Core Operating Limits Report

For

Oyster Creek 1 Cycle 24

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

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Table of Contents

1. List of Tables

2. References

1. Deleted.

2. GNF Document, 0000-0138-9259-SRLR, Revision 2, "Supplemental Reload Licensing Report for Oyster Creek Reload 24 Cycle 24," October 2012.

3. GNF Document, 0000-0138-9259-FBIR-P, Revision 0, "Fuel Bundle Information Report for Oyster Creek Reload 24 Cycle 24," September 2012.

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 23, 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-19 and Supplement NEDE-24011-P-A-19-US, "General Electric Standard Application for Reactor Fuel," May 2012 (GESTAR II).

14. Exelon TODI, ES1200008, Revision 0, "Final Resolved OPL-3 Parameters for Oyster Creek Cycle 24," dated May 31, 2012.

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)
FWCF	Feedwater Controller Failure
GNF	Global Nuclear Fuel
ICF	Increased Core Flow
ISOLATED	The recirculation loop suction, discharge and discharge bypass valves are in the closed position
Kf	MCPR flow dependent multiplier (i.e., adjustment to the MCPR limit when at core flow less than rated)
Kp	MCPR power dependent multiplier (i.e., adjustment to the MCPR limit when at core power less than rated)
LHGR	Linear Heat Generation Rate
LHGRFACp	LHGR power dependent multiplier (i.e., adjustment to the LHGR limit for the following coincident conditions: at core power less than rated and the pressure regulator is out of service)
LPRM	Local Power Range Monitor
MAPLHGR	Maximum Average Planar Linear Heat Generation Rate
MCPR	Minimum Critical Power Ratio
MCPRp	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
RWE	Rod Withdrawal Error
TBV	Turbine Bypass Valve
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 ELLLA 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 5-22 for operation with zero ISOLATED RECIRCULATION LOOPS (Reference 2). For operation with one ISOLATED RECIRCULATION LOOP, multiply the limits in Tables 5-1 through 5-22 by the ISOLATED Loop multiplier listed in Table 5-23 (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

Avg. Planar Exposure (GWd/ST)	MAPLHGR (kW/ft)
0.0	9.64
0.2	9.64
1.0	9.57
5.0	9.39
10.0	9.18
15.0	8.93
20.0	8.95
25.0	8.52
35.0	7.78
45.0	7.59
55.0	7.55
65.0	7.51

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

Avg. Planar Exposure (GWd/ST)	MAPLHGR (kW/ft)
0.0	9.62
0.2	9.62
1.0	9.56
5.0	9.44
10.0	9.17
15.0	8.87
20.0	8.93
25.0	8.52
35.0	7.76
45.0	7.59
55.0	7.55
65.0	7.48

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

Avg. Planar Exposure (GWd/ST)	MAPLHGR (kW/ft)
0.0	9.55
0.2	9.55
1.0	9.50
5.0	9.33
10.0	9.04
15.0	8.99
20.0	8.90
25.0	8.51
35.0	7.78
45.0	7.50
55.0	7.55
65.0	7.47

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

Avg. Planar Exposure (GWd/ST)	MAPLHGR (kW/ft)
0.0	9.57
0.2	9.57
1.0	9.56
5.0	9.40
10.0	9.22
15.0	8.92
20.0	8.89
25.0	8.50
35.0	7.78
45.0	7.53
55.0	7.56
65.0	7.53

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

Avg. Planar Exposure (GWd/ST)	MAPLHGR (kW/ft)
0.0	9.55
0.2	9.55
1.0	9.51
5.0	9.31
10.0	9.10
15.0	8.93
20.0	9.01
25.0	8.68
35.0	7.80
45.0	7.63
55.0	7.60
65.0	7.54

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

Avg. Planar Exposure (GWd/ST)	MAPLHGR (kW/ft)
0.0	9.58
0.2	9.58
1.0	9.55
5.0	9.29
10.0	9.08
15.0	8.98
20.0	8.96
25.0	8.67
35.0	7.82
45.0	7.63
55.0	7.56
65.0	7.53

