Exelon Generation.

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Subject: Core Operating Limits Report for Quad Cities Unit 1 Cycle 24, Revision 1

In accordance with Technical Specifications Section 5.6.5.d, enclosed is the revision to the Core Operating Limits Report (COLR) for Quad Cities Unit 1 Cycle 24. This revision implements improved MAPLHGR limits for the fresh fuel of Q1C24. These limits were developed by Westinghouse utilizing an updated NRC-approved LOCA methodology.

Should you have any questions concerning this letter, please contact Mr. Wally J. Beck at (309) 227-2800.

Respectfully,

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Site Vice President
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Enclosure: Core Operating Limits Report for Quad Cities Unit 1 Cycle 24, Revision 1

cc: Regional Administrator – NRC Region III
NRC Senior Resident Inspector – Quad Cities Nuclear Power Station

A001
NRR

Enclosure

Core Operating Limits Report

for

Quad Cities Unit 1 Cycle 24

Revision 1

Core Operating Limits Report

For

Quad Cities Unit 1 Cycle 24

Revision 1

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Record of COLR Quad Cities Unit 1 Cycle 24 Revisions

Revision	Description
1	Implements improved MAPLHGR limits for the fresh fuel of Quad Cities 1 Cycle 24. These limits were developed by Westinghouse utilizing an updated NRC-approved LOCA methodology. Also includes minor changes for consistency with the Quad Cities 2 Cycle 24 COLR.
0	New issue for Cycle 24

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1. Terms and Definitions

ASD	Adjustable Speed Drive
DEHC	Digital electro-hydraulic control
DLO	Dual loop operation
EFPD	Effective full power day
EFPH	Effective full power hour
EOC	End of cycle
EOOS	Equipment out of service
EOFPL	End of full power life
FWTR	Feedwater temperature reduction
FWT	Feedwater temperature
GWd/MTU	Gigawatt days per metric ton Uranium
ICF	Increased core flow
ISS	Intermediate scram speed
kW/ft	Kilowatt per foot
LHGR	Linear heat generation rate
LPRM	Local power range monitor
MAPLHGR	Maximum average planar linear heat generation rate
MCFL	Maximum Combined Flow Limiter
MCPR	Minimum critical power ratio
MCPR(F)	Flow dependent MCPR
MCPR(P)	Power dependent MCPR
MELLLA	Maximum extended load line limit analysis
Mlb/hr	Million pounds per hour
MSIV	Main steam isolation valve
MWd/MTU	Megawatt days per metric ton uranium
MWt	Megawatt thermal
NRC	Nuclear Regulatory Commission
NSS	Nominal Scram Speed
OLMCPR	Operating limit minimum critical power ratio
OOS	Out of service
OPRM	Oscillation power range monitor
PBDA	Period based detection algorithm
PLUOOS	Power load unbalance out of service
PCOOS	Pressure controller out of service
RBM	Rod block monitor
RWE	Rod withdrawal error
SLMCPR	Safety limit minimum critical power ratio
SLO	Single loop operation
TBVOOS	Turbine bypass valve out of service
TBV	Turbine bypass valve
TCV	Turbine control valve
TIP	Traversing Incore Probe
TMOL	Thermal mechanical operating limit
TSSS	Technical Specification scram speed
TSV	Turbine stop valve

2. General Information

Licensed rated thermal power is 2957 MWt. Rated core flow is 98 Mlb/hr. Operation up to 108% rated flow is licensed for this cycle. For allowed operating regions, see plant power/flow map.

The licensing analysis supports full power operation to EOFPL+25 EFPD (16797 MWd/MTU) and coastdown to a power level of 70%, given all burnup limits are satisfied. (Reference 3)

Power and flow-dependent limits are listed for various power and flow levels. Linear interpolation is to be used to find intermediate values.

The power-dependent OLMCPR and OLMCPR multiplier, K(P), are independent of scram speed. The MCPR(F) values are independent of scram speed and feedwater temperature.

The power-dependent and flow-dependent LHGR multipliers are independent of scram speed and feedwater temperature.

Only MCPR operating limits vary with scram speed. All other thermal limits are applicable with NSS, ISS, or TSSS.

For thermal limit monitoring above 100% rated core flow, the 100% core flow values can be used unless otherwise indicated in the applicable table.

3. Average Planar Linear Heat Generation Rate

Technical Specification Sections 3.2.1 and 3.4.1.

Lattice-specific MAPLHGR values for DLO and all EOOS conditions except SLO are provided in Tables 3-2 through 3-61. During single loop operation, these limits are multiplied by the EOOS multiplier listed in Table 3-1.

Table 3-1 MAPLHGR SLO multiplier
(References 5, 6, 7, and 8)

EOOS Condition	Multiplier
SLO	0.86

Table 3-2 MAPLHGR for Lattices 101 and 108
(References 5 and 6)

All Bundles Lattices 101: Opt2-B0.71 108: Opt2-T0.71	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	7.50 *
75.0	7.50 *

* All bundles in the core contain natural uranium lattice types 101 and 108. The MAPLHGR limits for those lattice types have been set equal to their most conservative value of 7.50 kW/ft.

Table 3-3 MAPLHGR for Lattice 129
(References 8 and 12)

Bundle Opt2-4.01-14GZ6.00 (QF21) Lattice 129: Opt2-B4.40-14G6.00	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.01
5.0	9.26
10.0	9.32
15.0	9.44
20.0	9.62
24.0	9.67
30.0	9.46
58.0	9.46
70.0	8.09

Table 3-4 MAPLHGR for Lattices 130 and 131
(References 8 and 12)

Bundle Opt2-4.01-14GZ6.00 (QF21) Lattices 130: Opt2-BE4.50-14G6.00 131: Opt2-M4.50-14G6.00	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.06
5.0	9.32
10.0	9.42
15.0	9.57
20.0	9.75
24.0	9.80
30.0	9.59
58.0	9.59
70.0	8.22

Table 3-5 MAPLHGR for Lattices 132 and 133
(References 8 and 12)

Bundle Opt2-4.01-14GZ6.00 (QF21) Lattices 132: Opt2-ME4.46-14G6.00 133: Opt2-T4.48-12G6.00	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.24
5.0	9.51
10.0	9.48
15.0	9.75
20.0	9.95
24.0	9.98
30.0	9.78
58.0	9.78
70.0	8.51

Table 3-6 MAPLHGR for Lattice 134
(References 7 and 11)

Bundle Opt2-4.07-19GZ7.50/5.50 (QG22) Lattice 134: Opt2-B4.49-19G7.50	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.63
2.5	9.62
5.0	9.51
7.5	9.35
10.0	9.23
12.0	9.20
15.0	9.37
17.0	9.51
20.0	9.71
22.0	9.68
24.0	9.64
30.0	9.55
36.0	9.46
42.0	9.44
50.0	9.42
60.0	9.44
62.0	9.46
64.0	9.66
72.0	9.84

Table 3-7 MAPLHGR for Lattice 135
(References 7 and 11)

Bundle Opt2-4.07-19GZ7.50/5.50 (QG22) Lattice 135: Opt2-BE4.57-19G7.50	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.72
2.5	9.69
5.0	9.56
7.5	9.38
10.0	9.23
12.0	9.25
15.0	9.47
17.0	9.61
20.0	9.82
22.0	9.76
24.0	9.72
30.0	9.63
36.0	9.54
42.0	9.51
50.0	9.50
60.0	9.48
62.0	9.50
64.0	9.70
72.0	9.89

Table 3-8 MAPLHGR for Lattice 136
(References 7 and 11)

