Vermont Yankee Nuclear Power Station
Cycle 15
Core Operating Limits Report
Revision 0

September 1990

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ABSTRACT

This report presents the cycle-specific operating limits for the operation of Cycle 15 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 15. 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 15 will frequently be referred to as the Present Cycle. If any of these limits are exceeded, 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 16 and in Technical Specification 6.7.A.4. The bases for these limits are in References 11 and 12, and 17 through 19.

2.0 CORE OPERATING LIMITS

The 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 2.1-5. 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 ANFIX bundle will be monitored as if it were a BP8DWB311 bundle. Therefore, the limits for the ANFIX bundle are the same as the BP8DWB311 bundle.

The MAPLHGR values are the most limiting composite of the fuel mechanical design analysis MAPLHGR and the ECCS MAPLHGR. The fuel mechanical design analysis, using the methods in Reference 12, demonstrates that all fuel rods in a lattice, operating at the bounding power history, meet the fuel design limits specified in Reference 12. The LOCA analysis performed in accordance with 10CFR50, Appendix K, demonstrates that the MAPLHGR values comply with the ECCS limits specified in 10CFR50.46.

The MAPLHGR actually varies axially, depending upon the specific combination of enriched uranium and gadolinia that comprises a fuel bundle cross section at a particular axial node. Each particular combination of enriched uranium and gadolinia is called a lattice type. Each lattice type has a set of MAPLHGR values that vary with fuel burnup. The process computer will verify that these lattice MAPLHGR limits are not violated. Tables 2.1-2 through 2.1-5 provide a limiting composite of MAPLHGR values for each fuel type, which evelope the lattice MAPLHGR values employed by the process computer. When hand calculations are required, these MAPLHGR values are used for all lattices in the bundle.

2.2 Minimum Cri.ical 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. The EOFPL exposure in Table 2.2-1 is 9,054 MWd/ST based on the analysis in Reference 18. 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 single loop 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.

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. The ANFIX bundle will be monitored as if it were a BP8DWB311 bundle. Therefore, the limits for the ANFIX bundle are the same as the BP8DWB311 bundle.

TABLE 2.1-1

MAPLHGR Versus Average Planar Exposure

Plant: Vermont Yankee

Fuel Type: BP8DRB299

Average Planar Exposure (MWd/ST)	MAPLHGR (kW/ft)	
	Two Loop Operation	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 11.

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: BD324B

Average Planar Exposure (MWd/ST)	MAPLHGR (kW/ft) Two Loop Operation	Single Loop Operation*
200.0	11.22	9.31
3,000.0	11.83	9.81
8,000.0	12.69	10.53
10,000.0	12.80	10.62
15,000.0	12.74	10.57
20,000.0	12.05	10.00
25,000.0	11.39	9.45
35,000.0	10.12	8.39
45,000.0	8.46	7.02
50,000.0	5.99	4.97

So ce: NEDE-21697, Supplement 1, November 1987, Reference 11.

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 2.1-3

MAPLHGR Versus Average Planar Exposure

Plant: Vermont Yankee | Fuel Type: BD326B

Average Planar Exposure (MWd/ST)	MAPLHGR (kW/ft) Two Loop Operation	MAPLHGR (kW/ft) Single Loop Operation*
200.0	11.26	9.34
3,000.0	11.72	9.72
8,000.0	12.76	10.59
10,000.0	12.90	10.70
15,000.0	12.82	10.64
20,000.0	12.12	10.05
25,000.0	11.44	9.49
35,000.0	10.15	8.42
45,000.0	8.63	7.16
50,000.0	6.17	5.12

Source: NEDE-21697, Supplement 1, November 1987, Reference 11.

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 2.1-4

MAPLHGR Versus Average Planar Exposure

Plant: Vermont Yankee

Fuel Type: B.8DWB311-10GZ
ANFIX-3.04B-EG7

Average Planar Exposure (MWd/ST)	MAPLHGR (kW/ft) Two Loop Operation	MAPLHGR (kW/ft) Single Loop Operation*
200.0	11.00	9.13
6,000.0	11.92	9.89
7,000.0	12.11	10.05
8,000.0	12.34	10.24
10,000.0	12.83	10.64
12,500.0	13.00	10.79
20,000.0	12.24	10.15
25,000.0	11.55	9.58
45,000.0	8.76	7.27
50,740.0	5.91	4.90

Source: NEDE-21697, Supplement 2, May 1990, Reference 11, and ANF-90-048, Reference 19.

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 2.1-5

MAPLHGR Versus Average Planar Exposure

Plant: Vermont Yankee   Fuel Type: BP8DWB311-11GZ

Average Planar Exposure (MWd/ST)	MAPLHGR (kW/ft) Two Loop Operation	Single Loop Operation*
200.0	11.00	9.13
6,000.0	11.92	9.89
7,000.0	12.11	10.05
8,000.0	12.34	10.24
10,000.0	12.83	10.64
12,500.0	12.90	10.70
15,000.0	12.81	10.63
35,000.0	10.24	8.49
45,000.0	8.76	7.27
50,740.0	5.91	4.90

Source: NEDE-21697, Supplement 2, May 1990, Reference 11.