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

Avg. Planar Exposure (GWd/ST)	MAPLHGR (kW/ft)
0.0	9.14
0.2	9.14
1.0	9.10
5.0	9.13
10.0	9.04
15.0	8.93
20.0	8.97
25.0	8.62
35.0	7.78
45.0	7.56
55.0	7.54
65.0	7.45

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

Avg. Planar Exposure (GWd/ST)	MAPLHGR (kW/ft)
0.0	9.28
0.2	9.28
1.0	9.26
5.0	9.22
10.0	9.09
15.0	8.96
20.0	8.97
25.0	8.58
35.0	7.81
45.0	7.55
55.0	7.54
65.0	7.47

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

Avg. Planar Exposure (GWd/ST)	MAPLHGR (kW/ft)
0.0	9.52
0.2	9.52
1.0	9.50
5.0	9.35
10.0	9.14
15.0	9.02
20.0	8.96
25.0	8.65
35.0	7.82
45.0	7.63
55.0	7.58
65.0	7.54

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

Avg. Planar Exposure (GWd/ST)	MAPLHGR (kW/ft)
0.0	9.51
0.2	9.51
1.0	9.49
5.0	9.32
10.0	9.16
15.0	8.94
20.0	8.97
25.0	8.65
35.0	7.80
45.0	7.61
55.0	7.59
65.0	7.52

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

Avg. Planar Exposure (GWd/ST)	MAPLHGR (kW/ft)
0.0	7.73
0.2	7.73
1.0	7.75
5.0	7.67
10.0	7.64
15.0	7.72
20.0	6.96
25.0	6.46
35.0	6.26
45.0	6.13
55.0	6.03
65.0	5.91

Table 5-12 MAPLHGR for bundle: GNF2-P10DG2B371-14GZ-100T2-145-T6-4136
All Lattices

Avg. Planar Exposure (GWd/ST)	MAPLHGR (kW/ft)
0.0	7.75
0.2	7.75
1.0	7.72
5.0	7.63
10.0	7.53
15.0	7.40
20.0	6.86
25.0	6.34
35.0	6.21
45.0	6.06
55.0	5.95
65.0	5.86

Table 5-13 MAPLHGR for bundle: GNF2-P10DG2B370-16GZ-100T2-145-T6-4137
All Lattices

Avg. Planar Exposure (GWd/ST)	MAPLHGR (kW/ft)
0.0	7.73
0.2	7.73
1.0	7.73
5.0	7.66
10.0	7.47
15.0	7.41
20.0	6.89
25.0	6.34
35.0	6.21
45.0	6.05
55.0	5.96
65.0	5.86

Table 5-14 MAPLHGR for bundle: GNF2-P10DG2B372-14GZ-100T2-145-T6-4138
All Lattices

Avg. Planar Exposure (GWd/ST)	MAPLHGR (kW/ft)
0.0	7.74
0.2	7.74
1.0	7.72
5.0	7.62
10.0	7.50
15.0	7.40
20.0	6.85
25.0	6.36
35.0	6.21
45.0	6.05
55.0	5.98
65.0	5.86

Table 5-15 MAPLHGR for bundle: GNF2-P10DG2B370-16GZ-100T2-145-T6-3356
All Lattices

Avg. Planar Exposure (GWd/ST)	MAPLHGR (kW/ft)
0.0	7.83
0.2	7.83
1.0	7.78
5.0	7.73
10.0	7.65
15.0	7.62
20.0	7.76
25.0	6.88
35.0	6.30
45.0	6.17
55.0	6.04
65.0	5.91

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

Avg. Planar Exposure (GWd/ST)	MAPLHGR (kW/ft)
0.0	7.87
0.2	7.87
1.0	7.85
5.0	7.75
10.0	7.70
15.0	7.60
20.0	7.76
25.0	6.83
35.0	6.30
45.0	6.16
55.0	6.03
65.0	5.91

Table 5-17 MAPLHGR for bundle: GE11-P9DUB367-11GZ-100T-145-T6-2921
GNF Lattices #7313, #7314, #7315, #7316

Avg. Planar Exposure (GWd/ST)	MAPLHGR (kW/ft)
0.0	8.84
0.2	8.84
1.0	8.87
5.0	8.89
10.0	8.93
15.0	8.91
20.0	8.84
25.0	8.18
35.0	7.84
45.0	7.80
55.0	7.86
65.0	7.90

