

## **ATTACHMENT 2**

Core Operating Limits Report for Reload 22, Cycle 23, Revision 5

Non-Proprietary Version

## Cycle 23 Core Operating Limits Report (COLR) – Oyster Creek

(This revision is a major rewrite; no annotations are used.)

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## 2. References

1. Deleted.
2. GNF Document, 0000-0108-7976-SRLR, Revision 1, "Supplemental Reload Licensing Report for Oyster Creek Reload 23 Cycle 23," November 2010.
3. GNF Document, 0000-0108-7978-FBIR, Revision 0, "Fuel Bundle Information Report for Oyster Creek Reload 23 Cycle 23," October 2010.
4. Deleted.
5. Deleted.
6. GENE Letter, NSA02-247, "Oyster Creek APRM Flow-Biased Setpoint Margin Between Scram and Rod Block for Stability Option II Adjustment," January 2002.
7. Deleted.
8. Deleted.
9. Deleted.
10. EXELON GENERATION COMPANY, LLC OYSTER CREEK GENERATING STATION DOCKET NO. 50-219, Renewed License No. DPR-16
11. Deleted.
12. Deleted.
13. GNF Document, NEDE-24011-P-A-17 and Supplement NEDE-24011-P-A-17-US, "General Electric Standard Application for Reactor Fuel," September 2010 (GESTAR II).

### 3. Terms and Definitions

APLHGR	Average Planar Linear Heat Generation Rate
ARTS	APRM, Rod Block Monitor, and Technical Specification (Improvement)
APRM	Average Power Range Monitor
BOC	Beginning of Cycle
BWROG	Boiling Water Reactor Owner's Group
Coastdown	Coastdown occurs when full power is not achievable with all rods out, maximum allowable core flow and feedwater temperature reduction, and equilibrium xenon
ELLLA	Extended Load Line Limit Analysis
EOC	End of Cycle
EOR	End of Rated Conditions (i.e., cycle exposure at 100% power, 100% flow, all-rods-out, all feedwater heaters in service and equilibrium xenon)
GNF	Global Nuclear Fuel
ICF	Increased Core Flow
ISOLATED	The recirculation loop suction, discharge and discharge bypass valves are in the closed position
K <sub>f</sub>	MCPR flow dependent multiplier (i.e., adjustment to the MCPR limit when at core flow less than rated)
K <sub>p</sub>	MCPR power dependent multiplier (i.e., adjustment to the MCPR limit when at core power less than rated)
LHGR	Linear Heat Generation Rate
LHGRFAC <sub>p</sub>	LHGR power dependent multiplier (i.e., adjustment to the LHGR limit when at core power less than rated)
LPRM	Local Power Range Monitor
MAPLHGR	Maximum Average Planar Linear Heat Generation Rate
MCPR	Minimum Critical Power Ratio
MCPR <sub>p</sub>	Off-rated power dependent Operating Limit MCPR
OOS	Out of Service
Option A	Option A refers to the Technical Specifications core average scram time speed that when applied results in a more restrictive MCPR limit
Option B	Option B refers to a specific core average scram time speed that when met allows the use of a lower MCPR limit
PROOS	Pressure Regulator Out of Service
TIP	Traversing In Core Probe

## 4. General Information

Oyster Creek is a non-ARTS plant. There are Oyster Creek specific flow-biased and power-biased MCPR operating limits for operation at less than rated flow and power. The flow-biased MCPR limits are discussed in Section 6.1. The power-biased MCPR limits are discussed in Section 6.2. There are power-biased LHGR limits for PROOS operating condition provided in Section 7. Rated core flow is 61 Mlb/hr and operation up to 110.7% of rated is licensed for this cycle. Additionally, Oyster Creek utilizes an ELLA operating domain, which has expanded the power/flow map to allow for greater operational flexibility.

## 5. Average Planar Linear Heat Generation Rate

The MAPLHGR limits are discussed in Technical Specifications Section 3.10.A. The MAPLHGR limits for the lattices in each fuel type as a function of average planar exposure are given in Tables 5-1 through 5-23 for operation with zero ISOLATED RECIRCULATION LOOPS (Reference 2 and Reference 3). For operation with one ISOLATED RECIRCULATION LOOP, multiply the limits in Tables 5-1 through 5-23 by the ISOLATED Loop multiplier listed in Table 5-24 (Reference 2). All lattices are defined in Reference 3.

**Table 5-1 MAPLHGR for bundle: GE11-P9DUB359-14GZ-100T-145-T6-3108**  
**GNF Lattice #8527, #8528, #8508, #8525**

<b>Avg. Planar Exposure (GWd/ST)</b>	<b>MAPLHGR (kW/ft)</b>
0.0	9.84
0.2	9.84
1.0	9.77
5.0	9.59
10.0	9.37
15.0	9.12
20.0	9.14
25.0	8.70
35.0	7.94
45.0	7.75
55.0	7.79
65.0	7.75



**Table 5-2 MAPLHGR for bundle: GE11-P9DUB359-14GZ-100T-145-T6-3108  
GNF Lattices #8507, #8526**

<b>Avg. Planar Exposure (GWd/ST)</b>	<b>MAPLHGR (kW/ft)</b>
0.0	9.82
0.2	9.82
1.0	9.76
5.0	9.64
10.0	9.36
15.0	9.06
20.0	9.12
25.0	8.70
35.0	7.92
45.0	7.75
55.0	7.79
65.0	7.72

**Table 5-3 MAPLHGR for bundle: GE11-P9DUB356-14GZ-100T-145-T6-3109  
GNF Lattices #8530, #8531, #8508, #8525**

<b>Avg. Planar Exposure (GWd/ST)</b>	<b>MAPLHGR (kW/ft)</b>
0.0	9.75
0.2	9.75
1.0	9.70
5.0	9.53
10.0	9.23
15.0	9.18
20.0	9.09
25.0	8.69
35.0	7.94
45.0	7.66
55.0	7.79
65.0	7.71

