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February 3, 2000

SVP-00-033

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

Quad Cities Nuclear Power Station, Units 1 and 2  
Facility Operating License Nos. DPR-29 and DPR-30  
NRC Docket Nos. 50-254 and 50-265

Subject: Q2C16 Core Operating Limits Report

On January 21, 2000, Quad Cities Nuclear Power Station Unit 2 was shutdown for refueling. In accordance with Technical Specification 6.9.A.6.c, the Quad Cities Unit 2 Cycle 16 Core Operating Limits Report is enclosed.

Should you have any questions concerning this letter, please contact Mr. C.C. Peterson at (309) 654-2241, extension 3609.

Respectfully,

A handwritten signature in black ink, appearing to read "Joel P. Dimmette, Jr.", is written over a large, stylized flourish that extends upwards and to the left.

Joel P. Dimmette, Jr.  
Site Vice President  
Quad Cities Nuclear Power Station

Attachments:

Q2C16 Core Operating Limits Report

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

AW01

**Attachment, Q2C16 Core Operating Limits Report,  
SVP-00-033**

**ISSUANCE OF CHANGES SUMMARY**

Affected Section	Affected Pages	Summary of Changes	Date
All	All	Original Issue (Cycle 14).	6/95
All	All	Latest Date Revised added to each COLR page, Added Special Instructions and boxed in TSUP References for TSUP Implementation. Added Control Rod Withdrawal Block Equation for Single Loop Operation.	5/96
All	All	Original Issue (Cycle 15).	5/97
All	All	<ol style="list-style-type: none"> <li>1. "Cycle 15" Changed to "Cycle 15 Revision 1"</li> <li>2. Added references 10, 11 and 12 to support Cycle 15 Revision 1 Core Loading to Reference Section on Page iv</li> <li>3. Page Dates Changed</li> </ol>	10/97
All	All	<ol style="list-style-type: none"> <li>1. Changed MCPR Operating Limits for ATRIUM-9B and associated wording</li> <li>2. Changed Revisions of Reload Analysis and Plant Transient Analysis (References 7 and 8)</li> <li>3. Added Reference 13 to support Cycle 15 Rev 1 CPR and Transient Re-analysis</li> <li>4. Page Dates Changed</li> <li>5. Added "C" to Section 3.2 in front of TLHGR section</li> <li>6. Added a table with the manual flow control MCPR<sub>r</sub> values</li> <li>7. Added Technical Specification reference 3.11.B to Section 3.1</li> </ol>	5/98
References, List of Tables, List of Figures, 1.0, 4.0 and 5.0	iv, v, vi, vii, Page 1, 4, 4-1, 4-2 and 5	<ol style="list-style-type: none"> <li>1. Changed MCPR Safety Limit to 1.11</li> <li>2. Changed MCPR Operating Limits to incorporate new SPC modeling GE fuel characteristics (gap conductance) and to implement exposure dependent MCPR limits and updated the references accordingly</li> <li>3. Changed rod block monitor setpoint</li> <li>4. Updated references</li> </ol>	2/99
All	All	Original Issue, Cycle 16	1/2000

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### **SPECIAL INSTRUCTIONS**

1. This Core Operating Limits Report (COLR) contains the applicable reactor core limits and operational information mandated by Technical Specifications Section 6.9.A.6. When the COLR is referenced by applicable Technical Specifications or procedures for Technical Specification compliance, a controlled copy of this report shall be used as the official source of the applicable limit or requirement.

