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U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

Quad Cities Nuclear Power Station, Unit 2
Renewed Facility Operating License No. DPR-30
NRC Docket No. 50-265

Subject: Core Operating Limits Report for Quad Cities Unit 2 Cycle 21

Quad Cities Nuclear Power Station Unit 2 was shutdown for Refuel Outage 20 (Q2R20) on March 15, 2010. In accordance with Technical Specifications Section 5.6.5.d, enclosed is the Core Operating Limits Report (COLR) for Quad Cities Unit 2 Cycle 21.

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

Respectfully,

Timothy J. Tulon
Site Vice President
Quad Cities Nuclear Power Station

Enclosure: Core Operating Limits Report for Quad Cities Unit 2 Cycle 21

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

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NRR

Enclosure

Core Operating Limits Report

for

Quad Cities Unit 2 Cycle 21

Core Operating Limits Report

For

Quad Cities Unit 2 Cycle 21

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List of Tables

1. Terms and Definitions

APLHGR	Average planar linear heat generation rate
ASD	Adjustable Speed Drive
CTP	Core Thermal Power
DLO	Dual loop operation
EFPH	Effective full power hours
EOC	End of cycle
EOOS	Equipment out of service
FWHOOS	Feedwater heater out of service
FWT	Feedwater temperature
FWTR	Feedwater temperature reduction
ICF	Increased core flow
ISS	Intermediate scram speed
LHGR	Linear heat generation rate
LHGRFAC(F)	Flow-dependent LHGR multiplier
LHGRFAC(P)	Power-dependent LHGR multiplier
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
MSIV	Main steam isolation valve
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
PCOOS	Pressure Controller Out of Service
PLUOOS	Power load unbalance out of service
RBM	Rod block monitor
RWE	Rod withdrawal error
SLO	Single Loop Operation
TBV	Turbine bypass valve
TBVOOS	Turbine bypass valves out of service
TCV	Turbine control valve
TIP	Traversing incore probe
TSSS	Technical Specification scram speed
TSV	Turbine stop valve

2. General Information

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

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

Coastdown operation is defined as cycle exposure beyond the full power, full flow, and all rods out condition with the plant power gradually reducing as available core reactivity diminishes.

MCPR(P) and MCPR(F) values are independent of scram time.

LHGRFAC(P) and LHGRFAC(F) values are independent of scram speed and feedwater temperature.

All thermal limits are analyzed to either NSS, ISS, or TSSS. Only MCPR limits vary with scram speed.

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

3. Average Planar Linear Heat Generation Rate

Lattice-specific MAPLHGR values for DLO and all EOOS conditions except SLO are provided in Tables 3-2 through 3-33. During single loop operation, these limits are multiplied by the EOOS multiplier listed in Table 3-1.

Table 3-1 MAPLHGR SLO multiplier
(Reference 3)

EOOS Condition	Multiplier
SLO	0.86

Table 3-2 MAPLHGR for Lattices 91 and 98
(Reference 3, 4, 6, and 8)

All Bundles Lattices 91 and 98	
Avg. Planar Exposure (GWd/MT)	**DLO MAPLHGR (kW/ft)**
0.0	7.50
72.0	7.50

Table 3-3 MAPLHGR for Lattices 92 and 93
(References 4 and 5)

Bundle Opt2-3.89-16GZ8.00-2G6.00 Lattices 92: Opt2-B4.27-16G8.00-2G6.00 93: Opt2-BE4.38-14G8.00-2G6.00	
Avg. Planar Exposure (GWd/MT)	**DLO MAPLHGR (kW/ft)**
0.0	9.43
7.5	9.10
17.5	9.10
24.0	9.55
58.0	9.55
70.0	8.18

Table 3-4 MAPLHGR for Lattices 94 and 95
(References 4 and 5)

Bundle Opt2-3.89-16GZ8.00-2G6.00 Lattices 94: Opt2-M4.38-14G8.00-2G6.00 95: Opt2-ME4.35-12G8.00-2G6.00	
Avg. Planar Exposure (GWd/MT)	**DLO MAPLHGR (kW/ft)**
0.0	9.74
7.5	9.30
17.5	9.30
24.0	9.68
58.0	9.68
70.0	8.31

Table 3-5 MAPLHGR for Lattices 96 and 97
(References 4 and 5)

Bundle Opt2-3.89-16GZ8.00-2G6.00 Lattices 96: Opt2-T4.35-12G8.00-2G6.00 97: Opt2-T4.35-14G6.00	
Avg. Planar Exposure (GWd/MT)	**DLO MAPLHGR (kW/ft)**
0.0	10.31
7.5	9.64
17.5	9.64
24.0	9.96
58.0	9.96
70.0	8.59

Table 3-6 MAPLHGR for Lattices 99 and 100
(References 4 and 5)

Bundle Opt2-3.94-13GZ7.00-2G6.00 Lattices 99: Opt2-B4.33-13G7.00-2G6.00 100: Opt2-BE4.43-12G7.00-2G6.00	
Avg. Planar Exposure (GWd/MT)	**DLO MAPLHGR (kW/ft)**
0.0	9.82
10.0	9.50
58.0	9.50
70.0	8.12