Table 5-18 MAPLHGR for bundle: GE11-P9DUB367-11GZ-100T-145-T6-2921
GNF Lattices #7311, #7312

Avg. Planar Exposure (GWd/ST)	MAPLHGR (kW/ft)
0.0	9.17
0.2	9.17
1.0	9.20
5.0	9.06
10.0	9.02
15.0	8.91
20.0	8.83
25.0	8.16
35.0	7.84
45.0	7.79
55.0	7.84
65.0	7.91

Table 5-19 MAPLHGR for bundle: GE11-P9DUB361-14GZ-100T-145-T6-2922
GNF Lattices #7318, #7319, #7315, #7320

Avg. Planar Exposure (GWd/ST)	MAPLHGR (kW/ft)
0.0	9.39
0.2	9.39
1.0	9.32
5.0	9.23
10.0	8.92
15.0	8.90
20.0	8.76
25.0	8.10
35.0	7.82
45.0	7.77
55.0	7.84
65.0	7.91

Table 5-20 MAPLHGR for bundle: GE11-P9DUB361-14GZ-100T-145-T6-2922
GNF Lattices #7311, #7317

Avg. Planar Exposure (GWd/ST)	MAPLHGR (kW/ft)
0.0	9.39
0.2	9.39
1.0	9.33
5.0	9.18
10.0	8.92
15.0	8.88
20.0	8.72
25.0	8.08
35.0	7.83
45.0	7.80
55.0	7.86
65.0	7.91

Table 5-21 MAPLHGR for bundle: GE11-P9DUB366-12GZ-100T-145-T6-3106
GNF Lattices #8518, #8519, #8508, #8520

Avg. Planar Exposure (GWd/ST)	MAPLHGR (kW/ft)
0.0	9.51
0.2	9.51
1.0	9.49
5.0	9.31
10.0	9.08
15.0	8.92
20.0	9.01
25.0	8.68
35.0	7.80
45.0	7.63
55.0	7.57
65.0	7.52

Table 5-22 MAPLHGR for bundle: GE11-P9DUB366-12GZ-100T-145-T6-3106
GNF Lattices #8507, #8517

Avg. Planar Exposure (GWd/ST)	MAPLHGR (kW/ft)
0.0	9.52
0.2	9.52
1.0	9.48
5.0	9.34
10.0	9.09
15.0	8.90
20.0	8.97
25.0	8.64
35.0	7.80
45.0	7.62
55.0	7.56
65.0	7.51

Table 5-23 MAPLHGR Multiplier with One ISOLATED Loop

Fuel Type	Isolated Loop Multiplier
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 Table 6-1 by the applicable MCPR multiplier, Kf, given in Table 6-2. Table 6-1 MCPR limits are the maximum values obtained from analysis of pressurization and non-pressurization events. MCPR values are determined by the cycle-specific fuel reload analyses in Reference 2. Table 6-1 MCPR limits are bounding for both GE11 and GNF2 fuel. The Kf multipliers are documented in Reference 2. Table 6-1 limits are independent of APRM status changes since Reference 2 analyzes the Rod Withdrawal Error (RWE) as unblocked. The appropriate Kf value may be determined by linear interpolation. Table 6-2 is applicable to GE11 and GNF2 fuel types per Reference 2.

Table 6-1 provides two sets of MCPR limits. One set is for nominal response function for the Turbine Bypass Valve (TBV) where the TBV fast opening to 80% of rated TBV flow has been demonstrated to be 1 second or less and has a TBV fast opening delay time of 200 msec or less (Reference 14). The other set, referred to as 'Slow to Open', represents MCPR limits which have taken no credit for the fast opening function of the TBV during a Feedwater Controller Failure (FWCF) event. The application of the (nominal versus 'slow to open') MCPR limits is dependent on the results of TBV testing.

6.2. Power Dependent MCPR Limits

The use of GNF2 fuel type requires the application 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 6-3 and documented in Reference 2. When core thermal power is greater than or equal to 40% of rated, the Kp multiplier from Table 6-3 is applied to the applicable rated condition MCPR limit shown in Tables 6-1. The appropriate MCPRp or Kp value may be determined by linear interpolation. Below 40% of rated power, the MCPR limits in Table 6-3 are applied directly. Table 6-3 is applicable to both GE11 and GNF2 fuel types per Reference 2.