## REFERENCES

1. Commonwealth Edison Company and Midamerican Energy Company Docket No. 50-265, Quad Cities Station, Unit 2 Facility Operating License, License No. DPR-30.
2. Letter from D. M. Crutchfield to All Power Reactor Licensees and Applicants, Generic Letter 88-16; Removal of Cycle-Specific Parameter Limits from Technical Specifications.
3. Quad Cities Nuclear Power Station, Units 1 and 2, SAFER/GESTR - LOCA Loss-of-Coolant Accident Analysis, NEDC-31345P, Revision 2, July 1989 (as amended).
4. Letter to Dr. R.J. Chin from R.E. Parr, "QC1/QC2 SAFER/GESTR Single Loop Operation Analysis with Delayed LPCI Injection", REP:93.020, February 12, 1993.
5. Lattice Dependent MAPLHGR Report for Quad Cities Nuclear Power Station, Unit 2, Reload 13 Cycle 14, 24A5161-AA Revision 0, December, 1994.
6. SPC Document, EMF-96-185(P) Rev. 4, "Quad Cities LOCA-ECCS Analysis MAPLHGR Limits for ATRIUM-9B Fuel", March, 1997, NDIT # NFM9700015 Seq. 3.
7. SPC Document EMF-96-037(P) Rev. 1, "Quad Cities Extended Operating Domain (EOD) and Equipment Out of Service (EOOS) Safety Analysis for ATRIUM-9B Fuel", September, 1996, and Rev. 1 Supplement 1, September 1998.
8. SPC Document, EMF-2299 Rev. 0, "Quad Cities Unit 2 Cycle 16 Reload Analysis", November 1999 (COLR Attachment).
9. SPC Document EMF-2302 Rev. 0, "Quad Cities Unit 2 Cycle 16 Plant Transient Analysis", November 1999 (COLR Attachment)
10. NDIT NFM9900245 Seq 1, "Quad Cities 2 Cycle 16 Design Basis Loading Plan (DBLP)", December 20, 1999.
11. NDIT NFM9900216 Seq 0, "Quad Cities Unit 2 Cycle 16 Neutronics Licensing Report (NLR), December 8, 1999.

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## 1.0 CONTROL ROD WITHDRAWAL BLOCK INSTRUMENTATION

### 1.1. TECHNICAL SPECIFICATION REFERENCE:

Technical Specification: 3.3.M, Table 3.2.E-1 [COLR 1.2], 3.6.A.1.c [COLR 1.3]
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### 1.2. DESCRIPTION (TLO):

The Rod Withdrawal Block Monitor Upscale Instrumentation Trip Setpoint for Two Recirculation Loop Operation is determined from the following relationship:

$$\leq (0.65)Wd + 55\% \text{ **}$$

### 1.3. DESCRIPTION (SLO):

The Rod Withdrawal Block Monitor Upscale Instrumentation Trip Setpoint for Single Recirculation Loop Operation (SLO) is determined from the following relationship.

$$\leq (0.65)Wd + 51\% \text{ **}$$

\*\* Clamped, with an allowable value not to exceed the allowable value for recirculation loop drive flow (Wd) of 100%.

Wd is the percent of drive flow required to produce a rated core flow of 98 million lb/hr. Trip level setting is in percent of rated power (2511 MWth).



## 2.0 AVERAGE PLANAR LINEAR HEAT GENERATION RATE (APLHGR)

### 2.1 TECHNICAL SPECIFICATION REFERENCE:

**Technical Specification 3.11.A**

### 2.2 DESCRIPTION:

MAPLHGR versus Average Planar Exposure for GE9B-P8DWB310-7G3.0-80M-145-T is determined from Table 2-1.

MAPLHGR versus Average Planar Exposure for GE9B-P8DWB308-10GZ1-80M-145-T is determined from Table 2-2.

MAPLHGR versus Average Planar Exposure for GE10-P8HXB316-8GZ-100M-145-T is determined from Table 2-3.

MAPLHGR versus Average Planar Exposure for GE10-P8HXB312-7GZ-100M-145-T is determined from Table 2-4.

MAPLHGR versus Average Planar Exposure for SPCA9-372B-11GZH-ADV is determined from Table 2-5.

MAPLHGR versus Average Planar Exposure for SPCA9-358B-11GZL-ADV is determined from Table 2-5.

