values for GE14I, per Reference 3. GE14C MCPR(P) limits are bounding for GNF2.
4. Includes TCV and/or TSV stuck closed, 1 TBVOOS.

Table 4-4
Dual Loop Operation (DLO) Flow Dependent MCPR Limits MCPR(F) for Base Case/PROOS[1]
(Reference 3)

Core Flow (% rated)	MCPR(F) GNF2/GE14C	MCPR(F) GE14I
0.0	1.88	1.95
25.0	1.70	1.77
84.1	1.27	-
93.7	-	1.27
109.0	1.27	1.27

Table 4-5
Single Loop Operation (SLO) Flow Dependent MCPR Limits MCPR(F) for Base Case/PROOS[1]
(Reference 3)

Core Flow (% rated)	MCPR(F) GNF2/GE14C	MCPR(F) GE14I
0.0	1.91	1.98
25.0	1.73	1.80
84.1	1.30	-
93.7	-	1.30
109.0	1.30	1.30

[1] Linear interpolation should be used for points not listed in the table.

Table 4-6
Dual Loop Operation (DLO) Flow Dependent MCPR Limits MCPR(F) for Two or More TBVOOS[1]
(Reference 3)

Core Flow (% rated)	MCPR(F) GNF2/GE14C	MCPR(F) GE14I
0.0	2.04	2.11
25.0	1.85	1.92
100.0	1.27	-
109.0	1.27	1.27

Table 4-7
Single Loop Operation (SLO) Flow Dependent MCPR Limits MCPR(F) for Two or More TBVOOS[1]
(Reference 3)

Core Flow (% rated)	MCPR(F) GNF2/GE14C	MCPR(F) GE14I
0.0	2.07	2.14
25.0	1.88	1.95
100.0	1.30	-
109.0	1.30	1.30

[1] Linear interpolation should be used for points not listed in the table.

5.0 Linear Heat Generation Rate Limits

5.1 Technical Specification Reference:

Section 3.2.3, 3.4.1, and 3.7.6.

5.2 Description:

The linear heat generation rate (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), the flow dependent LHGR Factor, LHGRFAC(F), or the single loop operation (SLO) multiplication factor if applicable. The LHGRFAC(P) is determined from Table 5-3. The LHGRFAC(F) is determined from Tables 5-4 and 5-5, depending on plant conditions. The SLO multiplication factor can be found in Table 5-6. Tables 5-1 and 5-2 are the LHGR limit as a function of peak pellet exposure.

The Gadolinia fuel rod limits referenced in Table 5-2 are the most limiting Gadolinia fuel rods. The most limiting values are provided here as a convenience and do not imply that all the Gadolinia fuel rods must satisfy the listed values.

For Loss of 'FULL' Feedwater Heating (±10 °F outside design NORMAL temperature, meaning changes in feedwater temperature greater than 10 °F and less than or equal to 50 °F), LHGRFAC(P) is determined from Table 5-7 and LHGRFAC(F) is determined from Tables 5-8 and 5-9, depending on plant conditions. Concurrent operation with SLO and reduced feedwater heating has not been evaluated and thus is not a valid operating mode. (Reference 8)

Table 5-1
Linear Heat Generation Rate Limits for UO_2 Rods[1]
(Reference 4)

Fuel Type	LHGR Limit
GNF2	See Appendix A
GE14C	See Appendix A
GE14I	See Appendix A

Table 5-2
Linear Heat Generation Rate Limits for Gad Rods[1]
(Reference 4)

Fuel Type	LHGR Limit
GNF2	See Appendix A
GE14C	See Appendix A
GE14I	See Appendix A

[1] Linear interpolation should be used for points not listed in the table.

Table 5-3
Power Dependent LHGR Multiplier LHGRFAC(P)[2]
(Reference 3)

EOOS Combination	Core Flow (% of Rated)	Core Thermal Power (%)							
		0.0	21.6	<33.3	≥33.3	40.0	<60.0	≥60.0	100.0
		LHGRFAC(P)							
Base Case[1] DLO/SLO	≤ 50	0.634	0.634	0.689	0.651	-	-	-	1.000
	> 50	0.572	0.572	0.600					
Two or More TBVOOS DLO/SLO	≤ 50	0.634	0.634	0.689	0.651	-	-	-	1.000
	> 50	0.572	0.572	0.600					
PROOS[1] DLO/SLO	≤ 50	0.560	0.560	0.560	0.560	0.560	0.709	0.749	1.000
	> 50	0.560	0.560	0.560					

Notes for Table 5-3:

1. Includes TCV and/or TSV stuck closed, 1 TBVOOS.
2. Linear interpolation should be used for points not listed in the table.

