Vermont Yankee Nuclear Power Station
Cycle 17
Core Operating Limits Report
Revision 0

July 1993

Reviewed 9351 8/18/93
Plant Operations Review Committee — Date

Approved R J Wanczyk 8/19/93
Plant Manager — Date

Approved Dennis A. Reid 8-23-93
Vice President Operations — Date

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REVISION RECORD

Cycle	Revision	Date	Description
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.

ABSTRACT

This report presents the cycle-specific operating limits for the operation of Cycle 17 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 in Cycle 17. It includes the limits for the maximum average planar linear heat generation rate, maximum linear heat generation rate, and minimum critical power ratio. 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 29 and in Technical Specification 6.7.A.4. The bases for these limits are in Reference 12, 17, and 30 through 32.

2.0 CORE OPERATING LIMITS

The Cycle 17 operating limits have been defined using NRC-approved methodologies. The Cycle 17 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 Cycle 17.

The MAPLHGR values are usually the most limiting composite of the fuel mechanical design analysis MAPLHGRs and the Loss-of-Coolant Accident (LOCA) MAPLHGRs. 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 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 2.1-4 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 10760 MWd/St.

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 Cycle 17.

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 17.

Table 2.1-1

MAPLHGR Versus Average Planar Exposure for BP8DWB311-10GZ Fuel

Plant: Vermont Yankee

Fuel Type: BP8DWB311-10GZ

Average Planar Exposure (MWd/ST)	MAPLHGR (kW/ft) Two Loop Operation	Single Loop Operation*
0.0	10.93	9.07
200.00	11.00	9.13
1,000.00	11.13	9.24
2,000.00	11.32	9.40
3,000.00	11.52	9.56
4,000.00	11.64	9.66
5,000.00	11.77	9.77
6,000.00	11.92	9.89
7,000.00	12.11	10.05
8,000.00	12.34	10.24
9,000.00	12.59	10.45
10,000.00	12.83	10.65
12,500.00	13.00	10.79
15,000.00	12.81	10.63
20,000.00	12.24	10.16
25,000.00	11.55	9.59
35,000.00	10.24	8.50
45,000.00	8.76	7.27
51,299.00	5.87	4.87

Source: Vermont Yankee Cycle 17 Core Performance Analysis Report, YAEC-1867, Reference 31 and Vermont Yankee Nuclear Power Station Single Loop Operation, NEDO-30060, Reference 30.

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 for BP8DWB311-11GZ Fuel

Plant: Vermont Yankee   Fuel Type: BP8DWB311-11GZ

Average Planar Exposure (MWd/ST)	MAPLHGR (kW/ft)	
	Two Loop Operation	Single Loop Operation*
0.00	10.93	9.07
200.00	11.00	9.13
1,000.00	11.13	9.24
2,000.00	11.32	9.40
3,000.00	11.52	9.56
4,000.00	11.64	9.66
5,000.00	11.77	9.77
6,000.00	11.92	9.89
7,000.00	12.11	10.05
8,000.00	12.34	10.24
9,000.00	12.59	10.45
10,000.00	12.83	10.65
12,500.00	13.00	10.79
15,000.00	12.81	10.63
20,000.00	12.24	10.16
25,000.00	11.55	9.59
35,000.00	10.24	8.50
45,000.00	8.76	7.27
51,466.00	5.83	4.84

Source: Vermont Yankee Cycle 17 Core Performance Analysis Report, YAEC-1867, Reference 31 and Vermont Yankee Nuclear Power Station Single Loop Operation, NEDO-30060, Reference 30.

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 BP8DWB335-10GZ Fuel

Plant: Vermont Yankee Fuel Type: BP8DWB335-10GZ

Average Planar Exposure (MWd/ST)	MAPLHGR (kW/ft)	
	Two Loop Operation	Single Loop Operation*
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	13.24	10.99
10,000.00	13.35	11.08
12,500.00	13.20	10.96
20,000.00	12.27	10.80
25,000.00	11.43	9.49
35,000.00	9.88	8.20
45,000.00	8.38	6.96
50,593.00	5.65	4.69

Source: Vermont Yankee Cycle 17 Core Performance Analysis Report, YAEC-1867, Reference 31 and Vermont Yankee Nuclear Power Station Single Loop Operation, NEDO-30060, Reference 30.