**Table 5-4 MAPLHGR for bundle: GE11-P9DUB356-14GZ-100T-145-T6-3109  
 GNF Lattices #8507, #8529**

<b>Avg. Planar Exposure (GWd/ST)</b>	<b>MAPLHGR (kW/ft)</b>
0.0	9.77
0.2	9.77
1.0	9.76
5.0	9.60
10.0	9.41
15.0	9.11
20.0	9.08
25.0	8.68
35.0	7.94
45.0	7.69
55.0	7.80
65.0	7.77

**Table 5-5 MAPLHGR for bundle: GE11-P9DUB367-12GZ-100T-145-T6-3104  
 GNF Lattices #8510, #8511, #8508, #8512**

<b>Avg. Planar Exposure (GWd/ST)</b>	<b>MAPLHGR (kW/ft)</b>
0.0	9.75
0.2	9.75
1.0	9.71
5.0	9.51
10.0	9.29
15.0	9.12
20.0	9.20
25.0	8.86
35.0	7.96
45.0	7.79
55.0	7.84
65.0	7.78

**Table 5-6 MAPLHGR for bundle: GE11-P9DUB367-12GZ-100T-145-T6-3104  
GNF Lattices #8507, #8509**

<b>Avg. Planar Exposure (GWd/ST)</b>	<b>MAPLHGR (kW/ft)</b>
0.0	9.78
0.2	9.78
1.0	9.75
5.0	9.48
10.0	9.27
15.0	9.17
20.0	9.15
25.0	8.85
35.0	7.98
45.0	7.79
55.0	7.80
65.0	7.77

**Table 5-7 MAPLHGR for bundle: GE11-P9DUB360-11GZ-100T-145-T6-3107  
GNF Lattices #8522, #8523, #8508, #8524**

<b>Avg. Planar Exposure (GWd/ST)</b>	<b>MAPLHGR (kW/ft)</b>
0.0	9.33
0.2	9.33
1.0	9.29
5.0	9.32
10.0	9.23
15.0	9.12
20.0	9.16
25.0	8.80
35.0	7.94
45.0	7.72
55.0	7.78
65.0	7.69

**Table 5-8 MAPLHGR for bundle: GE11-P9DUB360-11GZ-100T-145-T6-3107  
 GNF Lattices #8507, #8521**

<b>Avg. Planar Exposure (GWd/ST)</b>	<b>MAPLHGR (kW/ft)</b>
0.0	9.47
0.2	9.47
1.0	9.45
5.0	9.41
10.0	9.28
15.0	9.15
20.0	9.16
25.0	8.76
35.0	7.97
45.0	7.71
55.0	7.78
65.0	7.71

**Table 5-9 MAPLHGR for bundle: GE11-P9DUB365-10GZ-100T-145-T6-3105  
 GNF Lattices #8514, #8515, #8508, #8516**

<b>Avg. Planar Exposure (GWd/ST)</b>	<b>MAPLHGR (kW/ft)</b>
0.0	9.72
0.2	9.72
1.0	9.70
5.0	9.55
10.0	9.33
15.0	9.21
20.0	9.15
25.0	8.83
35.0	7.98
45.0	7.79
55.0	7.82
65.0	7.78

**Table 5-10 MAPLHGR for bundle: GE11-P9DUB365-10GZ-100T-145-T6-3105  
 GNF Lattices #8507, #8513**

<b>Avg. Planar Exposure (GWd/ST)</b>	<b>MAPLHGR (kW/ft)</b>
0.0	9.71
0.2	9.71
1.0	9.69
5.0	9.52
10.0	9.35
15.0	9.13
20.0	9.16
25.0	8.83
35.0	7.96
45.0	7.77
55.0	7.83
65.0	7.76

**Table 5-11 MAPLHGR for bundle: GNF2-P10DG2B370-15GZ-100T2-145-T6-3355  
 All Lattices**

<b>Avg. Planar Exposure (GWd/ST)</b>	<b>MAPLHGR (kW/ft)</b>
0.0	7.97
0.2	7.97
1.0	7.97
5.0	7.92
10.0	7.87
15.0	7.75
20.0	7.85
25.0	7.02
35.0	6.38
45.0	6.23
55.0	6.10
65.0	5.97

**Table 5-12 MAPLHGR for bundle: GE11-P9HUB363-12GZ-100T-145-T6-2817  
 GNF Lattices #6784, #6786, #6782, #6787**

<b>Avg. Planar Exposure (GWd/ST)</b>	<b>MAPLHGR (kW/ft)</b>
0.0	10.04
0.2	10.04
1.0	10.10
5.0	9.94
10.0	9.73
15.0	9.43
20.0	9.08
25.0	8.49
35.0	8.35
45.0	8.33
55.0	8.29
65.0	8.58

**Table 5-13 MAPLHGR for bundle: GE11-P9HUB363-12GZ-100T-145-T6-2817  
 GNF Lattices #6783, #6785**

<b>Avg. Planar Exposure (GWd/ST)</b>	<b>MAPLHGR (kW/ft)</b>
0.0	9.98
0.2	9.98
1.0	10.11
5.0	10.00
10.0	9.79
15.0	9.69
20.0	9.07
25.0	8.49
35.0	8.34
45.0	8.33
55.0	8.51
65.0	8.58

**Table 5-14 MAPLHGR for bundle: GE11-P9HUB364-14GZ-100T-145-T6-2818  
 GNF Lattices #6789, #6791, #6782, #6792**

Avg. Planar Exposure (GWd/ST)	MAPLHGR (kW/ft)
0.0	9.93
0.2	9.93
1.0	9.91
5.0	9.85
10.0	9.62
15.0	9.61
20.0	9.04
25.0	8.46
35.0	8.30
45.0	8.28
55.0	8.44
65.0	8.52

