Vermont Yankee Nuclear Power Station
Cycle 14
Core Operating Limits Report
Revision 0

September 1989

Reviewed _____ 9/20/89
Plant Operations Review Committee — Date

Approved _____ 9/23/89
Plant Manager — Date

Approved _____ 10/2/89
Vice President and Manager of Operations — Date

Controlled Copy No. _____

7503R

REVISION RECORD

Revision	Date	Description
0		Initial printing. Reviewed by PORC and approved by management.

ABSTRACT

This report presents the cycle-specific operating limits for the operation of Cycle 14 of the Vermont Yankee Nuclear Power Station. The limits are the maximum average planar linear heat generation rate, maximum linear heat generation rate, and minimum critical power ratio.

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1.0 INTRODUCTION

This report provides the cycle-specific limits for operation of the Vermont Yankee Nuclear Power Station through Cycle 14. It includes the limits for the maximum average planar linear heat generation rate, maximum linear heat generation rate, and minimum critical power ratio. In this report, Cycle 14 will frequently be referred to as the Present Cycle. If any of these limits are exceeded, the action will be taken as defined in the Technical Specifications.

This report has been prepared in accordance with the requirements of Technical Specification 6.7.A.4. The core operating limits have been developed using the NRC-approved methodologies listed in References 1 through 14 and in Technical Specification 6.7.A.4. The bases for these limits are in References 9, 10, and 15 through 18.

2.0 CORE OPERATING LIMITS

These Present Cycle operating limits have been defined using NRC-approved methodologies. The Present Cycle must be operated within the bounds of these limits and all others specified in the Technical Specifications.

2.1 Maximum Average Planar Linear Heat Generation Rate Limits

During steady-state power operation, the Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) for each fuel type, as a function of the average planar exposure, shall not exceed the limiting values shown in Tables 2.1-1 through 2.1-4. For single recirculation loop operation, the limiting values shall be the values from these Tables listed under the heading "Single Loop Operation." These values are obtained by multiplying the values for two loop operation by 0.83. The source of these values is identified on each table. These tables only list the limits for fuel types in the Present Cycle.

The fuel types, referred to in Tables 2.1-3 and 2.1-4, contain an enriched middle portion with short natural uranium ends at both the top and bottom of the assembly. The latter are called "Natural Ends" in the tables. The enriched middle portion of the assembly is broken down into three distinct lattices which have the same enrichment distribution, but differ by number and weight percent of gadolinium pins. These are called zones. There is a "Power Peaking Zone" near the bottom of the lattice. This is designed with a higher weight percent gadolinium to control the peaking of the predominantly bottom peaked power shapes typical of BWRs. The "Shutdown Margin Zone" is near the top of each assembly. It contains additional, part-length, gadolinium pins to control the flux peak near the top of the reactor when the reactor is in the cold shutdown condition. The remainder of the assembly is called the "Majority Lattice."

2.2 Minimum Critical Power Ratio Limits

During steady-state power operation, the Minimum Critical Power Ratio (MCPR) shall be equal to or greater than the limits shown in Table 2.2-1. For single recirculation loop operation, the MCPR limits at rated flow shall be

the values from the Table listed under the heading, "Single Loop Operation." The values are obtained by adding 0.01 to the two loop operation values. For core flows other than the rated condition, the MCPR limit shall be the appropriate value from Table 2.2-1 multiplied by K_f where K_f is given in Figure 2.2-1, as a function of the flow control method in use. These limits are only valid for the fuel types in the Present Cycle.

The EOFPL in Table 2.2-1 is the projected end-of-full-power life exposure for the present cycle provided in the licensing analysis described in Reference 16. This value of 9,480 MWd/ST cycle average exposure will be used in the implementation of the exposure dependent MCPR limits regardless of subsequent, more accurate predictions of EOFPL. Justification for this interpretation is the sensitivity study described in Reference 18. The differences between the licensing analysis EOFPL and the actual plant EOFPL can affect the validity of the MCPR limits. However, the MCPR limits will be valid if the actual EOFPL exposure falls within an exposure window defined as 8,880 to 9,480 MWd/ST. The MCPR limits are also valid during coastdown.

2.3 Maximum Linear Heat Generation Rate Limits

During steady-state power operation, the Linear Heat Generation Rate (LHGR) of any rod in any fuel bundle at any axial location shall not exceed the maximum allowable LHGR limits in Table 2.3-1. There are different LHGR limits for different fuel types. These limits are only valid for the fuel types in the Present Cycle.