Table 5-4
Flow Dependent LHGR Multiplier LHGRFAC(F) for Base Case/PROOS[1]
(Reference 3)

Core Flow (% rated)	LHGRFAC(F)
0.0	0.442
25.0	0.612
30.0	0.646
82.2	1.000
109.0	1.000

Table 5-5
Flow Dependent LHGR Multiplier LHGRFAC(F) for Two or More TBVOOS[1]
(Reference 3)

Core Flow (% rated)	LHGRFAC(F)
0.0	0.140
25.0	0.365
30.0	0.410
40.0	0.500
50.0	0.630
80.0	0.860
98.3	1.000
109.0	1.000

Table 5-6
LHGR Single Loop Operation (SLO) Reduction Factor
(Reference 3)

Fuel Type	LHGR SLO Multiplier
All Fuel Types	0.760

[1] Linear interpolation should be used for points not listed in the table.

Table 5-7
Power Dependent LHGR Multiplier LHGRFAC(P)
(Loss of 'FULL' Feedwater Heating)[2]
(Reference 3)

EOOS Combination	Core Flow (% of Rated)	Core Thermal Power (%)							
		0.0	21.6	<33.3	≥33.3	40.0	<60.0	≥60.0	100.0
		LHGRFAC(P)							
Base Case DLO[1]	≤ 50	0.628	0.628	0.682	0.644	-	-	-	0.990
	> 50	0.566	0.566	0.594					
Base Case SLO									
Two or More TBVOOS DLO	≤ 50	0.628	0.628	0.682	0.644	-	-	-	0.990
	> 50	0.566	0.566	0.594					
Two or More TBVOOS SLO									
PROOS DLO[1]	≤ 50	0.554	0.554	0.554	0.554	0.554	0.702	0.742	0.990
	> 50	0.554	0.554	0.554					
PROOS SLO									

Notes for Table 5-7:

1. Includes TCV and/or TSV stuck closed, 1 TBVOOS.
2. Linear interpolation should be used for points not listed in the table.

Table 5-8
Flow Dependent LHGR Multiplier LHGRFAC(F) for Base Case/PROOS
(Loss of 'FULL' Feedwater Heating)[1]
(Reference 3)

Core Flow (% rated)	LHGRFAC(F)
0.0	0.438
25.0	0.606
30.0	0.640
82.2	0.990
109.0	0.990

Table 5-9
Flow Dependent LHGR Multiplier LHGRFAC(F) for Two or More TBVOOS
(Loss of 'FULL' Feedwater Heating)[1]
(Reference 3)

Core Flow (% rated)	LHGRFAC(F)
0.0	0.139
25.0	0.361
30.0	0.406
40.0	0.495
50.0	0.624
80.0	0.851
98.3	0.990
109.0	0.990

[1] Linear interpolation should be used for points not listed in the table.

6.0 Reactor Protection System (RPS) Instrumentation

6.1 Technical Specification Reference:

Section 3.3.1.1

6.2 Description:

The Average Power Range Monitor (APRM) flow biased simulated thermal power-high time constant, shall be between 5.4 seconds and 6.6 seconds (Reference 6).

7.0 Turbine Bypass System Parameters

7.1 Technical Specification Reference:

Section 3.7.6

7.2 Description:

The operability requirements for the Main Turbine Bypass System are governed by Technical Specification 3.7.6. If the requirements of LCO 3.7.6 cannot be met, the appropriate reactor thermal power, minimum critical power ratio (MCPR), and linear heat generation rate (LHGR) limits must be used to comply with the assumptions in the design basis transient analysis.

Table 7-1 provides the reactor thermal power limitations for an inoperable Main Turbine Bypass System as specified in Technical Specification 3.7.6 action statement A.1. The MCPR and LHGR limits for one TBVOOS are included in the Base Case for Cycle 15, as identified in Table 9-1. The MCPR and LHGR limits for two or more TBVOOS are provided in Sections 4 and 5.

Table 7-1
Reactor Power Limitation – Turbine Bypass Valves Out of Service
(References 2 and 3)

Turbine Bypass System Status	Maximum Reactor Thermal Power (% Rated)
One Turbine Bypass Valve Out of Service	100.0
Two or More Turbine Bypass Valves Out of Service	97.0

8.0 Stability Protection Setpoints

The Clinton 1 Cycle 15 OPRM Period Based Detection Algorithm (PBDA) Trip Setpoints for the OPRM System for use in Technical Specification 3.3.1.3 are found in Table 8-1 and 8-2. These values are based on the cycle specific analysis documented in Reference 3.