**Table 5-15 MAPLHGR for bundle: GE11-P9HUB364-14GZ-100T-145-T6-2818  
 GNF Lattices #6788, #6790**

Avg. Planar Exposure (GWd/ST)	MAPLHGR (kW/ft)
0.0	9.96
0.2	9.96
1.0	9.97
5.0	9.85
10.0	9.73
15.0	9.57
20.0	9.03
25.0	8.47
35.0	8.30
45.0	8.26
55.0	8.43
65.0	8.50

**Table 5-16 MAPLHGR for bundle: GNF2-P10DG2B370-16GZ-100T2-145-T6-3356  
 All Lattices**

<b>Avg. Planar Exposure (GWd/ST)</b>	<b>MAPLHGR (kW/ft)</b>
0.0	7.99
0.2	7.99
1.0	8.03
5.0	7.94
10.0	7.86
15.0	7.81
20.0	7.89
25.0	6.96
35.0	6.37
45.0	6.23
55.0	6.10
65.0	5.97

**Table 5-17 MAPLHGR for bundle: GNF2-P10DG2B369-16GZ-100T2-145-T6-3357-LTD  
 All Lattices**

<b>Avg. Planar Exposure (GWd/ST)</b>	<b>MAPLHGR (kW/ft)</b>
0.0	8.03
0.2	8.03
1.0	8.08
5.0	7.96
10.0	7.91
15.0	7.83
20.0	7.89
25.0	6.96
35.0	6.37
45.0	6.23
55.0	6.10
65.0	5.97



**Table 5-18 MAPLHGR for bundle: GE11-P9DUB367-11GZ-100T-145-T6-2921  
 GNF Lattices #7313, #7314, #7315, #7316**

<b>Avg. Planar Exposure (GWd/ST)</b>	<b>MAPLHGR (kW/ft)</b>
0.0	9.03
0.2	9.03
1.0	9.06
5.0	9.08
10.0	9.12
15.0	9.10
20.0	9.03
25.0	8.35
35.0	8.00
45.0	7.96
55.0	8.11
65.0	8.15

**Table 5-19 MAPLHGR for bundle: GE11-P9DUB367-11GZ-100T-145-T6-2921  
 GNF Lattices #7311, #7312**

<b>Avg. Planar Exposure (GWd/ST)</b>	<b>MAPLHGR (kW/ft)</b>
0.0	9.36
0.2	9.36
1.0	9.39
5.0	9.25
10.0	9.21
15.0	9.10
20.0	9.02
25.0	8.33
35.0	8.00
45.0	7.95
55.0	8.09
65.0	8.16

**Table 5-20 MAPLHGR for bundle: GE11-P9DUB361-14GZ-100T-145-T6-2922**  
**GNF Lattices #7318, #7319, #7315, #7320**

<b>Avg. Planar Exposure (GWd/ST)</b>	<b>MAPLHGR (kW/ft)</b>
0.0	9.59
0.2	9.59
1.0	9.52
5.0	9.42
10.0	9.11
15.0	9.09
20.0	8.94
25.0	8.27
35.0	7.98
45.0	7.93
55.0	8.09
65.0	8.16

**Table 5-21 MAPLHGR for bundle: GE11-P9DUB361-14GZ-100T-145-T6-2922**  
**GNF Lattices #7311, #7317**

<b>Avg. Planar Exposure (GWd/ST)</b>	<b>MAPLHGR (kW/ft)</b>
0.0	9.59
0.2	9.59
1.0	9.53
5.0	9.37
10.0	9.11
15.0	9.07
20.0	8.90
25.0	8.25
35.0	7.99
45.0	7.96
55.0	8.11
65.0	8.16

**Table 5-22 MAPLHGR for bundle: GE11-P9DUB366-12GZ-100T-145-T6-3106  
GNF Lattices #8518, #8519, #8508, #8520**

<b>Avg. Planar Exposure (GWd/ST)</b>	<b>MAPLHGR (kW/ft)</b>
0.0	9.71
0.2	9.71
1.0	9.69
5.0	9.51
10.0	9.27
15.0	9.11
20.0	9.20
25.0	8.86
35.0	7.96
45.0	7.79
55.0	7.81
65.0	7.76

**Table 5-23 MAPLHGR for bundle: GE11-P9DUB366-12GZ-100T-145-T6-3106  
GNF Lattices #8507, #8517**

<b>Avg. Planar Exposure (GWd/ST)</b>	<b>MAPLHGR (kW/ft)</b>
0.0	9.72
0.2	9.72
1.0	9.68
5.0	9.54
10.0	9.28
15.0	9.09
20.0	9.16
25.0	8.82
35.0	7.96
45.0	7.78
55.0	7.80
65.0	7.75

**Table 5-24 MAPLHGR Multiplier with One ISOLATED Loop**

<b>Fuel Type</b>	<b>Isolated Loop Multiplier</b>
GE11	0.98
GNF2	0.98

## 6. Minimum Critical Power Ratio

The MCPR limits are discussed in Technical Specifications Section 3.10.C. For all conditions, the more limiting of the flow adjusted MCPR and power adjusted MCPR is applied.

### 6.1. Manual Flow Control MCPR Limits

The flow adjusted MCPR is determined by multiplying the applicable rated condition MCPR limit shown in Tables 6-1 and 6-2 by the applicable MCPR multiplier,  $K_f$ , given in Table 6-3. The MCPR values and  $K_f$  multipliers are documented in Reference 2. Table 6-1 and 6-2 limits are independent of APRM status changes since Reference 2 analyzes the Rod Withdrawal Error (RWE) as unblocked. The appropriate  $K_f$  value may be determined by linear interpolation. Table 6-3 is applicable to GE11 and GNF2 fuel types per Reference 2.