Table 6-3 provides two sets power dependent MCPR limits at off-rated conditions. One set is for nominal response function for the Turbine Bypass Valve (TBV) where the TBV fast opening to 80% of rated TBV flow has been demonstrated to be 1 second or less and has a TBV fast opening delay time of 200 msec or less (Reference 14). The other set, referred to as 'Slow to Open', represents power dependent MCPR limits which have taken no credit for the fast opening function of the TBV during a Feedwater Controller Failure (FWCF) event. The application of the (nominal versus 'slow to open') power dependent MCPR limits is dependent on the results of TBV testing.

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 (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 3 to Table 6-1 for further clarification).

Table 6-1 MCPR Limit – All Fuel Types

Applicability[2]	TBV Response Function	Option	Cycle Exposure[1]	
			BOC to < (EOR-4016) MWD/ST	≥ (EOR-4016) MWD/ST to EOC
Four or Five Recirculation Loops in Service	Nominal	A	1.54	1.60
	Nominal	B	1.45[3]	1.50
Three Recirculation Loops in Service[4]	Nominal	A	1.56	1.62
	Nominal	B	1.47[3]	1.52
Four or Five Recirculation Loops in Service	Slow to Open	A	1.58	1.64
	Slow to Open	B	1.48	1.54
Three Recirculation Loops in Service[4]	Slow to Open	A	1.60	1.66
	Slow to Open	B	1.50	1.56

Table 6-2 Kf Multiplier – All Fuel Types[5]

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

[1] The referenced MCPR cycle exposure breakpoint (EOR-4016) MWD/ST is conservative to the value (EOR-3716) MWD/ST in Reference 2 to allow for changes to the end of rated cycle exposure due to cycle operation.
[2] MCPR limits are applicable to rated power operation for Equipment in Service and PROOS conditions per Reference 2.
[3] 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 an Option B MCPR limit that is 0.01 less (BOC to (EOR-4016) MWD/ST) than the RWE event. Scram time adjustments are only required to be applied to MCPR limits that are set by pressurization transients.
[4] For three recirculation loops in service, the MCPR operating limit is 0.02 greater than the four/five loop value per Reference 2.
[5] Kf multipliers are applicable for Equipment in Service and PROOS conditions per Reference 2.

Table 6-3 Power Dependent MCPRp Limits and Multipliers – All Fuel Types

Applicability	TBV Response Function	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	Nominal	≤ 60	2.52	2.52	2.20						
		> 60	2.79	2.79	2.29	1.185	1.185	1.185	-	1.074	1.000
Three Recirculation Loops in Service	Nominal	≤ 60	2.54	2.54	2.22						
		> 60	2.81	2.81	2.31	1.185	1.185	1.185	-	1.074	1.000
PROOS – Four or Five Recirculation Loops in Service	Nominal	≤ 60	2.52	2.52	2.20						
		> 60	2.79	2.79	2.29	1.517	1.375	1.345	1.265	1.082[1]	1.000
PROOS – Three Recirculation Loops in Service	Nominal	≤ 60	2.54	2.54	2.22						
		> 60	2.81	2.81	2.31	1.517	1.375	1.345	1.265	1.082[1]	1.000
Four or Five Recirculation Loops in Service	Slow to Open	≤ 60	2.67	2.67	2.20						
		> 60	4.02	4.02	2.69	1.193	1.193	1.193	-	1.082	1.000
Three Recirculation Loops in Service	Slow to Open	≤ 60	2.69	2.69	2.22						
		> 60	4.04	4.04	2.71	1.193	1.193	1.193	-	1.082	1.000
PROOS – Four or Five Recirculation Loops in Service	Slow to Open	≤ 60	2.67	2.67	2.20						
		> 60	4.02	4.02	2.69	1.517	1.375	1.345	1.265	1.082	1.000
PROOS – Three Recirculation Loops in Service	Slow to Open	≤ 60	2.69	2.69	2.22						
		> 60	4.04	4.04	2.71	1.517	1.375	1.345	1.265	1.082	1.000

[1] Kp multiplier has been conservatively set to 1.082 (compared to the Reference 2 value of 1.074) so the PROOS "Nominal" curves can be used for the PROOS "Slow to Open" curves.