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 for BP8DWB335-11GZ Fuel

Plant: Vermont Yankee   Fuel Type: BP8DWB335-11GZ

Average Planar Exposure (MWd/ST)	MAPLHGR (kW/ft) Two Loop Operation	MAPLHGR (kW/ft) Single Loop Operation*
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	9.79
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	13.13	10.90
10,000.00	13.29	11.03
12,500.00	13.20	10.96
15,000.00	12.99	10.78
20,000.00	12.27	10.02
25,000.00	11.43	9.49
35,000.00	9.88	8.20
45,000.00	8.38	6.96
50,593.00	5.65	4.69

Source: Vermont Yankee Cycle 17 Core Performance Analysis Report, YAEC-1867, Reference 31 and Vermont Yankee Nuclear Power Station Single Loop Operation, NEDO-30060, Reference 30.

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	MCPR Operating Limits: Single Loop Operation[2]
42%	Equal or better than L.C.O. 3.3 C.1.1	0 TO 4000 MWd/St	1.42	1.43
		4000 to 10760 MWd/St	1.34	1.35
	Equal or better than L.C.O. 3.3 C.1.2	0 TO 4000 MWd/St	1.42	1 43
		4000 to 10760 MWd/St	1.34	1.35
41%	Equal or better than L.C.O. 3.3 C.1.1	0 to 4000 MWd/St	1.42	1.43
		4000 to 5500 MWd/St	1.34	1.35
		5500 to 9170 MWd/St	1.30	1.31
		9170 to 10760 MWd/St	1.32	1.33
	Equal or better than L.C.O. 3.3 C.1.2	0 to 4000 MWd/St	1.42	1.43
		4000 to 5500 MWd/St	1.34	1.35
		5500 to 9170 MWd/St	1.30	1.31
		9170 to 10760 MWd/St	1.34	1.35
≤40%	Equal or better than L.C.O. 3.3 C.1.1	0 to 4000 MWd/St	1.42	1.43
		4000 to 5500 MWd/St	1.34	1.35
		5500 to 6500 MWd/St	1.28	1.29
		6500 to 8170 MWd/St	1.25	1.26
		8170 to 9170 MWd/St	1.27	1.28
		9170 to 10760 MWd/St	1.32	1.33
	Equal or better than L.C.O. 3.3 C.1.2	0 to 4000 MWd/St	1.42	1.43
		4000 to 5500 MWd/St	1.34	1.35
		5500 to 6500 MWd/St	1.28	1.29
		6500 to 8170 MWd/St	1.25	1.26
		8170 to 9170 MWd/St	1.30	1.31
		9170 to 10760 MWd/St	1.34	1.35

Sources: Vermont Yankee Cycle 17 Core Performance Analysis Report, YAEC-1867, Reference 31; End-of-Full-Power-Life Sensitivity Study for the Revised BWR Licensing Methodology, YAEC-1822, Reference 32; and Vermont Yankee Nuclear Power Station Single Loop Operation, NEDO-30060, 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 0.01 for single loop operation.

Table 2.3-1

Maximum Allowable Linear Heat Generation Rate Limits

Fuel Type	Maximum Allowable Linear Heat Generation Rate (kW/ft)
BP8DWB311-10GZ	14.4
BP8DWB311-11GZ	14.4
BPDWB335-10GZ	14.4
BPDWB335-11GZ	14.4

Source: NEDE-24011-P-A, Reference 21.

