

Vermont Yankee Nuclear Power Station
Cycle 19
Core Operating Limits Report
Revision 0

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REVISION RECORD

<u>Cycle</u>	<u>Revision</u>	<u>Date</u>	<u>Description</u>
14	0	10/89	Initial printing. Reviewed by PORC and approved by management.
15	0	9/90	Cycle 15 revisions. Reviewed by PORC and approved by management.
15	1	11/91	Incorporate new MCPR limits to allow operation within the exposure window. Reviewed by PORC and approved by management.
16	0	3/92	Cycle 16 revisions. Reviewed by PORC and approved by management.
17	0	7/93	Cycle 17 revisions. Reviewed by PORC and approved by management.
18	0	4/95	Cycle 18 revisions. Reviewed by PORC and approved by management.
18	1	8/95	Incorporate new MAPLHGR limits to account for Loss of Stator Cooling Event. Reviewed by PORC and approved by management.
18	2	8/95	Incorporate the thermal-hydraulic stability exclusion region. Reviewed by PORC and approved by management.
18	3	11/95	Revise the thermal-hydraulic stability exclusion region to more accurately represent the exclusion region boundary equation. Revise the MCPR limits to allow SRV and S ₁ setpoint tolerance relaxation. Reviewed by PORC and approved by management.
19	0	10/96	Cycle 19 revisions. Reviewed by PORC and approved by management.

ABSTRACT

This report presents the cycle-specific operating limits for the operation of Cycle 19 of the Vermont Yankee Nuclear Power Station. The limits are the maximum average planar linear heat generation rate, maximum linear heat generation rate, minimum critical power ratio, and thermal-hydraulic stability exclusion region.

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1.0 INTRODUCTION

This report provides the cycle-specific limits for operation of the Vermont Yankee Nuclear Power Station in Cycle 19. It includes the limits for the maximum average planar linear heat generation rate, maximum linear heat generation rate, minimum critical power ratio, and thermal-hydraulic stability exclusion region. 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 13, and 27 through 28. The methodologies are also listed in Technical Specification 6.7.A.4 and the SERs are listed in References 14 through 22 and 29. The bases for these limits are in References 12, 13, 24 through 26, and 30.

2.0 CORE OPERATING LIMITS

The Cycle 19 operating limits have been defined using NRC-approved methodologies. Cycle 19 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 2.1-3. 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 Cycle 19.

The MAPLHGR values are usually the most limiting composite of the fuel thermal-mechanical design analysis MAPLHGRs and the Loss-of-Coolant Accident (LOCA) MAPLHGRs. The fuel thermal-mechanical design analysis, using the methods in Reference 13, demonstrates that all fuel rods in a lattice, operating at the bounding power history, meet the fuel design limits specified in Reference 13. The Vermont Yankee LOCA analysis, performed in accordance with 10CFR50, Appendix K, demonstrates that the LOCA analysis MAPLHGR values are bounded at all exposure points by the mechanical design analysis MAPLHGR values.

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 2.1-1 through 2.1-3 provide a limiting composite of MAPLHGR values for each fuel type, which envelope 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 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. The MCPR limits are also valid during coastdown beyond 10701 MWd/St.

For single recirculation loop operation, the MCPR limits at rated flow shall be the values from Table 2.2-1 listed under the heading, "Single Loop Operation." The single loop values are obtained by adding 0.02 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 Cycle 19.

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. This table only lists the limits for fuel types in Cycle 19.

2.4 Thermal-Hydraulic Stability Exclusion Region

Normal plant operation is not allowed inside the bounds of the exclusion region defined in Figure 2.4-1. These power and flow limits are applicable for Cycle 19. Operation inside of the exclusion region may result in a thermal-hydraulic oscillation. Operation within the buffer region is allowed when using the Stability Monitor. Otherwise, the buffer region is considered part of the exclusion region.

Table 2.1-1

MAPLHGR Versus Average Planar Exposure for BP8DWB335-10GZ Fuel

Plant: Vermont Yankee

Fuel Type: BP8DWB335-10GZ

Average Planar Exposure (MWd/ST)	MAPLHGR (kW/ft)	
	<u>Two Loop Operation</u>	<u>Single Loop Operation*</u>
0.00	11.29	9.37
200.00	11.34	9.41
1,000.00	11.48	9.53
2,000.00	11.69	9.70
3,000.00	11.92	9.89
4,000.00	12.17	10.10
5,000.00	12.43	10.32
6,000.00	12.68	10.52
7,000.00	12.87	10.68
8,000.00	13.06	10.84
9,000.00	13.20	10.96
10,000.00	12.79	10.62
12,500.00	12.65	10.50
15,000.00	12.47	10.35
20,000.00	11.76	9.76
25,000.00	11.09	9.20
35,000.00	9.83	8.20
45,000.00	8.38	6.96
50,590.00	5.65	4.69

Source: Vermont Yankee Cycle 19 Core Performance Analysis Report, YAEC-1935, Reference 24; Vermont Yankee Nuclear Power Station Single Loop Operation, NEDO-30060, Reference 23; Letter, "Revised Thermal Mechanical MAPLHGR Limits for Vermont Yankee Reload 18/Cycle 19," Reference 26.