Table 3-7 MAPLHGR for Lattices 101 and 102
(References 4 and 5)

Bundle Opt2-3.94-13GZ7.00-2G6.00 Lattices 101: Opt2-M4.43-12G7.00-2G6.00 102: Opt2-ME4.40-10G7.00-2G6.00	
Avg. Planar Exposure (GWd/MT)	**DLO MAPLHGR (kW/ft)**
0.0	10.22
10.0	9.64
58.0	9.64
70.0	8.27

Table 3-8 MAPLHGR for Lattice 103
(References 4 and 5)

Bundle Opt2-3.94-13GZ7.00-2G6.00 Lattice 103: Opt2-T4.40-10G7.00-2G6.00	
Avg. Planar Exposure (GWd/MT)	**DLO MAPLHGR (kW/ft)**
0.0	10.84
10.0	9.95
58.0	9.95
70.0	8.58

Table 3-9 MAPLHGR for Lattice 104
(References 6 and 7)

Bundle Opt2-3.99-15GZ8.00-3G6.00 Lattice 104: Opt2-B4.40-13G8.00-3G6.00	
Avg. Planar Exposure (GWd/MT)	**DLO MAPLHGR (kW/ft)**
0.0	9.52
7.5	9.25
17.5	9.25
24.0	9.47
58.0	9.47
70.0	8.10

Table 3-10 MAPLHGR for Lattice 105
(References 6 and 7)

Bundle Opt2-3.99-15GZ8.00-3G6.00 Lattice 105: Opt2-B4.38-15G8.00-3G6.00	
Avg. Planar Exposure (GWd/MT)	**DLO MAPLHGR (kW/ft)**
0.0	9.28
7.5	9.12
17.5	9.12
24.0	9.48
58.0	9.48
70.0	8.11

Table 3-11 MAPLHGR for Lattices 106 and 107
(References 6 and 7)

Bundle Opt2-3.99-15GZ8.00-3G6.00 Lattices 106: Opt2-BE4.47-15G8.00-3G6.00 107: Opt2-M4.47-15G8.00-3G6.00	
Avg. Planar Exposure (GWd/MT)	**DLO MAPLHGR (kW/ft)**
0.0	9.39
7.5	9.18
17.5	9.18
24.0	9.60
58.0	9.60
70.0	8.22

Table 3-12 MAPLHGR for Lattices 108 and 109
(References 6 and 7)

Bundle Opt2-3.99-15GZ8.00-3G6.00 Lattices 108: Opt2-ME4.46-11G8.00-3G6.00 109: Opt2-T4.46-11G8.00-3G6.00	
Avg. Planar Exposure (GWd/MT)	**DLO MAPLHGR (kW/ft)**
0.0	10.17
7.5	9.68
17.5	9.68
24.0	9.87
58.0	9.87
70.0	8.50

Table 3-13 MAPLHGR for Lattice 110
(References 6 and 7)

Bundle Opt2-3.99-15GZ8.00-3G6.00 Lattice 110: Opt2-T4.46-14G6.00	
Avg. Planar Exposure (GWd/MT)	**DLO MAPLHGR (kW/ft)**
0.0	10.24
7.5	9.79
58.0	9.79
70.0	8.41

Table 3-14 MAPLHGR for Lattice 111
(References 6 and 7)

Bundle Opt2-4.05-12GZ7.00-2G6.00 Lattice 111: Opt2-B4.44-12G7.00-2G6.00	
Avg. Planar Exposure (GWd/MT)	**DLO MAPLHGR (kW/ft)**
0.0	9.92
10.0	9.54
58.0	9.54
70.0	8.16

Table 3-15 MAPLHGR for Lattices 112 and 113
(References 6 and 7)

Bundle Opt2-4.05-12GZ7.00-2G6.00 Lattices 112: Opt2-BE4.55-10G7.00-2G6.00 113: Opt2-M4.55-10G7.00-2G6.00	
Avg. Planar Exposure (GWd/MT)	**DLO MAPLHGR (kW/ft)**
0.0	10.35
10.0	9.71
58.0	9.71
70.0	8.33

Table 3-16 MAPLHGR for Lattices 114 and 115
(References 6 and 7)

Bundle Opt2-4.05-12GZ7.00-2G6.00 Lattice 114: Opt2-ME4.51-10G7.00-2G6.00 115: Opt2-T4.51-10G7.00-2G6.00	
Avg. Planar Exposure (GWd/MT)	**DLO MAPLHGR (kW/ft)**
0.0	10.69
10.0	9.92
58.0	9.92
70.0	8.55

Table 3-17 MAPLHGR for Lattice 116
(References 3 and 8)

Bundle Opt2-4.02-14GZ8.00-4GZ5.50-14GZ5.50 Lattice 116: Opt2-B4.43-14G8.00-4G5.50	
Avg. Planar Exposure (GWd/MT)	**DLO MAPLHGR (kW/ft)**
0.0	8.55
2.5	8.75
5.0	8.89
7.5	8.99
10.0	9.04
12.0	9.10
15.0	9.24
17.0	9.29
20.0	9.38
22.0	9.49
24.0	9.61
30.0	9.56
36.0	9.52
42.0	9.53
50.0	9.51
60.0	9.48
72.0	9.71