MAPLHGR versus Average Planar Exposure for SPCA9-383B-11GZH-ADV is determined from Table 2-5.

MAPLHGR versus Average Planar Exposure for SPCA9-381B-12GZL-ADV is determined from Table 2-5.

### 2.3 SINGLE LOOP OPERATION MULTIPLIER:

The tabulated values are multiplied by 0.85 for GE fuel and 0.90 for SPC fuel whenever Quad Cities operates in Single Loop.

TABLE 2-1

MAPLHGR vs. AVERAGE PLANAR EXPOSURE  
FOR BUNDLE TYPE : GE9B-P8DWB310-7G3.0-80M-145-T

LATTICE 731 : P8DWL071-NOG-80M-T  
LATTICE 1644 : P8DWL334-7G3.0-80M-T  
LATTICE 1645 : P8DWL350-7G3.0-80M-T  
LATTICE 1004 : P8DWL071-7GE-80M-T

AVERAGE PLANAR EXPOSURE (GWd/ST)	MAPLHGR LIMITS (KW/FT)			
	731	1644	1645	1004
0.00	11.64	12.25	11.78	11.64
0.20	11.57	12.32	11.85	11.57
1.00	11.38	12.46	11.99	11.38
2.00	11.36	12.62	12.19	11.36
3.00	11.41	12.79	12.36	11.41
4.00	11.49	12.96	12.52	11.49
5.00	11.56	13.14	12.69	11.56
6.00	11.63	13.23	12.81	11.63
7.00	11.69	13.30	12.93	11.69
8.00	11.74	13.38	13.04	11.74
9.00	11.78	13.43	13.14	11.78
10.00	11.81	13.46	13.21	11.81
12.50	11.54	13.41	13.22	11.54
15.00	11.16	13.03	12.95	11.16
20.00	10.37	12.29	12.31	10.37
25.00	9.58	11.58	11.62	9.58
35.00	8.01	10.28	10.31	8.01
43.66	4.71	-	-	4.71
45.00	-	9.04	9.01	-
51.41	-	-	5.88	-
51.43	-	5.94	-	-

TABLE 2-2

**MAPLHGR vs. AVERAGE PLANAR EXPOSURE  
FOR BUNDLE TYPE : GE9B-P8DWB308-10GZ1-80M-145-T**

LATTICE 731 : P8DWL071-NOG-80M-T  
LATTICE 1642 : P8DWL332-8G4.0/2G3.0-80M-T  
LATTICE 1669 : P8DWL348-8G4.0/2G3.0-80M-T  
LATTICE 1188 : P8DWL071-10GE-80M-T

AVERAGE PLANAR EXPOSURE (GWd/ST)	MAPLHGR LIMITS (KW/FT)			
	731	1642	1669	1188
0.00	11.64	11.63	11.24	11.64
0.20	11.57	11.69	11.31	11.57
1.00	11.38	11.83	11.44	11.38
2.00	11.36	12.04	11.62	11.36
3.00	11.41	12.25	11.82	11.41
4.00	11.49	12.48	12.02	11.49
5.00	11.56	12.58	12.24	11.56
6.00	11.63	12.69	12.44	11.63
7.00	11.69	12.86	12.62	11.69
8.00	11.74	13.04	12.75	11.74
9.00	11.78	13.19	12.90	11.78
10.00	11.81	13.31	13.05	11.81
12.50	11.54	13.32	13.14	11.54
15.00	11.16	12.96	12.92	11.16
20.00	10.37	12.22	12.25	10.37
25.00	9.58	11.53	11.57	9.58
35.00	8.01	10.24	10.26	8.01
43.66	4.71	-	-	4.71
45.00	-	8.93	8.93	-
51.09	-	5.96	-	-
51.15	-	-	5.90	-