TABLE 2.1-1

MAPLHGR Versus Average Planar Exposure

Plant: Vermont Yankee

Fuel Type: P8DPB289

Average Planar Exposure (MWd/ST)	MAPHLGR (kW/ft) Two Loop Operation	Single Loop Operation*
200.0	11.2	9.3
1,000.0	11.2	9.3
5,000.0	11.8	9.8
10,000.0	12.0	10.0
15,000.0	12.1	10.0
20,000.0	11.8	9.8
25,000.0	11.3	9.4
30,000.0	11.1	9.2
35,000.0	10.4	8.6
40,000.0	9.8	8.1

Source: NEDO-21697, August 1977 (revised), Reference 9.

Technical Specification References: 3.6.G.1a and 3.11.A.

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* MAPLHGR for single loop operation is obtained by multiplying MAPLHGR for two loop operation by 0.83.

TABLE 2.1-2

MAPLHGR Versus Average Planar Exposure

Plant: Vermont Yankee

Fuel Type: BP8DRB299

Average Planar Exposure (MWd/ST)	MAPHLGR (kW/ft) Two Loop Operation	MAPHLGR (kW/ft) Single Loop Operation*
200.0	10.7	8.8
1,000.0	10.8	8.9
5,000.0	11.4	9.4
10,000.0	12.2	10.1
15,000.0	12.3	10.2
20,000.0	12.2	10.1
25,000.0	11.7	9.7
35,000.0	10.6	8.8
41,900.0	9.4	7.8

Source: NEDO-21697, August 1977 (revised), Reference 9.

Technical Specification References: 3.6.G.1a and 3.11.A.

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* MAPLHGR for single loop operation is obtained by multiplying MAPLHGR for two loop operation by 0.83.

TABLE 2.2-1

MCPR Operating Limits

Value of "N" in RBM Equation (1)	Average Control Rod Scram Time	Cycle Exposure Range	MCPR Operating Limits Two-Loop Operation	MCPR Operating Limits Single-Loop Operation (2)
42%	Equal or better than L.C.O. 3.3 C.1.1	BOC to EOFPL-2 GWD/T	1.26	1.27
		EOFPL-2 GWD/T to EOFPL-1 GWD/T	1.26	1.27
		EOFPL-1 GWD/T to EOFPL	1.26	1.27
	Equal or better than L.C.O. 3.3.C.1.2	BOC to EOFPL-2 GWD/T	1.26	1.27
		EOFPL-2 GWD/T to EOFPL-1 GWD/T	1.27	1.28
		EOFPL-1 GWD/T to EOFPL	1.31	1.32
41%	Equal or better than L.C.O. 3.3 C.1.1	BOC to EOFPL-2 GWD/T	1.22	1.23
		EOFPL-2 GWD/T to EOFPL-1 GWD/T	1.22	1.23
		EOFPL-1 GWD/T to EOFPL	1.26	1.27
	Equal or better than L.C.O. 3.3 C.1.2	BOC to EOFPL-2 GWD/T	1.22	1.23
		EOFPL-2 GWD/T to EOFPL-1 GWD/T	1.27	1.28
		EOFPL-1 GWD/T to EOFPL	1.31	1.32
≤40%	Equal or better than L.C.O. 3.3 C.1.1	BOC to EOFPL-2 GWD/T	1.22	1.23
		EOFPL-2 GWD/T to EOFPL-1 GWD/T	1.22	1.23
		EOFPL-1 GWD/T to EOFPL	1.26	1.27
	Equal or better than L.C.O. 3.3 C.1.2	BOC to EOFPL-2 GWD/T	1.22	1.23
		EOFPL-2 GWD/T to EOFPL-1 GWD/T	1.27	1.28
		EOFPL-1 GWD/T to EOFPL	1.31	1.32

Source: Revision to Cycle 14 Core Performance Analysis Report, YAEC-1706, Reference 17.

Technical Specification References: 3.6.G.1a and 3.11.C.

(1) The Rod Block Monitor (RBM) trip setpoints are determined by the equation shown in Table 3.2.5 of the Technical Specifications.

(2) MCPR Operating Limits are increased by 0.01 for single loop operation.