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 8-1
OPRM PBDA Trip Setpoints
(Valid for All Conditions)
(Reference 3)

PBDA Trip Amplitude	Corresponding Maximum Confirmation Count Trip Setting
1.10	13

Table 8-2
OPRM PBDA Trip Setpoints – SLO[1]
(Valid for SLO Conditions Only)
(Reference 3)

PBDA Trip Amplitude	Corresponding Maximum Confirmation Count Trip Setting
1.15	16

Notes for Table 8-2:

1. The standard two loop operation OPRM Trip Setpoints specified in Table 8-1 must be implemented prior to restarting the idle pump when exiting the SLO condition.

9.0 Modes of Operation

The Allowed Modes of Operation with combinations of Equipment Out-of-Service (EOOS) are as described below in Table 9-1:

Table 9-1
Modes of Operation
(Reference 3)

	Operating Region				
EOOS Options[2]	**Standard**	**MELLLA**	**ICF**	**FFWTR[1]**	**Coastdown**
Base Case DLO[3]	Yes	Yes	Yes	Yes	Yes
Base Case SLO[1,3]	Yes	No	No	No	Yes
PROOS DLO[3]	Yes	Yes	Yes	Yes	Yes
PROOS SLO[1,3]	Yes	No	No	No	Yes
Two or More TBVOOS DLO[4]	Yes	Yes	Yes	Yes	Yes
Two or More TBVOOS SLO[1,4]	Yes	No	No	No	Yes

Notes:

1. Concurrent operation with SLO and Loss of 'FULL' Feedwater Heating (±10 °F outside design NORMAL temperature, meaning changes in feedwater temperature greater than 10 °F and less than or equal to 50 °F) or FFWTR has not been evaluated and thus is not a valid operating mode. (Reference 8)

2. A single Main Steam Isolation Valve (MSIV) out of service is supported at or below 75% power. (Reference 3)

3. Includes 2 SRVOOS, 1 ADSOOS, 1 TCV stuck closed, 1 TSV stuck closed, 1 TBVOOS, and up to a 50°F feedwater temperature reduction (FWTR includes feedwater heater OOS or final feedwater temperature reduction) at any point in cycle operation in Dual Loop mode.

4. Includes 2 SRVOOS, 1 ADSOOS, and up to a 50°F feedwater temperature reduction (FWTR includes feedwater heater OOS or final feedwater temperature reduction) at any point in cycle operation in Dual Loop mode.

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. Global Nuclear Fuel Document, "General Electric Standard Application for Reactor Fuel", NEDE-24011-P-A-19-US, May 2012 and U.S. Supplement NEDE-24011-P-A-19-US, May 2012.

2. "BWR Owners' Group Reactor Stability Detect and Suppress Solutions Licensing Basis Methodology and Reload Applications", NEDO-32465, August 1996

11.0 References

1. Nuclear Regulatory Commission, Technical Specifications for Clinton Power Station Unit 1, Docket No. 50-461, License No. NPF-62.

2. GE Hitachi Nuclear Energy, 0000-0086-4634-R2-P, "Clinton Power Station One Bypass Out of Service or Turbine Bypass System out of Service Analysis – Final", July 2010.

3. Global Nuclear Fuel Document, 0000-0154-8722-SRLR Revision 0, "Supplemental Reload Licensing Report for Clinton Power Station Unit 1 Reload 14 Cycle 15", August 2013.

4. Global Nuclear Fuel Document, 0000-0154-8722-FBIR-NP Revision 0, "Fuel Bundle Information Report for Clinton Power Station Unit 1 Reload 14 Cycle 15", August 2013.

5. General Electric Document, GE-NE-0000-0000-7456-01P, "Option B Scram Times For Clinton Power Station", February 2002.

6. Exelon Transmittal of Design Information, TODI ES1300006 Revision 0, "Resolved OPL-3 Parameters for Clinton Cycle 15", May 9, 2013.

7. GE Hitachi Nuclear Energy Letter, CFL-EXN-LH1-12-059, "Affirmation of the Clinton Power Station Unit 1 MAPLHGR Reduction for Feedwater Riser Flow Asymmetry", April 25, 2012.

8. General Electric Document, GE-NE-0000-0026-1857-R1, "Evaluation of Operation With Equipment Out-Of-Service for the Clinton Power Station", June 28, 2004.