Bundle Opt2-4.07-19GZ7.50/5.50 (QG22) Lattice 136: Opt2-M4.57-19G7.50	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.73
2.5	9.69
5.0	9.55
7.5	9.37
10.0	9.21
12.0	9.24
15.0	9.48
17.0	9.63
20.0	9.82
22.0	9.76
24.0	9.71
30.0	9.62
36.0	9.53
42.0	9.51
50.0	9.48
60.0	9.46
62.0	9.48
64.0	9.69
72.0	9.89

Table 3-9 MAPLHGR for Lattice 137
(References 7 and 11)

Bundle Opt2-4.07-19GZ7.50/5.50 (QG22) Lattice 137: Opt2-ME4.53-19G7.50	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.85
2.5	9.84
5.0	9.71
7.5	9.54
10.0	9.39
12.0	9.41
15.0	9.67
17.0	9.87
20.0	9.99
22.0	9.95
24.0	9.93
30.0	9.84
36.0	9.75
42.0	9.72
50.0	9.64
60.0	9.65
62.0	9.68
64.0	9.90
72.0	10.16

Table 3-10 MAPLHGR for Lattice 138
(References 7 and 11)

Bundle Opt2-4.07-19GZ7.50/5.50 (QG22) Lattice 138: Opt2-T4.53-19G7.50	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.87
2.5	9.87
5.0	9.75
7.5	9.56
10.0	9.40
12.0	9.39
15.0	9.62
17.0	9.86
20.0	9.96
22.0	9.93
24.0	9.91
30.0	9.82
36.0	9.73
42.0	9.71
50.0	9.61
60.0	9.63
62.0	9.66
64.0	9.89
72.0	10.16

Table 3-11 MAPLHGR for Lattice 139
(References 7 and 11)

Bundle Opt2-4.07-19GZ7.50/5.50 (QG22) Lattice 139: Opt2-T4.53-19G5.50	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.96
2.5	9.92
5.0	9.74
7.5	9.53
10.0	9.49
12.0	9.62
15.0	10.08
17.0	10.05
20.0	10.03
22.0	10.00
24.0	9.98
30.0	9.87
36.0	9.78
42.0	9.76
50.0	9.68
60.0	9.69
62.0	9.72
64.0	9.94
72.0	10.21

Table 3-12 MAPLHGR for Lattice 140
(References 7 and 11)

Bundle Opt2-4.07-17GZ7.50/5.50 (QH22) Lattice 140: Opt2-B4.49-17G7.50	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.60
2.5	9.68
5.0	9.68
7.5	9.52
10.0	9.35
12.0	9.27
15.0	9.41
17.0	9.52
20.0	9.68
22.0	9.68
24.0	9.65
30.0	9.58
36.0	9.50
42.0	9.47
50.0	9.45
60.0	9.43
62.0	9.45
64.0	9.65
72.0	9.84

Table 3-13 MAPLHGR for Lattice 141
(References 7 and 11)

Bundle Opt2-4.07-17GZ7.50/5.50 (QH22) Lattice 141: Opt2-BE4.57-17G7.50	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.62
2.5	9.70
5.0	9.72
7.5	9.53
10.0	9.35
12.0	9.32
15.0	9.50
17.0	9.61
20.0	9.79
22.0	9.76
24.0	9.73
30.0	9.66
36.0	9.58
42.0	9.55
50.0	9.49
60.0	9.47
62.0	9.49
64.0	9.70
72.0	9.89

Table 3-14 MAPLHGR for Lattice 142
(References 7 and 11)

Bundle Opt2-4.07-17GZ7.50/5.50 (QH22) Lattice 142: Opt2-M4.57-17G7.50	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.58
2.5	9.66
5.0	9.68
7.5	9.53
10.0	9.34
12.0	9.31
15.0	9.50
17.0	9.62
20.0	9.80
22.0	9.76
24.0	9.73
30.0	9.65
36.0	9.57
42.0	9.54
50.0	9.47
60.0	9.46
62.0	9.48
64.0	9.69
72.0	9.90

Table 3-15 MAPLHGR for Lattice 143
(References 7 and 11)

Bundle Opt2-4.07-17GZ7.50/5.50 (QH22) Lattice 143: Opt2-ME4.53-17G7.50	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.75
2.5	9.85
5.0	9.88
7.5	9.72
10.0	9.53
12.0	9.48
15.0	9.70
17.0	9.86
20.0	9.98
22.0	9.96
24.0	9.96
30.0	9.88
36.0	9.79
42.0	9.76
50.0	9.62
60.0	9.64
62.0	9.67
64.0	9.90
72.0	10.17

Table 3-16 MAPLHGR for Lattice 144
(References 7 and 11)

Bundle Opt2-4.07-17GZ7.50/5.50 (QH22) Lattice 144: Opt2-T4.53-17G7.50	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.83
2.5	9.92
5.0	9.95
7.5	9.75
10.0	9.54
12.0	9.49
15.0	9.67
17.0	9.84
20.0	9.96
22.0	9.95
24.0	9.94
30.0	9.86
36.0	9.78
42.0	9.72
50.0	9.59
60.0	9.62
62.0	9.65
64.0	9.88
72.0	10.17

Table 3-17 MAPLHGR for Lattice 145
(References 7 and 11)

Bundle Opt2-4.07-17GZ7.50/5.50 (QH22) Lattice 145: Opt2-T4.53-17G5.50	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.87
2.5	9.97
5.0	9.94
7.5	9.68
10.0	9.56
12.0	9.63
15.0	10.04
17.0	10.04
20.0	10.04
22.0	10.02
24.0	9.99
30.0	9.89
36.0	9.81
42.0	9.78
50.0	9.66
60.0	9.68
62.0	9.72
64.0	9.94
72.0	10.22

Table 3-18 MAPLHGR for Lattice 146
(References 7 and 11)

Bundle Opt2-4.12-12G5.50-2GZ5.50 (QI22) Lattice 146: Opt2-B4.54-14G5.50	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.22
2.5	9.35
5.0	9.42
7.5	9.47
10.0	9.50
12.0	9.52
15.0	9.70
17.0	9.75
20.0	9.75
22.0	9.73
24.0	9.71
30.0	9.61
36.0	9.53
42.0	9.49
50.0	9.49
60.0	9.51
62.0	9.52
64.0	9.72
72.0	9.89

Table 3-19 MAPLHGR for Lattice 147
(References 7 and 11)

Bundle Opt2-4.12-12G5.50-2GZ5.50 (QI22) Lattice 147: Opt2-BE4.62-14G5.50	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.33
2.5	9.43
5.0	9.50
7.5	9.54
10.0	9.58
12.0	9.60
15.0	9.80
17.0	9.84
20.0	9.83
22.0	9.81
24.0	9.79
30.0	9.70
36.0	9.61
42.0	9.57
50.0	9.57
60.0	9.55
62.0	9.56
64.0	9.76
72.0	9.95

Table 3-20 MAPLHGR for Lattice 148
(References 7 and 11)

Bundle Opt2-4.12-12G5.50-2GZ5.50 (QI22) Lattice 148: Opt2-M4.62-14G5.50	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.32
2.5	9.42
5.0	9.49
7.5	9.53
10.0	9.57
12.0	9.61
15.0	9.78
17.0	9.83
20.0	9.83
22.0	9.81
24.0	9.78
30.0	9.69
36.0	9.60
42.0	9.57
50.0	9.56
60.0	9.53
62.0	9.55
64.0	9.76
72.0	9.95

Table 3-21 MAPLHGR for Lattice 149
(References 7 and 11)

