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March 27, 2018

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 25

Quad Cities Nuclear Power Station Unit 2 was shutdown for Refuel Outage 24 (Q2R24) on March 19, 2018. In accordance with Technical Specifications Section 5.6.5.d, enclosed is the Core Operating Limits Report (COLR) for Quad Cities Unit 2 Cycle 25.

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

Respectfully,

Ken Ohr
Site Vice President
Quad Cities Nuclear Power Station

Enclosure: Core Operating Limits Report for Quad Cities Unit 2 Cycle 25

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

Enclosure

Core Operating Limits Report

for

Quad Cities Unit 2 Cycle 25

Core Operating Limits Report

For

Quad Cities Unit 2 Cycle 25

Prepared By: _____ Date: 2/27/2018
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Reviewed By: _____ Date: 2/27/18
Kevin Egan – Reactor Engineering

Reviewed By: _____ Date: 2/27/18
Christopher Staum – Engineering Safety Analysis

Independent Review By: _____ Date: 2/27/18
Corie Glenn – Nuclear Fuels

Approved By: _____ Date: 06MAR18
Armando Johnson – NF Senior Manager

SQR By: _____ Date: 3/7/18
Kevin Egan – Station Qualified Reviewer

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Record of Quad Cities 2 Cycle 25 COLR Revisions

Revision	Description
12	Initial issuance for Q2C25

List of Tables

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1. Terms and Definitions

AOO	Anticipated operational occurrence
APLHGR	Average planar linear heat generation rate
ASD	Adjustable Speed Drive
CAVEX	Core average exposure
CPR	Critical power ratio
CRWE	Control rod withdrawal error
EFPD	Effective full power day
EFPH	Effective full power hour
EOC	End of cycle
EOCLB	End of cycle licensing basis
EOFPL	End of full power life
EOFPLB	End of full power licensing basis
EOOS	Equipment out of service
FHOOS	Feedwater heater out of service
FWT	Feedwater temperature
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
MCPR	Minimum critical power ratio
$MCPR_f$	Flow dependent MCPR
$MCPR_p$	Power dependent MCPR
MELLLA	Maximum extended load line limit analysis
MSIVOOS	Main steam isolation valve out of service
MWd/MTU	MegaWatt days per metric ton Uranium
NEOC	Near end of cycle
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
PCOOS	Pressure controller out of service
PLUOOS	Power load unbalance out of service
SLMCPR	Safety limit minimum critical power ratio
SLO	Single loop operation
TBV	Turbine bypass valve
TBVOOS	Turbine bypass valves out of service
TCV	Turbine control valve
TIP	Traversing incore probe
TLO	Two loop operation
TMOL	Thermal mechanical operating limit
TRM	Technical Requirements Manual
TSSS	Technical Specification scram speed
TSV	Turbine stop valve

2. General Information

This report is prepared in accordance with Technical Specification 5.6.5. The Q2C25 reload is licensed by Framatome. Framatome is the same company as AREVA, and many legal documents still contain the name AREVA. However, some legacy analyses by Westinghouse are still applicable for OPTIMA2 fuel as described in Reference 2.

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

The licensing analysis supports full power operation to EOCLB (38,325 MWd/MTU CAVEX). Note that this value includes coastdown, where full power operation is not expected. The transient analysis limits are provided for operation up to specific CAVEX exposures as defined in Section 4.3.

Coastdown is defined as operation beyond EOFPL with the plant power gradually reducing as available core reactivity diminishes. The Q2C25 reload analyses do not credit this reduced power during coastdown and the EOCLB limits remain valid for operation up to rated power.

Power and flow dependent limits are listed for various power and flow levels. Linear interpolation on power and flow (as applicable) is to be used to find intermediate values. Linear interpolation is also to be used for table items intentionally left blank, as indicated by boxes which are grayed out.

$MCPR_p$ for both fuel types and $LHGRFAC_p$ for OPTIMA2 vary with scram speed. All other thermal limits are analyzed to remain valid with NSS, ISS, and TSSS.

$LHGRFAC_f$ is independent of feedwater temperature and EOOS conditions.

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

For thermal limit monitoring above 100% rated power or 108% rated core flow, the 100% rated power or the 108% core flow thermal limit values, respectively, shall be used. Steady state operation is not allowed in this region. Limits are provided for transient conditions only.

3. Average Planar Linear Heat Generation Rate

Technical Specifications Sections 3.2.1 and 3.4.1

Table 3-1 provides the MAPLHGR SLO multipliers for ATRIUM 10XM and OPTIMA2 fuel. For OPTIMA2 natural uranium lattices, TLO and SLO MAPLHGR values are provided in Table 3-2. The limits provided in Table 3-2 were selected to be the more limiting of the limits provided in References 5 and 7. For all other OPTIMA2 lattices, lattice-specific MAPLHGR values for TLO are provided in Tables 3-3 through 3-41.

For ATRIUM 10XM fuel, the MAPLHGR values can be found in Tables 3-42 through 3-44.

During SLO, the limits in Tables 3-3 through 3-44 are multiplied by the fuel-specific SLO multiplier listed in Table 3-1. The ATRIUM 10XM multiplier may be applied to OPTIMA2 for SLO conditions, as the ATRIUM 10XM multiplier is more limiting.

Table 3-1: MAPLHGR SLO Multipliers
(References 2, 5, and 7)

Fuel Type	Multiplier
ATRIUM 10XM	0.80
OPTIMA2	0.86

Table 3-2: MAPLHGR for OPTIMA2 Lattices 91 and 98
(References 5, 6, 7, and 8)

All OPTIMA2 Bundles Lattices 91: Opt2-B0.71 98: Opt2-T0.71	
Average Planar Exposure (MWd/MTU)	**TLO and SLO MAPLHGR (kW/ft)**
0	7.50
75000	7.50

Table 3-3: MAPLHGR for OPTIMA2 Lattice 152
(References 7 and 8)

Bundle Opt2-3.97-14GZ7.50/5.50-4GZ5.50 (UK23) Lattice 152: Opt2-B4.26-14G7.50-4G5.50	
Avg. Planar Exposure (MWd/MTU)	**TLO MAPLHGR (kW/ft)**
0	8.89
2500	9.17
5000	9.26
7500	9.39
10000	9.72
12000	9.88
15000	9.93
17000	9.92
20000	9.95
22000	9.97
24000	9.98
30000	9.72
36000	9.59
42000	9.48
50000	9.40
60000	9.54
72000	9.81
75000	9.81

Table 3-4: MAPLHGR for OPTIMA2 Lattice 153
(References 7 and 8)

Bundle Opt2-3.97-14GZ7.50/5.50-4GZ5.50 (UK23) Lattice 153: Opt2-B4.40-14G7.50-4G5.50	
Avg. Planar Exposure (MWd/MTU)	**TLO MAPLHGR (kW/ft)**
0	8.84
2500	9.13
5000	9.17
7500	9.25
10000	9.39
12000	9.46
15000	9.56
17000	9.62
20000	9.73
22000	9.69
24000	9.65
30000	9.60
36000	9.54
42000	9.51
50000	9.51
60000	9.60
72000	9.85
75000	9.85

Table 3-5: MAPLHGR for OPTIMA2 Lattice 154
(References 7 and 8)

Bundle Opt2-3.97-14GZ7.50/5.50-4GZ5.50 (UK23) Lattice 154: Opt2-BE4.49-14G7.50-4G5.50	
Avg. Planar Exposure (MWd/MTU)	**TLO MAPLHGR (kW/ft)**
0	9.05
2500	9.40
5000	9.38
7500	9.34
10000	9.50
12000	9.57
15000	9.68
17000	9.74
20000	9.84
22000	9.80
24000	9.76
30000	9.69
36000	9.66
42000	9.58
50000	9.56
60000	9.60
72000	9.89
75000	9.89

Table 3-6: MAPLHGR for OPTIMA2 Lattice 155
(References 7 and 8)

Bundle Opt2-3.97-14GZ7.50/5.50-4GZ5.50 (UK23) Lattice 155: Opt2-M4.49-14G7.50-4G5.50	
Avg. Planar Exposure (MWd/MTU)	**TLO MAPLHGR (kW/ft)**
0	9.02
2500	9.37
5000	9.41
7500	9.35
10000	9.52
12000	9.59
15000	9.69
17000	9.76
20000	9.84
22000	9.80
24000	9.75
30000	9.69
36000	9.65
42000	9.58
50000	9.51
60000	9.58
72000	9.90
75000	9.90

Table 3-7: MAPLHGR for OPTIMA2 Lattice 156
(References 7 and 8)

Bundle Opt2-3.97-14GZ7.50/5.50-4GZ5.50 (UK23) Lattice 156: Opt2-ME4.45-14G7.50-4G5.50	
Avg. Planar Exposure (MWd/MTU)	**TLO MAPLHGR (kW/ft)**
0	9.16
2500	9.52
5000	9.52
7500	9.51
10000	9.68
12000	9.76
15000	9.88
17000	10.00
20000	9.98
22000	9.98
24000	9.93
30000	9.88
36000	9.83
42000	9.72
50000	9.64
60000	9.63
72000	10.16
75000	10.16

Table 3-8: MAPLHGR for OPTIMA2 Lattice 157
(References 7 and 8)

Bundle Opt2-3.97-14GZ7.50/5.50-4GZ5.50 (UK23) Lattice 157: Opt2-T4.45-18G5.50	
Avg. Planar Exposure (MWd/MTU)	**TLO MAPLHGR (kW/ft)**
0	9.28
2500	9.63
5000	9.46
7500	9.53
10000	9.66
12000	9.87
15000	10.18
17000	10.05
20000	9.99
22000	9.97
24000	9.93
30000	9.88
36000	9.79
42000	9.76
50000	9.65
60000	9.71
72000	10.20
75000	10.20

Table 3-9: MAPLHGR for OPTIMA2 Lattice 158
(References 7 and 8)

Bundle Opt2-3.97-14GZ7.50/5.50-4GZ5.50 (UK23) Lattice 158: Opt2-T4.47-14G5.50	
Avg. Planar Exposure (MWd/MTU)	**TLO MAPLHGR (kW/ft)**
0	9.96
2500	10.26
5000	10.10
7500	10.01
10000	9.92
12000	10.01
15000	10.06
17000	10.03
20000	10.02
22000	10.01
24000	9.97
30000	9.93
36000	9.87
42000	9.76
50000	9.65
60000	9.70
72000	10.22
75000	10.22

Table 3-10: MAPLHGR for OPTIMA2 Lattice 159
(References 7 and 8)

Bundle Opt2-4.00-14GZ7.50/5.50-2GZ5.50 (UL23) Lattice 159: Opt2-B4.30-14G7.50-2G5.50	
Avg. Planar Exposure (MWd/MTU)	**TLO MAPLHGR (kW/ft)**
0	9.42
2500	9.63
5000	9.70
7500	9.79
10000	9.87
12000	9.83
15000	9.88
17000	9.99
20000	10.11
22000	10.11
24000	10.13
30000	9.74
36000	9.61
42000	9.50
50000	9.41
60000	9.54
72000	9.81
75000	9.81

Table 3-11: MAPLHGR for OPTIMA2 Lattice 160
(References 7 and 8)

Bundle Opt2-4.00-14GZ7.50/5.50-2GZ5.50 (UL23) Lattice 160: Opt2-B4.43-14G7.50-2G5.50	
Avg. Planar Exposure (MWd/MTU)	**TLO MAPLHGR (kW/ft)**
0	9.37
2500	9.62
5000	9.63
7500	9.69
10000	9.82
12000	9.73
15000	9.61
17000	9.59
20000	9.70
22000	9.72
24000	9.75
30000	9.70
36000	9.66
42000	9.61
50000	9.52
60000	9.62
72000	9.84
75000	9.84

