Core Operating Limits Report

for

Clinton Power Station, Unit 1
Cycle 10

Revision 0

Issuance of Changes Summary

Affected Section	Affected Pages	Summary of Changes	Revision	Date
All	All	Original Issue (Cycle 10)	0	1/04

Table of Contents

References

1. Clinton Power Station Technical Specification 5.6.6, Core Operating Limits Report (COLR).

2. 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. Document 0000-0016-5277SRLR Revision 0, "Supplemental Reload Licensing Report for Clinton Power Station Unit 1 Reload 9 Cycle 10", December 2003.

4. TODI NF0300064 Revision 0, "OPL-3 Parameters for Clinton Unit 1 Cycle 10 Transient Analysis", August 19, 2003.

5. Document 0000-0016-5277FBIR Revision 0, "Fuel Bundle Information Report for Clinton Power Station Unit 1 Reload 9 Cycle 10", December 2003

6. Document GE-NE-0000-0000-7456-01P, "Option B Scram Times For Clinton Power Station", February 2002

7. TODI NF0300050 Revision 0, "Clinton Cycle 10 FRED Form", June 10, 2003

8. General Electric Standard Application for Reactor Fuel (GESTAR II) and US supplement, NEDE-24011-P-A-14, June 2000.

9. NEDC-31546P, "Maximum Extended Operating Domain and Feedwater Heater Out-of-Service Analysis for Clinton Power Station," August 1988.

10. DB-0012.03, Revision 0, GE Nuclear Energy Design Basis Document, "Fuel-Rod Thermal-Mechanical Performance Limits for GE14C," May 2000.

11. Letter to Nuclear Regulatory Commission from J. S. Perry (IP), "Clinton Power Station Proposed Amendment of Facility Operating License No. NFP-62," U-602085 [LS-92-004], February 11, 1993.

12. Letter to F. A. Spangenberg (IP) from D. V. Pickett (NRC), "Issuance of Amendment [No. 75] (TAC No. M85816), May 25, 1993.

13. RDW:95-160, "Simulated Thermal Power Monitor," letter from R. D. Williams (GE) to J. A. Miller (Clinton), November 16, 1995.

14. NEDC-32694P-A, "Power Distribution Uncertainties for Safety Limit MCPR Evaluations," August 1999.

1. Average Planar Linear Heat Generation Rate

1.1 Technical Specification Reference:

Sections 3.2.1 and 3.4.1.

1.2 Description:

Table 1-1 is used to determine the maximum average planar linear heat generation rate (MAPLHGR) limit for each fuel type. Limits listed in Table 1-1 are for dual reactor recirculation loop operation (DLO).

For single reactor recirculation loop operation (SLO), the MAPLHGR limits given in Table 1-1 must be multiplied by a SLO MAPLHGR multiplier provided in Table 1-2. The SLO MAPLHGR multiplier for GE14 fuel is 0.76 (Reference 3).

Table 1-1
Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) for all GE14C Fuel
(Reference 3)

Avg. Planar Exposure (GWd/ST)	MAPLHGR Limit (kW/ft)
0.00	12.82
14.51	12.82
19.13	12.82
57.61	8.00
63.50	5.00

Note for Table 1-1:
Linear interpolation should be used for points not listed in Table 1-1.

Table 1-2
MAPLHGR SLO Multiplier
(Reference 3)

Fuel Type	MAPLHGR SLO Multiplier
GE14C	0.76

2. Minimum Critical Power Ratio

2.1 Technical Specification Reference:

Sections 3.2.2 and 3.4.1

2.2 Description:

The various MCPR limits are described below.

2.2.1 Manual Flow Control MCPR Limits

The Operating Limit MCPR (OLMCPR) is determined from either section 2.2.1.1 or 2.2.1.2, whichever is greater at any given power and flow condition.

2.2.1.1 Power-Dependent MCPR ($MCPR_P$)

For operation less than or equal to 33.3% core thermal power, the OLMCPR as a function of core thermal power is shown in Table 2-3. For operation at greater than 33.3% core thermal power, the OLMCPR as a function of core thermal power is determined by multiplying the applicable rated condition OLMCPR limit shown in Table 2-1 or 2-2 by the applicable MCPR multiplier K(P) given in Table 2-3.

2.2.1.2 Flow-Dependent MCPR ($MCPR_f$)

Tables 2-4 through 2-7 give the $MCPR_F$ as a function of flow based on the applicable plant condition. The limits for dual loop operation are listed in Tables 2-4 and 2-5. The limits for single loop operation are listed in Tables 2-6 and 2-7. The $MCPR_F$ determined from these tables is the flow dependent OLMCPR.

2.2.2 Automatic Flow Control MCPR Limits

Automatic Flow Control MCPR Limits are not provided.

2.2.3 Option A and Option B

Option A and Option B refer to use of scram speeds for establishing MCPR operating limits.