Appendix A

Global Nuclear Fuel

0000-0154-8722-FBIR-NP
Revision 0
Class I
August 2013

Non-Proprietary Information – Class I (Public)

Fuel Bundle Information Report
for
Clinton Power Station Unit 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 Clinton Power Station Unit 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-19, May 2012; and the U.S. Supplement, NEDE-24011-P-A-19-US, May 2012.

Appendix A
UO_2/Gd Thermal-Mechanical LHGR Limits

Bundle Type: GE14-P10SNAB418-15GZ-120T-150-T6-3240 (GE14C)

Bundle Number: 3240

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

Peak Pellet Exposure	Most Limiting Gadolinia LHGR Limit [1]
GWd/MT (GWd/ST)	kW/ft
[[	
	]]

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

UO_2/Gd Thermal-Mechanical LHGR Limits

Bundle Type: GE14I-P10SCOB405-13GZ-120T-150-T6-3243 (GE14I)

Bundle Number: 3243

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

Peak Pellet Exposure	Most Limiting Gadolinia LHGR Limit [2]
GWd/MT (GWd/ST)	kW/ft
[[	
	]]

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

UO_2/Gd Thermal-Mechanical LHGR Limits

Bundle Type: GE14-P10SNAB418-15GZ-120T-150-T6-3242 (GE14C)

Bundle Number: 3242

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

Peak Pellet Exposure	Most Limiting Gadolinia LHGR Limit [3]
GWd/MT (GWd/ST)	kW/ft
[[	
	]]

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

UO_2/Gd Thermal-Mechanical LHGR Limits

Bundle Type: GE14-P10SNAB422-13GZ-120T-150-T6-3239 (GE14C)

Bundle Number: 3239

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

Peak Pellet Exposure	Most Limiting Gadolinia LHGR Limit [4]
GWd/MT (GWd/ST)	kW/ft
[[	
	]]

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

UO_2/Gd Thermal-Mechanical LHGR Limits

Bundle Type: GE14-P10SNAB418-15GZ-120T-150-T6-3241 (GE14C)

Bundle Number: 3241

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

Peak Pellet Exposure	Most Limiting Gadolinia LHGR Limit [5]
GWd/MT (GWd/ST)	kW/ft
[[	
	]]

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

UO_2/Gd Thermal-Mechanical LHGR Limits

Bundle Type: GNF2-P10SG2B402-15GZ-120T2-150-T6-4009 (GNF2)

Bundle Number: 4009

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

Peak Pellet Exposure	Most Limiting Gadolinia LHGR Limit [6]
GWd/MT (GWd/ST)	kW/ft
[[	
	]]

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

UO_2/Gd Thermal-Mechanical LHGR Limits

Bundle Type: GNF2-P10SG2B401-15GZ-120T2-150-T6-4010 (GNF2)

Bundle Number: 4010

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

Peak Pellet Exposure	Most Limiting Gadolinia LHGR Limit [7]
GWd/MT (GWd/ST)	kW/ft
[[	
	]]

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

UO_2/Gd Thermal-Mechanical LHGR Limits

Bundle Type: GNF2-P10SG2B402-12G7.0-120T2-150-T6-4011 (GNF2)

Bundle Number: 4011

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

Peak Pellet Exposure	Most Limiting Gadolinia LHGR Limit [8]
GWd/MT (GWd/ST)	kW/ft
[[	
	]]

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

UO_2/Gd Thermal-Mechanical LHGR Limits

Bundle Type: GNF2-P10SG2B402-14GZ-120T2-150-T6-4012 (GNF2)

Bundle Number: 4012

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

Peak Pellet Exposure	Most Limiting Gadolinia LHGR Limit [9]
GWd/MT (GWd/ST)	kW/ft
[[	
	]]

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

UO_2/Gd Thermal-Mechanical LHGR Limits

Bundle Type: GNF2-P10SG2B383-14GZ-120T2-150-T6-4252 (GNF2)

Bundle Number: 4252

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

Peak Pellet Exposure	Most Limiting Gadolinia LHGR Limit [10]
GWd/MT (GWd/ST)	kW/ft
[[	
	]]

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

UO_2/Gd Thermal-Mechanical LHGR Limits

Bundle Type: GNF2-P10SG2B384-14GZ-120T2-150-T6-4253 (GNF2)

Bundle Number: 4253

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

Peak Pellet Exposure	Most Limiting Gadolinia LHGR Limit [11]
GWd/MT (GWd/ST)	kW/ft
[[	
	]]

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

UO_2/Gd Thermal-Mechanical LHGR Limits

Bundle Type: GNF2-P10SG2B383-14GZ-120T2-150-T6-4254 (GNF2)

Bundle Number: 4254

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

Peak Pellet Exposure	Most Limiting Gadolinia LHGR Limit [12]
GWd/MT (GWd/ST)	kW/ft
[[	
	]]

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

UO_2/Gd Thermal-Mechanical LHGR Limits

Bundle Type: GNF2-P10SG2B396-12G5.0-120T2-150-T6-4255 (GNF2)

Bundle Number: 4255

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

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 [[ ]].