Table 3-18 MAPLHGR for Lattice 117
(References 3 and 8)

Bundle Opt2-4.02-14GZ8.00-4GZ5.50-14GZ5.50 Lattice 117: Opt2-BE4.52-14G8.00-4G5.50	
Avg. Planar Exposure (GWd/MT)	**DLO MAPLHGR (kW/ft)**
0.0	8.59
2.5	8.78
5.0	8.95
7.5	9.05
10.0	9.12
12.0	9.19
15.0	9.33
17.0	9.38
20.0	9.48
22.0	9.60
24.0	9.73
30.0	9.65
36.0	9.61
42.0	9.60
50.0	9.56
60.0	9.52
72.0	9.76

Table 3-19 MAPLHGR for Lattice 118
(References 3 and 8)

Bundle Opt2-4.02-14GZ8.00-4GZ5.50-14GZ5.50 Lattice 118: Opt2-M4.52-14G8.00-4G5.50	
Avg. Planar Exposure (GWd/MT)	**DLO MAPLHGR (kW/ft)**
0.0	8.57
2.5	8.76
5.0	8.94
7.5	9.06
10.0	9.12
12.0	9.21
15.0	9.34
17.0	9.39
20.0	9.49
22.0	9.61
24.0	9.72
30.0	9.65
36.0	9.60
42.0	9.58
50.0	9.54
60.0	9.51
72.0	9.76

Table 3-20 MAPLHGR for Lattice 119
(References 3 and 8)

Bundle Opt2-4.02-14GZ8.00-4GZ5.50-14GZ5.50 Lattice 119: Opt2-ME4.48-14G8.00-4G5.50	
Avg. Planar Exposure (GWd/MT)	**DLO MAPLHGR (kW/ft)**
0.0	8.69
2.5	8.89
5.0	9.07
7.5	9.22
10.0	9.28
12.0	9.37
15.0	9.53
17.0	9.59
20.0	9.80
22.0	9.93
24.0	9.93
30.0	9.87
36.0	9.81
42.0	9.73
50.0	9.67
60.0	9.68
72.0	10.03

Table 3-21 MAPLHGR for Lattice 120
(References 3 and 8)

Bundle Opt2-4.02-14GZ8.00-4GZ5.50-14GZ5.50 Lattice 120: Opt2-T4.48-14G8.00-4G5.50	
Avg. Planar Exposure (GWd/MT)	**DLO MAPLHGR (kW/ft)**
0.0	8.73
2.5	8.93
5.0	9.09
7.5	9.19
10.0	9.23
12.0	9.31
15.0	9.47
17.0	9.57
20.0	9.83
22.0	9.90
24.0	9.91
30.0	9.85
36.0	9.79
42.0	9.69
50.0	9.64
60.0	9.66
72.0	10.03

Table 3-22 MAPLHGR for Lattice 121
(References 3 and 8)

Bundles Opt2-4.02-14GZ8.00-4GZ5.50-14GZ5.50 Opt2-4.04-14GZ8.00-2GZ5.50-14GZ5.50 Lattice 121: Opt2-T4.50-14G5.50	
Avg. Planar Exposure (GWd/MT)	**DLO MAPLHGR (kW/ft)**
0.0	9.48
2.5	9.61
5.0	9.65
7.5	9.58
10.0	9.50
12.0	9.53
15.0	9.81
17.0	9.98
20.0	10.00
22.0	9.98
24.0	9.96
30.0	9.88
36.0	9.82
42.0	9.80
50.0	9.74
60.0	9.74
72.0	10.10

Table 3-23 MAPLHGR for Lattice 122
(References 3 and 8)

Bundle Opt2-4.04-14GZ8.00-2GZ5.50-14GZ5.50 Lattice 122: Opt2-B4.44-14G8.00-2G5.50	
Avg. Planar Exposure (GWd/MT)	**DLO MAPLHGR (kW/ft)**
0.0	8.82
2.5	8.98
5.0	9.08
7.5	9.12
10.0	9.12
12.0	9.15
15.0	9.26
17.0	9.30
20.0	9.38
22.0	9.48
24.0	9.60
30.0	9.54
36.0	9.50
42.0	9.50
50.0	9.51
60.0	9.48
72.0	9.71

Table 3-24 MAPLHGR for Lattice 123
(References 3 and 8)

Bundle Opt2-4.04-14GZ8.00-2GZ5.50-14GZ5.50 Lattice 123: Opt2-BE4.53-14G8.00-2G5.50	
Avg. Planar Exposure (GWd/MT)	**DLO MAPLHGR (kW/ft)**
0.0	8.87
2.5	9.02
5.0	9.14
7.5	9.19
10.0	9.20
12.0	9.23
15.0	9.34
17.0	9.38
20.0	9.47
22.0	9.59
24.0	9.70
30.0	9.63
36.0	9.59
42.0	9.59
50.0	9.56
60.0	9.52
72.0	9.76