Bundle Opt2-4.12-12G5.50-2GZ5.50 (QI22) Lattice 149: Opt2-ME4.58-14G5.50	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.51
2.5	9.61
5.0	9.69
7.5	9.74
10.0	9.79
12.0	9.81
15.0	10.01
17.0	10.05
20.0	10.06
22.0	10.04
24.0	10.01
30.0	9.91
36.0	9.83
42.0	9.80
50.0	9.72
60.0	9.73
62.0	9.75
64.0	9.97
72.0	10.23

Table 3-22 MAPLHGR for Lattice 150
(References 7 and 11)

Bundle Opt2-4.12-12G5.50-2GZ5.50 (QI22) Lattice 150: Opt2-T4.58-14G5.50	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.54
2.5	9.64
5.0	9.72
7.5	9.74
10.0	9.74
12.0	9.78
15.0	9.99
17.0	10.03
20.0	10.05
22.0	10.03
24.0	10.00
30.0	9.90
36.0	9.81
42.0	9.79
50.0	9.69
60.0	9.70
62.0	9.73
64.0	9.95
72.0	10.23

Table 3-23 MAPLHGR for Lattice 151
(References 7 and 11)

Bundle Opt2-4.12-12G5.50-2GZ5.50 (QI22) Lattice 151: Opt2-T4.60-12G5.50	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.77
2.5	9.84
5.0	9.86
7.5	9.87
10.0	9.88
12.0	9.93
15.0	9.99
17.0	10.04
20.0	10.06
22.0	10.04
24.0	10.01
30.0	9.92
36.0	9.83
42.0	9.80
50.0	9.71
60.0	9.72
62.0	9.75
64.0	9.97
72.0	10.25

Table 3-24 MAPLHGR for Lattice 152
(References 6 and 10)

Bundle Opt2-4.03-18GZ8.00/6.00 (QJ23) Lattice 152: Opt2-B4.29-18G8.00	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	8.91
2.5	9.19
5.0	9.22
7.5	9.37
10.0	9.67
12.0	9.78
15.0	10.00
17.0	10.04
20.0	9.97
22.0	9.87
24.0	9.87
30.0	9.76
36.0	9.63
42.0	9.52
50.0	9.42
60.0	9.57
72.0	9.76
75.0	9.57

Table 3-25 MAPLHGR for Lattice 153
(References 6 and 10)

Bundle Opt2-4.03-18GZ8.00/6.00 (QJ23) Lattice 153: Opt2-B4.47-18G8.00	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	8.82
2.5	9.10
5.0	9.06
7.5	9.01
10.0	9.12
12.0	9.15
15.0	9.26
17.0	9.34
20.0	9.49
22.0	9.60
24.0	9.65
30.0	9.56
36.0	9.52
42.0	9.48
50.0	9.52
60.0	9.67
72.0	9.77
75.0	9.67

Table 3-26 MAPLHGR for Lattice 154
(References 6 and 10)

Bundle Opt2-4.03-18GZ8.00/6.00 (QJ23) Lattice 154: Opt2-BE4.57-18G8.00	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	8.95
2.5	9.28
5.0	9.23
7.5	9.03
10.0	9.17
12.0	9.22
15.0	9.36
17.0	9.44
20.0	9.61
22.0	9.72
24.0	9.73
30.0	9.65
36.0	9.62
42.0	9.55
50.0	9.59
60.0	9.64
72.0	9.91
75.0	9.64

Table 3-27 MAPLHGR for Lattice 155
(References 6 and 10)

Bundle Opt2-4.03-18GZ8.00/6.00 (QJ23) Lattice 155: Opt2-M4.57-18G8.00	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	8.93
2.5	9.28
5.0	9.24
7.5	9.06
10.0	9.19
12.0	9.23
15.0	9.36
17.0	9.46
20.0	9.63
22.0	9.74
24.0	9.73
30.0	9.64
36.0	9.61
42.0	9.56
50.0	9.58
60.0	9.60
72.0	9.87
75.0	9.60

Table 3-28 MAPLHGR for Lattice 156
(References 6 and 10)

Bundle Opt2-4.03-18GZ8.00/6.00 (QJ23) Lattice 156: Opt2-ME4.54-18G8.00	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.06
2.5	9.39
5.0	9.34
7.5	9.17
10.0	9.32
12.0	9.38
15.0	9.53
17.0	9.63
20.0	9.92
22.0	9.96
24.0	9.89
30.0	9.84
36.0	9.77
42.0	9.73
50.0	9.68
60.0	9.66
72.0	10.24
75.0	9.66

Table 3-29 MAPLHGR for Lattice 157
(References 6 and 10)

Bundle Opt2-4.03-18GZ8.00/6.00 (QJ23) Lattice 157: Opt2-T4.54-18G8.00	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.10
2.5	9.42
5.0	9.31
7.5	9.14
10.0	9.30
12.0	9.34
15.0	9.48
17.0	9.58
20.0	9.92
22.0	9.96
24.0	9.90
30.0	9.84
36.0	9.78
42.0	9.70
50.0	9.66
60.0	9.66
72.0	10.16
75.0	9.66

Table 3-30 MAPLHGR for Lattice 158
(References 6 and 10)

Bundle Opt2-4.03-18GZ8.00/6.00 (QJ23) Lattice 158: Opt2-T4.55-16G6.00	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.51
2.5	9.81
5.0	9.72
7.5	9.58
10.0	9.67
12.0	9.62
15.0	9.79
17.0	10.01
20.0	10.05
22.0	10.04
24.0	9.99
30.0	9.93
36.0	9.87
42.0	9.81
50.0	9.71
60.0	9.71
72.0	10.22
75.0	9.71

Table 3-31 MAPLHGR for Lattice 159
(References 6 and 10)

Bundle Opt2-4.08-18GZ8.00/6.00 (QK23) Lattice 159: Opt2-B4.36-18G8.00	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.77
2.5	9.98
5.0	9.86
7.5	9.77
10.0	9.91
12.0	9.93
15.0	9.95
17.0	9.92
20.0	10.09
22.0	10.01
24.0	10.00
30.0	9.84
36.0	9.69
42.0	9.57
50.0	9.46
60.0	9.59
72.0	9.81
75.0	9.59

Table 3-32 MAPLHGR for Lattice 160
(References 6 and 10)

Bundle Opt2-4.08-18GZ8.00/6.00 (QK23) Lattice 160: Opt2-B4.54-18G8.00	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.82
2.5	10.04
5.0	9.91
7.5	9.75
10.0	9.86
12.0	9.80
15.0	9.60
17.0	9.48
20.0	9.46
22.0	9.45
24.0	9.50
30.0	9.66
36.0	9.65
42.0	9.59
50.0	9.60
60.0	9.70
72.0	9.85
75.0	9.70

Table 3-33 MAPLHGR for Lattice 161
(References 6 and 10)

Bundle Opt2-4.08-18GZ8.00/6.00 (QK23) Lattice 161: Opt2-BE4.63-18G8.00	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.88
2.5	10.23
5.0	10.08
7.5	9.79
10.0	9.93
12.0	9.94
15.0	9.64
17.0	9.52
20.0	9.53
22.0	9.54
24.0	9.62
30.0	9.78
36.0	9.72
42.0	9.67
50.0	9.65
60.0	9.66
72.0	9.99
75.0	9.66

Table 3-34 MAPLHGR for Lattice 162
(References 6 and 10)

Bundle Opt2-4.08-18GZ8.00/6.00 (QK23) Lattice 162: Opt2-M4.63-18G8.00	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.85
2.5	10.21
5.0	10.01
7.5	9.75
10.0	9.91
12.0	9.94
15.0	9.63
17.0	9.52
20.0	9.55
22.0	9.55
24.0	9.63
30.0	9.78
36.0	9.75
42.0	9.66
50.0	9.61
60.0	9.58
72.0	9.91
75.0	9.58