Table 3-12: MAPLHGR for OPTIMA2 Lattice 161
(References 7 and 8)

Bundle Opt2-4.00-14GZ7.50/5.50-2GZ5.50 (UL23) Lattice 161: Opt2-BE4.51-14G7.50-2G5.50	
Avg. Planar Exposure (MWd/MTU)	**TLO MAPLHGR (kW/ft)**
0	9.53
2500	9.76
5000	9.77
7500	9.73
10000	9.90
12000	9.77
15000	9.68
17000	9.69
20000	9.79
22000	9.84
24000	9.85
30000	9.81
36000	9.74
42000	9.65
50000	9.55
60000	9.62
72000	9.90
75000	9.90

Table 3-13: MAPLHGR for OPTIMA2 Lattice 162
(References 7 and 8)

Bundle Opt2-4.00-14GZ7.50/5.50-2GZ5.50 (UL23) Lattice 162: Opt2-M4.51-14G7.50-2G5.50	
Avg. Planar Exposure (MWd/MTU)	**TLO MAPLHGR (kW/ft)**
0	9.47
2500	9.74
5000	9.77
7500	9.69
10000	9.89
12000	9.77
15000	9.68
17000	9.69
20000	9.80
22000	9.85
24000	9.85
30000	9.80
36000	9.73
42000	9.62
50000	9.51
60000	9.59
72000	9.90
75000	9.90

Table 3-14: MAPLHGR for OPTIMA2 Lattice 163
(References 7 and 8)

Bundle Opt2-4.00-14GZ7.50/5.50-2GZ5.50 (UL23) Lattice 163: Opt2-ME4.47-14G7.50-2G5.50	
Avg. Planar Exposure (MWd/MTU)	**TLO MAPLHGR (kW/ft)**
0	9.66
2500	9.95
5000	9.94
7500	9.89
10000	10.06
12000	10.00
15000	9.89
17000	9.90
20000	10.05
22000	10.06
24000	10.08
30000	10.02
36000	9.93
42000	9.76
50000	9.59
60000	9.63
72000	10.16
75000	10.16

Table 3-15: MAPLHGR for OPTIMA2 Lattice 164
(References 7 and 8)

Bundle Opt2-4.00-14GZ7.50/5.50-2GZ5.50 (UL23) Lattice 164: Opt2-T4.47-16G5.50	
Avg. Planar Exposure (MWd/MTU)	**TLO MAPLHGR (kW/ft)**
0	9.77
2500	10.09
5000	10.03
7500	10.00
10000	10.19
12000	10.13
15000	10.16
17000	10.15
20000	10.13
22000	10.14
24000	10.09
30000	10.04
36000	9.98
42000	9.82
50000	9.65
60000	9.71
72000	10.20
75000	10.20

Table 3-16: MAPLHGR for OPTIMA2 Lattice 165
(References 7 and 8)

Bundle Opt2-4.00-14GZ7.50/5.50-2GZ5.50 (UL23) Lattice 165: Opt2-T4.49-14G5.50	
Avg. Planar Exposure (MWd/MTU)	**TLO MAPLHGR (kW/ft)**
0	9.46
2500	9.77
5000	9.58
7500	9.60
10000	9.65
12000	9.71
15000	9.98
17000	10.13
20000	10.12
22000	10.13
24000	10.09
30000	10.04
36000	9.99
42000	9.78
50000	9.67
60000	9.70
72000	10.21
75000	10.21

Table 3-17: MAPLHGR for OPTIMA2 Lattice 166
(References 7 and 8)

Bundle Opt2-4.17-2GZ6.00-10G6.00 (UM23) Lattice 166: Opt2-B4.59-12G6.00	
Avg. Planar Exposure (MWd/MTU)	**TLO MAPLHGR (kW/ft)**
0	9.30
2500	9.48
5000	9.38
7500	9.34
10000	9.35
12000	9.37
15000	9.41
17000	9.45
20000	9.52
22000	9.58
24000	9.60
30000	9.63
36000	9.63
42000	9.62
50000	9.63
60000	9.67
72000	9.90
75000	9.90

Table 3-18: MAPLHGR for OPTIMA2 Lattice 167
(References 7 and 8)

Bundle Opt2-4.17-2GZ6.00-10G6.00 (UM23) Lattice 167: Opt2-BE4.67-12G6.00	
Avg. Planar Exposure (MWd/MTU)	**TLO MAPLHGR (kW/ft)**
0	9.35
2500	9.57
5000	9.42
7500	9.45
10000	9.56
12000	9.45
15000	9.51
17000	9.56
20000	9.63
22000	9.69
24000	9.71
30000	9.74
36000	9.78
42000	9.70
50000	9.68
60000	9.64
72000	9.94
75000	9.94

Table 3-19: MAPLHGR for OPTIMA2 Lattice 168
(References 7 and 8)

Bundle Opt2-4.17-2GZ6.00-10G6.00 (UM23) Lattice 168: Opt2-M4.67-12G6.00	
Avg. Planar Exposure (MWd/MTU)	**TLO MAPLHGR (kW/ft)**
0	9.34
2500	9.58
5000	9.40
7500	9.50
10000	9.58
12000	9.47
15000	9.51
17000	9.57
20000	9.70
22000	9.69
24000	9.72
30000	9.77
36000	9.79
42000	9.69
50000	9.65
60000	9.62
72000	9.95
75000	9.95

Table 3-20: MAPLHGR for OPTIMA2 Lattice 169
(References 7 and 8)

Bundle Opt2-4.17-2GZ6.00-10G6.00 (UM23) Lattice 169: Opt2-ME4.65-12G6.00	
Avg. Planar Exposure (MWd/MTU)	**TLO MAPLHGR (kW/ft)**
0	9.56
2500	9.79
5000	9.63
7500	9.66
10000	9.68
12000	9.65
15000	9.73
17000	9.82
20000	9.93
22000	9.98
24000	9.98
30000	10.00
36000	10.00
42000	9.94
50000	9.80
60000	9.77
72000	10.21
75000	10.21

Table 3-21: MAPLHGR for OPTIMA2 Lattice 170
(References 7 and 8)

Bundle Opt2-4.17-2GZ6.00-10G6.00 (UM23) Lattice 170: Opt2-T4.64-10G6.00	
Avg. Planar Exposure (MWd/MTU)	**TLO MAPLHGR (kW/ft)**
0	10.00
2500	10.18
5000	9.96
7500	10.04
10000	9.83
12000	9.81
15000	9.82
17000	9.85
20000	9.93
22000	9.98
24000	9.97
30000	10.00
36000	10.00
42000	9.94
50000	9.82
60000	9.77
72000	10.24
75000	10.24

Table 3-22: MAPLHGR for OPTIMA2 Lattice 171
(References 5 and 6)

Bundle Opt2-4.00-16GZ7.50/5.50-2G5.50 (UN24) Lattice 171: Opt2-B4.30-16G7.50-2G5.50	
Avg. Planar Exposure (MWd/MTU)	**TLO MAPLHGR (kW/ft)**
0	9.15
2500	9.49
5000	9.44
7500	9.58
10000	9.81
12000	9.96
15000	10.19
17000	10.33
20000	10.54
22000	10.55
24000	10.56
30000	10.27
36000	10.14
42000	10.02
50000	9.92
75000	9.92

Table 3-23: MAPLHGR for OPTIMA2 Lattice 172
(References 5 and 6)

Bundle Opt2-4.00-16GZ7.50/5.50-2G5.50 (UN24) Lattice 172: Opt2-B4.43-16G7.50-2G5.50	
Avg. Planar Exposure (MWd/MTU)	**TLO MAPLHGR (kW/ft)**
0	9.08
2500	9.43
5000	9.35
7500	9.31
10000	9.44
12000	9.53
15000	9.69
17000	9.77
20000	9.93
22000	10.06
24000	10.18
30000	10.15
36000	10.11
42000	10.06
50000	10.04
75000	10.04

Table 3-24: MAPLHGR for OPTIMA2 Lattice 173
(References 5 and 6)

Bundle Opt2-4.00-16GZ7.50/5.50-2G5.50 (UN24) Lattice 173: Opt2-BE4.52-16G7.50-2G5.50	
Avg. Planar Exposure (MWd/MTU)	**TLO MAPLHGR (kW/ft)**
0	9.11
2500	9.43
5000	9.36
7500	9.34
10000	9.51
12000	9.61
15000	9.78
17000	9.87
20000	10.03
22000	10.19
24000	10.30
30000	10.24
36000	10.20
42000	10.13
50000	10.07
75000	10.07

Table 3-25: MAPLHGR for OPTIMA2 Lattice 174
(References 5 and 6)

Bundle Opt2-4.00-16GZ7.50/5.50-2G5.50 (UN24) Lattice 174: Opt2-M4.52-16G7.50-2G5.50	
Avg. Planar Exposure (MWd/MTU)	**TLO MAPLHGR (kW/ft)**
0	9.09
2500	9.43
5000	9.34
7500	9.34
10000	9.52
12000	9.63
15000	9.79
17000	9.88
20000	10.05
22000	10.21
24000	10.29
30000	10.23
36000	10.19
42000	10.12
50000	10.03
75000	10.03

Table 3-26: MAPLHGR for OPTIMA2 Lattice 175
(References 5 and 6)

Bundle Opt2-4.00-16GZ7.50/5.50-2G5.50 (UN24) Lattice 175: Opt2-ME4.48-16G7.50-2G5.50	
Avg. Planar Exposure (MWd/MTU)	**TLO MAPLHGR (kW/ft)**
0	9.22
2500	9.57
5000	9.47
7500	9.49
10000	9.66
12000	9.78
15000	9.95
17000	10.07
20000	10.39
22000	10.53
24000	10.48
30000	10.43
36000	10.37
42000	10.26
50000	10.13
75000	10.13

Table 3-27: MAPLHGR for OPTIMA2 Lattice 176
(References 5 and 6)

Bundle Opt2-4.00-16GZ7.50/5.50-2G5.50 (UN24) Lattice 176: Opt2-T4.48-16G7.50-2G5.50	
Avg. Planar Exposure (MWd/MTU)	**TLO MAPLHGR (kW/ft)**
0	9.27
2500	9.60
5000	9.49
7500	9.47
10000	9.61
12000	9.76
15000	9.92
17000	10.06
20000	10.42
22000	10.50
24000	10.46
30000	10.42
36000	10.36
42000	10.22
50000	10.10
75000	10.10

Table 3-28: MAPLHGR for OPTIMA2 Lattice 177
(References 5 and 6)

Bundle Opt2-4.00-16GZ7.50/5.50-2G5.50 (UN24) Lattice 177: Opt2-T4.48-18G5.50	
Avg. Planar Exposure (MWd/MTU)	**TLO MAPLHGR (kW/ft)**
0	9.35
2500	9.70
5000	9.61
7500	9.58
10000	9.75
12000	9.96
15000	10.29
17000	10.50
20000	10.53
22000	10.51
24000	10.47
30000	10.42
36000	10.34
42000	10.31
50000	10.18
75000	10.18

Table 3-29: MAPLHGR for OPTIMA2 Lattice 178
(References 5 and 6)

Bundle Opt2-4.00-16GZ7.50/5.50 (UO24) Lattice 178: Opt2-B4.30-16G7.50	
Avg. Planar Exposure (MWd/MTU)	**TLO MAPLHGR (kW/ft)**
0	9.44
2500	9.71
5000	9.58
7500	9.71
10000	9.88
12000	9.99
15000	10.21
17000	10.33
20000	10.48
22000	10.50
24000	10.52
30000	10.26
36000	10.12
42000	10.01
50000	9.92
75000	9.92