TABLE 2.1-3

MAPLHGR Versus Average Planar Exposure

Plant: Vermont Yankee

Fuel Type: BD324B

Average Planar Exposure (MWd/ST)	MAPHLGR (kW/ft) for Two Loop Operation			
	Majority Lattice	Shutdown Margin Zone	Power Peaking Zone	Natural Ends
200.0	11.76	11.24	11.71	11.50
1,000.0	11.90	11.42	11.83	11.30
2,000.0	12.05	11.61	11.96	11.28
3,000.0	12.21	11.85	12.15	11.33
5,000.0	12.51	12.17	12.40	11.47
7,000.0	12.63	12.54	12.63	11.61
10,000.0	12.80	12.80	12.80	11.72
14,400.0	12.80	12.80	12.80	11.15
15,000.0	12.75	12.74	12.74	11.07
20,000.0	12.07	12.05	12.06	10.29
25,000.0	11.41	11.39	11.40	9.50
35,000.0	10.14	10.12	10.12	7.93
43,360.0	8.80	8.73	8.74	4.66
50,000.0	6.08	5.99	6.02	-

Average Planar Exposure (MWd/ST)	MAPHLGR (kW/ft) for Single Loop Operation*			
	Majority Lattice	Shutdown Margin Zone	Power Peaking Zone	Natural Ends
200.0	9.76	9.32	9.71	9.54
1,000.0	9.87	9.47	9.81	9.37
2,000.0	10.00	9.63	9.92	9.36
3,000.0	10.13	9.83	10.08	9.40
5,000.0	10.38	10.10	10.29	9.52
7,000.0	10.48	10.40	10.48	9.63
10,000.0	10.62	10.62	10.62	9.72
14,400.0	10.62	10.62	10.62	9.25
15,000.0	10.58	10.57	10.57	9.18
20,000.0	10.01	10.00	10.00	8.54
25,000.0	9.47	9.45	9.46	7.88
35,000.0	8.41	8.39	8.39	6.58
43,360.0	7.30	7.24	7.25	3.86
50,000.0	5.04	4.97	4.99	-

Source: NEDO-21697, August 1977 (revised), Reference 9.

Technical Specification References: 3.6.G.1a and 3.11.A.

* MAPLHGR for single loop operation is obtained by multiplying MAPLHGR for two loop operation by 0.83.

TABLE 2.1-4

MAPLHGR Versus Average Planar Exposure

Plant: Vermont Yankee

Fuel Type: BD326B

Average Planar Exposure (MWd/ST)	MAPHLGR (kW/ft) for Two Loop Operation			
	Majority Lattice	Shutdown Margin Zone	Power Peaking Zone	Natural Ends
200.0	11.80	11.35	11.76	11.50
1,000.0	11.86	11.42	11.79	11.30
2,000.0	11.97	11.56	11.88	11.28
3,000.0	12.10	11.74	11.99	11.33
5,000.0	12.48	12.16	12.33	11.47
7,000.0	12.69	12.66	12.69	11.6[illegible]
10,000.0	12.90	12.90	12.90	11.7[illegible]
14,400.0	12.90	12.90	12.90	11.15
15,000.0	12.84	12.82	12.82	11.07
20,000.0	12.14	12.12	12.12	10.29
25,000.0	11.46	11.44	11.45	9.50
35,000.0	10.17	10.15	10.16	7.93
43,360.0	8.94	8.87	8.91	4.66
50,000.0	6.25	6.17	6.22	-

Average Planar Exposure (MWd/ST)	MAPHLGR (kW/ft) for Single Loop Operation*			
	Majority Lattice	Shutdown Margin Zone	Power Peaking Zone	Natural Ends
200.0	9.79	9.42	9.76	9.54
1,000.0	9.84	9.47	9.78	9.37
2,000.0	9.93	9.59	9.86	9.36
3,000.0	10.04	9.74	9.95	9.40
5,000.0	10.35	10.09	10.23	9.52
7,000.0	10.53	10.50	10.53	9.63
10,000.0	10.70	10.70	10.70	9.72
14,400.0	10.70	10.70	10.70	9.25
15,000.0	10.65	10.64	10.64	9.18
20,000.0	10.07	10.05	10.05	8.54
25,000.0	9.51	9.49	9.50	7.88
35,000.0	8.44	8.42	8.43	6.58
43,360.0	7.42	7.36	7.39	3.86
50,000.0	5.18	5.12	5.16	-

Source: NEDO-21697, August 1977 (revised), Reference 9.

Technical Specification References: 3.6.G.1a and 3.11.A.

* MAPLHGR for single loop operation is obtained by multiplying MAPLHGR for two loop operation by 0.83.