Table 3-35 MAPLHGR for Lattice 163
(References 6 and 10)

Bundle Opt2-4.08-18GZ8.00/6.00 (QK23) Lattice 163: Opt2-ME4.60-18G8.00	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	10.02
2.5	10.35
5.0	10.23
7.5	9.95
10.0	10.09
12.0	10.06
15.0	9.86
17.0	9.73
20.0	9.80
22.0	9.83
24.0	9.95
30.0	9.99
36.0	9.95
42.0	9.89
50.0	9.73
60.0	9.69
72.0	10.23
75.0	9.69

Table 3-40 MAPLHGR for Lattice 168
(References 6 and 10)

Bundle Opt2-4.17-2GZ6.00-10G6.00 (QL23) Lattice 168: Opt2-M4.67-12G6.00	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.36
2.5	9.60
5.0	9.42
7.5	9.52
10.0	9.59
12.0	9.48
15.0	9.51
17.0	9.57
20.0	9.70
22.0	9.70
24.0	9.72
30.0	9.76
36.0	9.79
42.0	9.69
50.0	9.66
60.0	9.62
72.0	9.99
75.0	9.62

Table 3-41 MAPLHGR for Lattice 169
(References 6 and 10)

Bundle Opt2-4.17-2GZ6.00-10G6.00 (QL23) Lattice 169: Opt2-ME4.65-12G6.00	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.57
2.5	9.81
5.0	9.65
7.5	9.67
10.0	9.72
12.0	9.66
15.0	9.73
17.0	9.82
20.0	9.93
22.0	9.98
24.0	9.98
30.0	10.00
36.0	10.00
42.0	9.94
50.0	9.81
60.0	9.77
72.0	10.21
75.0	9.77

Table 3-42 MAPLHGR for Lattice 170
(References 6 and 10)

Bundle Opt2-4.17-2GZ6.00-10G6.00 (QL23) Lattice 170: Opt2-T4.64-10G6.00	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	10.01
2.5	10.19
5.0	9.98
7.5	10.07
10.0	9.84
12.0	9.82
15.0	9.82
17.0	9.85
20.0	9.94
22.0	9.97
24.0	9.97
30.0	9.99
36.0	9.99
42.0	9.93
50.0	9.81
60.0	9.77
72.0	10.21
75.0	9.77

Table 3-43 MAPLHGR for Lattice 171
(References 5 and 9)

Bundle Opt2-4.03-16GZ8.00/5.50-2GZ5.50 (QM24) Lattice 171: Opt2-B4.33-16G8.00-2G5.50	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.08
2.5	9.42
5.0	9.34
7.5	9.51
10.0	9.72
12.0	9.86
15.0	10.08
17.0	10.19
20.0	10.38
22.0	10.39
24.0	10.39
30.0	10.19
36.0	10.05
42.0	9.93
50.0	9.83
75.0	9.83

Table 3-44 MAPLHGR for Lattice 172
(References 5 and 9)

Bundle Opt2-4.03-16GZ8.00/5.50-2GZ5.50 (QM24) Lattice 172: Opt2-B4.47-16G8.00-2G5.50	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.01
2.5	9.35
5.0	9.26
7.5	9.23
10.0	9.38
12.0	9.46
15.0	9.60
17.0	9.66
20.0	9.79
22.0	9.90
24.0	10.02
30.0	10.02
36.0	9.98
42.0	9.94
50.0	9.95
75.0	9.95

Table 3-45 MAPLHGR for Lattice 173
(References 5 and 9)

Bundle Opt2-4.03-16GZ8.00/5.50-2GZ5.50 (QM24) Lattice 173: Opt2-BE4.56-16G8.00-2G5.50	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.04
2.5	9.36
5.0	9.26
7.5	9.25
10.0	9.44
12.0	9.53
15.0	9.68
17.0	9.75
20.0	9.90
22.0	10.01
24.0	10.15
30.0	10.11
36.0	10.08
42.0	10.02
50.0	9.98
75.0	9.98

Table 3-46 MAPLHGR for Lattice 174
(References 5 and 9)

Bundle Opt2-4.03-16GZ8.00/5.50-2GZ5.50 (QM24) Lattice 174: Opt2-M4.56-16G8.00-2G5.50	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.02
2.5	9.36
5.0	9.25
7.5	9.26
10.0	9.44
12.0	9.54
15.0	9.69
17.0	9.76
20.0	9.92
22.0	10.02
24.0	10.16
30.0	10.10
36.0	10.07
42.0	10.01
50.0	9.94
75.0	9.94

Table 3-47 MAPLHGR for Lattice 175
(References 5 and 9)

Bundle Opt2-4.03-16GZ8.00/5.50-2GZ5.50 (QM24) Lattice 175: Opt2-ME4.52-16G8.00-2G5.50	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.15
2.5	9.50
5.0	9.39
7.5	9.41
10.0	9.59
12.0	9.70
15.0	9.86
17.0	9.96
20.0	10.21
22.0	10.38
24.0	10.35
30.0	10.31
36.0	10.25
42.0	10.19
50.0	10.06
75.0	10.06

Table 3-52 MAPLHGR for Lattice 180
(References 5 and 9)

Bundle Opt2-4.03-14GZ8.00/5.50-2GZ5.50 (QN24) Lattice 180: Opt2-BE4.55-14G8.00-2G5.50	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.32
2.5	9.62
5.0	9.48
7.5	9.43
10.0	9.56
12.0	9.61
15.0	9.74
17.0	9.79
20.0	9.86
22.0	9.98
24.0	10.11
30.0	10.11
36.0	10.08
42.0	10.00
50.0	9.91
75.0	9.91

Table 3-53 MAPLHGR for Lattice 181
(References 5 and 9)

Bundle Opt2-4.03-14GZ8.00/5.50-2GZ5.50 (QN24) Lattice 181: Opt2-M4.55-14G8.00-2G5.50	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.31
2.5	9.62
5.0	9.53
7.5	9.47
10.0	9.57
12.0	9.63
15.0	9.75
17.0	9.80
20.0	9.87
22.0	10.00
24.0	10.12
30.0	10.10
36.0	10.07
42.0	10.00
50.0	9.84
75.0	9.84

Table 3-54 MAPLHGR for Lattice 182
(References 5 and 9)

Bundle Opt2-4.03-14GZ8.00/5.50-2GZ5.50 (QN24) Lattice 182: Opt2-ME4.51-14G8.00-2G5.50	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.46
2.5	9.78
5.0	9.66
7.5	9.61
10.0	9.73
12.0	9.80
15.0	9.93
17.0	9.98
20.0	10.14
22.0	10.32
24.0	10.36
30.0	10.31
36.0	10.27
42.0	10.16
50.0	10.06
75.0	10.06

Table 3-55 MAPLHGR for Lattice 183
(References 5 and 9)

Bundle Opt2-4.03-14GZ8.00/5.50-2GZ5.50 (QN24) Lattice 183: Opt2-T4.51-14G8.00-2G5.50	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.51
2.5	9.82
5.0	9.69
7.5	9.59
10.0	9.71
12.0	9.77
15.0	9.89
17.0	9.94
20.0	10.17
22.0	10.36
24.0	10.34
30.0	10.32
36.0	10.24
42.0	10.12
50.0	9.96
75.0	9.96

Table 3-56 MAPLHGR for Lattice 184
(References 5 and 9)

Bundle Opt2-4.03-14GZ8.00/5.50-2GZ5.50 (QN24) Lattice 184: Opt2-T4.52-14G5.50	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.98
2.5	10.25
5.0	10.18
7.5	9.89
10.0	9.90
12.0	10.01
15.0	10.18
17.0	10.36
20.0	10.45
22.0	10.46
24.0	10.42
30.0	10.37
36.0	10.30
42.0	10.22
50.0	10.04
75.0	10.04