TABLE 2-3

**MAPLHGR vs. AVERAGE PLANAR EXPOSURE  
FOR BUNDLE TYPE : GE10-P8HXB316-8GZ-100M-145-T**

LATTICE 7400 : P8HXL071-NOG-100M  
LATTICE 7467 : P8HXL341-6G4.0/2G3.0-100M  
LATTICE 7469 : P8HXL357-6G4.0/2G3.0-100M  
LATTICE 7468 : P8HXL341-8G3.0-100M  
LATTICE 7404 : P8HXL071-8GE-100M

AVERAGE PLANAR EXPOSURE (GWd/ST)	MAPLHGR LIMITS (KW/FT)				
	1054 7400*	1916 7467*	1917 7469*	1918 7468*	1807 7404*
0.00	11.85	12.00	11.11	12.08	11.85
0.20	11.78	12.06	11.14	12.15	11.78
1.00	11.59	12.18	11.24	12.30	11.59
2.00	11.57	12.36	11.44	12.53	11.57
3.00	11.61	12.50	11.70	12.68	11.61
4.00	11.68	12.60	11.99	12.82	11.68
5.00	11.75	12.71	12.26	12.96	11.75
6.00	11.81	12.84	12.37	13.12	11.81
7.00	11.86	13.01	12.51	13.29	11.86
8.00	11.91	13.20	12.68	13.44	11.91
9.00	11.94	13.39	12.86	13.53	11.94
10.00	11.97	13.52	13.01	13.55	11.97
12.50	11.75	13.44	13.09	13.44	11.75
15.00	11.38	13.06	12.84	13.07	11.38
20.00	10.59	12.32	12.21	12.33	10.59
25.00	9.81	11.60	11.54	11.61	9.81
35.00	8.26	10.21	10.25	10.22	8.26
44.89	4.93	-	-	-	4.93
45.00	-	8.72	8.82	8.72	-
50.76	-	-	-	5.87	-
50.78	-	5.86	-	-	-
50.88	-	-	5.90	-	-

\* Indicates ComEd lattice identifiers as opposed to the GE lattice identifiers

TABLE 2-4

MAPLHGR vs. AVERAGE PLANAR EXPOSURE  
FOR BUNDLE TYPE : GE10-P8HXB312-7GZ-100M-145-T

LATTICE 7400 : P8HXL071-NOG-100M  
LATTICE 7405 : P8HXL336-3G4.0/4G3.0-100M  
LATTICE 7406 : P8HXL354-1G4.0/6G3.0-100M  
LATTICE 7407 : P8HXL336-7G3.0-100M  
LATTICE 7408 : P8HXL071-7GE-100M

AVERAGE PLANAR EXPOSURE (GWd/ST)	MAPLHGR LIMITS (KW/FT)				
	1054 7400*	1808 7405*	1809 7406*	1810 7407*	1811 7408*
0.00	11.85	12.01	11.27	12.04	11.85
0.20	11.78	12.08	11.31	12.11	11.78
1.00	11.59	12.23	11.42	12.27	11.59
2.00	11.57	12.43	11.65	12.49	11.57
3.00	11.61	12.65	11.93	12.72	11.61
4.00	11.68	12.88	12.24	12.96	11.68
5.00	11.75	13.09	12.58	13.15	11.75
6.00	11.81	13.22	12.94	13.30	11.81
7.00	11.86	13.32	13.15	13.41	11.86
8.00	11.91	13.40	13.32	13.46	11.91
9.00	11.94	13.45	13.43	13.47	11.94
10.00	11.97	13.47	13.50	13.45	11.97
12.50	11.75	13.35	13.45	13.35	11.75
15.00	11.38	12.97	13.10	12.97	11.38
20.00	10.59	12.23	12.41	12.24	10.59
25.00	9.81	11.51	11.74	11.52	9.81
35.00	8.26	10.14	10.41	10.15	8.26
44.89	4.93	-	-	-	4.93
45.00	-	8.61	9.01	8.60	-
50.55	-	-	-	5.85	-
50.59	-	5.85	-	-	-
51.56	-	-	5.86	-	-