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 operaticn 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	BOC to EOFPL-2 GWD/T	1.34	1.35
	than L.C.O.	EOFPL-2 GWD/T to EOFPL-1 GWD/T	1.34	1.35
	3.3 C.1.1	EOFPL-1 GWD/T to EOFPL	1.34	1.35
	Equal or better	BOC to EOFPL-2 GWD/T	1.34	1.35
	than L.C.O.	EOFPL-2 GWD/T to EOFPL-1 GWD/T	1.34	1.35
	3.3.C.1.2	EOFPL-1 GWD/T to EOFPL	1.34	1.35
41%	Equal or better	BOC to EOFPL-2 GWD/T	1.28	1.29
	than L.C.O.	EOFPL-2 GWD/T to EOFPL-1 GWD/T	1.28	1.29
	3.3 C.1.1	EOFPL-1 GWD/T to EOFPL	1.28	1.29
	Equal or better	BOC to EOFPL-2 GWD/T	1.28	1.29
	than L.C.O.	EOFPL-2 GWD/T to EOFPL-1 GWD/T	1.28	1.29
	3.3 C.1.2	EOFPL-1 GWD/T to EOFPL	1.29	1.30
≤40%	Equal or better	BOC to EOFPL-2 GWD/T	1.25	1.26
	than L.C.O.	EOFPL-2 GWD/T to EOFPL-1 GWD/T	1.25	1.26
	3.3 C.1.1	EOFPL-1 GWD/T to EOFPL	1.25	1.26
	Equal or better	BOC to EOFPL-2 GWD/T	1.25	1.26
	than L.C.O.	EOFPL-2 GWD/T to EOFPL-1 GWD/T	1.25	1.26
	3.3 C.1.2	EOFPL-1 GWD/T to EOFPL	1.29	1.30

Source: Cycle 15 Core Performance Analysis Report, YAEC-1749, Reference 18.

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

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(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 2.3-1

Maximum Allowable LHGR Limits

Fuel Type	Maximum Allowable Linear Heat Generation Rate (kW/ft)
BP8DRB299	13.4
BD324B	14.4
BD326B	14.4
BP8DWB311-10GZ	14.4
BP8DWB311-11GZ	14.4
ANFIX-3.01B-EGZ	14.4

Source: NEDE-24011-P-A, Reference 12, and ANF-90-048, Reference 19.

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

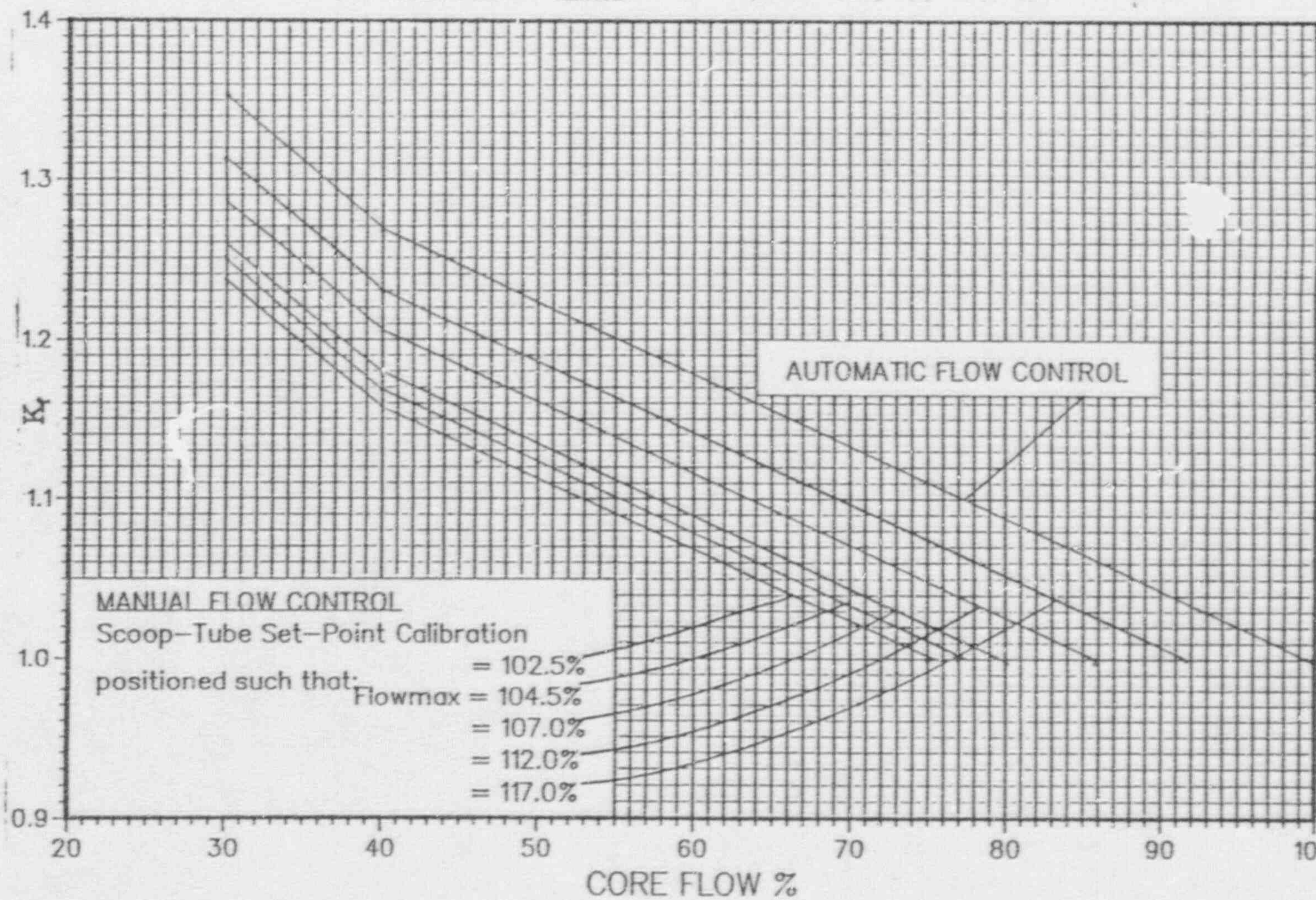

FIGURE 2.2-1

K_f Versus Percent of Rated Core Flow Rate

Technical Specification Reference 3.11.C

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