Table 3-25 MAPLHGR for Lattice 124
(References 3 and 8)

Bundle Opt2-4.04-14GZ8.00-2GZ5.50-14GZ5.50 Lattice 124: Opt2-M4.53-14G8.00-2G5.50	
Avg. Planar Exposure (GWd/MT)	**DLO MAPLHGR (kW/ft)**
0.0	8.86
2.5	9.01
5.0	9.13
7.5	9.20
10.0	9.21
12.0	9.25
15.0	9.35
17.0	9.39
20.0	9.48
22.0	9.60
24.0	9.69
30.0	9.63
36.0	9.58
42.0	9.57
50.0	9.53
60.0	9.51
72.0	9.77

Table 3-26 MAPLHGR for Lattice 125
(References 3 and 8)

Bundle Opt2-4.04-14GZ8.00-2GZ5.50-14GZ5.50 Lattice 125: Opt2-ME4.49-14G8.00-2G5.50	
Avg. Planar Exposure (GWd/MT)	**DLO MAPLHGR (kW/ft)**
0.0	9.00
2.5	9.17
5.0	9.29
7.5	9.38
10.0	9.37
12.0	9.43
15.0	9.53
17.0	9.59
20.0	9.78
22.0	9.90
24.0	9.90
30.0	9.85
36.0	9.80
42.0	9.72
50.0	9.67
60.0	9.68
72.0	10.03

Table 3-27 MAPLHGR for Lattice 126
(References 3 and 8)

Bundle Opt2-4.04-14GZ8.00-2GZ5.50-14GZ5.50 Lattice 126: Opt2-T4.49-14G8.00-2G5.50	
Avg. Planar Exposure (GWd/MT)	**DLO MAPLHGR (kW/ft)**
0.0	9.04
2.5	9.21
5.0	9.31
7.5	9.35
10.0	9.32
12.0	9.37
15.0	9.48
17.0	9.56
20.0	9.80
22.0	9.87
24.0	9.89
30.0	9.83
36.0	9.78
42.0	9.68
50.0	9.64
60.0	9.66
72.0	10.03

Table 3-28 MAPLHGR for Lattice 127
(References 3 and 8)

Bundle Opt2-4.07-14G5.50-2GZ5.50 Lattice 127: Opt2-B4.48-16G5.50	
Avg. Planar Exposure (GWd/MT)	**DLO MAPLHGR (kW/ft)**
0.0	8.81
2.5	8.96
5.0	9.10
7.5	9.15
10.0	9.16
12.0	9.18
15.0	9.34
17.0	9.48
20.0	9.64
22.0	9.68
24.0	9.67
30.0	9.58
36.0	9.52
42.0	9.53
50.0	9.59
60.0	9.56
72.0	9.76

Table 3-29 MAPLHGR for Lattice 128
(References 3 and 8)

Bundle Opt2-4.07-14G5.50-2GZ5.50 Lattice 128: Opt2-BE4.57-16G5.50	
Avg. Planar Exposure (GWd/MT)	**DLO MAPLHGR (kW/ft)**
0.0	8.86
2.5	9.01
5.0	9.16
7.5	9.21
10.0	9.22
12.0	9.26
15.0	9.44
17.0	9.59
20.0	9.76
22.0	9.78
24.0	9.76
30.0	9.67
36.0	9.62
42.0	9.61
50.0	9.66
60.0	9.60
72.0	9.81

Table 3-30 MAPLHGR for Lattice 129
(References 3 and 8)

Bundle Opt2-4.07-14G5.50-2GZ5.50 Lattice 129: Opt2-M4.57-16G5.50	
Avg. Planar Exposure (GWd/MT)	**DLO MAPLHGR (kW/ft)**
0.0	8.84
2.5	9.00
5.0	9.16
7.5	9.21
10.0	9.23
12.0	9.27
15.0	9.45
17.0	9.61
20.0	9.77
22.0	9.78
24.0	9.76
30.0	9.66
36.0	9.61
42.0	9.61
50.0	9.64
60.0	9.59
72.0	9.81

Table 3-31 MAPLHGR for Lattice 130
(References 3 and 8)

Bundle Opt2-4.07-14G5.50-2GZ5.50 Lattice 130: Opt2-ME4.54-16G5.50	
Avg. Planar Exposure (GWd/MT)	**DLO MAPLHGR (kW/ft)**
0.0	9.00
2.5	9.16
5.0	9.31
7.5	9.40
10.0	9.39
12.0	9.48
15.0	9.75
17.0	9.94
20.0	10.02
22.0	10.00
24.0	9.98
30.0	9.88
36.0	9.82
42.0	9.83
50.0	9.81
60.0	9.77
72.0	10.08

Table 3-32 MAPLHGR for Lattice 131
(References 3 and 8)