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 UO_2 and Gd_2O_3 Thermal-Mechanical LHGR limits are contained in Appendix A and apply to all modes of operation as described in Table 9-1. 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 power adjusted LHGR for PROOS operating conditions is determined by multiplying the applicable Reference 3 LHGR limit by the LHGR multiplier, LHGRFACp, given in Table 7-1. The appropriate LHGRFACp value may be determined by linear interpolation.

Table 7-1 Power Dependent LHGR Multiplier LHGRFACp for PROOS

Power (% rated)	LHGRFACp
0.0	0.702
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

Technical Specification 2.3.A.1 Neutron Flux, Scram - APRM

For $W \leq 27.5 \times 10^6$ lb / hr:

$S \leq (1.433 \times 10^{-6}) W + 24.8$

where:

S = setting in percent of rated power

W = recirculation flow (lb/hr)

Technical Specification 2.3.B Neutron Flux, Control Rod Block

For $W \leq 27.5 \times 10^6$ lb / hr:

$S \leq (1.433 \times 10^{-6}) W + 17.5$

where:

S = setting in percent of rated power

W = recirculation flow (lb/hr)

9. Modes of Operation

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

Table 9-1 Modes of Operation

	Operating Region		
Options[1,3]	**Standard**	**ELLLA**	**ICF[2]**
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

[1] 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).

[2] Operation up to 67.5 Mlb/hr core flow is licensed for this cycle (Reference 2).

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

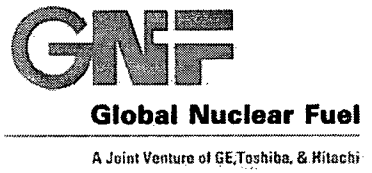
10. Methodology

1. GENE 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-19 and Supplement NEDE-24011-P-A-19-US, "General Electric Standard Application for Reactor Fuel," May 2012.

3. GENE Document, NEDC-33065P, Rev. 0, "Application of Stability Long-Term Solution Option II to Oyster Creek," April 2002.

Appendix A



Global Nuclear Fuel

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Non- Proprietary Information – Class I (Public)

Fuel Bundle Information Report
for
Oyster Creek
Reload 24 Cycle 24

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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 Oyster Creek for Cycle 24. 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: GE11-P9DUB359-14GZ-100T-145-T6-3108 (GE11)

Bundle Number: 3108

Peak Pellet Exposure	UO_2 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 [1]
GWd/MT (GWd/ST)	kW/ft
0.00 (0.00)	10.29
16.52 (14.99)	9.00
63.65 (57.74)	5.14

[1] 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: GE11-P9DUB356-14GZ-100T-145-T6-3109 (GE11)

Bundle Number: 3109

Peak Pellet Exposure	UO_2 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 [2]
GWd/MT (GWd/ST)	kW/ft
0.00 (0.00)	10.29
16.52 (14.99)	9.00
63.65 (57.74)	5.14

[2] 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: GE11-P9DUB367-12GZ-100T-145-T6-3104 (GE11)

Bundle Number: 3104

Peak Pellet Exposure	UO_2 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 [3]
GWd/MT (GWd/ST)	kW/ft
0.00 (0.00)	10.29
16.52 (14.99)	9.00
63.65 (57.74)	5.14

[3] 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: GE11-P9DUB360-11GZ-100T-145-T6-3107 (GE11)

Bundle Number: 3107

Peak Pellet Exposure	UO_2 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 [4]
GWd/MT (GWd/ST)	kW/ft
0.00 (0.00)	10.29
16.52 (14.99)	9.00
63.65 (57.74)	5.14

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

Bundle Number: 3105

Peak Pellet Exposure	UO_2 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 [5]
GWd/MT (GWd/ST)	kW/ft
0.00 (0.00)	10.29
16.52 (14.99)	9.00
63.65 (57.74)	5.14

[5] 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: GNF2-P10DG2B370-16GZ-100T2-145-T6-4137 (GNF2)