Table 3-57 MAPLHGR for Lattice 185
(References 5 and 9)

Bundle Opt2-4.16-12G6.00-2GZ6.00 (QO24) Lattice 185: Opt2-B4.58-14G6.00	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.31
2.5	9.51
5.0	9.45
7.5	9.46
10.0	9.50
12.0	9.56
15.0	9.67
17.0	9.75
20.0	9.87
22.0	9.97
24.0	9.99
30.0	10.01
36.0	10.03
42.0	10.01
50.0	9.99
75.0	9.99

Table 3-58 MAPLHGR for Lattice 186
(References 5 and 9)

Bundle Opt2-4.16-12G6.00-2GZ6.00 (QO24) Lattice 186: Opt2-BE4.67-14G6.00	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.34
2.5	9.56
5.0	9.49
7.5	9.52
10.0	9.67
12.0	9.65
15.0	9.75
17.0	9.85
20.0	9.99
22.0	10.08
24.0	10.11
30.0	10.15
36.0	10.14
42.0	10.09
50.0	10.02
75.0	10.02

Table 3-59 MAPLHGR for Lattice 187
(References 5 and 9)

Bundle Opt2-4.16-12G6.00-2GZ6.00 (QO24) Lattice 187: Opt2-M4.67-14G6.00	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.32
2.5	9.57
5.0	9.47
7.5	9.51
10.0	9.70
12.0	9.66
15.0	9.76
17.0	9.86
20.0	10.05
22.0	10.09
24.0	10.11
30.0	10.17
36.0	10.13
42.0	10.08
50.0	9.99
75.0	9.99

Table 3-60 MAPLHGR for Lattice 188
(References 5 and 9)

Bundle Opt2-4.16-12G6.00-2GZ6.00 (QO24) Lattice 188: Opt2-ME4.64-14G6.00	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.51
2.5	9.75
5.0	9.67
7.5	9.71
10.0	9.80
12.0	9.84
15.0	9.98
17.0	10.13
20.0	10.31
22.0	10.37
24.0	10.38
30.0	10.41
36.0	10.37
42.0	10.32
50.0	10.16
75.0	10.16

Table 3-61 MAPLHGR for Lattice 189
(References 5 and 9)

Bundle Opt2-4.16-12G6.00-2GZ6.00 (QO24) Lattice 189: Opt2-T4.64-12G6.00	
Avg. Planar Exposure (GWd/MTU)	**DLO MAPLHGR (kW/ft)**
0.0	9.91
2.5	10.14
5.0	9.98
7.5	10.01
10.0	9.98
12.0	9.96
15.0	10.07
17.0	10.16
20.0	10.31
22.0	10.37
24.0	10.37
30.0	10.37
36.0	10.38
42.0	10.31
50.0	10.13
75.0	10.13

4. Operating Limit Minimum Critical Power Ratio

Technical Specification Sections 3.2.2, 3.4.1, and 3.7.7

The OLMCPRs for Quad Cities 1 Cycle 24 were established to protect the SLMCPR during the anticipated operational occurrences.

4.1. Manual Flow Control MCPR Operating Limits

The OLMCPR is determined for a given power and flow condition by evaluating the power-dependent OLMCPR and the flow-dependent OLMCPR and selecting the greater of the two.

4.1.1. Power - Dependent MCPR Operating Limit

For operation at less than 38.5% of rated core thermal power, the OLMCPR as a function of core thermal power is shown in Tables 4-5 and 4-6. For operation at greater than 38.5% of rated core thermal power, the OLMCPR as a function of core thermal power is determined by multiplying the applicable rated condition OLMCPR limit shown in Tables 4-2 through 4-4 by the applicable OLMCPR multiplier K(P) given in Tables 4-5 and 4-6. For operation at exactly 38.5% of rated core thermal power, the OLMCPR as a function of core thermal power is the maximum of either of the two aforementioned methods evaluated at 38.5% of rated core thermal power.

4.1.2. Flow - Dependent MCPR Operating Limit

Table 4-7 gives the OLMCPR as a function of the flow based on the applicable plant condition. The flow-dependent OLMCPR values are applicable to all base case and EOOS combinations.

4.2. Scram Time

TSSS, ISS, and NSS refer to scram speeds. The scram time values associated with these speeds are shown in Table 4-1. The TSSS scram times shown in Table 4-1 are the same as those specified in the Technical Specifications (Reference 13). Reference 3 indicates that the TSSS control rod insertion times that were actually used in the transient analysis are conservative with respect to the scram times specified in the Technical Specifications.

To utilize the OLMCPR limits for Nominal Scram Speed in Table 4-4, the average control rod insertion time at each control rod insertion fraction must be equal to or less than the NSS time shown on Table 4-1 below.

To utilize the OLMCPR limits for Intermediate Scram Speed in Table 4-3, the average control rod insertion time at each control rod insertion fraction must be equal to or less than the ISS time shown on Table 4-1 below.

To utilize the OLMCPR limits for Technical Specification Scram Speed in Table 4-2, the average control rod insertion time at each control rod insertion fraction must be equal to or less than the TSSS time shown on Table 4-1 below.

The average control rod insertion time is defined as the sum of the control rod insertion times of all operable control rods divided by the number of operable control rods. The time for inoperable drives fully inserted (notch 00) can be conservatively included for calculation of core average scram speed. (Reference 3)

Table 4-1 Scram Times
(References 3, 13 and 17)

Control Rod Insertion Fraction (% from fully withdrawn)	TSSS (seconds)	ISS (seconds)	NSS (seconds)
5	0.48	0.360	0.324
20	0.89	0.720	0.694
50	1.98	1.580	1.510
90	3.44	2.800	2.670

4.3. Recirculation Pump ASD Settings

Technical Requirements Manual Section 2.1.a.1

Quad Cities 1 Cycle 24 was analyzed with a maximum core flow runout of 110%; therefore the recirculation pump ASD must be set to maintain core flow less than 110% (107.8 Mlb/hr) for all runout events. (Reference 4) This value is consistent with the analyses of Reference 3.

Table 4-2 MCPR TSSS Based Operating Limits – Nominal FWT and FWTR
(Reference 3)

EOOS Combination	Nominal FWT		FWTR	
	Cycle Exposure (MWd/MTU)		Cycle Exposure (MWd/MTU)	
	≤ 15,000	> 15,000	≤ 15,000	> 15,000
Base	1.71	1.76	1.71	1.76
Base SLO	1.76	1.81	1.76	1.81
PLUOOS	1.77	1.81	1.77	1.81
PLUOOS SLO	1.82	1.86	1.82	1.86
TBVOOS	1.88	1.91	1.89	1.91
TBVOOS SLO	1.94	1.97	1.95	1.97
TCV Slow Closure	1.81	1.86	1.81	1.86
TCV Slow Closure SLO	1.86	1.92	1.86	1.92
TCV Stuck Closed	1.71	1.76	1.71	1.76
TCV Stuck Closed SLO	1.76	1.81	1.76	1.81

Table 4-3 MCPR ISS Based Operating Limits -- Nominal FWT and FWTR
(Reference 3)