Table 3-30: MAPLHGR for OPTIMA2 Lattice 179
(References 5 and 6)

Bundle Opt2-4.00-16GZ7.50/5.50 (UO24) Lattice 179: Opt2-B4.43-16G7.50	
Avg. Planar Exposure (MWd/MTU)	**TLO MAPLHGR (kW/ft)**
0	9.38
2500	9.62
5000	9.50
7500	9.44
10000	9.52
12000	9.57
15000	9.69
17000	9.77
20000	9.92
22000	10.05
24000	10.16
30000	10.13
36000	10.08
42000	10.04
50000	10.03
75000	10.03

Table 3-31: MAPLHGR for OPTIMA2 Lattice 180
(References 5 and 6)

Bundle Opt2-4.00-16GZ7.50/5.50 (UO24) Lattice 180: Opt2-BE4.53-16G7.50	
Avg. Planar Exposure (MWd/MTU)	**TLO MAPLHGR (kW/ft)**
0	9.42
2500	9.70
5000	9.56
7500	9.49
10000	9.60
12000	9.65
15000	9.79
17000	9.87
20000	10.02
22000	10.17
24000	10.28
30000	10.23
36000	10.19
42000	10.12
50000	10.06
75000	10.06

Table 3-32: MAPLHGR for OPTIMA2 Lattice 181
(References 5 and 6)

Bundle Opt2-4.00-16GZ7.50/5.50 (UO24) Lattice 181: Opt2-M4.53-16G7.50	
Avg. Planar Exposure (MWd/MTU)	**TLO MAPLHGR (kW/ft)**
0	9.40
2500	9.71
5000	9.59
7500	9.51
10000	9.62
12000	9.67
15000	9.80
17000	9.88
20000	10.04
22000	10.19
24000	10.28
30000	10.22
36000	10.19
42000	10.11
50000	10.03
75000	10.03

Table 3-33: MAPLHGR for OPTIMA2 Lattice 182
(References 5 and 6)

Bundle Opt2-4.00-16GZ7.50/5.50 (UO24) Lattice 182: Opt2-ME4.49-16G7.50	
Avg. Planar Exposure (MWd/MTU)	**TLO MAPLHGR (kW/ft)**
0	9.55
2500	9.86
5000	9.73
7500	9.66
10000	9.76
12000	9.82
15000	9.96
17000	10.06
20000	10.36
22000	10.51
24000	10.47
30000	10.42
36000	10.37
42000	10.25
50000	10.10
75000	10.10

Table 3-34: MAPLHGR for OPTIMA2 Lattice 183
(References 5 and 6)

Bundle Opt2-4.00-16GZ7.50/5.50 (UO24) Lattice 183: Opt2-T4.49-16G7.50	
Avg. Planar Exposure (MWd/MTU)	**TLO MAPLHGR (kW/ft)**
0	9.61
2500	9.89
5000	9.74
7500	9.65
10000	9.72
12000	9.81
15000	9.92
17000	10.05
20000	10.39
22000	10.47
24000	10.45
30000	10.42
36000	10.35
42000	10.21
50000	10.09
75000	10.09

Table 3-35: MAPLHGR for OPTIMA2 Lattice 184
(References 5 and 6)

Bundle Opt2-4.00-16GZ7.50/5.50 (UO24) Lattice 184: Opt2-T4.49-16G5.50	
Avg. Planar Exposure (MWd/MTU)	**TLO MAPLHGR (kW/ft)**
0	9.69
2500	10.00
5000	9.87
7500	9.76
10000	9.86
12000	10.01
15000	10.28
17000	10.48
20000	10.55
22000	10.54
24000	10.50
30000	10.45
36000	10.39
42000	10.31
50000	10.17
75000	10.17

Table 3-36: MAPLHGR for OPTIMA2 Lattice 185
(References 5 and 6)

Bundle Opt2-4.17-2GZ6.00-10G6.00 (UP24) Lattice 185: Opt2-B4.59-12G6.00	
Avg. Planar Exposure (MWd/MTU)	**TLO MAPLHGR (kW/ft)**
0	9.71
2500	9.89
5000	9.80
7500	9.77
10000	9.77
12000	9.82
15000	9.87
17000	9.92
20000	10.00
22000	10.07
24000	10.09
30000	10.12
36000	10.12
42000	10.13
50000	10.12
75000	10.12

Table 3-37: MAPLHGR for OPTIMA2 Lattice 186
(References 5 and 6)

Bundle Opt2-4.17-2GZ6.00-10G6.00 (UP24) Lattice 186: Opt2-BE4.67-12G6.00	
Avg. Planar Exposure (MWd/MTU)	**TLO MAPLHGR (kW/ft)**
0	9.75
2500	9.96
5000	9.82
7500	9.86
10000	9.99
12000	9.91
15000	9.96
17000	10.03
20000	10.11
22000	10.18
24000	10.20
30000	10.25
36000	10.27
42000	10.20
50000	10.15
75000	10.15

Table 3-38: MAPLHGR for OPTIMA2 Lattice 187
(References 5 and 6)

Bundle Opt2-4.17-2GZ6.00-10G6.00 (UP24) Lattice 187: Opt2-M4.67-12G6.00	
Avg. Planar Exposure (MWd/MTU)	**TLO MAPLHGR (kW/ft)**
0	9.74
2500	9.97
5000	9.80
7500	9.89
10000	10.01
12000	9.92
15000	9.98
17000	10.04
20000	10.18
22000	10.18
24000	10.21
30000	10.26
36000	10.28
42000	10.20
50000	10.15
75000	10.15

Table 3-39: MAPLHGR for OPTIMA2 Lattice 188
(References 5 and 6)

Bundle Opt2-4.17-2GZ6.00-10G6.00 (UP24) Lattice 188: Opt2-ME4.65-12G6.00	
Avg. Planar Exposure (MWd/MTU)	**TLO MAPLHGR (kW/ft)**
0	9.96
2500	10.19
5000	10.03
7500	10.06
10000	10.15
12000	10.10
15000	10.19
17000	10.29
20000	10.41
22000	10.47
24000	10.47
30000	10.50
36000	10.50
42000	10.44
50000	10.28
75000	10.28

Table 3-40: MAPLHGR for OPTIMA2 Lattice 189
(References 5 and 6)

Bundle Opt2-4.17-2GZ6.00-10G6.00 (UP24) Lattice 189: Opt2-T4.65-12G6.00	
Avg. Planar Exposure (MWd/MTU)	**TLO MAPLHGR (kW/ft)**
0	10.02
2500	10.25
5000	10.09
7500	10.11
10000	10.09
12000	10.07
15000	10.18
17000	10.27
20000	10.43
22000	10.47
24000	10.48
30000	10.51
36000	10.49
42000	10.42
50000	10.24
75000	10.24

Table 3-41: MAPLHGR for OPTIMA2 Lattice 190
(References 5 and 6)

Bundle Opt2-4.17-2GZ6.00-10G6.00 (UP24) Lattice 190: Opt2-T4.64-10G6.00	
Avg. Planar Exposure (MWd/MTU)	**TLO MAPLHGR (kW/ft)**
0	10.42
2500	10.60
5000	10.39
7500	10.48
10000	10.30
12000	10.27
15000	10.28
17000	10.32
20000	10.41
22000	10.46
24000	10.46
30000	10.48
36000	10.49
42000	10.43
50000	10.28
75000	10.28

Table 3-42: MAPLHGR for ATRIUM 10XM Bottom Lattices
(References 2 and 13)

Bundles XMLC-4102B-16GV80, XMLC-4102B-15GV80, XMLC-4183B-12GV80 Lattices XMLCP-0720L-0G0a, XMLCB-0720L-0G0a, XMLCB-4574L-14G80, XMLCB-4562L-16G80, XMLCB-4574L-14GV80, XMLCB-4568L-15GV80	
Average Planar Exposure (MWd/MTU)	**TLO MAPLHGR (kW/ft)**
0	11.70
15000	11.70
20000	11.70
67000	6.60

Table 3-43: MAPLHGR for ATRIUM 10XM Bottom Lattice XMLCB-4667L-12G80
(References 2 and 13)

Bundle XMLC-4183B-12GV80 Lattice XMLCB-4667L-12G80	
Average Planar Exposure (MWd/MTU)	**TLO MAPLHGR (kW/ft)**
0	11.70
15000	11.70
20000	11.44
67000	6.62

Table 3-44: MAPLHGR for ATRIUM 10XM Top Lattices
(References 2 and 13)

Bundles **XMLC-4102B-16GV80, XMLC-4102B-15GV80, XMLC-4183B-12GV80** **Lattices** **XMLCT-0720L-0G0da, XMLCT-0720L-0G0a, XMLCT-4650L-12G60, XMLCT-4637L-14G80, XMLCTP-4637L-14G80, XMLCT-4630L-15GV80, XMLCTP-4630L-15GV80, XMLCT-4720L-12G60, XMLCT-4722L-12G80, XMLCTP-4722L-12G80**	
Average Planar Exposure (MWd/MTU)	**TLO MAPLHGR (kW/ft)**
0	11.70
15000	11.60
20000	11.21
67000	6.60

4. Operating Limit Minimum Critical Power Ratio

Technical Specification Sections 3.2.2, 3.4.1, and 3.7.7

The OLMCPRs for Q2C25 were established so that less than 0.1% of the fuel rods in the core are expected to experience boiling transition during an AOO initiated from rated or off-rated conditions and are based on the Technical Specifications SLMCPR values (Reference 2).

Tables 4-3 through 4-27 include MCPR limits for various specified EOOS conditions. The EOOS conditions separated by "/" in these tables represent single EOOS conditions and not any combination of conditions. Refer to Section 8 for a detailed explanation of allowable combined EOOS conditions.

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

The OLMCPR as a function of core thermal power ($MCPR_P$) is shown in Tables 4-3 through 4-26. $MCPR_P$ limits are dependent on scram times as described in Section 4.2, exposure as described in Section 4.3, fuel type, FWT, and whether the plant is in TLO or SLO. TLO limits for ATRIUM 10XM fuel are given in Tables 4-3 through 4-11 and SLO limits for ATRIUM 10XM are given in Tables 4-21 through 4-23. TLO limits for OPTIMA2 fuel are given in Tables 4-12 through 4-20 and SLO limits for OPTIMA2 fuel are given in Tables 4-24 through 4-26.

4.1.2. Flow-Dependent MCPR

Table 4-27 gives the OLMCPR limit as a function of the flow ($MCPR_f$) based on the applicable plant condition. These values are applicable to both ATRIUM 10XM and OPTIMA2 fuel.

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 4).

To utilize the OLMCPR limits for NSS in Tables 4-3, 4-6, 4-9, 4-12, 4-15, 4-18, 4-21, and 4-24, the average control rod insertion time at each control rod insertion fraction must be equal to or less than the NSS time shown in Table 4-1 below.

To utilize the OLMCPR limits for ISS in Tables 4-4, 4-7, 4-10, 4-13, 4-16, 4-19, 4-22 and 4-25, the average control rod insertion time at each control rod insertion fraction must be equal to or less than the ISS time shown in 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. Conservative adjustments to the NSS and ISS scram speeds were made to the analysis inputs to appropriately account for the effects of 1 stuck control rod and one additional control rod that is assumed to fail to scram (Reference 2).