Bundle Number: 4137

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

Bundle Number: 3355

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

Bundle Number: 3356

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

Bundle Number: 3357

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-P10DG2B372-14GZ-100T2-145-T6-4138 (GNF2)

Bundle Number: 4138

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

Bundle Number: 2921

Peak Pellet Exposure	UO_2 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 [11]
GWd/MT (GWd/ST)	kW/ft
0.00 (0.00)	10.29
16.52 (14.99)	9.00
63.65 (57.74)	5.14

[11] 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: GE11-P9DUB361-14GZ-100T-145-T6-2922 (GE11)

Bundle Number: 2922

Peak Pellet Exposure	UO_2 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 [12]
GWd/MT (GWd/ST)	kW/ft
0.00 (0.00)	10.29
16.52 (14.99)	9.00
63.65 (57.74)	5.14

[12] 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: GE11-P9DUB366-12GZ-100T-145-T6-3106 (GE11)

Bundle Number: 3106

Peak Pellet Exposure	UO_2 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 [13]
GWd/MT (GWd/ST)	kW/ft
0.00 (0.00)	10.29
16.52 (14.99)	9.00
63.65 (57.74)	5.14

[13] 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: GNF2-P10DG2B371-14GZ-100T2-145-T6-4136 (GNF2)

Bundle Number: 4136

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

Peak Pellet Exposure	Most Limiting Gadolinia LHGR Limit [14]
GWd/MT (GWd/ST)	kW/ft
[[	
	]]

[14] 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 [15]	Exposure at Max k_∞ 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-P10DG2B370-16GZ-100T2-145-T6-4137 (GNF2)	4137					
GNF2-P10DG2B370-15GZ-100T2-145-T6-3355 (GNF2)	3355					
GNF2-P10DG2B370-16GZ-100T2-145-T6-3356 (GNF2)	3356					
GNF2-P10DG2B369-16GZ-100T2-145-T6-3357-LTD (GNF2)	3357					
GNF2-P10DG2B372-14GZ-100T2-145-T6-4138 (GNF2)	4138					
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					
GNF2-P10DG2B371-14GZ-100T2-145-T6-4136 (GNF2)	4136					]]

[15] 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. 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-P9DUB356-14GZ-100T-145-T6-3109 (GE11)

[[

]]

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

[[

]]

Figure B-4 Enrichment and Gadolinium Distribution for EDB No. 3107 Fuel Bundle GE11-P9DUB360-11GZ-100T-145-T6-3107 (GE11)

[[

]]

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

[[

]]

Figure B-6 Enrichment and Gadolinium Distribution for EDB No. 4137
Fuel Bundle GNF2-P10DG2B370-16GZ-100T2-145-T6-4137 (GNF2)

[[

]]

Figure B-7 Enrichment and Gadolinium Distribution for EDB No. 3355 Fuel Bundle GNF2-P10DG2B370-15GZ-100T2-145-T6-3355 (GNF2)

[[

]]

Figure B-8 Enrichment and Gadolinium Distribution for EDB No. 3356 Fuel Bundle GNF2-P10DG2B370-16GZ-100T2-145-T6-3356 (GNF2)

[[

]]

Figure B-9 Enrichment and Gadolinium Distribution for EDB No. 3357
Fuel Bundle GNF2-P10DG2B369-16GZ-100T2-145-T6-3357-LTD (GNF2)

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Figure B-10 Enrichment and Gadolinium Distribution for EDB No. 4138 Fuel Bundle GNF2-P10DG2B372-14GZ-100T2-145-T6-4138 (GNF2)

[[

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Figure B-11 Enrichment and Gadolinium Distribution for EDB No. 2921 Fuel Bundle GE11-P9DUB367-11GZ-100T-145-T6-2921 (GE11)

[[

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Figure B-12 Enrichment and Gadolinium Distribution for EDB No. 2922
Fuel Bundle GE11-P9DUB361-14GZ-100T-145-T6-2922 (GE11)

[[

]]

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

[[

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Figure B-14 Enrichment and Gadolinium Distribution for EDB No. 4136
Fuel Bundle GNF2-P10DG2B371-14GZ-100T2-145-T6-4136 (GNF2)