EOOS Combination	Nominal FWT		FWTR	
	Cycle Exposure (MWd/MTU)		Cycle Exposure (MWd/MTU)	
	≤ 15,000	> 15,000	≤ 15,000	> 15,000
Base	1.46	1.51	1.52	1.53
Base SLO	1.50	1.56	1.57	1.58
PLUOOS	1.54	1.59	1.54	1.59
PLUOOS SLO	1.59	1.64	1.59	1.64
TBVOOS	1.62	1.66	1.65	1.68
TBVOOS SLO	1.67	1.71	1.70	1.73
TCV Slow Closure	1.56	1.60	1.56	1.60
TCV Slow Closure SLO	1.61	1.65	1.61	1.65
TCV Stuck Closed	1.46	1.51	1.52	1.53
TCV Stuck Closed SLO	1.50	1.56	1.57	1.58

Table 4-4 MCPR NSS Based Operating Limits – Nominal FWT and FWTR
(Reference 3)

EOOS Combination	Nominal FWT		FWTR	
	Cycle Exposure (MWd/MTU)		Cycle Exposure (MWd/MTU)	
	≤ 15,000	> 15,000	≤ 15,000	> 15,000
Base	1.46	1.48	1.51	1.52
Base SLO	1.50	1.52	1.56	1.57
PLUOOS	1.51	1.55	1.51	1.55
PLUOOS SLO	1.56	1.60	1.56	1.60
TBVOOS	1.58	1.62	1.63	1.65
TBVOOS SLO	1.63	1.67	1.68	1.70
TCV Slow Closure	1.54	1.58	1.54	1.58
TCV Slow Closure SLO	1.59	1.63	1.59	1.63
TCV Stuck Closed	1.46	1.48	1.51	1.52
TCV Stuck Closed SLO	1.50	1.52	1.56	1.57

Table 4-5 MCPR(P) – Nominal FWT
(Reference 3)

EOOS Combination	Core Flow (% of Rated)	Core Thermal Power (% of rated)							
		0	25	38.5	38.5	50	60	80	100
		OLMCPR			OLMCPR Multiplier, K(P)				
Base	≤ 60	3.03	2.43	2.11	1.31	1.18	1.12	1.05	1.00
	> 60	3.13	2.68	2.44					
Base SLO	≤ 60	3.12	2.50	2.17					
	> 60	3.23	2.76	2.51					
PLUOOS	≤ 60	3.03	2.43	2.11	1.55	1.43	1.31	1.06	1.00
	> 60	3.13	2.68	2.44					
PLUOOS SLO	≤ 60	3.12	2.50	2.17					
	> 60	3.23	2.76	2.51					
TBVOOS	≤ 60	4.36	3.13	2.47	1.31	1.18	1.12	1.05	1.00
	> 60	4.36	3.34	2.86					
TBVOOS SLO	≤ 60	4.48	3.22	2.54					
	> 60	4.48	3.44	2.94					
TCV Slow Closure	≤ 60	3.03	2.43	2.11	1.55	1.43	1.31	1.06	1.00
	> 60	3.13	2.68	2.44					
TCV Slow Closure SLO	≤ 60	3.12	2.50	2.17					
	> 60	3.23	2.76	2.51					
TCV Stuck Closed	≤ 60	3.03	2.43	2.11	1.31	1.18	1.12	1.05	1.00
	> 60	3.13	2.68	2.44					
TCV Stuck Closed SLO	≤ 60	3.12	2.50	2.17					
	> 60	3.23	2.76	2.51					

Table 4-6 MCPR(P) – FWTR
(Reference 3)

EOOS Combination	Core Flow (% of Rated)	Core Thermal Power (% of rated)							
		0	25	38.5	38.5	50	60	80	100
		OLMCPR			OLMCPR Multiplier, K(P)				
Base	≤ 60	3.03	2.43	2.11	1.34	1.20	1.13	1.05	1.00
	> 60	3.13	2.68	2.44					
Base SLO	≤ 60	3.12	2.50	2.17					
	> 60	3.23	2.76	2.51					
PLUOOS	≤ 60	3.03	2.43	2.11	1.55	1.43	1.31	1.06	1.00
	> 60	3.13	2.68	2.44					
PLUOOS SLO	≤ 60	3.12	2.50	2.17					
	> 60	3.23	2.76	2.51					
TBVOOS	≤ 60	4.73	3.30	2.53	1.34	1.20	1.13	1.05	1.00
	> 60	4.73	3.34	2.93					
TBVOOS SLO	≤ 60	4.86	3.39	2.60					
	> 60	4.86	3.44	3.01					
TCV Slow Closure	≤ 60	3.03	2.43	2.11	1.55	1.43	1.31	1.06	1.00
	> 60	3.13	2.68	2.44					
TCV Slow Closure SLO	≤ 60	3.12	2.50	2.17					
	> 60	3.23	2.76	2.51					
TCV Stuck Closed	≤ 60	3.03	2.43	2.11	1.34	1.20	1.13	1.05	1.00
	> 60	3.13	2.68	2.44					
TCV Stuck Closed SLO	≤ 60	3.12	2.50	2.17					
	> 60	3.23	2.76	2.51					

Table 4-7 MCPR(F) – DLO and SLO Operation
(Reference 3)

Core Flow (% of rated)	DLO	SLO
0	1.98	2.04
100	1.38	1.42
108	1.38	1.42

5. Linear Heat Generation Rate

Technical Specification Sections 3.2.3 and 3.4.1

The TMOL at rated conditions for the Optima2 fuel is established in terms of the maximum LHGR as a function of rod nodal exposure. The limits in Table 5-1 apply to bundle lattices that do not require Gadolinia set down penalties as well as any natural blanket segment in the core (lattice types 101 and 108). The limits in Tables 5-2 through 5-9 apply to bundle lattices that require Gadolinia set down penalties.

The LHGR limit is the product of the exposure dependent LHGR limit from Table 5-1 through Table 5-9 and the minimum of the power-dependent LHGR multiplier or the flow-dependent LHGR multiplier, as applicable. The power-dependent LHGR multiplier is determined from Table 5-10. The flow-dependent LHGR multiplier is determined from Table 5-11, and is applicable for DLO and SLO and for all Base Case and EOOS conditions.

Table 5-1 LHGR Limits for Lattices 101, 108, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, and 151
(References 3, 11 and 12)

Rod Nodal Exposure (GWd/MTU)	LHGR Limit (kW/ft)
0.000	13.72
14.000	13.11
23.000	12.22
57.000	8.87
62.000	8.38
75.000	3.43

Table 5-2 LHGR Limits for Lattices 152, 153, 154, 155, 163, 164, and 165
(Reference 18)

Rod Nodal Exposure (GWd/MTU)	LHGR Limit (kW/ft)
0.000	13.72
14.000	13.11
14.999	13.01
15.000	12.62
35.000	10.71
35.001	11.04
62.000	8.38
75.000	3.43

Table 5-3 LHGR Limits for Lattices 156, 157 and 158
(Reference 18)

Rod Nodal Exposure (GWd/MTU)	LHGR Limit (kW/ft)
0.000	13.72
14.000	13.11
14.999	13.01
15.000	12.55
45.000	9.70
45.001	10.06
62.000	8.38
75.000	3.43

Table 5-4 LHGR Limits for Lattices 159, 160, 161, and 162
(Reference 18)

Rod Nodal Exposure (GWd/MTU)	LHGR Limit (kW/ft)
0.000	13.72
14.000	13.11
17.999	12.71
18.000	12.52
32.000	11.17
32.001	11.34
62.000	8.38
75.000	3.43

Table 5-5 LHGR Limits for Lattices 166, 167, 168, 169, and 170
(Reference 18)

Rod Nodal Exposure (GWd/MTU)	LHGR Limit (kW/ft)
0.000	13.72
14.000	13.11
62.000	8.38
75.000	3.43

Table 5-6 LHGR Limits for Lattices 181, 185, 186, 187, and 189
(Reference 3)