### 6.2. Power Dependent MCPR Limits

Introduction of the GNF2 fuel type requires use of power dependent MCPR limits at off-rated conditions. Power dependent limits are required because APRM Trip Setdown may not provide adequate protection for the MCPR Safety Limit. Use of these limits ensures that the MCPR Safety Limit is not violated as a result of any anticipated operational occurrence (AOO). Plant specific power dependent MCPR limits are presented in Table 6-4 and documented in Reference 2. When core thermal power is greater than or equal to 40% of rated, the  $K_p$  multiplier from Table 6-4 is applied to the applicable rated condition MCPR limit shown in Tables 6-1 and 6-2. The appropriate MCPR<sub>p</sub> or  $K_p$  value may be determined by linear interpolation. Below 40% of rated power, the MCPR limits in Table 6-4 are applied directly. Table 6-4 is applicable to both GE11 and GNF2 fuel types per Reference 2.

### 6.3. Scram Time

Core average scram insertion times are determined per Technical Specifications 3.2.B. Based on the results of the scram time surveillance testing and calculation of the core average insertion time, a MCPR limit is chosen from Table 6-1 for GE11 fuel and Table 6-2 for GNF2 fuel (Reference 2). If the core average scram insertion time does not meet the Option B criteria, but has met Option A criteria, then the appropriate MCPR value may be determined from a linear interpolation between the Option A and B limits with standard mathematical rounding to two decimal places. The scram time adjustment to MCPR only applies to MCPR limits that are set by pressurization transients (see Note 2 to Table 6-1 for further clarification).

**Table 6-1 MCPR Limit - GE11**

Applicability <sup>1</sup>	Option	Cycle Exposure	
		BOC to < (EOR-2525) MWD/ST	≥ (EOR-2525) MWD/ST to EOC
Four or Five Recirculation Loops in Service	A	1.43	1.49
	B	1.43 <sup>2</sup>	1.43 <sup>2</sup>
Three Recirculation Loops in Service <sup>3</sup>	A	1.45	1.51
	B	1.45 <sup>2</sup>	1.45 <sup>2</sup>

**Table 6-2 MCPR Limit - GNF2**

Applicability <sup>1</sup>	Option	Cycle Exposure	
		BOC to < (EOR-2525) MWD/ST	≥ (EOR-2525) MWD/ST to EOC
Four or Five Recirculation Loops in Service	A	1.53	1.61
	B	1.43	1.51
Three Recirculation Loops in Service <sup>3</sup>	A	1.55	1.63
	B	1.45	1.53

<sup>1</sup> MCPR limits are applicable to rated power operation for Equipment in Service and PROOS conditions per Reference 2.

<sup>2</sup> The documented MCPR limit is based on the Rod Withdrawal Error (RWE) event, which is a non-pressurization event. The limiting pressurization event results in Option B MCPR limits that are 0.11 less (BOC to (EOR-2525) MWD/ST) and 0.05 less ((EOR-2525) MWD/ST to EOC) than the stated value per Reference 2. Scram time adjustments are only required to be applied to MCPR limits that are set by pressurization transients.

<sup>3</sup> For three recirculation loops in service, the MCPR operating limit is 0.02 greater than the four/five loop value per Reference 2.

**Table 6-3 Kf Multiplier - GE11 and GNF2<sup>1</sup>**

Flow (% rated)	Kf
117.0	1.00
100.0	1.00
90.0	1.00
80.0	1.05
70.0	1.09
60.0	1.13
50.0	1.17
40.0	1.22
30.0	1.28

**Table 6-4 Power Dependent MCPR Limits and Multipliers - GE11 and GNF2**

Applicability	Core Flow (% of rated)	Core Thermal Power (% of rated)								
		0	25	<40	≥40	60	70	79	90	100
		Operating Limit MCPR			Operating Limit MCPR Multiplier, Kp					
Four or Five Recirculation Loops in Service	≤ 60	2.52	2.52	2.20	1.185	1.185	1.185	-	1.068	1.000
	> 60	2.66	2.66	2.29						
Three Recirculation Loops in Service	≤ 60	2.54	2.54	2.22	1.185	1.185	1.185	-	1.068	1.000
	> 60	2.68	2.68	2.31						
PROOS – Four or Five Recirculation Loops in Service	≤ 60	2.52	2.52	2.20	1.517	1.375	1.345	1.265	1.068	1.000
	> 60	2.66	2.66	2.29						
PROOS – Three Recirculation Loops in Service	≤ 60	2.54	2.54	2.22	1.517	1.375	1.345	1.265	1.068	1.000
	> 60	2.68	2.68	2.31						

<sup>1</sup> Kf multipliers are applicable for Equipment in Service and PROOS conditions per Reference 2.

## 7. Linear Heat Generation Rate

The LHGR limits are discussed in Technical Specifications Section 3.10.B. The maximum LHGR shall not exceed the LHGR limits as specified in Reference 3, attached as Appendix A. The exposure dependent  $\text{UO}_2$  and  $\text{Gd}_2\text{O}_3$  Thermal-Mechanical LHGR limits are contained in Appendix A. Power dependent LHGR multipliers are listed in Table 7-1 for PROOS operating conditions and are applicable to GE11 and GNF2 fuel types (Reference 2). The appropriate LHGRFACp value may be determined by linear interpolation.

**Table 7-1 Power Dependent LHGR Multiplier LHGRFACp for PROOS**

Power (% rated)	LHGRFACp
40.0	0.702
50.0	0.760
60.0	0.808
70.0	0.891
79.0	0.905
90.0	1.000
100.0	1.000

## 8. Stability Protection Settings

The stability protection settings are discussed in Technical Specifications 2.3. Oyster Creek utilizes the BWROG Option II solution in the licensing stability calculations. Table 8-1 provides the analytical limit equations for APRM based stability protection settings and related Control Rod Block settings to support Option II implementation (References 2 and 6).

**Table 8-1 Option II Stability Protection Settings**

<p>Technical Specification 2.3.A.1 Neutron Flux, Scram - APRM</p> <p>For <math>W \leq 27.5 \times 10^6 \text{ lb / hr}</math>:</p> $S \leq (1.433 \times 10^{-6}) W + 24.8$ <p>where:</p> <p>S = setting in percent of rated power</p> <p>W = recirculation flow (lb/hr)</p>
<p>Technical Specification 2.3.B Neutron Flux, Control Rod Block</p> <p>For <math>W \leq 27.5 \times 10^6 \text{ lb / hr}</math>:</p> $S \leq (1.433 \times 10^{-6}) W + 17.5$ <p>where:</p> <p>S = setting in percent of rated power</p> <p>W = recirculation flow (lb/hr)</p>



## 9. Modes of Operation

The allowed Modes of Operation are as described in Table 9-1.