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 [14]	Exposure at Max k_∞ GWd/MT (GWd/ST)
GE14-P10SNAB418-15GZ-120T-150-T6-3240 (GE14C)	3240	[[				
GE14I-P10SCOB405-13GZ-120T-150-T6-3243 (GE14I)	3243					
GE14-P10SNAB418-15GZ-120T-150-T6-3242 (GE14C)	3242					
GE14-P10SNAB422-13GZ-120T-150-T6-3239 (GE14C)	3239					
GE14-P10SNAB418-15GZ-120T-150-T6-3241 (GE14C)	3241					
GNF2-P10SG2B402-15GZ-120T2-150-T6-4009 (GNF2)	4009					
GNF2-P10SG2B401-15GZ-120T2-150-T6-4010 (GNF2)	4010					
GNF2-P10SG2B402-12G7.0-120T2-150-T6-4011 (GNF2)	4011					
GNF2-P10SG2B402-14GZ-120T2-150-T6-4012 (GNF2)	4012					
GNF2-P10SG2B383-14GZ-120T2-150-T6-4252 (GNF2)	4252					
GNF2-P10SG2B384-14GZ-120T2-150-T6-4253 (GNF2)	4253					
GNF2-P10SG2B383-14GZ-120T2-150-T6-4254 (GNF2)	4254					
GNF2-P10SG2B396-12G5.0-120T2-150-T6-4255 (GNF2)	4255					]]

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

[[

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Figure B-1 Enrichment and Gadolinium Distribution for EDB No. 3240 Fuel Bundle GE14-P10SNAB418-15GZ-120T-150-T6-3240 (GE14C)

[[

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Figure B-2 Enrichment and Gadolinium Distribution for EDB No. 3243
Fuel Bundle GE14I-P10SCOB405-13GZ-120T-150-T6-3243 (GE14I)

[[

]]

Figure B-3 Enrichment and Gadolinium Distribution for EDB No. 3242
Fuel Bundle GE14-P10SNAB418-15GZ-120T-150-T6-3242 (GE14C)

[[

]]

Figure B-4 Enrichment and Gadolinium Distribution for EDB No. 3239
Fuel Bundle GE14-P10SNAB422-13GZ-120T-150-T6-3239 (GE14C)

[[

]]

Figure B-5 Enrichment and Gadolinium Distribution for EDB No. 3241 Fuel Bundle GE14-P10SNAB418-15GZ-120T-150-T6-3241 (GE14C)

[[

]]

Figure B-6 Enrichment and Gadolinium Distribution for EDB No. 4009
Fuel Bundle GNF2-P10SG2B402-15GZ-120T2-150-T6-4009 (GNF2)

[[

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Figure B-7 Enrichment and Gadolinium Distribution for EDB No. 4010 Fuel Bundle GNF2-P10SG2B401-15GZ-120T2-150-T6-4010 (GNF2)

[[

]]

Figure B-8 Enrichment and Gadolinium Distribution for EDB No. 4011
Fuel Bundle GNF2-P10SG2B402-12G7.0-120T2-150-T6-4011 (GNF2)

[[

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Figure B-9 Enrichment and Gadolinium Distribution for EDB No. 4012
Fuel Bundle GNF2-P10SG2B402-14GZ-120T2-150-T6-4012 (GNF2)

[[

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Figure B-10 Enrichment and Gadolinium Distribution for EDB No. 4252
Fuel Bundle GNF2-P10SG2B383-14GZ-120T2-150-T6-4252 (GNF2)

[[

]]

Figure B-11 Enrichment and Gadolinium Distribution for EDB No. 4253
Fuel Bundle GNF2-P10SG2B384-14GZ-120T2-150-T6-4253 (GNF2)

[[

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**Figure B-12 Enrichment and Gadolinium Distribution for EDB No. 4254
Fuel Bundle GNF2-P10SG2B383-14GZ-120T2-150-T6-4254 (GNF2)**

[[

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Figure B-13 Enrichment and Gadolinium Distribution for EDB No. 4255
Fuel Bundle GNF2-P10SG2B396-12G5.0-120T2-150-T6-4255 (GNF2)