\* ComEd lattice identifiers as opposed to GE lattice identifiers

**TABLE 2-5**

**MAPLHGR vs. AVERAGE PLANAR EXPOSURE  
FOR BUNDLE TYPES :  
SPCA9-372B-11GZH-ADV  
SPCA9-358B-11GZL-ADV  
SPCA9-383B-11GZH-ADV  
SPCA9-381B-12GZL-ADV**

<b>Average Planar Exposure (GWd/MTU)</b>	<b>ATRIUM-9B MAPLHGR (kW/ft)</b>
0.0	13.5
20.0	13.5
60.0	8.7
61.1	8.6

**3.0 LINEAR HEAT GENERATION RATE (LHGR)**

**3.1 TECHNICAL SPECIFICATION REFERENCE:**

**Technical Specification 3.11.B, 3.11.D**

**3.2 DESCRIPTION:**

A. The LHGR limit is 14.4 Kw/ft for all GE fuel types:

1. GE9B-P8DWB310-7G3.0-80M-145-T
2. GE9B-P8DWB308-10GZ1-80M-145-T
3. GE10-P8HXB316-8GZ-100M-145-T
4. GE10-P8HXB312-7GZ-100M-145-T

B. The LHGR limits are provided in the table below for all of the SPC fuel types:

1. SPCA9-372B-11GZH-ADV
2. SPCA9-358B-11GZL-ADV
3. SPCA9-383B-11GZH-ADV
4. SPCA9-381B-12GZL-ADV

Average Planar Exposure (GWd/MTU)	ATRIUM-9B LHGR (kW/ft)
0.0	14.4
15.0	14.4
61.1	8.32

C. The Protection Against Power Transient LHGR Limit for ATRIUM-9B Offset fuel is provided in in the table below:

Average Planar Exposure (GWd/MTU)	LHGR (kW/ft)
0.0	19.4
15.0	19.4
61.1	11.2

#### 4.0 MINIMUM CRITICAL POWER RATIO (MCPR)

##### 4.1 TECHNICAL SPECIFICATION REFERENCE:

Technical Specifications 2.1.B and 3.11.C

##### 4.2 DESCRIPTION:

The MCPR Operating Limits are based on the dual loop MCPR Safety Limit of 1.11. For Single Loop Operation the MCPR Safety Limit is 1.12 which increases the MCPR operating limit by 0.01. The MCPR Operating Limits are also based on a 15 psi reduction in steam dome pressure and Technical Specification SCRAM speeds. EOD/EOOS conditions that require MCPR penalties are FHOOS, FFTR and coastdown or any combination thereof. Other analyzed EOD/EOOS conditions (per EMF-2299 Rev. 0) do not require a MCPR penalty.

The Operating Limit MCPR shall be determined as follows:

1. During steady-state operation at rated core flow, the Operating Limit MCPR shall be greater than or equal to the limits provided in Table 4-1 for the appropriate operating conditions.
2. During off-rated flow conditions in Manual Flow Control Mode, the Operating Limit MCPR for each fuel type at a specific core flow condition shall be determined from the greater of the following:
  - a. Table 4-2 or 4-3 using the appropriate operating condition and flow rate, or
  - b. Table 4-1 using the appropriate operating condition.
3. During off-rated flow conditions in Automatic Flow Control Mode, the Operating Limit MCPR for each fuel type at a specific core flow condition shall be determined from table 4-4 or 4-5 using the appropriate operating conditions.
4. During PLU Out of Service conditions a 0.973 MFLCPR multiplier shall be used during operation up to EOFP and a 0.969 MFLCPR multiplier shall be used during coastdown.