Bundle Opt2-4.07-14G5.50-2GZ5.50 Lattice 131: Opt2-T4.54-16G5.50	
Avg. Planar Exposure (GWd/MT)	**DLO MAPLHGR (kW/ft)**
0.0	9.03
2.5	9.19
5.0	9.33
7.5	9.35
10.0	9.35
12.0	9.41
15.0	9.75
17.0	9.95
20.0	10.00
22.0	9.99
24.0	9.97
30.0	9.87
36.0	9.81
42.0	9.82
50.0	9.79
60.0	9.75
72.0	10.08

Table 3-33 MAPLHGR for Lattice 132
(References 3 and 8)

Bundle Opt2-4.07-14G5.50-2GZ5.50 Lattice 132: Opt2-T4.55-14G5.50	
Avg. Planar Exposure (GWd/MT)	**DLO MAPLHGR (kW/ft)**
0.0	9.39
2.5	9.51
5.0	9.60
7.5	9.57
10.0	9.49
12.0	9.51
15.0	9.76
17.0	9.94
20.0	10.01
22.0	10.00
24.0	9.98
30.0	9.89
36.0	9.83
42.0	9.82
50.0	9.79
60.0	9.75
72.0	10.09

4. Operating Limit Minimum Critical Power Ratio

4.1. Manual Flow Control MCPR Limits

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

4.1.1. Power - Dependent MCPR

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 MCPR 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 higher of either of the two methods evaluated at 38.5% of rated core thermal power.

4.1.2. Flow - Dependent MCPR

Table 4-7 gives the MCPR(F) limit as a function of the flow based on the applicable plant condition. The MCPR(F) limit determined from this table is the flow-dependent OLMCPR.

4.2. Automatic Flow Control MCPR Limits

Automatic flow control MCPR limits are not provided.

4.3. Scram Time

TSSS, ISS, and NSS refer to scram speeds. The scram time values 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 12). 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 MCPR 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 MCPR 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 MCPR 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 average control rod insertion time of all operable control rods based on the sum of the most recent scram time data divided by the number of operable drives. The time for inoperable drives (notch 00) can be conservatively included for calculation of core average scram speed.

Table 4-1 Scram Times
(References 3, 12, and 14)

Control Rod Insertion Fraction (%)	TSSS (seconds)	ISS (seconds)	NSS (seconds)
5	0.480	0.360	0.324
20	0.890	0.720	0.694
50	1.980	1.580	1.510
90	3.440	2.800	2.670

4.4. Recirculation Pump ASD Settings

Cycle 21 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 9). 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 Cycle Exposure (MWd/MTU)		FWTR Cycle Exposure (MWd/MTU)	
	≤14,000	>14,000	≤14,000	>14,000
Base	1.68	1.74	1.68	1.74
Base SLO	1.72	1.78	1.72	1.78
PLUOOS	1.72	1.77	1.72	1.77
PLUOOS SLO	1.76	1.81	1.76	1.81
TBVOOS	1.85	1.87	1.86	1.87
TBVOOS SLO	1.89	1.91	1.90	1.91
TCV Slow Closure	1.77	1.80	1.77	1.80
TCV Slow Closure SLO	1.81	1.84	1.81	1.84
TCV Stuck Closed	1.68	1.74	1.68	1.74
TCV Stuck Closed SLO	1.72	1.78	1.72	1.78

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

EOOS Combination	Nominal FWT Cycle Exposure (MWd/MTU)		FWTR Cycle Exposure (MWd/MTU)	
	≤14,000	>14,000	≤14,000	>14,000
Base	1.44	1.48	1.48	1.50
Base SLO	1.47	1.51	1.51	1.53
PLUOOS	1.48	1.54	1.48	1.54
PLUOOS SLO	1.51	1.57	1.51	1.57
TBVOOS	1.56	1.61	1.60	1.64
TBVOOS SLO	1.59	1.64	1.63	1.67
TCV Slow Closure	1.50	1.55	1.50	1.55
TCV Slow Closure SLO	1.53	1.58	1.53	1.58
TCV Stuck Closed	1.44	1.48	1.48	1.50
TCV Stuck Closed SLO	1.47	1.51	1.51	1.53

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

EOOS Combination	Nominal FWT Cycle Exposure (MWd/MTU)		FWTR Cycle Exposure (MWd/MTU)	
	≤14,000	>14,000	≤14,000	>14,000
Base	1.43	1.45	1.47	1.49
Base SLO	1.46	1.48	1.50	1.52
PLUOOS	1.47	1.51	1.47	1.51
PLUOOS SLO	1.50	1.54	1.50	1.54
TBVOOS	1.55	1.58	1.58	1.61
TBVOOS SLO	1.58	1.61	1.61	1.64
TCV Slow Closure	1.47	1.53	1.47	1.53
TCV Slow Closure SLO	1.50	1.56	1.50	1.56
TCV Stuck Closed	1.43	1.45	1.47	1.49
TCV Stuck Closed SLO	1.46	1.48	1.50	1.52