To utilize the OLMCPR limits for TSSS in Tables 4-5, 4-8, 4-11, 4-14, 4-17, 4-20, 4-23, and 4-26, the control rod insertion time of each operable control rod at each control rod insertion fraction must be less than or equal to the TSSS time shown in Table 4-1 below. The Technical Specifications allow operation with up to 12 "slow" and 1 stuck control rod. One additional control rod is assumed to fail to scram for the system transient analyses performed to establish $MCPR_P$ limits (Reference 2). Conservative adjustments to the TSSS scram speeds were made to the analysis inputs to appropriately account for the effects of the slow and stuck rods on scram reactivity (Reference 2).

For cases below 38.5% power (P_{bypass}), the results are relatively insensitive to scram speed, and only TSSS analyses were performed (Reference 2).

Table 4-1: Scram Times
(References 2 and 4)

Control Rod Insertion Fraction (%)	NSS (seconds)	ISS (seconds)	TSSS (seconds)
5	0.324	0.36	0.48
20	0.694	0.72	0.89
50	1.510	1.58	1.98
90	2.670	2.80	3.44

4.3. Exposure Dependent MCPR Limits

Exposure-dependent $MCPR_p$ limits were established to support operation from BOC to NEOC (CAVEX of 35,057 MWd/MTU), NEOC to EOFPLB (CAVEX of 37,507 MWd/MTU), and EOFPLB to EOCLB (CAVEX of 38,325 MWd/MTU) as defined by the CAVEX values listed in Table 4-2. Note that the thermal limits are based on CAVEX. The limits at a later exposure range can be used earlier in the cycle as they are the same or more conservative.

Table 4-2: Exposure Basis for Transient Analysis
(Reference 2)

Core Average Exposure (CAVEX) (MWd/MTU)	Description
35,057	Break point for exposure-dependent $MCPR_p$ limits (NEOC)
37,507	Design basis rod patterns to EOFPL + 25 EFPD (EOFPLB)
38,325	EOCLB – Maximum licensing core exposure, including coastdown

4.4. Recirculation Pump ASD Settings

Technical Requirement Manual 2.1.a.1

Quad Cities 2 Cycle 25 was analyzed with a slow flow excursion event assuming a failure of the recirculation flow control system such that the core flow increases slowly to the maximum flow physically permitted by the equipment, assumed to be 112% of rated core flow (Reference 2); therefore, the recirculation pump ASD must be set to maintain core flow less than 112% (109.76 Mlb/hr) for all runout events.

Table 4-3: ATRIUM 10XM TLO $MCPR_p$ Limits for NSS Insertion Times, BOC to NEOC (35,057 MWd/MTU CAVEX)
(Reference 2)

Nominal FWT							
EOOS Condition	**Core Flow (% rated)**	**Core Power (% rated)**					
		0	**25**	**≤ 38.5**	**> 38.5**	**70**	**100**
Base/TCV Stuck Closed/MSIVOOS	≤ 60	2.52	2.52	2.20	1.96		1.48
	> 60	2.73	2.73	2.32			
TBVOOS	≤ 60	3.44	3.44	2.63	2.01		1.48
	> 60	3.54	3.54	2.77			
TCV Slow Closure/ PLUOOS/PCOOS	≤ 60	2.52	2.52	2.32	2.30	1.93	1.48
	> 60	2.73	2.73	2.32			
FHOOS							
EOOS Condition	**Core Flow (% rated)**	**Core Power (% rated)**					
		0	**25**	**≤ 38.5**	**> 38.5**	**70**	**100**
Base/TCV Stuck Closed/MSIVOOS	≤ 60	2.69	2.69	2.33	2.07		1.48
	> 60	2.73	2.73	2.33			
TBVOOS	≤ 60	3.57	3.57	2.73	2.12		1.48
	> 60	3.65	3.65	2.85			
TCV Slow Closure/ PLUOOS/PCOOS	≤ 60	2.69	2.69	2.33	2.30	1.93	1.48
	> 60	2.73	2.73	2.33			

Table 4-4: ATRIUM 10XM TLO $MCPR_p$ Limits for ISS Insertion Times, BOC to NEOC (35,057 MWd/MTU CAVEX)
(Reference 2)

Nominal FWT							
EOOS Condition	Core Flow (% rated)	Core Power (% rated)					
		0	25	≤ 38.5	> 38.5	70	100
Base/TCV Stuck Closed/MSIVOOS	≤ 60	2.52	2.52	2.20	1.96		1.48
	> 60	2.73	2.73	2.32			
TBVOOS	≤ 60	3.44	3.44	2.63	2.02		1.48
	> 60	3.54	3.54	2.77			
TCV Slow Closure/ PLUOOS/PCOOS	≤ 60	2.52	2.52	2.32	2.30	1.94	1.48
	> 60	2.73	2.73	2.32			
FHOOS							
EOOS Condition	Core Flow (% rated)	Core Power (% rated)					
		0	25	≤ 38.5	> 38.5	70	100
Base/TCV Stuck Closed/MSIVOOS	≤ 60	2.69	2.69	2.33	2.08		1.48
	> 60	2.73	2.73	2.33			
TBVOOS	≤ 60	3.57	3.57	2.73	2.13		1.48
	> 60	3.65	3.65	2.85			
TCV Slow Closure/ PLUOOS/PCOOS	≤ 60	2.69	2.69	2.33	2.30	1.94	1.48
	> 60	2.73	2.73	2.33			

Table 4-5: ATRIUM 10XM TLO $MCPR_p$ Limits for TSSS Insertion Times, BOC to NEOC (35,057 MWd/MTU CAVEX)
(Reference 2)

Nominal FWT							
EOOS Condition	**Core Flow (% rated)**	**Core Power (% rated)**					
		0	**25**	**≤ 38.5**	**> 38.5**	**70**	**100**
Base/TCV Stuck Closed/MSIVOOS	≤ 60	2.52	2.52	2.20	1.98		1.48
	> 60	2.73	2.73	2.32			
TBVOOS	≤ 60	3.44	3.44	2.63	2.04		1.49
	> 60	3.54	3.54	2.77			
TCV Slow Closure/ PLUOOS/PCOOS	≤ 60	2.52	2.52	2.32	2.32	1.97	1.48
	> 60	2.73	2.73	2.32			
FHOOS							
EOOS Condition	**Core Flow (% rated)**	**Core Power (% rated)**					
		0	**25**	**≤ 38.5**	**> 38.5**	**70**	**100**
Base/TCV Stuck Closed/MSIVOOS	≤ 60	2.69	2.69	2.33	2.11		1.48
	> 60	2.73	2.73	2.33			
TBVOOS	≤ 60	3.57	3.57	2.73	2.15		1.50
	> 60	3.65	3.65	2.85			
TCV Slow Closure/ PLUOOS/PCOOS	≤ 60	2.69	2.69	2.33	2.32	1.97	1.48
	> 60	2.73	2.73	2.33			

Table 4-6: ATRIUM 10XM TLO MCPR$_p$ Limits for NSS Insertion Times, NEOC to EOFPLB (37,507 MWd/MTU CAVEX)
(Reference 2)

Nominal FWT							
EOOS Condition	**Core Flow (% rated)**	**Core Power (% rated)**					
		0	**25**	**≤ 38.5**	**> 38.5**	**70**	**100**
Base/TCV Stuck Closed/MSIVOOS	≤ 60	2.52	2.52	2.20	1.96		1.48
	> 60	2.73	2.73	2.32			
TBVOOS	≤ 60	3.44	3.44	2.63	2.01		1.48
	> 60	3.54	3.54	2.77			
TCV Slow Closure/ PLUOOS/PCOOS	≤ 60	2.52	2.52	2.32	2.30	1.95	1.48
	> 60	2.73	2.73	2.32			
FHOOS							
EOOS Condition	**Core Flow (% rated)**	**Core Power (% rated)**					
		0	**25**	**≤ 38.5**	**> 38.5**	**70**	**100**
Base/TCV Stuck Closed/MSIVOOS	≤ 60	2.69	2.69	2.33	2.07		1.48
	> 60	2.73	2.73	2.33			
TBVOOS	≤ 60	3.57	3.57	2.73	2.12		1.49
	> 60	3.65	3.65	2.85			
TCV Slow Closure/ PLUOOS/PCOOS	≤ 60	2.69	2.69	2.33	2.30	1.95	1.48
	> 60	2.73	2.73	2.33			

Table 4-7: ATRIUM 10XM TLO MCPR$_p$ Limits for ISS Insertion Times, NEOC to EOFPLB (37,507 MWd/MTU CAVEX)
(Reference 2)

Nominal FWT							
EOOS Condition	**Core Flow (% rated)**	**Core Power (% rated)**					
		0	**25**	**≤ 38.5**	**> 38.5**	**70**	**100**
Base/TCV Stuck Closed/MSIVOOS	≤ 60	2.52	2.52	2.20	1.96		1.48
	> 60	2.73	2.73	2.32			
TBVOOS	≤ 60	3.44	3.44	2.63	2.02		1.48
	> 60	3.54	3.54	2.77			
TCV Slow Closure/ PLUOOS/PCOOS	≤ 60	2.52	2.52	2.32	2.30	1.95	1.48
	> 60	2.73	2.73	2.32			
FHOOS							
EOOS Condition	**Core Flow (% rated)**	**Core Power (% rated)**					
		0	**25**	**≤ 38.5**	**> 38.5**	**70**	**100**
Base/TCV Stuck Closed/MSIVOOS	≤ 60	2.69	2.69	2.33	2.08		1.48
	> 60	2.73	2.73	2.33			
TBVOOS	≤ 60	3.57	3.57	2.73	2.13		1.50
	> 60	3.65	3.65	2.85			
TCV Slow Closure/ PLUOOS/PCOOS	≤ 60	2.69	2.69	2.33	2.30	1.95	1.48
	> 60	2.73	2.73	2.33			

Table 4-8: ATRIUM 10XM TLO MCPR$_p$ Limits for TSSS Insertion Times, NEOC to EOFPLB (37,507 MWd/MTU CAVEX)
(Reference 2)

Nominal FWT							
EOOS Condition	**Core Flow (% rated)**	**Core Power (% rated)**					
		0	**25**	**≤ 38.5**	**> 38.5**	**70**	**100**
Base/TCV Stuck Closed/MSIVOOS	≤ 60	2.52	2.52	2.20	1.98		1.48
	> 60	2.73	2.73	2.32			
TBVOOS	≤ 60	3.44	3.44	2.63	2.04		1.51
	> 60	3.54	3.54	2.77			
TCV Slow Closure/ PLUOOS/PCOOS	≤ 60	2.52	2.52	2.32	2.32	1.99	1.49
	> 60	2.73	2.73	2.32			
FHOOS							
EOOS Condition	**Core Flow (% rated)**	**Core Power (% rated)**					
		0	**25**	**≤ 38.5**	**> 38.5**	**70**	**100**
Base/TCV Stuck Closed/MSIVOOS	≤ 60	2.69	2.69	2.33	2.11		1.48
	> 60	2.73	2.73	2.33			
TBVOOS	≤ 60	3.57	3.57	2.73	2.15		1.52
	> 60	3.65	3.65	2.85			
TCV Slow Closure/ PLUOOS/PCOOS	≤ 60	2.69	2.69	2.33	2.32	1.99	1.49
	> 60	2.73	2.73	2.33			

Table 4-9: ATRIUM 10XM TLO $MCPR_p$ Limits for NSS Insertion Times, EOFPLB to EOCLB (38,325 MWd/MTU CAVEX)
(Reference 2)