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 2.1-2

MAPLHGR Versus Average Planar Exposure for BP8DWB335-11GZ Fuel

Plant: Vermont Yankee

Fuel Type: BP8DWB335-11GZ

Average Planar Exposure (MWd/ST)	MAPLHGR (kW/ft)	
	<u>Two Loop Operation</u>	<u>Single Loop Operation*</u>
0.00	11.28	9.36
200.00	11.33	9.40
1,000.00	11.43	9.49
2,000.00	11.60	9.63
3,000.00	11.80	9.80
4,000.00	12.04	9.99
5,000.00	12.30	10.21
6,000.00	12.53	10.40
7,000.00	12.73	10.57
8,000.00	12.94	10.74
9,000.00	13.12	10.89
10,000.00	12.79	10.62
12,500.00	12.65	10.50
15,000.00	12.47	10.35
20,000.00	11.76	9.76
25,000.00	11.09	9.20
35,000.00	9.88	8.20
45,000.00	8.38	6.96
50,590.00	5.65	4.69

Source: Vermont Yankee Cycle 19 Core Performance Analysis Report, YAEC-1935, Reference 24; Vermont Yankee Nuclear Power Station Single Loop Operation, NEDO-30060, Reference 23; Letter, "Revised Thermal Mechanical MAPLHGR Limits for Vermont Yankee Reload 18/Cycle 19," Reference 26.

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 for BP8DWB354-12GZ Fuel

Plant: Vermont Yankee

Fuel Type: BP8DWB354-12GZ

Average Planar Exposure (MWd/ST)	MAPLHGR (kW/ft)	
	<u>Two Loop Operation</u>	<u>Single Loop Operation*</u>
0.00	10.96	9.10
200.00	11.04	9.16
1,000.00	11.18	9.28
2,000.00	11.40	9.46
3,000.00	11.63	9.65
4,000.00	11.81	9.80
5,000.00	12.01	9.97
6,000.00	12.14	10.08
7,000.00	12.26	10.18
8,000.00	12.37	10.27
9,000.00	12.46	10.34
10,000.00	12.52	10.39
12,500.00	12.40	10.29
15,000.00	12.10	10.04
20,000.00	11.40	9.46
25,000.00	10.72	8.90
35,000.00	9.44	7.84
45,000.00	7.24	6.01
48,200.00	5.67	4.71

Source: Vermont Yankee Cycle 19 Core Performance Analysis Report, YAEC-1935, Reference 24; Vermont Yankee Nuclear Power Station Single Loop Operation, NEDO-30060, Reference 23; Letter, "Revised Thermal Mechanical MAPLHGR Limits for Vermont Yankee Reload 18/Cycle 19," Reference 26.

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 2.2-1

Minimum Critical Power Ratio Operating Limits

Value of "N" in RBM Equation (A) ¹	Average Control Rod Scram Time	Cycle Exposure Range	MCPR Operating Limits	
			Two Loop Operation	Single Loop Operation ²
42%	Equal to or better than L.C.O. 3.3.C.1.1	0.0 to 9701 MWd/St	1.32	1.34
		9701 to 10701 MWd/St	1.34	1.36
	Equal to or better than L.C.O. 3.3.C.1.2	0.0 to 9701 MWd/St	1.32	1.34
		9701 to 10701 MWd/St	1.41	1.43
41%	Equal to or better than L.C.O. 3.3.C.1.1	0.0 to 9701 MWd/St	1.29	1.31
		9701 to 10701 MWd/St	1.34	1.36
	Equal to or better than L.C.O. 3.3.C.1.2	0.0 to 8701 MWd/St	1.29	1.31
		8701 to 9701 MWd/St 9701 to 10701 MWd/St	1.32 1.41	1.34 1.43
≤40%	Equal to or better than L.C.O. 3.3.C.1.1	0.0 to 9701 MWd/St	1.29	1.31
		9701 to 10701 MWd/St	1.34	1.36
	Equal to or better than L.C.O. 3.3.C.1.2	0.0 to 8701 MWd/St	1.29	1.31
		8701 to 9701 MWd/St 9701 to 10701 MWd/St	1.32 1.41	1.34 1.43

Sources: Vermont Yankee Cycle 19 Core Performance Analysis Report,
YAEC-1935, Reference 24, "SLMCPR Calculation for Vermont Yankee
Reload 18/Cycle 19," Reference 30.