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	41	60	80	100	102
		Operating Limit MCPR			Operating Limit MCPR Multiplier, Kp					
Base	≤60	2.71	2.30	2.08	1.33	1.29	1.13	1.05	1.00	1.00
	>60	2.77	2.49	2.34						
Base SLO	≤60	2.76	2.35	2.12						
	>60	2.82	2.54	2.39						
PLUOOS	≤60	2.71	2.30	2.08	1.57	1.55	1.33	1.06	1.00	1.00
	>60	2.77	2.49	2.34						
PLUOOS SLO	≤60	2.76	2.35	2.12						
	>60	2.82	2.54	2.39						
TBVOOS	≤60	3.94	2.97	2.45	1.33	1.29	1.13	1.05	1.00	1.00
	>60	4.07	3.21	2.75						
TBVOOS SLO	≤60	4.02	3.03	2.50						
	>60	4.15	3.27	2.80						
TCV Slow Closure	≤60	2.71	2.30	2.08	1.58	1.55	1.34	1.08	1.00	1.00
	>60	2.77	2.49	2.34						
TCV Slow Closure SLO	≤60	2.76	2.35	2.12						
	>60	2.82	2.54	2.39						
TCV Stuck Closed	≤60	2.71	2.30	2.08	1.33	1.29	1.14	1.06	1.00	1.00
	>60	2.77	2.49	2.34						
TCV Stuck Closed SLO	≤60	2.76	2.35	2.12						
	>60	2.82	2.54	2.39						

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	41	60	80	100	102
		Operating Limit MCPR			Operating Limit MCPR Multiplier, Kp					
Base	≤60	2.71	2.30	2.08	1.39	1.35	1.15	1.05	1.00	1.00
	>60	2.77	2.49	2.34						
Base SLO	≤60	2.76	2.35	2.12						
	>60	2.82	2.54	2.39						
PLUOOS	≤60	2.71	2.30	2.08	1.57	1.55	1.33	1.06	1.00	1.00
	>60	2.77	2.49	2.34						
PLUOOS SLO	≤60	2.76	2.35	2.12						
	>60	2.82	2.54	2.39						
TBVOOS	≤60	4.37	3.16	2.51	1.39	1.35	1.15	1.05	1.00	1.00
	>60	4.37	3.31	2.86						
TBVOOS SLO	≤60	4.45	3.22	2.56						
	>60	4.45	3.37	2.92						
TCV Slow Closure	≤60	2.71	2.30	2.08	1.58	1.55	1.34	1.08	1.00	1.00
	>60	2.77	2.49	2.34						
TCV Slow Closure SLO	≤60	2.76	2.35	2.12						
	>60	2.82	2.54	2.39						
TCV Stuck Closed	≤60	2.71	2.30	2.08	1.39	1.35	1.15	1.06	1.00	1.00
	>60	2.77	2.49	2.34						
TCV Stuck Closed SLO	≤60	2.76	2.35	2.12						
	>60	2.82	2.54	2.39						

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

Core Flow (% of rated)	DLO	SLO
0.0	1.98	2.02
100.0	1.38	1.41
110.0	1.38	1.41

5. Linear Heat Generation Rate

The thermal mechanical operating limit at rated conditions for the Optima2 fuel is established in terms of the maximum LHGR given in Table 5-1 as a function of rod nodal exposure. The limit applies to all Optima2 bundle designs.

The linear heat generation rate (LHGR) limit is the product of the exposure dependent LHGR limit from Table 5-1 and the minimum of: the power-dependent LHGR multiplier, LHGRFAC(P) or the flow-dependent LHGR multiplier, LHGRFAC(F) as applicable. The LHGRFAC(P) is determined from Table 5-2. For operation at exactly 38.5% of rated core thermal power, the LHGRFAC(P) as a function of core thermal power is the lower of either of the two multipliers evaluated at 38.5% of rated core thermal power. The LHGRFAC(F) is determined from Table 5-3, and is applicable for all EOOS conditions.

Table 5-1 LHGR Limit for All Bundles
(Reference 3)

Rod Nodal Exposure (GWd/MTU)	LHGR Limit (kW/ft)
0.0	13.11
14.0	13.11
72.0	6.48

Table 5-2 LHGRFAC(P)
(Reference 3)

EOOS Combination	Core Thermal Power (% of rated)								
	0	25	38.5	38.5	41	60	80	100	102
	LHGRFAC(P) Multiplier								
Base	0.49	0.62	0.69	0.72	0.74	0.83	0.88	1.00	1.00
Base SLO	0.49	0.62	0.69	0.72	0.74	0.83	0.88	1.00	1.00
PLUOOS	0.49	0.62	0.69	0.69	0.69	0.82	0.88	1.00	1.00
PLUOOS SLO	0.49	0.62	0.69	0.69	0.69	0.82	0.88	1.00	1.00
TBVOOS	0.31	0.44	0.51	0.69	0.70	0.78	0.78	1.00	1.00
TBVOOS SLO	0.31	0.44	0.51	0.69	0.70	0.78	0.78	1.00	1.00
TCV Slow Closure	0.49	0.62	0.69	0.69	0.69	0.82	0.87	1.00	1.00
TCV Slow Closure SLO	0.49	0.62	0.69	0.69	0.69	0.82	0.87	1.00	1.00
TCV Stuck Closed	0.49	0.62	0.69	0.72	0.74	0.83	0.88	1.00	1.00
TCV Stuck Closed SLO	0.49	0.62	0.69	0.72	0.74	0.83	0.88	1.00	1.00

Table 5-3 LHGRFAC(F)
(Reference 3)

Flow (% of rated)	LHGRFAC(F) Multiplier
0.0	0.27
20.0	0.43
40.0	0.60
60.0	0.80
80.0	1.00
100.0	1.00
110.0	1.00

6. Control Rod Block Setpoints

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

Table 6-1 RBM Upscale Setpoints
(Reference 10)

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 rod withdrawal error (RWE) analysis because RWE is analyzed unblocked.

