Vermont Yankee Nuclear Power Station
Cycle 18
Core Operating Limits Report
Revision 3

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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.
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 SV setpoint tolerance relaxation. Reviewed by PORC and approved by management.

ABSTRACT

This report presents the cycle-specific operating limits for the operation of Cycle 18 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 18. 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 29, 34 through 36, and in Technical Specification 6.7.A.4. The bases for these limits are in References 20, 21, 30 through 35, and 37.

2.0 CORE OPERATING LIMITS

The Cycle 18 operating limits have been defined using NRC-approved methodologies. Cycle 18 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 18.

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 21, demonstrates that all fuel rods in a lattice, operating at the bounding power history, meet the fuel design limits specified in Reference 21. 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 10644 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 0.01 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 18.

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 18.

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 18. 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 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
50,735.00	5.91	4.91

Source: Vermont Yankee Cycle 18 Core Performance Analysis Report, YAEC-1908, Reference 31; Vermont Yankee Nuclear Power Station Single Loop Operation, NEDO-30060, Reference 30; Letter, "Transmittal of Modified Thermal Mechanical MAPLHGR Limits for Vermont Yankee Cycle 18 Loss of Stator Cooling Event," Reference 33.

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 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
50,735.00	5.91	4.91

Source: Vermont Yankee Cycle 18 Core Performance Analysis Report, YAEC-1908, Reference 31; Vermont Yankee Nuclear Power Station Single Loop Operation, NEDO-30060, Reference 30; Letter, "Transmittal of Modified Thermal Mechanical MAPLHGR Limits for Vermont Yankee Cycle 18 Loss of Stator Cooling Event," Reference 33.

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	12.99	10.78
12,500.00	12.84	10.66
15,000.00	12.65	10.50
20,000.00	11.93	9.90
25,000.00	11.26	9.35
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 18 Core Performance Analysis Report, YAEC-1908, Reference 31; Vermont Yankee Nuclear Power Station Single Loop Operation, NEDO-30060, Reference 30; Letter, "Transmittal of Modified Thermal Mechanical MAPLHGR Limits for Vermont Yankee Cycle 18 Loss of Stator Cooling Event," Reference 33.

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 for BP8DWB335-11GZ Fuel

Plant: Vermont Yankee

Fuel Type: BP8DWB335-11GZ

Average Planar Exposure (MWd/ST)	MAPLHGR (kW/ft)	
	Two Loop Operation	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	12.99	10.78
12,500.00	12.84	10.66
15,000.00	12.65	10.50
20,000.00	11.93	9.90
25,000.00	11.26	9.35
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 18 Core Performance Analysis Report, YAEC-1908, Reference 31; Vermont Yankee Nuclear Power Station Single Loop Operation, NEDO-30060, Reference 30; Letter, "Transmittal of Modified Thermal Mechanical MAPLHGR Limits for Vermont Yankee Cycle 18 Loss of Stator Cooling Event," Reference 33.

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 to or better than L.C.O. 3.3.C.1.1	0.0 to 4000 MWd/St	1.39	1.40
		4000 to 5500 MWd/St	1.35	1.36
		5500 to 10644 MWd/St	1.33	1.34
	Equal to or better than L.C.O. 3.3.C.1.2	0.0 to 4000 MWd/St	1.39	1.40
		4000 to 5500 MWd/St	1.35	1.36
		5500 to 9035 MWd/St	1.33	1.34
		9035 to 10644 MWd/St	1.36	1.37
41%	Equal to or better than L.C.O. 3.3.C.1.1	0.0 to 4000 MWd/St	1.39	1.40
		4000 to 5500 MWd/St	1.35	1.36
		5500 to 6500 MWd/St	1.29	1.30
		6500 to 9035 MWd/St	1.27	1.28
		9035 to 10644 MWd/St	1.34	1.35
	Equal to or better than L.C.O. 3.3.C.1.2	0.0 to 4000 MWd/St	1.39	1.40
		4000 to 5500 MWd/St	1.35	1.36
		5500 to 6500 MWd/St	1.29	1.30
		6500 to 8035 MWd/St	1.27	1.28
		8035 to 9035 MWd/St	1.32	1.33
		9035 to 10644 MWd/St	1.36	1.37
≤40%	Equal to or better than L.C.O. 3.3.C.1.1	0.0 to 4000 MWd/St	1.39	1.40
		4000 to 5500 MWd/St	1.35	1.36
		5500 to 6500 MWd/St	1.29	1.30
		6500 to 8035 MWd/St	1.25	1.26
		8035 to 9035 MWd/St	1.29	1.30
		9035 to 10644 MWd/St	1.34	1.35
	Equal to or better than L.C.O. 3.3.C.1.2	0.0 to 4000 MWd/St	1.39	1.40
		4000 to 5500 MWd/St	1.35	1.36
		5500 to 6500 MWd/St	1.29	1.30
		6500 to 8035 MWd/St	1.25	1.26
		8035 to 9035 MWd/St	1.32	1.33
		9035 to 10644 MWd/St	1.36	1.37