Nominal FWT							
EOOS Condition	**Core Flow (% rated)**	**Core Power (% rated)**					
		0	**25**	**≤ 38.5**	**> 38.5**	**70**	**100**
Base/TCV Stuck Closed/MSIVOOS	≤ 60	2.52	2.52	2.20	1.96		1.48
	> 60	2.73	2.73	2.32			
TBVOOS	≤ 60	3.44	3.44	2.63	2.01		1.48
	> 60	3.54	3.54	2.77			
TCV Slow Closure/ PLUOOS/PCOOS	≤ 60	2.52	2.52	2.32	2.30	1.95	1.48
	> 60	2.73	2.73	2.32			
FHOOS							
EOOS Condition	**Core Flow (% rated)**	**Core Power (% rated)**					
		0	**25**	**≤ 38.5**	**> 38.5**	**70**	**100**
Base/TCV Stuck Closed/MSIVOOS	≤ 60	2.69	2.69	2.33	2.07		1.48
	> 60	2.73	2.73	2.33			
TBVOOS	≤ 60	3.57	3.57	2.73	2.12		1.49
	> 60	3.65	3.65	2.85			
TCV Slow Closure/ PLUOOS/PCOOS	≤ 60	2.69	2.69	2.33	2.30	1.95	1.48
	> 60	2.73	2.73	2.33			

Table 4-10: ATRIUM 10XM TLO $MCPR_p$ Limits for ISS Insertion Times, EOFPLB to EOCLB (38,325 MWd/MTU CAVEX)
(Reference 2)

Nominal FWT							
EOOS Condition	**Core Flow (% rated)**	**Core Power (% rated)**					
		0	**25**	**≤ 38.5**	**> 38.5**	**70**	**100**
Base/TCV Stuck Closed/MSIVOOS	≤ 60	2.52	2.52	2.20	1.96		1.48
	> 60	2.73	2.73	2.32			
TBVOOS	≤ 60	3.44	3.44	2.63	2.02		1.48
	> 60	3.54	3.54	2.77			
TCV Slow Closure/ PLUOOS/PCOOS	≤ 60	2.52	2.52	2.32	2.30	1.95	1.48
	> 60	2.73	2.73	2.32			
FHOOS							
EOOS Condition	**Core Flow (% rated)**	**Core Power (% rated)**					
		0	**25**	**≤ 38.5**	**> 38.5**	**70**	**100**
Base/TCV Stuck Closed/MSIVOOS	≤ 60	2.69	2.69	2.33	2.08		1.48
	> 60	2.73	2.73	2.33			
TBVOOS	≤ 60	3.57	3.57	2.73	2.13		1.50
	> 60	3.65	3.65	2.85			
TCV Slow Closure/ PLUOOS/PCOOS	≤ 60	2.69	2.69	2.33	2.30	1.95	1.48
	> 60	2.73	2.73	2.33			

Table 4-11: ATRIUM 10XM TLO $MCPR_p$ Limits for TSSS Insertion Times, EOFPLB to EOCLB (38,325 MWd/MTU CAVEX)
(Reference 2)

Nominal FWT							
EOOS Condition	**Core Flow (% rated)**	**Core Power (% rated)**					
		0	**25**	**≤ 38.5**	**> 38.5**	**70**	**100**
Base/TCV Stuck Closed/MSIVOOS	≤ 60	2.52	2.52	2.20	1.98		1.48
	> 60	2.73	2.73	2.32			
TBVOOS	≤ 60	3.44	3.44	2.63	2.04		1.51
	> 60	3.54	3.54	2.77			
TCV Slow Closure/ PLUOOS/PCOOS	≤ 60	2.52	2.52	2.32	2.32	1.99	1.49
	> 60	2.73	2.73	2.32			
FHOOS							
EOOS Condition	**Core Flow (% rated)**	**Core Power (% rated)**					
		0	**25**	**≤ 38.5**	**> 38.5**	**70**	**100**
Base/TCV Stuck Closed/MSIVOOS	≤ 60	2.69	2.69	2.33	2.11		1.48
	> 60	2.73	2.73	2.33			
TBVOOS	≤ 60	3.57	3.57	2.73	2.15		1.52
	> 60	3.65	3.65	2.85			
TCV Slow Closure/ PLUOOS/PCOOS	≤ 60	2.69	2.69	2.33	2.32	1.99	1.49
	> 60	2.73	2.73	2.33			

Table 4-12: OPTIMA2 TLO $MCPR_p$ Limits for NSS Insertion Times, BOC to NEOC (35,057 MWd/MTU CAVEX)
(Reference 2)

Nominal FWT							
EOOS Condition	Core Flow (% rated)	Core Power (% rated)					
		0	25	≤ 38.5	> 38.5	70	100
Base/TCV Stuck Closed/MSIVOOS	≤ 60	2.41	2.41	2.10	1.96		1.53
	> 60	2.71	2.71	2.35			
TBVOOS	≤ 60	3.24	3.24	2.49	2.03		1.54
	> 60	3.47	3.47	2.77			
TCV Slow Closure/ PLUOOS/PCOOS	≤ 60	2.41	2.41	2.35	2.33	1.96	1.53
	> 60	2.71	2.71	2.35			
FHOOS							
EOOS Condition	Core Flow (% rated)	Core Power (% rated)					
		0	25	≤ 38.5	> 38.5	70	100
Base/TCV Stuck Closed/MSIVOOS	≤ 60	2.57	2.57	2.24	2.12		1.53
	> 60	2.71	2.71	2.35			
TBVOOS	≤ 60	3.36	3.36	2.57	2.14		1.54
	> 60	3.60	3.60	2.86			
TCV Slow Closure/ PLUOOS/PCOOS	≤ 60	2.57	2.57	2.35	2.33	1.96	1.53
	> 60	2.71	2.71	2.35			

Table 4-13: OPTIMA2 TLO $MCPR_p$ Limits for ISS Insertion Times, BOC to NEOC (35,057 MWd/MTU CAVEX)
(Reference 2)

Nominal FWT							
EOOS Condition	Core Flow (% rated)	Core Power (% rated)					
		0	25	≤ 38.5	> 38.5	70	100
Base/TCV Stuck Closed/MSIVOOS	≤ 60	2.41	2.41	2.10	1.96		1.53
	> 60	2.71	2.71	2.35			
TBVOOS	≤ 60	3.24	3.24	2.49	2.04		1.54
	> 60	3.47	3.47	2.77			
TCV Slow Closure/ PLUOOS/PCOOS	≤ 60	2.41	2.41	2.35	2.34	1.97	1.53
	> 60	2.71	2.71	2.35			
FHOOS							
EOOS Condition	Core Flow (% rated)	Core Power (% rated)					
		0	25	≤ 38.5	> 38.5	70	100
Base/TCV Stuck Closed/MSIVOOS	≤ 60	2.57	2.57	2.24	2.12		1.53
	> 60	2.71	2.71	2.35			
TBVOOS	≤ 60	3.36	3.36	2.57	2.15		1.54
	> 60	3.60	3.60	2.86			
TCV Slow Closure/ PLUOOS/PCOOS	≤ 60	2.57	2.57	2.35	2.34	1.97	1.53
	> 60	2.71	2.71	2.35			

Table 4-14: OPTIMA2 TLO $MCPR_p$ Limits for TSSS Insertion Times, BOC to NEOC (35,057 MWd/MTU CAVEX)
(Reference 2)

Nominal FWT							
EOOS Condition	**Core Flow (% rated)**	**Core Power (% rated)**					
		0	**25**	**≤ 38.5**	**> 38.5**	**70**	**100**
Base/TCV Stuck Closed/MSIVOOS	≤ 60	2.41	2.41	2.10	1.97		1.53
	> 60	2.71	2.71	2.35			
TBVOOS	≤ 60	3.24	3.24	2.49	2.07		1.54
	> 60	3.47	3.47	2.77			
TCV Slow Closure/ PLUOOS/PCOOS	≤ 60	2.41	2.41	2.35	2.35	2.00	1.53
	> 60	2.71	2.71	2.35			
FHOOS							
EOOS Condition	**Core Flow (% rated)**	**Core Power (% rated)**					
		0	**25**	**≤ 38.5**	**> 38.5**	**70**	**100**
Base/TCV Stuck Closed/MSIVOOS	≤ 60	2.57	2.57	2.24	2.14		1.53
	> 60	2.71	2.71	2.35			
TBVOOS	≤ 60	3.36	3.36	2.57	2.18		1.54
	> 60	3.60	3.60	2.86			
TCV Slow Closure/ PLUOOS/PCOOS	≤ 60	2.57	2.57	2.35	2.35	2.00	1.53
	> 60	2.71	2.71	2.35			

Table 4-15: OPTIMA2 TLO MCPR$_p$ Limits for NSS Insertion Times, NEOC to EOFPLB (37,507 MWd/MTU CAVEX)
(Reference 2)

Nominal FWT							
EOOS Condition	**Core Flow (% rated)**	**Core Power (% rated)**					
		0	**25**	**≤ 38.5**	**> 38.5**	**70**	**100**
Base/TCV Stuck Closed/MSIVOOS	≤ 60	2.41	2.41	2.10	1.96		1.53
	> 60	2.71	2.71	2.35			
TBVOOS	≤ 60	3.24	3.24	2.49	2.03		1.54
	> 60	3.47	3.47	2.77			
TCV Slow Closure/ PLUOOS/PCOOS	≤ 60	2.41	2.41	2.35	2.33	1.97	1.53
	> 60	2.71	2.71	2.35			
FHOOS							
EOOS Condition	**Core Flow (% rated)**	**Core Power (% rated)**					
		0	**25**	**≤ 38.5**	**> 38.5**	**70**	**100**
Base/TCV Stuck Closed/MSIVOOS	≤ 60	2.57	2.57	2.24	2.12		1.53
	> 60	2.71	2.71	2.35			
TBVOOS	≤ 60	3.36	3.36	2.57	2.14		1.54
	> 60	3.60	3.60	2.86			
TCV Slow Closure/ PLUOOS/PCOOS	≤ 60	2.57	2.57	2.35	2.33	1.97	1.53
	> 60	2.71	2.71	2.35			

Table 4-16: OPTIMA2 TLO $MCPR_p$ Limits for ISS Insertion Times, NEOC to EOFPLB (37,507 MWd/MTU CAVEX)
(Reference 2)

Nominal FWT							
EOOS Condition	**Core Flow (% rated)**	**Core Power (% rated)**					
		0	**25**	**≤ 38.5**	**> 38.5**	**70**	**100**
Base/TCV Stuck Closed/MSIVOOS	≤ 60	2.41	2.41	2.10	1.96		1.53
	> 60	2.71	2.71	2.35			
TBVOOS	≤ 60	3.24	3.24	2.49	2.04		1.54
	> 60	3.47	3.47	2.77			
TCV Slow Closure/ PLUOOS/PCOOS	≤ 60	2.41	2.41	2.35	2.34	1.98	1.53
	> 60	2.71	2.71	2.35			
FHOOS							
EOOS Condition	**Core Flow (% rated)**	**Core Power (% rated)**					
		0	**25**	**≤ 38.5**	**> 38.5**	**70**	**100**
Base/TCV Stuck Closed/MSIVOOS	≤ 60	2.57	2.57	2.24	2.12		1.53
	> 60	2.71	2.71	2.35			
TBVOOS	≤ 60	3.36	3.36	2.57	2.15		1.54
	> 60	3.60	3.60	2.86			
TCV Slow Closure/ PLUOOS/PCOOS	≤ 60	2.57	2.57	2.35	2.34	1.98	1.53
	> 60	2.71	2.71	2.35			

Table 4-17: OPTIMA2 TLO $MCPR_p$ Limits for TSSS Insertion Times, NEOC to EOFPLB (37,507 MWd/MTU CAVEX)
(Reference 2)