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

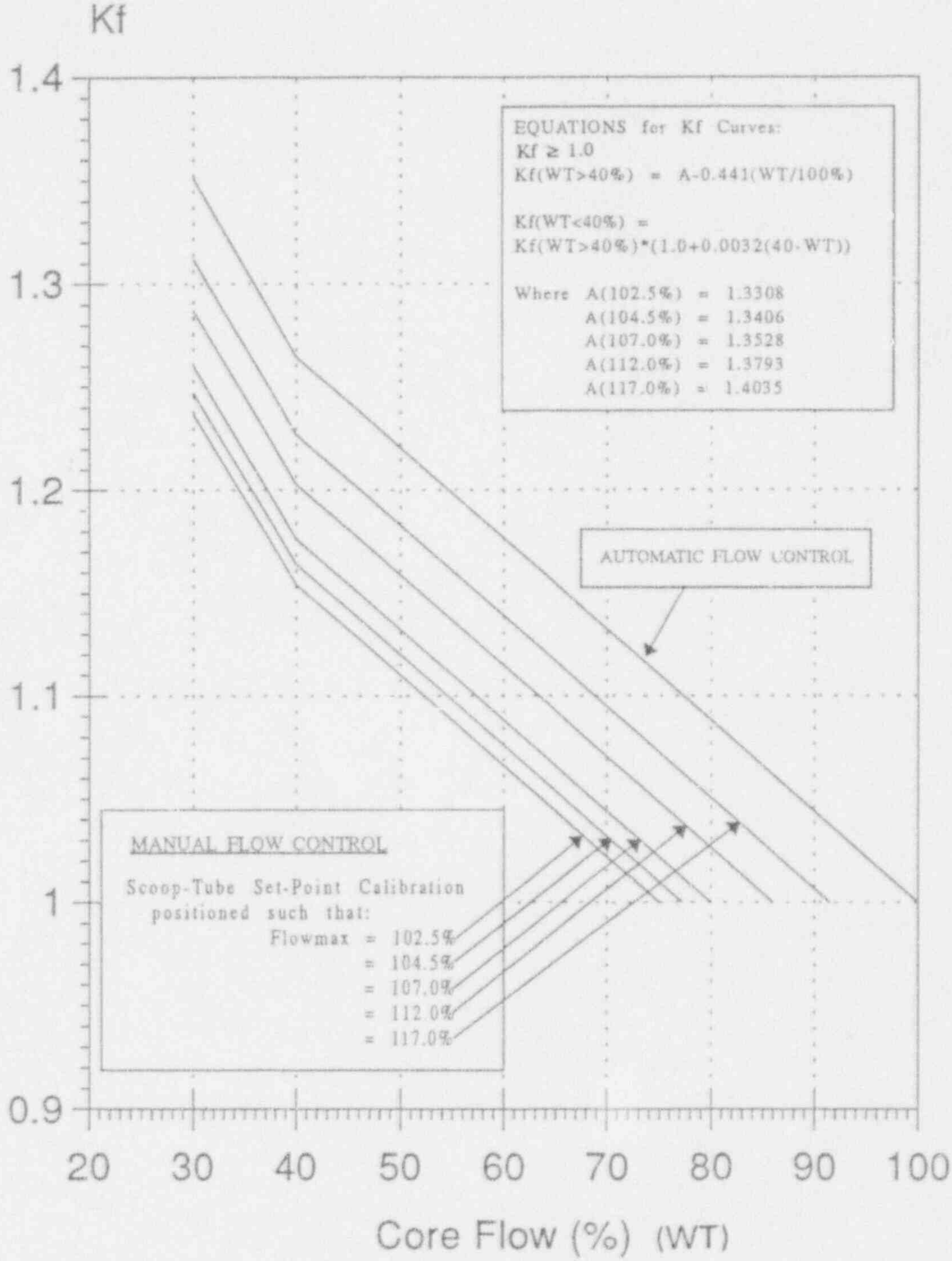

Figure 2.2-1

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

3.0 REFERENCES

1. Report, A. A. F. Ansari, Methods for the Analysis of Boiling Water Reactors: Steady-State Core Flow Distribution Code (FIBWR), YAEC-1234, December 1980.

2. Report, A. A. F. Ansari and J. T. Cronin, Methods for the Analysis of Boiling Water Reactors: A System Transient Analysis Model (RETRAN), YAEC-1233, April 1981.

3. Report, A. A. F. Ansari, K. J. Burns and D. K. Beller, Methods for the Analysis of Boiling Water Reactors: Transient Critical Power Ratio Analysis (RETRAN-TCPYA01), YAEC-1299P, March 1982.

4. Report, A. S. DiGiovine, et al., CASMO-3G Validation, YAEC-1363-A, April 1988.

5. Report, A. S. DiGiovine, J. P. Gorski, and M. A. Tremblay, SIMULATE-3 Validation and Verification, YAEC-1659-A, September 1988.