Rod Nodal Exposure (GWd/MTU)	LHGR Limit (kW/ft)
0.000	13.72
14.000	13.11
23.000	12.22
57.000	8.87
62.000	8.38
75.000	3.43

Table 5-7 LHGR Limits for Lattices 171, 172, 173, 174, 178, 179, 180, 183, and 188
(Reference 3)

Rod Nodal Exposure (GWd/MTU)	LHGR Limit (kW/ft)
0.000	13.72
14.000	13.11
19.500	12.56
19.501	12.44
23.000	12.09
34.000	11.01
34.001	11.13
57.000	8.87
62.000	8.38
75.000	3.43

Table 5-8 LHGR Limits for Lattices 176, 177, and 184
(Reference 3)

Rod Nodal Exposure (GWd/MTU)	LHGR Limit (kW/ft)
0.000	13.72
14.000	13.11
18.500	12.66
18.501	12.41
23.000	11.97
41.000	10.23
41.001	10.44
57.000	8.87
62.000	8.38
75.000	3.43

Table 5-9 LHGR Limits for Lattices 175 and 182
(Reference 3)

Rod Nodal Exposure (GWd/MTU)	LHGR Limit (kW/ft)
0.000	13.72
13.999	13.11
14.000	12.71
23.000	11.85
36.000	10.60
36.001	10.93
57.000	8.87
62.000	8.38
75.000	3.43

Table 5-10 Power-Dependent LHGR Multipliers
(Reference 3)

EOOS Combination	Core Thermal Power (% of rated)							
	0	25	≤ 38.5	> 38.5	50	60	80	100
	LHGR Multiplier							
Base	0.53	0.63	0.68	0.75	0.80	0.84	0.89	1.00
Base SLO								
PLUOOS	0.53	0.63	0.68	0.68	0.72	0.81	0.87	1.00
PLUOOS SLO								
TBVOOS	0.33	0.46	0.53	0.69	0.72	0.74	0.78	1.00
TBVOOS SLO								
TCV Slow Closure	0.53	0.63	0.68	0.68	0.72	0.80	0.87	1.00
TCV Slow Closure SLO								
TCV Stuck Closed	0.53	0.63	0.68	0.75	0.80	0.84	0.89	1.00
TCV Stuck Closed SLO								

Table 5-11 Flow-Dependent LHGR Multipliers
(Reference 3)

Flow (% of rated)	LHGR Multiplier
0	0.27
20	0.43
40	0.60
60	0.80
80	1.00
100	1.00
108	1.00

6. Control Rod Block Setpoints

Technical Specification Sections 3.3.2.1 and 3.4.1

The rod block monitor upscale instrumentation setpoints are determined from the relationships shown in Table 6-1:

Table 6-1 RBM Allowable Values
(Reference 20)

ROD BLOCK MONITOR UPSCALE TRIP FUNCTION	ALLOWABLE VALUE
Two Recirculation Loop Operation	$0.65 W_d + 56.1\%$
Single Recirculation Loop Operation	$0.65 W_d + 51.4\%$

The setpoint may be lower/higher and will still comply with the RWE analysis because RWE is analyzed unblocked (Reference 4).

W_d – percent of recirculation loop drive flow required to produce a rated core flow of 98 Mlb/hr.

7. Stability Protection Setpoints

Technical Specification Section 3.3.1.3

The OPRM PBDA trip settings are given in Table 7-1.

Table 7-1 OPRM PBDA Trip Settings
(Reference 3)

PBDA Trip Amplitude Setpoint (Sp)	Corresponding Maximum Confirmation Count Setpoint (Np)
1.14	16

The PBDA settings are the only OPRM settings credited in the safety analysis as documented in the licensing basis for the OPRM system. (Methodology Reference 11)

The OPRM PBDA trip settings are based, in part, on the cycle specific OLMCPR and the power/flow-dependent MCPR limits. Any change to the OLMCPR values and/or the power/flow-dependent MCPR limits should be evaluated for potential impact on the OPRM PBDA trip settings.

The OPRM PBDA trip settings are applicable when the OPRM system is declared operable, and the associated Technical Specifications are implemented.

8. Modes of Operation

The allowed modes of operation with combinations of equipment out-of-service are described in Table 8-1 below:

Table 8-1 Allowed Modes of Operation and EOOS Conditions
(Reference 3)

EOOS Options	Thermal Limit Sets
Base	Base (DLO or SLO)
PLUOOS	PLUOOS (DLO or SLO)
TBVOOS	TBVOOS (DLO or SLO)
TCV Slow Closure	TCV Slow Closure (DLO or SLO)
TCV Stuck Closed *	Base (DLO or SLO) ** See Table 8-2 for power restrictions.
PCOOS	PLUOOS (DLO or SLO)
PCOOS and PLUOOS	PLUOOS (DLO or SLO)
PCOOS and TCV Slow Closure	TCV Slow Closure (DLO or SLO)
PCOOS and one TCV Stuck Closed *	PLUOOS (DLO or SLO) See Table 8-2 for power restrictions.
PLUOOS and one TCV Stuck Closed *	PLUOOS (DLO or SLO) See Table 8-2 for power restrictions.

* Also applicable to one TSV stuck closed or one TCV and TSV stuck closed in the same line (Reference 3).
** EOOS condition TCV Stuck Closed has identical thermal limits as the Base Case. Therefore, this condition will use the Base Case thermal limit set.

Common Notes – Applicable to Base Case and all EOOS Combinations for DLO/SLO:

1. All modes are allowed for operation at MELLLA, ICF (up to 108% rated core flow), and coastdown subject to the power restrictions in Table 8-2 (Reference 3). Either EOC must be reached or coastdown must begin prior to exceeding 16797 MWd/MTU. The licensing analysis remains valid down to a coastdown power level of 70% given all burnup limits are satisfied per Methodology Reference 1. Each OOS Option may be combined with each of the following conditions:

    - Up to 16 TIP channel traces and 2 common channel traces may be substituted using the SUBTIP methodology (Reference 15) provided the requirements for utilizing SUBTIP methodology are met as clarified in Reference 14.
    - Up to 50% of the LPRMs OOS. (Reference 15)
    - An LPRM calibration frequency of up to 2500 EFPH (2000 EFPH + 25%). (Reference 15)

2. Nominal FWT results are valid for application within a +10°F/-30°F temperature band around the nominal FWT (nominal FWT curve is contained in Reference 4) and operating steam dome pressure region bounded by the maximum value of 1020 psia and the minimum pressure curve in Reference 4. (Reference 3)

3. For operation outside of Nominal FWT, FWTR results are valid for the minimum FWT curve (i.e., the -120°F curve in Reference 4) and support a feedwater temperature reduction of up to 120°F for Base and all EOOS DLO/SLO conditions for cycle operation through EOC subject to the restriction in Reference 16 for feedwater temperature reductions of greater than 100°F. The restriction requires that for a FWT reduction greater than 100°F, operation needs to be restricted to less than the 100% rod line. For a feedwater temperature reduction of between 30°F and 120°F, the FWTR limits should be applied.

4. All analyses support the fastest TBV (assumed to be #1) OOS, with the remaining 8 TBVs meeting the assumed opening profile in Reference 17. The analyses also assume a minimum turbine bypass flow of 3.467 Mlb/hr steam flow, equivalent to one TBV out of service (or partially closed TBVs equivalent to one closed TBV), with the assumed opening profile for the remaining TBVs met. If the opening profile is **NOT** met, or if the TBV system **CANNOT** pass an equivalent of 3.467 Mlb/hr steam flow, utilize the TBVOOS condition. (Reference 3)

5. If any TBVs are OOS in the pressure control mode, the maximum steam flow removal capability for pressure control needs to be evaluated to ensure that at least the equivalent of two turbine bypass valves are available for pressure control (Reference 3). The DEHC system opens bypass valves sequentially for pressure control, and the total number allowed to open is limited by the MCFL setting. See calculation QDC-5650-I-1598 (Reference 19) for the relationship between MCFL "Limit Ref" setpoint and the number of bypass valves allowed to open in pressure control. Note that the MCFL is a limit on valve position demand, and not on actual valve position. In other words, DEHC does not receive feedback on valve position when limiting demand per the MCFL, therefore inoperable bypass valves requested to open prior to reaching the MCFL will reduce total steam flow capability. If this condition **CANNOT** be met, enter Technical Specification LCO 3.2.2 and 3.2.3.