The allowable value is clamped with a maximum value not to exceed the allowable value for a recirculation loop drive flow (W_d) of 100%.

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

7. Stability Protection Setpoints

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 is the only OPRM setting credited in the safety analysis as documented in the licensing basis for the OPRM system.

The OPRM PBDA trip settings are based, in part, on the cycle specific OLMCPR and the power-dependent MCPR limits. Any change to the OLMCPR values and/or the power-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 as described below:

EOOS Options	Thermal Limit Sets
Base	Base (DLO or SLO)
PLUOOS	PLUOOS (DLO or SLO)
TBVOOS	TBVOOS (DLO or SLO) ➢ See Table 8-1 for power restrictions
TCV Slow Closure	TCV Slow Closure (DLO or SLO)
TCV Stuck Closed	TCV Stuck Closed (DLO or SLO) ➢ Not applicable to combination of one TCV and one TSV Stuck Closed ➢ See Table 8-2 for power restrictions
TSV Stuck Closed	TCV Stuck Closed (DLO or SLO) ➢ Not applicable to combination of one TCV and one TSV Stuck Closed ➢ See Table 8-2 for power restrictions
PCOOS	TCV Slow Closure (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/TSV Stuck Closed	➢ Operation is only allowed at or below thermal power as specified in Table 8-2 and ➢ The more restrictive of the flow-dependent limits (established by one TCV/TSV Stuck Closed) and power-dependent limits (established by one TCV/TSV Stuck Closed, TCV Slow Closure and PLUOOS limits) apply.
PLUOOS and one TCV/TSV Stuck Closed	➢ Operation is only allowed at or below thermal power as specified in Table 8-2 and ➢ The more restrictive of the flow-dependent limits (established by one TCV/TSV Stuck Closed) and power-dependent limits (established by one TCV/TSV Stuck Closed, TCV Slow Closure and PLUOOS limits) apply.

Common Notes – Applicable to all EOOS Combinations

1. All modes are allowed for operation at MELLLA, ICF (up to 108%), and full power operation up to 16,188 MWd/MTU cycle exposure (Reference 3), subject to the restrictions in Tables 8-1 and 8-2. Each OOS Option may be combined with each of the following conditions:
   - A maximum of 18 TIP channels OOS provided the requirements (as clarified in Reference 13) for utilizing SUBTIP methodology are met.
   - Up to 50% LPRMs OOS
   - An LPRM calibration frequency of up to 2500 EFPH (2000 EFPH + 25%)

2. All analyses support the fastest Turbine Bypass Valve (assumed to be #1) OOS, with the remaining 8 Turbine Bypass Valves meeting the assumed opening profile in Reference 14 (Reference 3). The analyses also support Turbine Bypass flow of 29.6% of vessel rated steam flow, equivalent to one Turbine Bypass Valve OOS (or partially closed Turbine Bypass Valves equivalent to one closed Turbine Bypass Valve), if the assumed opening profile for the remaining Turbine Bypass Valves is met. If the opening profile is **NOT** met, or if the Turbine Bypass Valve system cannot pass an equivalent of 29.6% of vessel rated steam flow, utilize the TBVOOS condition.

3. For both Base and EOOS DLO/SLO conditions, for operation at Nominal FWT, the OLMCPR limit is applicable to a variation of +10°F/-30°F in feedwater temperature and an operating steam dome pressure region bounded by the maximum value of 1020 psia and the minimum pressure curve (Reference 9).

4. For operation outside of Nominal FWT, a feedwater temperature reduction of up to 120°F is supported for Base and EOOS DLO/SLO conditions for cycle operation through EOC subject to the restriction in Reference 11 for feedwater temperature reductions of greater than 100°F. The restriction is to maintain less than 100% rod line with a feedwater temperature reduction of greater than 100°F. This includes, but is not limited to, FWHOOS and final FWTR. For a feedwater temperature reduction of between 30°F and 120°F, the FWTR limits should be applied.

5. For all cases including TBVOOS, equivalent of 2 of the first 3.4 Turbine Bypass Valves must be capable of opening via the pressure control system while Turbine Bypass Valves #5-9 are allowed to be out of service. For all cases except TBVOOS, the equivalent of 8 of 9 Turbine Bypass Valves (as stated in Note 2 above) are required to trip open on Turbine Control Valve fast closure or on Turbine Stop Valve closure. The TBVOOS condition assumes that all of the Turbine Bypass Valves do not trip open on Turbine Control Valve fast closure or on Turbine Stop Valve closure.