**TABLE 4-1**  
**Steady State MCPR Operating Limits**

<b>Operating Condition</b>	<b>GE9</b>	<b>GE10</b>	<b>ATRIUM-9B</b>
Normal Operation (1.11 SLMCPR)	1.53	1.49	1.46
Single Loop Operation (1.12 SLMCPR)	1.54	1.50	1.47
EOD/EOOS Dual Loop Operation (1.11 SLMCPR) to support FFTR, FHOOS, coastdown or any combination thereof. Other EOD/EOOS conditons require no MCPR penalty.	1.55	1.59	1.49
EOD/EOOS Single Loop Operation (1.12 SLMCPR) to support FFTR, FHOOS, coastdown or any combination thereof in single loop operation. Other EOD/EOOS conditions require no MCPR penalty.	1.56	1.60	1.50

For core flows less than rated, reduced flow MCPR<sub>r</sub> curves for Manual Flow Control are provided in Tables 4-2 and 4-3. MCPR<sub>r</sub> values for Automatic Flow Control are provided in Tables 4-4 and 4-5. **Percent Rated Recirculation Flow based on 98 MLB/hr with 110% Maximum Flow in Manual Flow Control and 108% Maximum Flow in Automatic Flow Control operation (Technical Specification 4.6.A).**

**TABLE 4-2**  
**Reduced Flow MCPR<sub>r</sub> Limit for Manual Flow Control based on 1.11 SLMCPR**  
**(Two-Loop Operation)**

Recirculation Flow (% of rated)	GE 9 MCPR <sub>r</sub> Limit	GE 10 MCPR <sub>r</sub> Limit	ATRIUM-9B Offset MCPR <sub>r</sub> Limit
110	1.11	1.11	1.11
30	1.98	1.96	2.02
0	2.54	2.52	2.57

**TABLE 4-3**  
**Reduced Flow MCPR<sub>r</sub> Limit for Manual Flow Control based on 1.12 SLMCPR**  
**(Single-Loop Operation)**

Recirculation Flow (% of rated)	GE 9 MCPR <sub>r</sub> Limit	GE 10 MCPR <sub>r</sub> Limit	ATRIUM-9B Offset MCPR <sub>r</sub> Limit
110	1.12	1.12	1.12
30	1.99	1.97	2.03
0	2.55	2.53	2.58

**TABLE 4-4**  
**Reduced Flow MCPR<sub>r</sub> Limit for Automatic Flow Control based on 1.11 SLMCPR**  
**(Two-Loop Operation)**

Recirculation Flow (% of rated)	GE 9 Base Case	GE 9 EOD/ EOOS	GE 10 Base Case	GE 10 EOD/ EOOS	ATRIUM- 9B Base Case	ATRIUM- 9B EOD/ EOOS
108	1.53	1.55	1.49	1.59	1.46	1.49
30	2.84	2.87	2.75	2.93	2.78	2.83
0	3.76	3.80	3.65	3.87	3.65	3.72

**TABLE 4-5**  
**Reduced Flow MCPR<sub>r</sub> Limit for Automatic Flow Control based on 1.12 SLMCPR**  
**(Single-Loop Operation)**

Recirculation Flow (% of rated)	GE 9 Base Case	GE 9 EOD/ EOOS	GE 10 Base Case	GE 10 EOD/ EOOS	ATRIUM- 9B Base Case	ATRIUM- 9B EOD/ EOOS
108	1.54	1.56	1.50	1.60	1.47	1.50
30	2.85	2.88	2.76	2.94	2.79	2.84
0	3.77	3.81	3.66	3.88	3.66	3.73

**5.0 Analytical Methods**

The analytical methods used to determine the core operating limits shall be those previously reviewed and approved by the NRC in the latest approved revision or supplement of the topical reports describing the methodology. For Quad Cities Unit 2, the topical reports are:

**SEE SECTION 6.9.A.6.b OF THE QUAD CITIES TECHNICAL SPECIFICATIONS**

**6.0 Attachments**

**Attachment 1. Quad Cities Unit 2 Cycle 16 Reload Analysis**

**Attachment 2. Quad Cities Unit 2 Cycle 16 Plant Transient Analysis**