Nominal FWT							
EOOS Condition	**Core Flow (% rated)**	**Core Power (% rated)**					
		0	**25**	**≤ 38.5**	**> 38.5**	**70**	**100**
Base/TCV Stuck Closed/MSIVOOS	≤ 60	2.41	2.41	2.10	1.97		1.53
	> 60	2.71	2.71	2.35			
TBVOOS	≤ 60	3.24	3.24	2.49	2.07		1.54
	> 60	3.47	3.47	2.77			
TCV Slow Closure/ PLUOOS/PCOOS	≤ 60	2.41	2.41	2.35	2.35	2.02	1.53
	> 60	2.71	2.71	2.35			
FHOOS							
EOOS Condition	**Core Flow (% rated)**	**Core Power (% rated)**					
		0	**25**	**≤ 38.5**	**> 38.5**	**70**	**100**
Base/TCV Stuck Closed/MSIVOOS	≤ 60	2.57	2.57	2.24	2.14		1.53
	> 60	2.71	2.71	2.35			
TBVOOS	≤ 60	3.36	3.36	2.57	2.18		1.54
	> 60	3.60	3.60	2.86			
TCV Slow Closure/ PLUOOS/PCOOS	≤ 60	2.57	2.57	2.35	2.35	2.02	1.53
	> 60	2.71	2.71	2.35			

Table 4-18: OPTIMA2 TLO $MCPR_p$ Limits for NSS Insertion Times, EOFPLB to EOCLB (38,325 MWd/MTU CAVEX)
(Reference 2)

Nominal FWT							
EOOS Condition	**Core Flow (% rated)**	**Core Power (% rated)**					
		0	**25**	**≤ 38.5**	**> 38.5**	**70**	**100**
Base/TCV Stuck Closed/MSIVOOS	≤ 60	2.41	2.41	2.10	1.96		1.53
	> 60	2.71	2.71	2.35			
TBVOOS	≤ 60	3.24	3.24	2.49	2.03		1.54
	> 60	3.47	3.47	2.77			
TCV Slow Closure/ PLUOOS/PCOOS	≤ 60	2.41	2.41	2.35	2.33	1.97	1.53
	> 60	2.71	2.71	2.35			
FHOOS							
EOOS Condition	**Core Flow (% rated)**	**Core Power (% rated)**					
		0	**25**	**≤ 38.5**	**> 38.5**	**70**	**100**
Base/TCV Stuck Closed/MSIVOOS	≤ 60	2.57	2.57	2.24	2.12		1.53
	> 60	2.71	2.71	2.35			
TBVOOS	≤ 60	3.36	3.36	2.57	2.14		1.54
	> 60	3.60	3.60	2.86			
TCV Slow Closure/ PLUOOS/PCOOS	≤ 60	2.57	2.57	2.35	2.33	1.97	1.53
	> 60	2.71	2.71	2.35			

Table 4-19: OPTIMA2 TLO $MCPR_P$ Limits for ISS Insertion Times, EOFPLB to EOCLB (38,325 MWd/MTU CAVEX)
(Reference 2)

Nominal FWT							
EOOS Condition	**Core Flow (% rated)**	**Core Power (% rated)**					
		0	**25**	**≤ 38.5**	**> 38.5**	**70**	**100**
Base/TCV Stuck Closed/MSIVOOS	≤ 60	2.41	2.41	2.10	1.96		1.53
	> 60	2.71	2.71	2.35			
TBVOOS	≤ 60	3.24	3.24	2.49	2.04		1.54
	> 60	3.47	3.47	2.77			
TCV Slow Closure/ PLUOOS/PCOOS	≤ 60	2.41	2.41	2.35	2.34	1.98	1.53
	> 60	2.71	2.71	2.35			
FHOOS							
EOOS Condition	**Core Flow (% rated)**	**Core Power (% rated)**					
		0	**25**	**≤ 38.5**	**> 38.5**	**70**	**100**
Base/TCV Stuck Closed/MSIVOOS	≤ 60	2.57	2.57	2.24	2.12		1.53
	> 60	2.71	2.71	2.35			
TBVOOS	≤ 60	3.36	3.36	2.57	2.15		1.54
	> 60	3.60	3.60	2.86			
TCV Slow Closure/ PLUOOS/PCOOS	≤ 60	2.57	2.57	2.35	2.34	1.98	1.53
	> 60	2.71	2.71	2.35			

Table 4-20: OPTIMA2 TLO $MCPR_p$ Limits for TSSS Insertion Times, EOFPLB to EOCLB (38,325 MWd/MTU CAVEX)
(Reference 2)

Nominal FWT							
EOOS Condition	**Core Flow (% rated)**	**Core Power (% rated)**					
		0	**25**	**≤ 38.5**	**> 38.5**	**70**	**100**
Base/TCV Stuck Closed/MSIVOOS	≤ 60	2.41	2.41	2.10	1.97		1.53
	> 60	2.71	2.71	2.35			
TBVOOS	≤ 60	3.24	3.24	2.49	2.07		1.54
	> 60	3.47	3.47	2.77			
TCV Slow Closure/ PLUOOS/PCOOS	≤ 60	2.41	2.41	2.35	2.35	2.02	1.53
	> 60	2.71	2.71	2.35			
FHOOS							
EOOS Condition	**Core Flow (% rated)**	**Core Power (% rated)**					
		0	**25**	**≤ 38.5**	**> 38.5**	**70**	**100**
Base/TCV Stuck Closed/MSIVOOS	≤ 60	2.57	2.57	2.24	2.14		1.53
	> 60	2.71	2.71	2.35			
TBVOOS	≤ 60	3.36	3.36	2.57	2.18		1.54
	> 60	3.60	3.60	2.86			
TCV Slow Closure/ PLUOOS/PCOOS	≤ 60	2.57	2.57	2.35	2.35	2.02	1.53
	> 60	2.71	2.71	2.35			

Table 4-21: ATRIUM 10XM SLO $MCPR_p$ Limits for NSS Insertion Times, All Exposures
(Reference 2)

Nominal FWT					
EOOS Condition (all include SLO)	**Core Power (% rated)**				
	0	**25**	**≤ 38.5**	**> 38.5**	**50**
Base/TCV Stuck Closed/MSIVOOS	2.54	2.54	2.22	2.09	2.06
TBVOOS	3.46	3.46	2.65	2.09	2.06
TCV Slow Closure/ PLUOOS/PCOOS	2.54	2.54	2.34	2.32	2.20
FHOOS					
EOOS Condition (all include SLO)	**Core Power (% rated)**				
	0	**25**	**≤ 38.5**	**> 38.5**	**50**
Base/TCV Stuck Closed/MSIVOOS	2.71	2.71	2.35	2.09	2.06
TBVOOS	3.59	3.59	2.75	2.14	2.06
TCV Slow Closure/ PLUOOS/PCOOS	2.71	2.71	2.35	2.32	2.20

Table 4-22: ATRIUM 10XM SLO $MCPR_p$ Limits for ISS Insertion Times, All Exposures
(Reference 2)

Nominal FWT					
EOOS Condition (all include SLO)	**Core Power (% rated)**				
	0	**25**	**≤ 38.5**	**> 38.5**	**50**
Base/TCV Stuck Closed/MSIVOOS	2.54	2.54	2.22	2.09	2.06
TBVOOS	3.46	3.46	2.65	2.09	2.06
TCV Slow Closure/ PLUOOS/PCOOS	2.54	2.54	2.34	2.32	2.20
FHOOS					
EOOS Condition (all include SLO)	**Core Power (% rated)**				
	0	**25**	**≤ 38.5**	**> 38.5**	**50**
Base/TCV Stuck Closed/MSIVOOS	2.71	2.71	2.35	2.10	2.06
TBVOOS	3.59	3.59	2.75	2.15	2.06
TCV Slow Closure/ PLUOOS/PCOOS	2.71	2.71	2.35	2.32	2.20

Table 4-23: ATRIUM 10XM SLO $MCPR_p$ Limits for TSSS Insertion Times, All Exposures
(Reference 2)

Nominal FWT					
EOOS Condition (all include SLO)	**Core Power (% rated)**				
	0	**25**	**≤ 38.5**	**> 38.5**	**50**
Base/TCV Stuck Closed/MSIVOOS	2.54	2.54	2.22	2.09	2.06
TBVOOS	3.46	3.46	2.65	2.09	2.06
TCV Slow Closure/ PLUOOS/PCOOS	2.54	2.54	2.34	2.34	2.22
FHOOS					
EOOS Condition (all include SLO)	**Core Power (% rated)**				
	0	**25**	**≤ 38.5**	**> 38.5**	**50**
Base/TCV Stuck Closed/MSIVOOS	2.71	2.71	2.35	2.13	2.06
TBVOOS	3.59	3.59	2.75	2.17	2.06
TCV Slow Closure/ PLUOOS/PCOOS	2.71	2.71	2.35	2.34	2.22

Table 4-24: OPTIMA2 SLO $MCPR_p$ Limits for NSS Insertion Times, All Exposures
(Reference 2)

Nominal FWT					
EOOS Condition (all include SLO)	**Core Power (% rated)**				
	0	**25**	**≤ 38.5**	**> 38.5**	**50**
Base/TCV Stuck Closed/MSIVOOS	2.43	2.43	2.17	2.17	2.14
TBVOOS	3.26	3.26	2.51	2.17	2.14
TCV Slow Closure/ PLUOOS/PCOOS	2.43	2.43	2.37	2.35	2.22
FHOOS					
EOOS Condition (all include SLO)	**Core Power (% rated)**				
	0	**25**	**≤ 38.5**	**> 38.5**	**50**
Base/TCV Stuck Closed/MSIVOOS	2.59	2.59	2.26	2.17	2.14
TBVOOS	3.38	3.38	2.59	2.17	2.14
TCV Slow Closure/ PLUOOS/PCOOS	2.59	2.59	2.37	2.35	2.22

Table 4-25: OPTIMA2 SLO $MCPR_p$ Limits for ISS Insertion Times, All Exposures
(Reference 2)

Nominal FWT					
EOOS Condition (all include SLO)	**Core Power (% rated)**				
	0	**25**	**≤ 38.5**	**> 38.5**	**50**
Base/TCV Stuck Closed/MSIVOOS	2.43	2.43	2.17	2.17	2.14
TBVOOS	3.26	3.26	2.51	2.17	2.14
TCV Slow Closure/ PLUOOS/PCOOS	2.43	2.43	2.37	2.36	2.23
FHOOS					
EOOS Condition (all include SLO)	**Core Power (% rated)**				
	0	**25**	**≤ 38.5**	**> 38.5**	**50**
Base/TCV Stuck Closed/MSIVOOS	2.59	2.59	2.26	2.17	2.14
TBVOOS	3.38	3.38	2.59	2.17	2.14
TCV Slow Closure/ PLUOOS/PCOOS	2.59	2.59	2.37	2.36	2.23

Table 4-26: OPTIMA2 SLO $MCPR_p$ Limits for TSSS Insertion Times, All Exposures
(Reference 2)

Nominal FWT					
EOOS Condition (all include SLO)	**Core Power (% rated)**				
	0	**25**	**≤ 38.5**	**> 38.5**	**50**
Base/TCV Stuck Closed/MSIVOOS	2.43	2.43	2.17	2.17	2.14
TBVOOS	3.26	3.26	2.51	2.17	2.14
TCV Slow Closure/ PLUOOS/PCOOS	2.43	2.43	2.37	2.37	2.25
FHOOS					
EOOS Condition (all include SLO)	**Core Power (% rated)**				
	0	**25**	**≤ 38.5**	**> 38.5**	**50**
Base/TCV Stuck Closed/MSIVOOS	2.59	2.59	2.26	2.17	2.14
TBVOOS	3.38	3.38	2.59	2.20	2.14
TCV Slow Closure/ PLUOOS/PCOOS	2.59	2.59	2.37	2.37	2.25

Table 4-27: ATRIUM 10XM and OPTIMA2 $MCPR_f$ Limits, All Insertion Times, All Exposures
(Reference 2)

EOOS Condition*	Core Flow (% rated)	$MCPR_f$ Limit
Base Case / FHOOS / PCOOS / PLUOOS / TCV Slow Closure / PLUOOS + PCOOS in TLO and SLO	0	1.70
	35	1.70
	108	1.18
Any Scenario with One MSIVOOS**	0	1.81
	35	1.81
	108	1.18
Any Scenario with TBVOOS**	0	1.90
	35	1.90
	108	1.35
Any Scenario with 1 Stuck Closed TCV/TSV**	0	1.70
	35	1.70
	108	1.18

* See Section 8 for further operating restrictions.
** "Any Scenario" implies any other combination of allowable EOOS conditions that is not otherwise covered by this table.