6. A single MSIV may be taken OOS (shut) under any of the specified OOS options as long as core thermal power is maintained $\leq$ 2218 MWt. (Reference 3)

7. Between 25% and 50% of rated thermal power the PLUOOS thermal limits must be used if the protective relaying is out of service, such that a load reject event will not result in a turbine trip. (Reference 3)

Table 8-2 Core Thermal Power Restriction for OOS Conditions
(Reference 3)

EOOS Condition	Core Thermal Power (MWt)
One TCV Stuck Closed *, PCOOS and one TCV Stuck Closed *, PLUOOS and one TCV Stuck Closed *	$\leq$ 2366**

* Also applicable to one TSV stuck closed or one TCV and TSV stuck closed in the same line (Reference 3).
** The 2366 MWt power restriction is conservatively set. Operation above 2366 MWt is analyzed and allowed, but may require raising the MCFL setpoint and/or increasing TBV availability to increase the available total reactor vessel steam flow capability as described in Reference 3.

9. 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. Westinghouse Topical Report CENPD-300-P-A, Revision 0, "Reference Safety Report for Boiling Water Reactor Reload Fuel," July 1996.
2. Westinghouse Topical Report CENPD-390-P-A, Revision 0, "The Advanced PHOENIX and POLCA Codes for Nuclear Design of Boiling Water Reactors," December 2000.
3. Westinghouse Report WCAP-16081-P-A, Revision 0, "10x10 SVEA Fuel Critical Power Experiments and CPR Correlation: SVEA-96 Optima2," March 2005.
4. Westinghouse Topical Report WCAP-16081-P-A Addendum 1-A, Revision 0, "SVEA-96 Optima2 CPR Correlation (D4): High and Low Flow Applications," March 2009.
5. Westinghouse Topical Report WCAP-16081-P-A Addendum 2-A, Revision 0, "SVEA-96 Optima2 CPR Correlation (D4): Modified R-factors for Part-Length Rods," February 2009.
6. Westinghouse Topical Report WCAP-15682-P-A, Revision 0, "Westinghouse BWR ECCS Evaluation Model: Supplement 2 to Code Description, Qualification and Application," April 2003.
7. Westinghouse Topical Report WCAP-16078-P-A, Revision 0, "Westinghouse BWR ECCS Evaluation Model: Supplement 3 to Code Description, Qualification and Application to SVEA-96 Optima2 Fuel," November 2004.
8. Westinghouse Topical Report WCAP-15836-P-A, Revision 0, "Fuel Rod Design Methods for Boiling Water Reactors – Supplement 1," April 2006.
9. Westinghouse Topical Report WCAP-15942-P-A, Revision 0, "Fuel Assembly Mechanical Design Methodology for Boiling Water Reactors, Supplement 1 to CENPD-287," March 2006.
10. Westinghouse Topical Report, WCAP-16865-P-A, Revision 1, "Westinghouse BWR ECCS Evaluation Model Updates: Supplement 4 to Code Description, Qualification and Application," October 2011.
11. GE Topical Report NEDO-32465-A, Revision 0, "Reactor Stability Detect and Suppress Solutions Licensing Basis Methodology for Reload Applications," August 1996.
12. GE Topical Report, NEDE-24011-P-A-14, "General Electric Standard Application for Reactor Fuel," June 2000.

10. References

1. Exelon Generation Company, LLC and MidAmerican Energy Company Docket No. 50-254, Quad Cities Nuclear Power Station, Unit 1 Renewed Facility Operating License, License No. DPR-29.
2. Deleted.
3. Westinghouse Document, NF-BEX-15-2, Revision 0, "Quad Cities Nuclear Power Station Unit 1 Cycle 24 Reload Licensing Report," January 2015.
4. Westinghouse Document, NF-BEX-15-1, Revision 0, "Quad Cities Nuclear Power Station Unit 1 Cycle 24 Reload Engineering Report," January 2015.
5. Westinghouse Document, NF-BEX-14-135-NP, Revision 1, "Quad Cities Nuclear Power Station Unit 1 Cycle 24 Supplemental MAPLHGR Report," October 2015.
6. Westinghouse Document, NF-BEX-12-188-NP, Revision 0, "Quad Cities Nuclear Power Station Unit 1 Cycle 23 MAPLHGR Report," January 2013.
7. Westinghouse Document, NF-BEX-11-9-NP, Revision 1, "Quad Cities Nuclear Power Station Unit 1 Cycle 22 MAPLHGR Report," October 2014.
8. Westinghouse Document, NF-BEX-09-17-NP, Revision 1, "Quad Cities Nuclear Power Station Unit 1 Cycle 21 MAPLHGR Report," October 2014.
9. Westinghouse Letter, NF-BEX-14-98, Revision 0, "Bundle Design Report for Quad Cities 1 Cycle 24," August 5, 2014.
10. Westinghouse Letter, NF-BEX-12-120, Revision 0, "Bundle Design Report for Quad Cities 1 Cycle 23," September 4, 2012.
11. Westinghouse Letter, NF-BEX-10-162, Revision 1, "Rev. 1 Bundle Design Report for Quad Cities 1 Cycle 22," November 18, 2010.
12. Westinghouse Letter, NF-BEX-08-129, Revision 1, "Final Report for Quad Cities 1 Cycle 21 Bundle Designs Revision 1," November 6, 2008.
13. Technical Specifications for Quad Cities 1 and 2, Table 3.1.4-1, "Control Rod Scram Times".
14. FANP Letter, NJC:04:031/FAB04-496, "Startup with TIP Equipment Out of Service," April 20, 2004. (Exelon Engineering Evaluation EC 348897-000)
15. Exelon Engineering Evaluation EC 357691-000, "EVALUATION OF APPROPRIATE UNCERTAINTIES FOR USE BY WESTINGHOUSE IN SAFETY LIMIT MCPR ANALYSES", November 28, 2005.
16. Exelon Letter, NF-MW:02-0081, "Approval of GE Evaluation of Dresden and Quad Cities Extended Final Feedwater Temperature Reduction," Carlos de la Hoz to Doug Wise and Alex Misak, August 27, 2002.
17. Exelon TODI, QDC-14-022, Revision 0, "Operating Parameters List - Westinghouse (OPL-W) for Quad Cities Unit 1 Cycle 24 Transient Analysis," June 26, 2014.
18. Westinghouse Document, NF-BEX-13-2, Revision 0, "Quad Cities Nuclear Power Station Unit 1 Cycle 23 Reload Licensing Report," January 2013.
19. Exelon Design Analysis, QDC-5650-I-1598, Revision 1, "Digital EHC Controller Settings for Maximum Combined Flow Limit (MCFL)," November 10, 2015.
20. GE Document, GE DRF C51-00217-01, "Instrument Setpoint Calculation Nuclear Instrumentation, Rod Block Monitor, Commonwealth Edison Company, Quad Cities 1 & 2," December 14, 1999. (Attachment A to Exelon Design Analysis, QDC-0700-I-1419, Revision 0)