TABLE 2.3-1

Maximum Allowable LHGR Limits

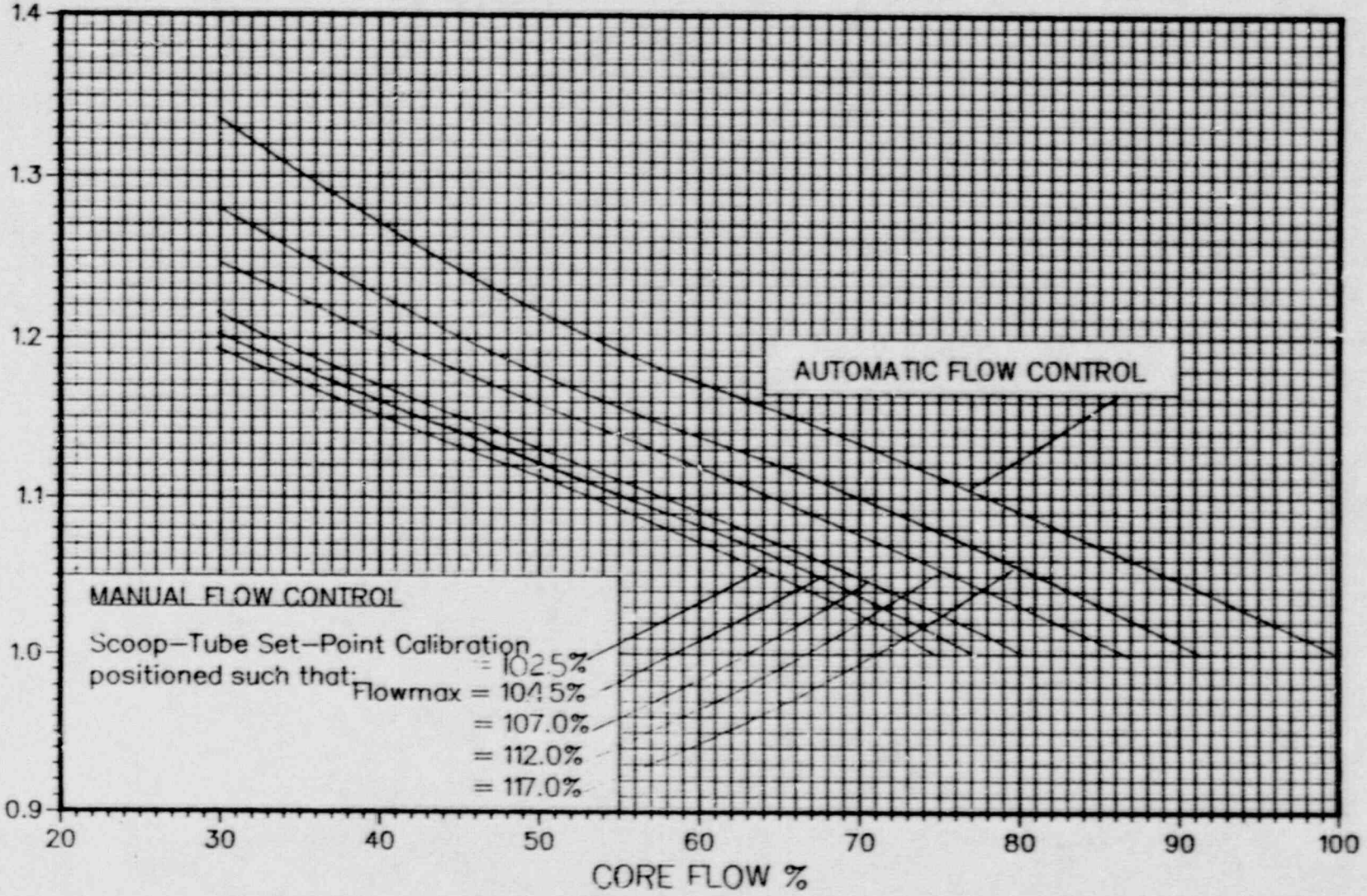
Fuel Type	Maximum Allowable Linear Heat Generation Rate (kW/ft)
P8DPB289	13.4
BP8DRB299	13.4
BD324B	14.4
BD326B	14.4

Source: NEDE-24011-P-A, Reference 10.

Technical Specification References: 2.1.A.1a, 2.1.B.1, and 3.11.B

FIGURE 2.2–1

K_F Versus Percent Of Core Flow Rate
Technical Specification Reference 3.11.C



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