Note that the $MCPR_f$ limits for any scenario with 1 stuck closed TCV/TSV are identical to base case $MCPR_f$ limits. This is reflected in the thermal limit sets presented in Table 8-1.

5. Linear Heat Generation Rate

Technical Specification Sections 3.2.3, 3.4.1, and 3.7.7

The TMOL at rated conditions for the OPTIMA2 and ATRIUM 10XM fuel is established in terms of the maximum LHGR as a function of peak pellet (rod nodal) exposure. The LHGR limits for OPTIMA2 fuel are presented in Tables 5-1 through 5-5. The limits in Table 5-1 apply to OPTIMA2 lattices that do not require Gadolinia set down penalties as well as any natural blanket segments in OPTIMA2 fuel (lattice types 91 and 98). The limits in Tables 5-2 through 5-5 apply to OPTIMA2 lattices that do require Gadolinia set down penalties. The LHGR limits for ATRIUM 10XM fuel are presented in Table 5-6.

The power- and flow-dependent LHGR multipliers ($LHGRFAC_p$ and $LHGRFAC_f$) are applied directly to the LHGR limits to protect against fuel melting and overstraining of the cladding during an AOO (Reference 2). In all conditions, the margin to the LHGR limits is determined by applying the lowest multiplier from the applicable $LHGRFAC_p$ and $LHGRFAC_f$ multipliers for the power/flow statepoint of interest to the steady state LHGR limit (Reference 2).

$LHGRFAC_p$ and $LHGRFAC_f$ multipliers were established to support base case and all EOOS conditions for all Cycle 25 exposures and scram speeds. $LHGRFAC_p$ is scram speed-dependent for OPTIMA2 fuel. The $LHGRFAC_p$ multipliers for ATRIUM 10XM are presented in Table 5-7. The $LHGRFAC_p$ multipliers for OPTIMA2 are presented in Tables 5-8 and 5-9, with Table 5-8 containing multipliers for NSS and ISS and Table 5-9 containing multipliers for TSSS. NSS, ISS, and TSSS are defined in Section 4.2. The $LHGRFAC_f$ multipliers for ATRIUM 10XM and OPTIMA2 are presented in Table 5-10 and Table 5-11, respectively.

Table 5-1: LHGR Limits for OPTIMA2 Lattices 91, 98, 152, 153, 154, 155, 159, 160, 161, 162, 163, 164, 166, 167, 168, 169, 170, 171, 172, 173, 174, 178, 179, 180, 181, 185, 186, 187, 188, 189, and 190
(References 3 and 10)

Rod Nodal Exposure (MWd/MTU)	LHGR Limit (kW/ft)
0	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 OPTIMA2 Lattices 156, 157, and 158
(Reference 10)

Rod Nodal Exposure (MWd/MTU)	LHGR Limit (kW/ft)
0	13.72
14,000	13.11
19,999	12.51
20,000	12.38
35,000	10.92
35,001	11.04
62,000	8.38
75,000	3.43

Table 5-3: LHGR Limits for OPTIMA2 Lattice 165
(Reference 10)

Rod Nodal Exposure (MWd/MTU)	LHGR Limit (kW/ft)
0	13.72
14,000	13.11
32,999	11.24
33,000	11.11
37,000	10.73
37,001	10.84
62,000	8.38
75,000	3.43

Table 5-4: LHGR Limits for OPTIMA2 Lattices 176, 177, 183 and 184
(Reference 3)

Rod Nodal Exposure (MWd/MTU)	LHGR Limit (kW/ft)
0	13.72
14,000	13.11
20,000	12.52
20,001	12.39
23,000	12.10
37,000	10.73
37,001	10.84
57,000	8.87
62,000	8.38
75,000	3.43

Table 5-5: LHGR Limits for OPTIMA2 Lattices 175 and 182
(Reference 3)

Rod Nodal Exposure (MWd/MTU)	LHGR Limit (kW/ft)
0	13.72
14,000	13.11
14,001	12.84
23,000	11.98
34,000	10.92
34,001	11.14
57,000	8.87
62,000	8.38
75,000	3.43

Table 5-6: LHGR Limits for ATRIUM 10XM
(Reference 2)

Peak Pellet Exposure (MWd/MTU)	LHGR Limit (kW/ft)
0	14.1
18,900	14.1
74,400	7.4

Table 5-7: ATRIUM 10XM LHGRFAC$_p$ Multipliers, All Insertion Times, All Exposures
(Reference 2)

Nominal FWT								
EOOS Condition	**Core Flow (% rated)**	**Core Power (%rated)**						
		0	**25**	**≤ 38.5**	**> 38.5**	**50**	**80**	**100**
Base/TCV Stuck Closed/MSIVOOS	≤ 60	0.51	0.51	0.59	0.67	0.70	0.93	1.00
	> 60	0.51	0.51	0.59				
TBVOOS	≤ 60	0.39	0.39	0.55	0.67	0.70	0.93	1.00
	> 60	0.38	0.38	0.51				
TCV Slow Closure/ PLUOOS/PCOOS	≤ 60	0.51	0.51	0.59	0.67	0.70	0.93	1.00
	> 60	0.51	0.51	0.59				
FHOOS								
EOOS Condition	**Core Flow (% rated)**	**Core Power (%rated)**						
		0	**25**	**≤ 38.5**	**> 38.5**	**50**	**80**	**100**
Base/TCV Stuck Closed/MSIVOOS	≤ 60	0.49	0.49	0.57	0.67	0.70	0.93	1.00
	> 60	0.47	0.47	0.55				
TBVOOS	≤ 60	0.38	0.38	0.51	0.67	0.70	0.93	1.00
	> 60	0.36	0.36	0.48				
TCV Slow Closure/ PLUOOS/PCOOS	≤ 60	0.49	0.49	0.57	0.67	0.70	0.93	1.00
	> 60	0.47	0.47	0.55				

Table 5-8: OPTIMA2 LHGRFAC$_p$ Multipliers, NSS and ISS Insertion Times, All Exposures
(Reference 2)

Nominal FWT									
EOOS Condition	Core Flow (% rated)	Core Power (%rated)							
		0	25	≤ 38.5	> 38.5	50	60	70	80	100
Base/TCV Stuck Closed/MSIVOOS	≤ 60	0.58	0.58	0.63	0.69	0.76	0.83		0.88	0.99
	> 60	0.54	0.54	0.63						
TBVOOS	≤ 60	0.42	0.42	0.54	0.68	0.72	0.73		0.76	0.96
	> 60	0.42	0.42	0.50						
TCV Slow Closure/ PLUOOS/PCOOS	≤ 60	0.58	0.58	0.63	0.63	0.68		0.72	0.85	0.98
	> 60	0.54	0.54	0.63						
FHOOS										
EOOS Condition	Core Flow (% rated)	Core Power (%rated)							
		0	25	≤ 38.5	> 38.5	50	60	70	80	100
Base/TCV Stuck Closed/MSIVOOS	≤ 60	0.53	0.53	0.60	0.63	0.70	0.76		0.87	0.97
	> 60	0.53	0.53	0.60						
TBVOOS	≤ 60	0.40	0.40	0.52	0.63	0.69	0.73		0.76	0.94
	> 60	0.40	0.40	0.49						
TCV Slow Closure/ PLUOOS/PCOOS	≤ 60	0.53	0.53	0.60	0.63	0.68		0.72	0.85	0.97
	> 60	0.53	0.53	0.60						

Table 5-9: OPTIMA2 LHGRFAC$_p$ Multipliers, TSSS Insertion Times, All Exposures
(Reference 2)

Nominal FWT										
EOOS Condition	Core Flow (% rated)	Core Power (%rated)								
		0	25	≤ 38.5	> 38.5	50	60	70	80	100
Base/TCV Stuck Closed/MSIVOOS	≤ 60	0.58	0.58	0.63	0.69	0.76	0.83		0.88	0.97
	> 60	0.54	0.54	0.63						
TBVOOS	≤ 60	0.42	0.42	0.54	0.68	0.72	0.73		0.76	0.94
	> 60	0.42	0.42	0.50						
TCV Slow Closure/ PLUOOS/PCOOS	≤ 60	0.58	0.58	0.63	0.63	0.68		0.72	0.85	0.97
	> 60	0.54	0.54	0.63						
FHOOS										
EOOS Condition	Core Flow (% rated)	Core Power (%rated)								
		0	25	≤ 38.5	> 38.5	50	60	70	80	100
Base/TCV Stuck Closed/MSIVOOS	≤ 60	0.53	0.53	0.60	0.63	0.70	0.76		0.87	0.96
	> 60	0.53	0.53	0.60						
TBVOOS	≤ 60	0.40	0.40	0.52	0.63	0.69	0.73		0.76	0.93
	> 60	0.40	0.40	0.49						
TCV Slow Closure/ PLUOOS/PCOOS	≤ 60	0.53	0.53	0.60	0.63	0.68		0.72	0.85	0.96
	> 60	0.53	0.53	0.60						

Table 5-10: ATRIUM 10XM $LHGRFAC_f$ Multipliers, All Insertion Times, All Exposures, All EOOS
(Reference 2)

Core Flow (% rated)	$LHGRFAC_f$
0.0	0.57
35.0	0.57
80.0	1.00
108.0	1.00

Table 5-11: OPTIMA2 $LHGRFAC_f$ Multipliers, All Insertion Times, All Exposures, All EOOS
(Reference 2)

Core Flow (% rated)	$LHGRFAC_f$
0.0	0.27
20.0	0.43
40.0	0.60
80.0	1.00
100.0	1.00
108.0	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: Rod Block Monitor Upscale Instrumentation Setpoints
(Reference 11)

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%

W_d – percent of recirculation loop drive flow required to produce a rated core flow of 98.0 Mlb/hr.

The setpoint may be lower/higher and will still comply with the CRWE analysis because CRWE is analyzed unblocked (Reference 2).

7. Stability Protection Setpoints

Technical Specifications Section 3.3.1.3

The OPRM PBDA Trip Settings are provided in Table 7-1.

Table 7-1: OPRM PBDA Trip Settings
(Reference 2)

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 (Methodology 3).

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 EOOS are as described in Table 8-1. The EOOS conditions separated by "/" in these tables represent single EOOS conditions and not combinations of conditions.

Note that the following EOOS options have operational restrictions: all SLO, all EOOS options with 1 TCV/TSV stuck closed, and MSIVOOS. See Table 8-2 for specific restrictions.