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 0.02 for single loop operation.

Table 2.3-1

Maximum Allowable Linear Heat Generation Rate Limits

<u>Fuel Type</u>	<u>Maximum Allowable Linear Heat Generation Rate (kW/ft)</u>
BP8DWB335-10GZ	14.4
BP8DWB335-11GZ	14.4
BP8DWB354-12GZ	14.4

| Source: NEDE-24011-P-A, Reference 13.

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

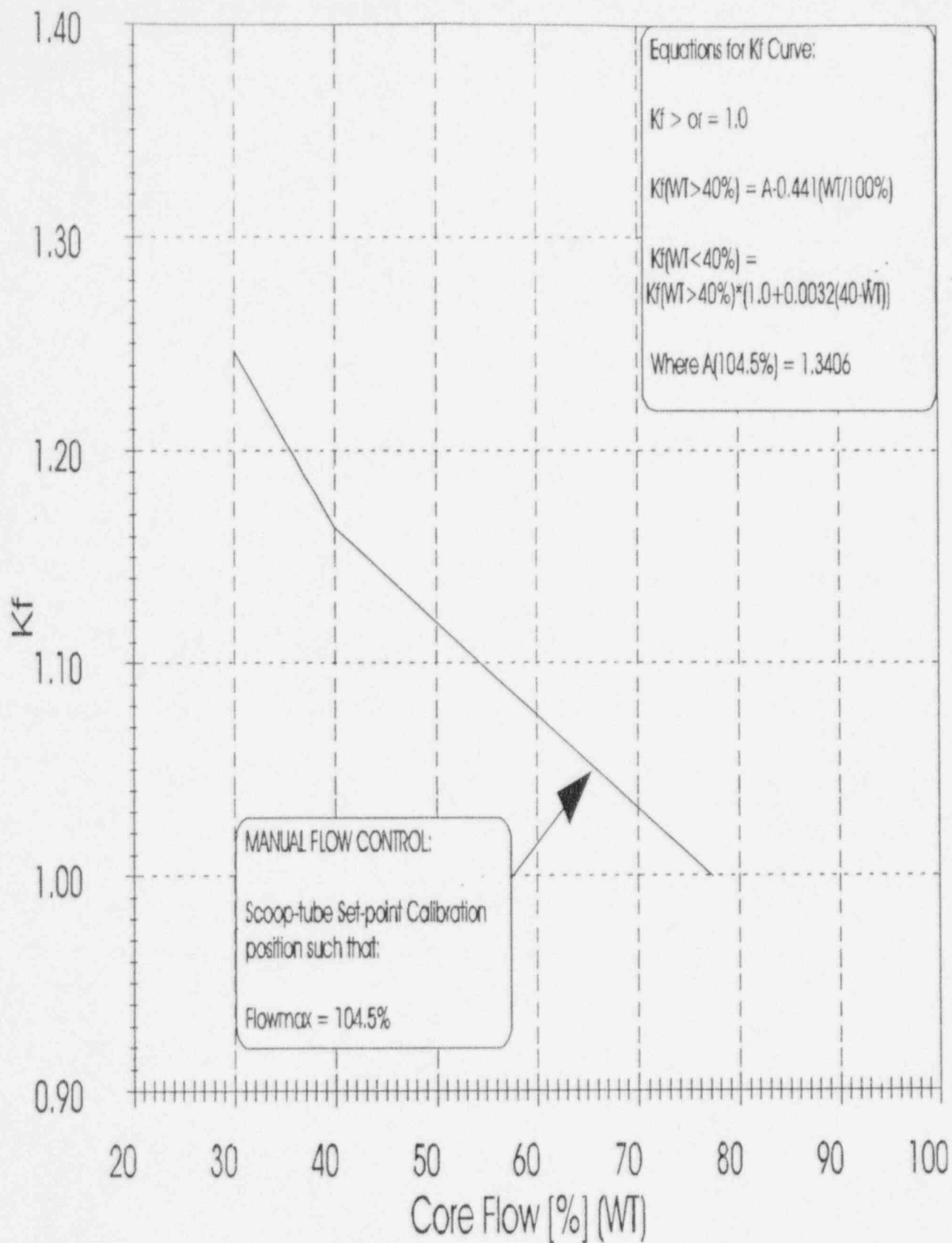
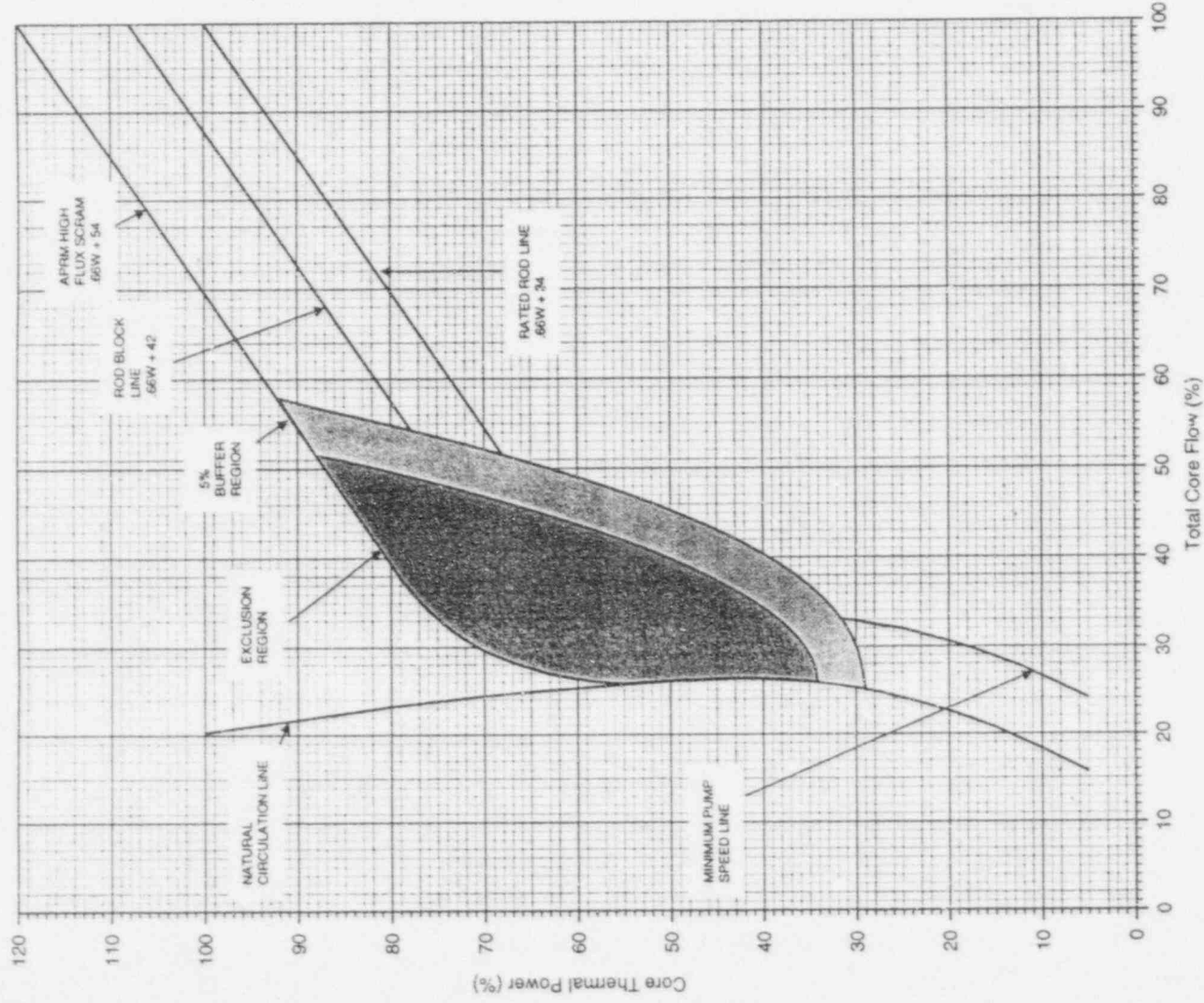


Figure 2.2-1

K_f Versus Percent of Rated Core Flow Rate
(Technical Specification Reference 3.11.C)



Exclusion Region Boundary Equation

$$\text{POWER} = 86.8915 - 4.1430 (\text{Flow} - 0.5) + 0.081393 (\text{Flow} - 0.5)^2$$

Figure 2.4-1

Limits of Power Flow Operation

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