Option A scram speed is the BWR/6 Technical Specification scram speed. The Technical Specification scram speeds must be met to utilize the Option A MCPR limits. Reload analyses performed by GNF for cycle 10 Option A MCPR limits utilized a 20% core average insertion time of 0.516 seconds.

To utilize the MCPR limits for the Option B scram speed, the cycle average scram insertion time for 20% insertion must satisfy equation 2 in Reference 6 Section 4. If the cycle average scram insertion time does not meet the Option B criteria, the appropriate MCPR value may be

determined from a linear interpolation between the Option A and B limits as specified by equation 4 in Reference 6 Section 4.

2.2.4 Recirculation Flow Control Valve Settings

Cycle 10 was analyzed with a maximum core flow runout of 109%; therefore the recirculation flow control valve must be set to maintain core flow less than 109% (92.105 Mlb/hr) for all runout events (Reference 7). This value is consistent with the analyses of Reference 3.

Table 2-1
MCPR Option A Based Operating Limits
(Reference 3)

EOOS Combination	Fuel Type	Cycle Exposure All exposures
Base Case	GE14C	1.30
Base Case SLO	GE14C	1.33

Table 2-2
MCPR Option B Based Operating Limits
(Reference 3)

EOOS Combination	Fuel Type	Cycle Exposure All exposures
Base Case	All GE14C except for GE14-P10SNAB395-16GZ-120T-150-T6-2521	1.27
Base Case	GE14-P10SNAB395-16GZ-120T-150-T6-2521	1.28
Base Case SLO	All GE14C except for GE14-P10SNAB395-16GZ-120T-150-T6-2521	1.30
Base Case SLO	GE14-P10SNAB395-16GZ-120T-150-T6-2521	1.31

Table 2-3
$MCPR_P$ for all GE14 Fuel
(Reference 3)

EOOS Combination	Core Flow	Core Thermal Power (% Rated)						
		0	21.6	≤33.3	>33.3	≤70	>70	100
		$MCPR_P$			K_P			
Base Case	≤ 50	2.20	2.20	1.97	1.351	1.212	1.15	1.00
	> 50	2.46	2.46	2.17				
Base Case SLO	≤ 50	2.23	2.23	2.00	1.351	1.212	1.15	1.00
	> 50	2.49	2.49	2.20				

Notes for Table 2-3:

- Core flow units are in percent (%) of rated.
- Values are interpolated between relevant power levels.
- For thermal limit monitoring at greater than 100% core thermal power, the 100% core thermal power multiplier K(P) should be applied.
- Allowable EOOS conditions are listed in Section 5.

Table 2-4
$MCPR_F$ for Base Case for GE14C Fuel
except for GE14-P10SNAB395-16GZ-120T-150-T6-2521
(Reference 3)

Core Flow (% rated)	$MCPR_F$
0.00	1.8754
25.00	1.6954
93.78	1.20
109.00	1.20

Table 2-5
$MCPR_F$ for Base Case
for GE14-P10SNAB395-16GZ-120T-150-T6-2521
(Reference 3)

Core Flow (% rated)	$MCPR_F$
0.00	1.8754
25.00	1.6954
82.67	1.28
109.00	1.28

Note for Table 2-4 and 2-5:
- Linear interpolation should be used for points not listed in the table.

Table 2-6
$MCPR_F$ for Base Case SLO for GE14C Fuel
except for GE14-P10SNAB395-16GZ-120T-150-T6-2521
(Reference 3)

Core Flow (% rated)	$MCPR_F$
0.00	1.9054
25.00	1.7254
93.78	1.23
109.00	1.23

Table 2-7
$MCPR_F$ for Base Case SLO
for GE14-P10SNAB395-16GZ-120T-150-T6-2521
(Reference 3)

Core Flow (% rated)	$MCPR_F$
0.00	1.9054
25.00	1.7254
82.67	1.31
109.00	1.31

Note for Table 2-6 and Table 2-7:
- Linear interpolation should be used for points not listed in the tables.

3. Linear Heat Generation Rate (3.2.3)

3.1 Technical Specification Reference:

Section 3.2.3.

3.2 Description:

The linear heat generation rate (LHGR) limit is the product of the exposure dependent LHGR limit (from Table 3-1 for UO2 fuel rods and Tables 3-2 through 3-4 for Gadolinia fuel rods) and the minimum of: the power dependent LHGR Factor, $LHGRFAC_P$, the flow dependent LHGR Factor, $LHGRFAC_F$, or the single loop operation (SLO) multiplication factor if applicable. The $LHGRFAC_P$ is determined from Table 3-5. The $LHGRFAC_F$ is determined from Table 3-6. The SLO multiplication factor can be found in Table 3-7. Tables 3-1 through 3-4 are the LHGR limit as a function of peak pellet exposure.

The Gadolinia fuel rod limits in Tables 3-2 through 3-4 are the most limiting Gadolinia fuel rods. The most limiting values are provided here as a convenience and do not imply that all the Gadolinia fuel rods must satisfy the listed values.