Table 8-1: Modes of Operation
(Reference 2)

EOOS Option	Thermal Limit Set
Base Case	BASE CASE ➢ TLO or SLO ➢ Nominal FWT or FHOOS
TBVOOS due to Main Generator Load Reject Trip Relays OOS	PLUOOS/TCV SLOW C ➢ TLO for Nominal FWT*
TBVOOS	TBVOOS ➢ TLO or SLO ➢ Nominal FWT or FHOOS
1 TCV/TSV Stuck Closed	BASE CASE ➢ TLO or SLO ➢ Nominal FWT or FHOOS
One MSIVOOS	MSIVOOS ➢ TLO or SLO ➢ Nominal FWT or FHOOS
TCV Slow Closure	PLUOOS/TCV SLOW C ➢ TLO or SLO ➢ Nominal FWT or FHOOS
PLUOOS	PLUOOS/TCV SLOW C ➢ TLO or SLO ➢ Nominal FWT or FHOOS
PCOOS	PLUOOS/TCV SLOW C ➢ TLO or SLO ➢ Nominal FWT or FHOOS
PLUOOS and 1 TCV/TSV Stuck Closed	PLUOOS/TCV SLOW C ➢ TLO for Nominal FWT or FHOOS ➢ SLO for Nominal FWT**
PCOOS and PLUOOS	PLUOOS/TCV SLOW C ➢ TLO for Nominal FWT or FHOOS ➢ SLO for Nominal FWT**
PCOOS and 1 TCV/TSV Stuck Closed	PLUOOS/TCV SLOW C ➢ TLO for Nominal FWT or FHOOS ➢ SLO for Nominal FWT**

* SLO and FHOOS cannot be applied for the case of TBVOOS due to main generator load reject trip relays OOS.
** FHOOS cannot be applied to SLO for the cases of PLUOOS and 1 TCV/TSV Stuck Closed, for the case of PCOOS and PLUOOS, or for the case of PCOOS and 1 TCV/TSV Stuck Closed.

Common Notes:

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 2). The licensing analysis supports full power operation to EOCLB (38,325 MWd/MTU CAVEX). Note that this value includes coastdown, where full power operation is not expected. Each OOS Option may be combined with each of the following conditions (Reference 2):
    a. Up to 40% of the TIP channels OOS
    b. Up to 50% of the LPRMs OOS
    c. An LPRM calibration frequency of up to 2500 EFPH

2. Nominal FWT results are valid for application within a +10°F/-30°F temperature band around the nominal FWT curve (Reference 2). For operation outside of nominal FWT, a FWT reduction of between 30°F and 120°F is supported for all FHOOS conditions listed in Table 8-1 for cycle operation through EOCLB (Reference 2). At lower power levels, the feedwater temperature reduction is less (Reference 2). Per Reference 12, there is a restriction which 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 FHOOS limits should be applied.

3. The base case and EOOS limits and multipliers support operation with 8 of 9 turbine bypass valves operational (i.e., one bypass valve out of service) with the exception of the TBVOOS condition in which all bypass valves are inoperable (Reference 2). Use of the response curve in TRM Appendix H supports operation with any single TBV OOS. TRM Appendix H facilitates analysis with one valve OOS in that the capacity at 0.45 seconds from start of TSV closure is equivalent to the total capacity with eight out of the nine valves in service (Reference 9). The analyses also support Turbine Bypass flow of 29.6% of vessel rated steam flow (Reference 9), equivalent to one TBV OOS (or partially closed TBVs equivalent to one closed TBV), if the assumed opening profile for the remaining TBVs is met. If the opening profile is NOT met, or if the TBV system CANNOT pass an equivalent of 29.6% of vessel rated steam flow, utilize the TBVOOS condition.

4. For the TBVOOS condition, analyses assume zero TBVs trip open and zero TBVs are available for pressure control during the slow portion of the transient analysis (Reference 9). Steam relief capacity is defined in Reference 9.

5. Failure of the main generator load reject trip relays to actuate (e.g., main generator load reject trip relays OOS) will render the turbine bypass valve system inoperable during load reject events (Reference 14). Operation with the main generator load reject trip relays out of service in TLO is supported by the TCV slow closure limits (Reference 2), meaning that, in accordance with Table 8-1, the PLUOOS/TCV SLOW C thermal limit set should be applied. This is applicable between 25% and 50% of rated thermal power.

Table 8-2: Core Operational Restrictions for EOOS Conditions
(Reference 2)

EOOS Condition	Core Flow (% of Rated)	Core Thermal Power (% of Rated Power)	Rod Line (%)
1 TCV/TSV Stuck Closed PCOOS and 1 TCV/TSV Stuck Closed PLUOOS and 1 TCV/TSV Stuck Closed	N/A	< 75	< 80
One MSIVOOS	N/A	< 75	N/A
SLO	< 51	< 50	N/A

All requirements for all applicable conditions listed in Table 8-2 MUST be met.

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. GE Topical Report NEDE-24011-P-A, Revision 14, "General Electric Standard Application for Reactor Fuel (GESTAR)," June 2000.

2. Removed.

3. GE Topical Report NEDO-32465-A, Revision 0, "Reactor Stability Detect and Suppress Solutions Licensing Basis Methodology for Reload Applications," August 1996.

4. Westinghouse Topical Report CENPD-300-P-A, Revision 0, "Reference Safety Report for Boiling Water Reactor Reload Fuel," July 1996.

5. Westinghouse Report WCAP-16081-P-A, Revision 0, "10x10 SVEA Fuel Critical Power Experiments and CPR Correlation: SVEA-96 Optima2," March 2005.

6. Westinghouse Report WCAP-15682-P-A, Revision 0, "Westinghouse BWR ECCS Evaluation Model: Supplement 2 to Code Description, Qualification and Application," April 2003.

7. Westinghouse 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 CENP-287," March 2006.

10. Westinghouse Topical Report CENPD-390-P-A, Revision 0, "The Advanced PHOENIX and POLCA Codes for Nuclear Design of Boiling Water Reactors," December 2000.

11. Westinghouse Report WCAP-16865-P-A, Revision 1, "Westinghouse BWR ECCS Evaluation Model Updates: Supplement 4 to Code Description, Qualification and Application," October 2011.

12. Exxon Nuclear Company Report XN-NF-81-58(P)(A), Revision 2 and Supplements 1 and 2, "RODEX2 Fuel Rod Thermal-Mechanical Response Evaluation Model," March 1984.

13. Advanced Nuclear Fuels Corporation Report ANF-89-98(P)(A), Revision 1 and Supplement 1, "Generic Mechanical Design Criteria for BWR Fuel Designs," May 1995.

14. Siemens Power Corporation Report EMF-85-74(P), Revision 0 Supplement 1 (P)(A) and Supplement 2 (P)(A), "RODEX2A (BWR) Fuel Rod Thermal-Mechanical Evaluation Model," February 1998.

15. AREVA NP Topical Report BAW-10247PA, Revision 0, "Realistic Thermal-Mechanical Fuel Rod Methodology for Boiling Water Reactors," February 2008.

16. Exxon Nuclear Company Topical Report XN-NF-80-19(P)(A), Volume 1 Revision 0 and Supplements 1 and 2, "Exxon Nuclear Methodology for Boiling Water Reactors – Neutronic Methods for Design and Analysis," March 1983.

17. Exxon Nuclear Company Topical Report XN-NF-80-19(P)(A), Volume 4 Revision 1, "Exxon Nuclear Methodology for Boiling Water Reactors: Application of the ENC Methodology for BWR Reloads," June 1986.

18. Exxon Nuclear Company Topical Report XN-NF-80-19(P)(A), Volume 3 Revision 2, "Exxon Nuclear Methodology for Boiling Water Reactors, THERMEX: Thermal Limits Methodology Summary Description," January 1987.

19. Siemens Power Corporation Topical Report EMF-2158(P)(A), Revision 0, "Siemens Power Corporation Methodology for Boiling Water Reactors: Evaluation and Validation of CASMO-4/MICROBURN-B2," October 1999.

20. Siemens Power Corporation Report EMF-2245(P)(A), Revision 0, "Application of Siemens Power Corporation's Critical Power Correlations to Co-Resident Fuel," August 2000.

21. AREVA NP Report EMF-2209(P)(A), Revision 3, "SPCB Critical Power Correlation," September 2009.

22. AREVA Topical Report ANP-10298P-A, Revision 1, "ACE/ATRIUM 10XM Critical Power Correlation," March 2014.

23. AREVA NP Topical Report ANP-10307PA, Revision 0, "AREVA MCPR Safety Limit Methodology for Boiling Water Reactors," June 2011.

24. Exxon Nuclear Company Report XN-NF-84-105(P)(A), Volume 1 Revision 0 and Volume 1 Supplements 1 and 2, "XCOBRA-T: A Computer Code for BWR Transient Thermal-Hydraulic Core Analysis," February 1987.

25. Advanced Nuclear Fuels Corporation Report ANF-913(P)(A), Volume 1 Revision 1 and Volume 1 Supplements 2, 3, and 4, "COTRANSA2: A Computer Program for Boiling Water Reactor Transient Analyses," August 1990.

26. Framatome ANP Report EMF-2361(P)(A), Revision 0, "EXEM BWR-2000 ECCS Evaluation Model," May 2001.

27. Siemens Power Corporation Report EMF-2292 (P)(A), Revision 0, "ATRIUM™-10: Appendix K Spray Heat Transfer Coefficients," September 2000.

28. Framatome ANP Topical Report ANF-1358(P)(A), Revision 3, "The Loss of Feedwater Heating Transient in Boiling Water Reactors," September 2005.

29. Siemens Power Corporation Topical Report EMF-CC-074(P)(A), Volume 4 Revision 0, "BWR Stability Analysis: Assessment of STAIF with Input from MICROBURN-B2," August 2000.

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 No. DPR-30.
2. Framatome Report, ANP-3642P, Revision 1, "Quad Cities Unit 2 Cycle 25 Reload Safety Analysis," February 2018.
3. Westinghouse Document, NF-BEX-16-2, Revision 0, "Quad Cities Nuclear Power Station Unit 2 Cycle 24 Reload Licensing Report," January 2016.
4. Technical Specifications for Quad Cities 1 and 2, Table 3.1.4-1, "Control Rod Scram Times".
5. Westinghouse Document, NF-BEX-15-174-NP, Revision 0, "Quad Cities Nuclear Power Station Unit 2 Cycle 24 MAPLHGR Report," January 2016.
6. Westinghouse Letter, NF-BEX-15-109, Revision 0, "Bundle Design Report for Quad Cities Unit 2 Cycle 24," August 4, 2015.
7. Westinghouse Document, NF-BEX-13-168-NP, Revision 0, "Quad Cities Nuclear Power Station Unit 2 Cycle 23 MAPLHGR Report," January 2014.
8. Westinghouse Letter, NF-BEX-13-122, Revision 0, "Bundle Design Report for Quad Cities 2 Cycle 23," September 9, 2013.
9. Exelon TODI, ES1700011, Revision 4, "Quad Cities Unit 2 Cycle 25 Plant Parameters Document," November 7, 2017.
10. Westinghouse Document, NF-BEX-14-4, Revision 0, "Quad Cities Nuclear Power Station Unit 2 Cycle 23 Reload Licensing Report," February 2014.
11. 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)
12. Exelon Letter, NF-MW:02-0081, "Approval of GE Evaluation of Dresden and Quad Cities Extended Final Feedwater Temperature Reduction," August 27, 2002.
13. AREVA Report, ANP-3612P, Revision 0, "Quad Cities Unit 2 Cycle 25 ATRIUM 10XM Fuel Nuclear Fuel Design Report," September 2017.