6. A single MSIV may be taken OOS (shut) under all OOS Options, as long as core thermal power is maintained ≤ 75% of 2957 MWth (Reference 3).

Table 8-1 Core Thermal Power Restriction for OOS Conditions
(Reference 3)

EOOS Condition	Core Thermal Power Restriction (% of Rated Power)	Cycle Exposure (MWd/MTU)	Number of Safety Valves Available (Reference 9)
Base, PLUOOS, TCV Slow Closure	≤ 100	Entire Cycle	8 of 9
TBVOOS	≤ 100	Entire Cycle	8 of 9
One TCV/TSV Stuck Closed	See Table 8-2	Entire Cycle	8 of 9

Table 8-2 Core Thermal Power Restriction for One TCV/TSV Stuck Closed Based on the Minimum Available Total Reactor Vessel Steam Flow Capability
(Reference 3)

Core Thermal Power Restriction (% of Rated Power)	Minimum Available Total Reactor Vessel Steam Flow Capacity (% of 11.713 Mlb/hr)	Number of Available TBV's Required to Prevent System Pressurization†
≤ 75	82.5	1.9
≤ 80	88.1	3.4
≤ 85	94.7	5.2
≤ 90	100.6	6.8

†Based on a nominal capacity of 3.7% of rated steam flow for each turbine bypass valve. The maximum power level assumed for operation with 3 TCVs and one TBVOOS is 75% of rated power with 2 TBVs available to limit system pressurization. Operation above the 75% of rated core thermal power requires raising the MCFL setpoint and/or increasing TBV availability to increase the available total reactor vessel steam flow capability.

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, "Reference Safety Report for Boiling Water Reactor Reload Fuel," July 1996.

2. Westinghouse Topical Report CENPD-390-P-A, "The Advanced PHOENIX and POLCA Codes for Nuclear Design of Boiling Water Reactors," December 2000.

3. Westinghouse Report WCAP-16081-P-A, "10x10 SVEA Fuel Critical Power Experiments and CPR Correlation: SVEA-96 Optima2," March 2005.

4. Westinghouse 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 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 Report WCAP-15682-P-A, "Westinghouse BWR ECCS Evaluation Model: Supplement 2 to Code Description, Qualification and Application," April 2003.

7. Westinghouse Report WCAP-16078-P-A, "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, "Fuel Rod Design Methods for Boiling Water Reactors – Supplement 1," April 2006.

9. Westinghouse Topical Report WCAP-15942-P-A, "Fuel Assembly Mechanical Design Methodology for Boiling Water Reactors, Supplement 1 to CENPD-287-P-A," March 2006.

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

10. References

1. Exelon Generation Company, LLC and MidAmerican Energy Company, Docket No. 50-265, Quad Cities Nuclear Power Station, Unit 2, Renewed Facility Operating License, License No. DPR-30.

2. NRC Letter from D. M. Crutchfield to All Power Reactor Licensees and Applicants, Generic Letter 88-16; Concerning the Removal of Cycle-Specific Parameter Limits from Tech Specs, October 3, 1988.

3. Westinghouse Document, NF-BEX-09-188, Revision 0, "Quad Cities Nuclear Power Station Unit 2 Cycle 21 Reload Licensing Report", January 2010.

4. Westinghouse Document, NF-BEX-05-151, Revision 0, "Final Report Quad Cities 2 Cycle 19 Bundle Designs", October 12, 2005. (Attachment 3 to EC/FCP 354483-02)

5. Westinghouse Document, NF-BEX-07-95-NP, Revision 1, "Quad Cities Nuclear Power Station Unit 2 Cycle 19 MAPLHGR Report", July 2007. (Attachment 15 to EC/FCP 360358-05)

6. Westinghouse Document, NF-BEX-07-177, Revision 0, "Final Report for Quad Cities 2 Cycle 20 Bundle Designs", September 7, 2007. (Attachment 3 to EC/FCP 364632-00)

7. Westinghouse Document, NF-BEX-08-1, Revision 0, "Quad Cities Nuclear Power Station Unit 2 Cycle 20 Reload Licensing Report", January 2008. (Attachment 15 to EC/FCP 364632-00)

8. Westinghouse Letter NF-BEX-09-133, "Bundle Design Report for Quad Cities 2 Cycle 21", August 27, 2009.

9. Westinghouse Document, NF-BEX-09-187, Revision 0, "Quad Cities Nuclear Power Station Unit 2 Cycle 21 Reload Engineering Report", January 2010.

10. 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)

11. 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.

12. Technical Specifications for Quad Cities 1 and 2, Table 3.1.4-1, "Control Rod Scram Times".

13. FANP Letter, NJC:04:031/FAB04-496, "Startup with TIP Equipment Out of Service," April 20, 2004 (EC 348897-00).

14. Exelon TODI QDC-09-023, Revision 0, "OPL-W Parameters for Quad Unit 2 Cycle 21 Transient Analysis," July 20, 2009. (Attachment 13 to EC/FCP 375564-00)