**Table 9-1 Modes of Operation**

Options <sup>1,3</sup>	Operating Region		
	Standard	ELLLA	ICF <sup>2</sup>
Five-loop Operation, Option A or B	Yes	Yes	Yes
Four-loop Operation, Option A or B	Yes	Yes	Yes
Three-loop Operation, Option A or B	Yes	Yes	Yes
PROOS, Five-loop Operation, Option A or B	Yes	Yes	Yes
PROOS, Four-loop Operation, Option A or B	Yes	Yes	Yes
PROOS, Three-loop Operation, Option A or B	Yes	Yes	Yes

<sup>1</sup> Each operational mode may be combined with up to a 100°F reduction in feedwater temperature (Final Feedwater Temperature Reduction or Feedwater Heaters OOS) at any point in the cycle (Reference 2).

<sup>2</sup> Operation up to 67.5 Mlb/hr core flow is licensed for this cycle (Reference 2).

<sup>3</sup> Each operational mode may be coincident with coastdown operation. The minimum coastdown power level is 40% per GESTAR II (Reference 13).

## 10. Methodology

1. GNF Document, NEDC-31462P and NEDE-31462, "Oyster Creek NGS SAFER/CORECOOL/GESTR-LOCA Loss-of-Coolant Accident Analysis," August 1987.
2. GNF Document, NEDE-24011-P-A-17 and Supplement NEDE-24011-P-A-17-US, "General Electric Standard Application for Reactor Fuel," September 2010.
3. GNF Document, NEDC-33065P, Rev. 0, "Application of Stability Long-Term Solution Option II to Oyster Creek," April 2002.

## Appendix A

## Global Nuclear Fuel - Americas LLC

### AFFIDAVIT

**I, Anthony P. Reese, state as follows:**

- (1) I am the Manager, Reload Design & Analysis, of Global Nuclear Fuel – Americas, LLC (GNF-A), and have been delegated the function of reviewing the information described in paragraph (2) which is sought to be withheld, and have been authorized to apply for its withholding.
- (2) The information sought to be withheld is contained in the GNF-A proprietary report, 0000-0108-7976-FBIR-P, *Fuel Bundle Information Report for Oyster Creek Reload 23 Cycle 23*, Revision 0, Class III (GNF-A Proprietary Information), dated October 2010. GNF-A proprietary information in 0000-0108-7976-FBIR-P is identified by a dark red dotted underline inside double square brackets. ~~[[This sentence is an example.<sup>(3)</sup>]]~~ Figures and large equation objects containing GNF-A proprietary information are identified with double square brackets before and after the object. In each case, the superscript notation <sup>(3)</sup> refers to Paragraph (3) of this affidavit that provides the basis for the proprietary determination.
- (3) In making this application for withholding of proprietary information of which it is the owner or licensee, GNF-A relies upon the exemption from disclosure set forth in the Freedom of Information Act (FOIA), 5 USC Sec. 552(b)(4), and the Trade Secrets Act, 18 USC Sec. 1905, and NRC regulations 10 CFR 9.17(a)(4), and 2.390(a)(4) for trade secrets (Exemption 4). The material for which exemption from disclosure is here sought also qualifies under the narrower definition of trade secret, within the meanings assigned to those terms for purposes of FOIA Exemption 4 in, respectively, Critical Mass Energy Project v. Nuclear Regulatory Commission, 975 F2d 871 (DC Cir. 1992), and Public Citizen Health Research Group v. FDA, 704 F2d 1280 (DC Cir. 1983).
- (4) The information sought to be withheld is considered to be proprietary for the reasons set forth in paragraphs (4)a. and (4)b. Some examples of categories of information that fit into the definition of proprietary information are:
  - a. Information that discloses a process, method, or apparatus, including supporting data and analyses, where prevention of its use by GNF-A's competitors without license from GNF-A constitutes a competitive economic advantage over GNF-A and/or other companies.
  - b. Information that, if used by a competitor, would reduce their expenditure of resources or improve their competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing of a similar product.
  - c. Information that reveals aspects of past, present, or future GNF-A customer-funded development plans and programs, that may include potential products of GNF-A.

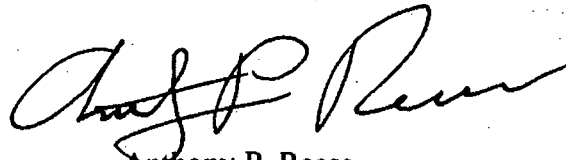
- d. Information that discloses trade secret and/or potentially patentable subject matter for which it may be desirable to obtain patent protection.
- (5) To address 10 CFR 2.390(b)(4), the information sought to be withheld is being submitted to the NRC in confidence. The information is of a sort customarily held in confidence by GNF-A, and is in fact so held. The information sought to be withheld has, to the best of my knowledge and belief, consistently been held in confidence by GNF-A, not been disclosed publicly, and not been made available in public sources. All disclosures to third parties, including any required transmittals to the NRC, have been made, or must be made, pursuant to regulatory provisions or proprietary and/or confidentiality agreements that provide for maintaining the information in confidence. The initial designation of this information as proprietary information, and the subsequent steps taken to prevent its unauthorized disclosure are as set forth in the following paragraphs (6) and (7).
- (6) Initial approval of proprietary treatment of a document is made by the manager of the originating component, who is the person most likely to be acquainted with the value and sensitivity of the information in relation to industry knowledge, or who is the person most likely to be subject to the terms under which it was licensed to GNF-A. Access to such documents within GNF-A is limited to a "need to know" basis.
- (7) The procedure for approval of external release of such a document typically requires review by the staff manager, project manager, principal scientist, or other equivalent authority for technical content, competitive effect, and determination of the accuracy of the proprietary designation. Disclosures outside GNF-A are limited to regulatory bodies, customers, and potential customers, and their agents, suppliers, and licensees, and others with a legitimate need for the information, and then only in accordance with appropriate regulatory provisions or proprietary and/or confidentiality agreements.
- (8) The information identified in paragraph (2) above is classified as proprietary because it contains details of GNF-A's fuel design and licensing methodology for the Boiling Water Reactor (BWR). Development of these methods, techniques, and information and their application for the design, modification, and analyses methodologies and processes was achieved at a significant cost to GNF-A. The development of the evaluation process along with the interpretation and application of the analytical results is derived from the extensive experience database that constitutes a major GNF-A asset.
- (9) Public disclosure of the information sought to be withheld is likely to cause substantial harm to GNF-A's competitive position and foreclose or reduce the availability of profit-making opportunities. The fuel design and licensing methodology is part of GNF-A's comprehensive BWR safety and technology base, and its commercial value extends beyond the original development cost. The value of the technology base goes beyond the extensive physical database and analytical methodology and includes development of the expertise to determine and apply the appropriate evaluation process. In addition, the technology base includes the value derived from providing analyses done with NRC-approved methods.