6. Report, R. A. Woehlke, et al., MICBURN-3/CASMO-3/TABLES-3/SIMULATE-3 Benchmarking of Vermont Yankee Cycles 9 through 13, YAEC-1683-A, March 1989.

7. Report, J. T. Cronin, Method for Generation of One-Dimensional Kinetics Data for RETRAN-02, YAEC-1694-A, June 1989.

8. Report, V. Chandola, M. P. LeFrancois and J. D. Robichaud, Application of One-Dimensional Kinetics to Boiling Water Reactor Transient Analysis Methods, YAEC-1693-A, Revision 1, November 1989.

9. Report, RELAP5YA, A Computer Program for Light-Water Reactor System Thermal-Hydraulic Analysis, YAEC-1300P-A, Revision 0, October 1982; Revision 1, July 1993.

10. Report, Vermont Yankee BWR Loss-of-Coolant Accident Licensing Analysis Method, YAEC-1547P-A, July 1993.

11. Letter from R. W. Capstick (VYNPC) to USNRC, HUXY Computer Code Information for the Vermont Yankee BWR LOCA Licensing Analysis Method, FVY 87-63, dated June 4, 1987.

12. Letter from R. W. Capstick (VYNPC) to USNRC, Vermont Yankee LOCA Analysis Method FROSSTEY Fuel Performance Code (FROSSTEY-2), FVY 87-116, dated December 16, 1987.

13. Letter from R. W. Capstick (VYNPC) to USNRC, Response to NRC Request for Additional Information on the FROSSTEY-2 Fuel Performance Code, BVY 89-65, dated July 14, 1989.

14. Letter from R. W. Capstick (VYNPC) to USNRC, Supplemental Information on the FROSSTEY-2 Fuel Performance Code, BVY 89-74, dated August 4, 1989.

15. Letter from L. A. Tremblay, Jr. (VYNPC) to USNRC, Responses to Request for Additional Information on FROSSTEY-2 Fuel Performance Code, BVY 90-045, dated April 19, 1990.

16. Letter from L. A. Tremblay, Jr. (VYNPC) to USNRC, Supplemental Information to VYNPC April 19, 1990 Response Regarding FROSSTEY-2 Fuel Performance Code, BVY 90-054, dated May 10, 1990.

17. Letter from L. A. Tremblay, Jr. (VYNPC) to USNRC, Responses to Request for Additional Information on FROSSTEY-2 Fuel Performance Code, BVY 91-024, dated March 6, 1991.

18. Letter from L. A. Tremblay, Jr. (VYNPC) to USNRC, LOCA-Related Responses to Open Issues on FROSSTEY-2 Fuel Performance Code, BVY 92-39, dated March 27, 1992.

19. Letter from L. A. Tremblay, Jr. (VYNPC) to USNRC, FROSSTEY-2 Fuel Performance Code - Vermont Yankee Response to Remaining Concerns, BVY 92-54, dated May 15, 1992.

20. Report, L. Schor, et al., Vermont Yankee Loss-of-Coolant Accident Analysis, YAEC-1772, June 1993.

21. Report, General Electric Standard Application for Reactor Fuel (GESTARII), NEDE-24011-P-A-10, GE Company Proprietary, February 1991, as amended.

22. Letter, USNRC to VYNPC, SER, November 27, 1981.

23. Letter, USNRC to VYNPC, SER, NVY 82-157, September 15, 1982.

24. Letter, USNRC to VYNPC, SER, NVY 85-205, September 27, 1985.

25. Letter, USNRC to VYNPC, SER, November 30, 1977.

26. Letter, USNRC to VYNPC, SER, NVY 87-136, August 25, 1987.

27. Letter, USNRC to VYNPC, SER, NVY 91-26, February 27, 1991.

28. Letter, USNRC to VYNPC, SER, NVY 92-192, October 21, 1992.

29. Letter, USNRC to VYNPC, SER, NVY 92-178, September 24, 1992.

30. Report, Vermont Yankee Nuclear Power Station Single Loop Operation, NEDO-30060, February 1983.

31. Report, M. A. Sironen, Vermont Yankee Cycle 17 Core Performance Analysis Report, YAEC-1867, June 1993.

32. Report, B. Y. Hubbard, et al., End-of-Full-Power-Life Sensitivity Study for the Revised BWR Licensing Methodology, YAEC-1822, October 1991.