Table 3-1
LHGR Limits for GE14C UO2 Fuel rods
(Reference 5)

Peak Pellet Exposure (GWd/ST)	LHGR Limit (kW/ft)
0.00	13.40

Note for Table 3-1:
- Linear interpolation should be used for points not listed in Table 3-1.

Table 3-2
LHGR Limits for GE14C Gadolinia Fuel rods
for GE14-P10SNAB353-13GZ-120T-150-T6-3894
and GE14-P10SNAB354-15GZ-120T-150-T6-3895 bundles
(Reference 5)

Peak Pellet Exposure (GWd/ST)	LHGR Limit (kW/ft)

Table 3-3
LHGR Limits for GE14C Gadolinia Fuel rods
for GE14-P10SNAB395-16GZ-120T-150-T6-2521
and GE14-P10SNAB422-18GZ-120T-150-T6-2653 bundles
(Reference 5)

Peak Pellet Exposure (GWd/ST)	LHGR Limit (kW/ft)

Note for Table 3-2 and 3-3
- Linear interpolation should be used for points not listed in the tables.

Table 3-4
LHGR Limits for GE14C Gadolinia Fuel rods
for GE14-P10SNAB385-16GZ-120T-150-T6-2522,
GE14-P10SNAB422-18GZ-120T-150-T6-2648
and GE14-P10SNAB419-15GZ-120T-150-T6-2649 bundles
(Reference 5)

Peak Pellet Exposure (GWd/ST)	LHGR Limit (kW/ft)

Note for Table 3-4
- Linear interpolation should be used for points not listed in Table 3-4.

Table 3-5
LHGRFAC$_P$ for G14C Fuel
(Reference 3)

EOOS Combination	Core Flow	Core Thermal Power (% Rated)							
		0	21.6	≤ 33.3	> 33.3	40	≤60	>60	100
		LHGRFAC$_P$							
Base Case	≤ 50	0.634	0.634	0.689	0.689	[redacted]			1.00
	> 50	0.572	0.572	0.600					
Base Case SLO	≤ 50	0.634	0.634	0.689	0.689	[redacted]			1.00
	> 50	0.572	0.572	0.600					

Notes for Table 3-5:
- Values are interpolated between relevant power levels.
- For thermal limit monitoring at greater than 100% core thermal power, the 100% core thermal power LHGRFAC$_P$ multiplier should be applied.
- Allowable EOOS conditions are listed in Section 5.

Table 3-6
LHGRFAC$_P$ for all cases for GE14C Fuel
(Reference 3)

Core Flow (% rated)	LHGRFAC$_P$
0.00	0.4430
30.00	0.6463
82.18	1.00
109.00	1.00

Note for Table 3-6
- Linear interpolation should be used for points not listed in Table 3-6.

Table 3-7
LHGR SLO Multiplier
(Reference 3)

Fuel Type	LHGR SLO Multiplier
GE14C	0.76

4. Reactor Protection System (RPS) Instrumentation

4.1 Technical Specification Reference:

3.3.1.1

4.2 Description:

The Average Power Range Monitor (APRM) simulated thermal power time constant, References 11 and 12, shall be between 5.4 seconds and 6.6 seconds (6.0±0.6 seconds) as described in Reference 13.

5. Allowed Modes of Operation

The Allowed Modes of Operation with combinations of Equipment Out-of-Service (EOOS) are as described below:

	Operating Region			
EOOS Options[1,2,3,7]	Standard	MELLLA	ICF[4]	Coastdown[5]
Base Case, Option A	Yes	Yes	Yes	Yes
Base Case SLO[6], Option A	Yes	No	No	Yes
Base Case, Option B	Yes	Yes	Yes	Yes
Base Case SLO[6], Option B	Yes	No	No	Yes

[1] See References 8 and 14 for restrictions related to TIP and LPRM system operability.

[2] The Base case was analyzed with two (2) Safety-Relief Valves Out-of-Service (OOS), one (1) ADS valve OOS, and up to a 50°F feedwater temperature reduction (feedwater heater OOS or final feedwater temperature reduction) at any point in the cycle operation in Dual Loop mode (Reference 3).

[3] A single Main Steam Isolation Valve (MSIV) may be taken OOS (shut) under any one OOS Option so long as core thermal power is maintained ≤75% of 3473 MWt (Reference 3).

[4] The maximum ICF flow utilized in licensing analysis is 107.0% (Reference 3).

[5] Design coastdown operation is defined as any cycle exposure beyond the full power, all rods out condition with plant power slowly lowering to a lesser value while core flow is held constant.

[6] Concurrent operation with SLO and feedwater temperature reduction has not been evaluated and thus not a valid operating mode. (Reference 3)

[7] Pressure Regulator Out-Of-Service (PROOS) was evaluated for thermal limits only in dual loop mode with up to 100°F feedwater temperature reduction at any point in the cycle (Reference 3). PROOS has **not** been evaluated for Balance of Plant operation.

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