The research, development, engineering, analytical and NRC review costs comprise a substantial investment of time and money by GNF-A. The precise value of the expertise to devise an evaluation process and apply the correct analytical methodology is difficult to quantify, but it clearly is substantial. GNF-A's competitive advantage will be lost if its competitors are able to use the results of the GNF-A experience to normalize or verify their own process or if they are able to claim an equivalent understanding by demonstrating that they can arrive at the same or similar conclusions.

The value of this information to GNF-A would be lost if the information were disclosed to the public. Making such information available to competitors without their having been required to undertake a similar expenditure of resources would unfairly provide competitors with a windfall, and deprive GNF-A of the opportunity to exercise its competitive advantage to seek an adequate return on its large investment in developing and obtaining these very valuable analytical tools.

I declare under penalty of perjury that the foregoing affidavit and the matters stated therein are true and correct to the best of my knowledge, information, and belief.

Executed on this 8th day of October, 2010



Anthony P. Reese  
Manager, Reload Design & Analysis  
Global Nuclear Fuel - Americas LLC



**Global Nuclear Fuel**

A Joint Venture of GE, Toshiba, & Hitachi

**0000-0108-7976-FBIR-NP**

**Revision 0**

**Class I**

**October 2010**

*Non-Proprietary Information*

**Fuel Bundle Information Report**  
**for**  
**Oyster Creek**  
**Reload 23 Cycle 23**

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## **Important Notice Regarding Contents of This Report**

### **Please Read Carefully**

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### **Proprietary Information Notice**

This is a non-proprietary version of the document 0000-0108-7976-FBIR-P (which has the proprietary information removed). Portions of the document that have been removed are indicated by an open and closed double brackets as shown here [[ ]].

## 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 Oyster Creek for Cycle 23. 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.



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## 2. References

1. *General Electric Standard Application for Reactor Fuel*, NEDE-24011-P-A-17, September 2010; and the U.S. Supplement, NEDE-24011-P-A-17-US, September 2010.

## Appendix A

### UO<sub>2</sub>/Gd Thermal-Mechanical LHGR Limits

Bundle Type: GE11-P9DUB359-14GZ-100T-145-T6-3108 (GE11)

Bundle Number: 3108

Peak Pellet Exposure	UO <sub>2</sub> LHGR Limit
GWd/MT (GWd/ST)	kW/ft
0.00 ( 0.00)	12.00
20.00 (18.14)	10.50
70.00 (63.50)	6.00

Peak Pellet Exposure	Most Limiting Gadolinia LHGR Limit <sup>1</sup>
GWd/MT (GWd/ST)	kW/ft
0.00 ( 0.00)	10.29
16.52 (14.99)	9.00
63.65 (57.74)	5.14

<sup>1</sup> Bounding gadolinia LHGR limit for all gadolinium concentrations occurring in this bundle design ( 7.0% Gd).

## UO<sub>2</sub>/Gd Thermal-Mechanical LHGR Limits

Bundle Type: GE11-P9DUB356-14GZ-100T-145-T6-3109 (GE11)

Bundle Number: 3109

Peak Pellet Exposure	UO <sub>2</sub> LHGR Limit
GWd/MT (GWd/ST)	kW/ft
0.00 ( 0.00)	12.00
20.00 (18.14)	10.50
70.00 (63.50)	6.00

Peak Pellet Exposure	Most Limiting Gadolinia LHGR Limit <sup>2</sup>
GWd/MT (GWd/ST)	kW/ft
0.00 ( 0.00)	10.29
16.52 (14.99)	9.00
63.65 (57.74)	5.14

<sup>2</sup> Bounding gadolinia LHGR limit for all gadolinium concentrations occurring in this bundle design ( 7.0% Gd).

## UO<sub>2</sub>/Gd Thermal-Mechanical LHGR Limits

Bundle Type: GE11-P9DUB367-12GZ-100T-145-T6-3104 (GE11)

Bundle Number: 3104

Peak Pellet Exposure	UO <sub>2</sub> LHGR Limit
GWd/MT (GWd/ST)	kW/ft
0.00 ( 0.00)	12.00
20.00 (18.14)	10.50
70.00 (63.50)	6.00

Peak Pellet Exposure	Most Limiting Gadolinia LHGR Limit <sup>3</sup>
GWd/MT (GWd/ST)	kW/ft
0.00 ( 0.00)	10.29
16.52 (14.99)	9.00
63.65 (57.74)	5.14

<sup>3</sup> Bounding gadolinia LHGR limit for all gadolinium concentrations occurring in this bundle design ( 7.0% Gd).

## UO<sub>2</sub>/Gd Thermal-Mechanical LHGR Limits

Bundle Type: GE11-P9DUB360-11GZ-100T-145-T6-3107 (GE11)

Bundle Number: 3107

Peak Pellet Exposure	UO <sub>2</sub> LHGR Limit
GWd/MT (GWd/ST)	kW/ft
0.00 ( 0.00)	12.00
20.00 (18.14)	10.50
70.00 (63.50)	6.00

Peak Pellet Exposure	Most Limiting Gadolinia LHGR Limit <sup>4</sup>
GWd/MT (GWd/ST)	kW/ft
0.00 ( 0.00)	10.29
16.52 (14.99)	9.00
63.65 (57.74)	5.14

<sup>4</sup> Bounding gadolinia LHGR limit for all gadolinium concentrations occurring in this bundle design ( 7.0% Gd).

## UO<sub>2</sub>/Gd Thermal-Mechanical LHGR Limits

Bundle Type: GE11-P9DUB365-10GZ-100T-145-T6-3105 (GE11)

Bundle Number: 3105

Peak Pellet Exposure	UO <sub>2</sub> LHGR Limit
GWd/MT (GWd/ST)	kW/ft
0.00 ( 0.00)	12.00
20.00 (18.14)	10.50
70.00 (63.50)	6.00

Peak Pellet Exposure	Most Limiting Gadolinia LHGR Limit <sup>5</sup>
GWd/MT (GWd/ST)	kW/ft
0.00 ( 0.00)	10.29
16.52 (14.99)	9.00
63.65 (57.74)	5.14

<sup>5</sup> Bounding gadolinia LHGR limit for all gadolinium concentrations occurring in this bundle design ( 7.0% Gd).

## UO<sub>2</sub>/Gd Thermal-Mechanical LHGR Limits

Bundle Type: GNF2-P10DG2B370-15GZ-100T2-145-T6-3355 (GNF2)

Bundle Number: 3355

Peak Pellet Exposure	UO <sub>2</sub> LHGR Limit
GWd/MT (GWd/ST)	kW/ft
[[	
	]]

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

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

## UO<sub>2</sub>/Gd Thermal-Mechanical LHGR Limits

Bundle Type: GE11-P9HUB363-12GZ-100T-145-T6-2817 (GE11)

Bundle Number: 2817

Peak Pellet Exposure	UO <sub>2</sub> LHGR Limit
GWd/MT (GWd/ST)	kW/ft
0.00 ( 0.00)	12.00
20.00 (18.14)	10.50
70.00 (63.50)	6.00

Peak Pellet Exposure	Most Limiting Gadolinia LHGR Limit <sup>7</sup>
GWd/MT (GWd/ST)	kW/ft
0.00 ( 0.00)	10.29
16.52 (14.99)	9.00
63.65 (57.74)	5.14

<sup>7</sup> Bounding gadolinia LHGR limit for all gadolinium concentrations occurring in this bundle design ( 7.0% Gd).



## UO<sub>2</sub>/Gd Thermal-Mechanical LHGR Limits

Bundle Type: GE11-P9HUB364-14GZ-100T-145-T6-2818 (GE11)

Bundle Number: 2818

Peak Pellet Exposure	UO <sub>2</sub> LHGR Limit
GWd/MT (GWd/ST)	kW/ft
0.00 ( 0.00)	12.00
20.00 (18.14)	10.50
70.00 (63.50)	6.00

Peak Pellet Exposure	Most Limiting Gadolinia LHGR Limit <sup>8</sup>
GWd/MT (GWd/ST)	kW/ft
0.00 ( 0.00)	10.29
16.52 (14.99)	9.00
63.65 (57.74)	5.14

<sup>8</sup> Bounding gadolinia LHGR limit for all gadolinium concentrations occurring in this bundle design ( 7.0% Gd).

## UO<sub>2</sub>/Gd Thermal-Mechanical LHGR Limits

Bundle Type: GNF2-P10DG2B370-16GZ-100T2-145-T6-3356 (GNF2)

Bundle Number: 3356

Peak Pellet Exposure	UO <sub>2</sub> LHGR Limit
GWd/MT (GWd/ST)	kW/ft
[[	
	]]

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

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

## UO<sub>2</sub>/Gd Thermal-Mechanical LHGR Limits

Bundle Type: GNF2-P10DG2B369-16GZ-100T2-145-T6-3357-LTD (GNF2)

Bundle Number: 3357

Peak Pellet Exposure	UO <sub>2</sub> LHGR Limit
GWd/MT (GWd/ST)	kW/ft
[[	
	]]

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

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

## UO<sub>2</sub>/Gd Thermal-Mechanical LHGR Limits

Bundle Type: GE11-P9DUB367-11GZ-100T-145-T6-2921 (GE11)

Bundle Number: 2921

Peak Pellet Exposure	UO <sub>2</sub> LHGR Limit
GWd/MT (GWd/ST)	kW/ft
0.00 ( 0.00)	12.00
20.00 (18.14)	10.50
70.00 (63.50)	6.00

Peak Pellet Exposure	Most Limiting Gadolinia LHGR Limit <sup>11</sup>
GWd/MT (GWd/ST)	kW/ft
0.00 ( 0.00)	10.29
16.52 (14.99)	9.00
63.65 (57.74)	5.14

<sup>11</sup> Bounding gadolinia LHGR limit for all gadolinium concentrations occurring in this bundle design ( 7.0% Gd).

## UO<sub>2</sub>/Gd Thermal-Mechanical LHGR Limits

Bundle Type: GE11-P9DUB361-14GZ-100T-145-T6-2922 (GE11)

Bundle Number: 2922

Peak Pellet Exposure	UO <sub>2</sub> LHGR Limit
GWd/MT (GWd/ST)	kW/ft
0.00 ( 0.00)	12.00
20.00 (18.14)	10.50
70.00 (63.50)	6.00

Peak Pellet Exposure	Most Limiting Gadolinia LHGR Limit <sup>12</sup>
GWd/MT (GWd/ST)	kW/ft
0.00 ( 0.00)	10.29
16.52 (14.99)	9.00
63.65 (57.74)	5.14

<sup>12</sup> Bounding gadolinia LHGR limit for all gadolinium concentrations occurring in this bundle design ( 7.0% Gd).

## UO<sub>2</sub>/Gd Thermal-Mechanical LHGR Limits

Bundle Type: GE11-P9DUB366-12GZ-100T-145-T6-3106 (GE11)

Bundle Number: 3106

Peak Pellet Exposure	UO <sub>2</sub> LHGR Limit
GWd/MT (GWd/ST)	kW/ft
0.00 ( 0.00)	12.00
20.00 (18.14)	10.50
70.00 (63.50)	6.00

Peak Pellet Exposure	Most Limiting Gadolinia LHGR Limit <sup>13</sup>
GWd/MT (GWd/ST)	kW/ft
0.00 ( 0.00)	10.29
16.52 (14.99)	9.00
63.65 (57.74)	5.14

<sup>13</sup> Bounding gadolinia LHGR limit for all gadolinium concentrations occurring in this bundle design ( 7.0% Gd).

## Appendix B

### Fuel Bundle Information

Table B-1 Bundle Specific Information						
Fuel Bundle	Bundle Number	Enrichment (wt% U-235)	Weight of UO <sub>2</sub> (kg)	Weight of U (kg)	Max k <sub>∞</sub> at 20°C <sup>14</sup>	Exposure at Max k <sub>∞</sub> GWd/MT (GWd/ST)
GE11-P9DUB359-14GZ-100T-145-T6-3108 (GE11)	3108	[[				
GE11-P9DUB356-14GZ-100T-145-T6-3109 (GE11)	3109					
GE11-P9DUB367-12GZ-100T-145-T6-3104 (GE11)	3104					
GE11-P9DUB360-11GZ-100T-145-T6-3107 (GE11)	3107					
GE11-P9DUB365-10GZ-100T-145-T6-3105 (GE11)	3105					
GNF2-P10DG2B370-15GZ-100T2-145-T6-3355 (GNF2)	3355					
GE11-P9HUB363-12GZ-100T-145-T6-2817 (GE11)	2817					
GE11-P9HUB364-14GZ-100T-145-T6-2818 (GE11)	2818					
GNF2-P10DG2B370-16GZ-100T2-145-T6-3356 (GNF2)	3356					
GNF2-P10DG2B369-16GZ-100T2-145-T6-3357-LTD (GNF2)	3357					
GE11-P9DUB367-11GZ-100T-145-T6-2921 (GE11)	2921					
GE11-P9DUB361-14GZ-100T-145-T6-2922 (GE11)	2922					
GE11-P9DUB366-12GZ-100T-145-T6-3106 (GE11)	3106					]]

<sup>14</sup> Maximum lattice k<sub>∞</sub> 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. 3108**  
**Fuel Bundle GE11-P9DUB359-14GZ-100T-145-T6-3108 (GE11)**



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**Figure B-2 Enrichment and Gadolinium Distribution for EDB No. 3109  
Fuel Bundle GE11-P99UB356-14GZ-100T-145-T6-3109 (GE11)**

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Class I

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**Figure B-3 Enrichment and Gadolinium Distribution for EDB No. 3104  
Fuel Bundle GE11-P9DUB367-12GZ-100T-145-T6-3104 (GE11)**

Oyster Creek  
Reload 23

Non-Proprietary Information  
Class I

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**Figure B-4 Enrichment and Gadolinium Distribution for Fuel Bundle 3107**  
**Fuel Bundle GE11-P9DUB360-11GZ-100T-145-T6-3 (1)**

Oyster Creek

Non-Proprietary Information

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**Figure B-5 Enrichment and Gadolinium Distribution for EDB No. 3105**  
**Fuel Bundle GE11-P9DUB365-10GZ-100T-145-T6-3105 (GE11)**

**Oyster Creek**  
**Reload 23**

**Non-Proprietary Information**  
**Class I**

**0000-0108-7976-FBIR-NP**  
**Revision 0**

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**Figure B-6 Enrichment and Gadolinium Distribution for Fuel Bundle GNF2-P10DG2B370-15GZ-100T2-145-T6-3555 (F2)**

Oyster Creek

Non-Proprietary Information

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**Figure B-7 Enrichment and Gadolinium Distribution for EDB No. 2817**  
**Fuel Bundle GE11-P9HUB363-12GZ-100T-145-T6-2817 (GE11)**

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**Figure B-8 Enrichment and Gadolinium Distribution for EDB N 2818**  
**Fuel Bundle GE11-P9HUB364-14GZ-100T-145-T6-2818 (G11)**

**Oyster Creek**  
**Reload 23**

**Non-Proprietary Information**  
**Class I**

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**Revision 0**

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**Figure B-9 Enrichment and Gadolinium Distribution for EDB No. 3356**  
**Fuel Bundle GNF2-P10DG2B370-16GZ-100T2-145-T6-3356 (GNF2)**



Oyster Creek

Non-Proprietary Information

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**Figure B-10 Enrichment and Gadolinium Distribution for EDB No. 3357  
Fuel Bundle GNF2-P10DG2B369-16GZ-100T2-145-T6-3357-LTD (GNF2)**

Oyster Creek

Non-Proprietary Information

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**Figure B-11 Enrichment and Gadolinium Distribution for EDB 2921  
Fuel Bundle GE11-P9DUB367-11GZ-100T-145-T6-2921 (GE)**

Oyster Creek

Non-Proprietary Information

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**Figure B-12 Enrichment and Gadolinium Distribution for EDB 2922  
Fuel Bundle GE11-P90UB361-14GZ-100T-145-T6-2922 (G11)**

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**Figure B-13 Enrichment and Gadolinium Distribution for FDB No. 3106**  
**Fuel Bundle GE11-P9DUB366-12GZ-100T-145-T6-3106 (E11)**