Sources: Vermont Yankee Cycle 18 Core Performance Analysis Report, YAEC-1908, Reference 31; End-of-Full-Power-Life Sensitivity Study for the Revised BWR Licensing Methodology, YAEC-1822, Reference 32; Vermont Yankee Nuclear Power Station Single Loop Operation, NEDO-30060, Reference 30; and Safety Analysis of Safety/Relief Valve Setpoint Tolerance Relaxation for the Vermont Yankee Nuclear Power Station, YAEC-1910, Reference 37.

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
BP8DWB335-10GZ	14.4
BP8DWB335-11GZ	14.4

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

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

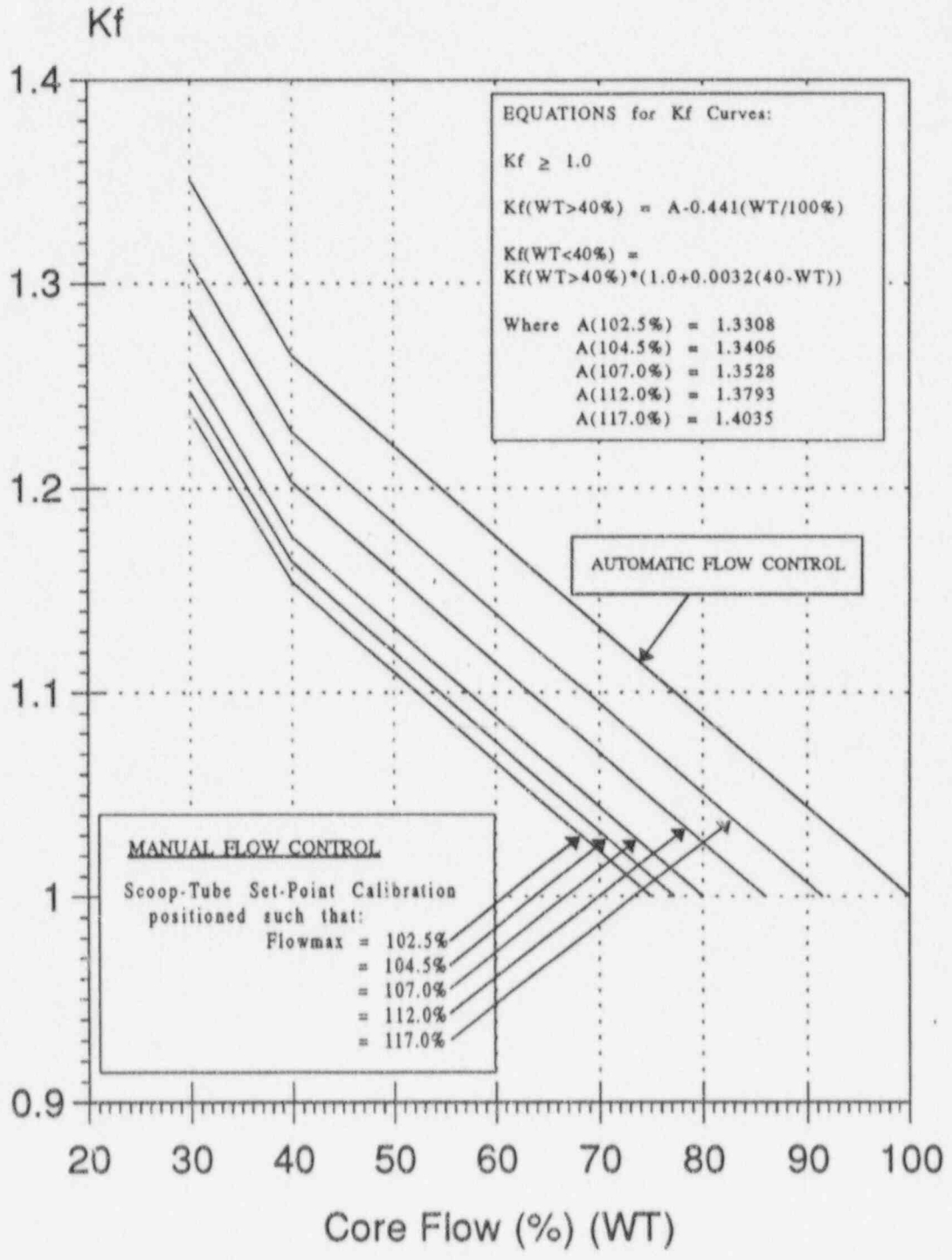
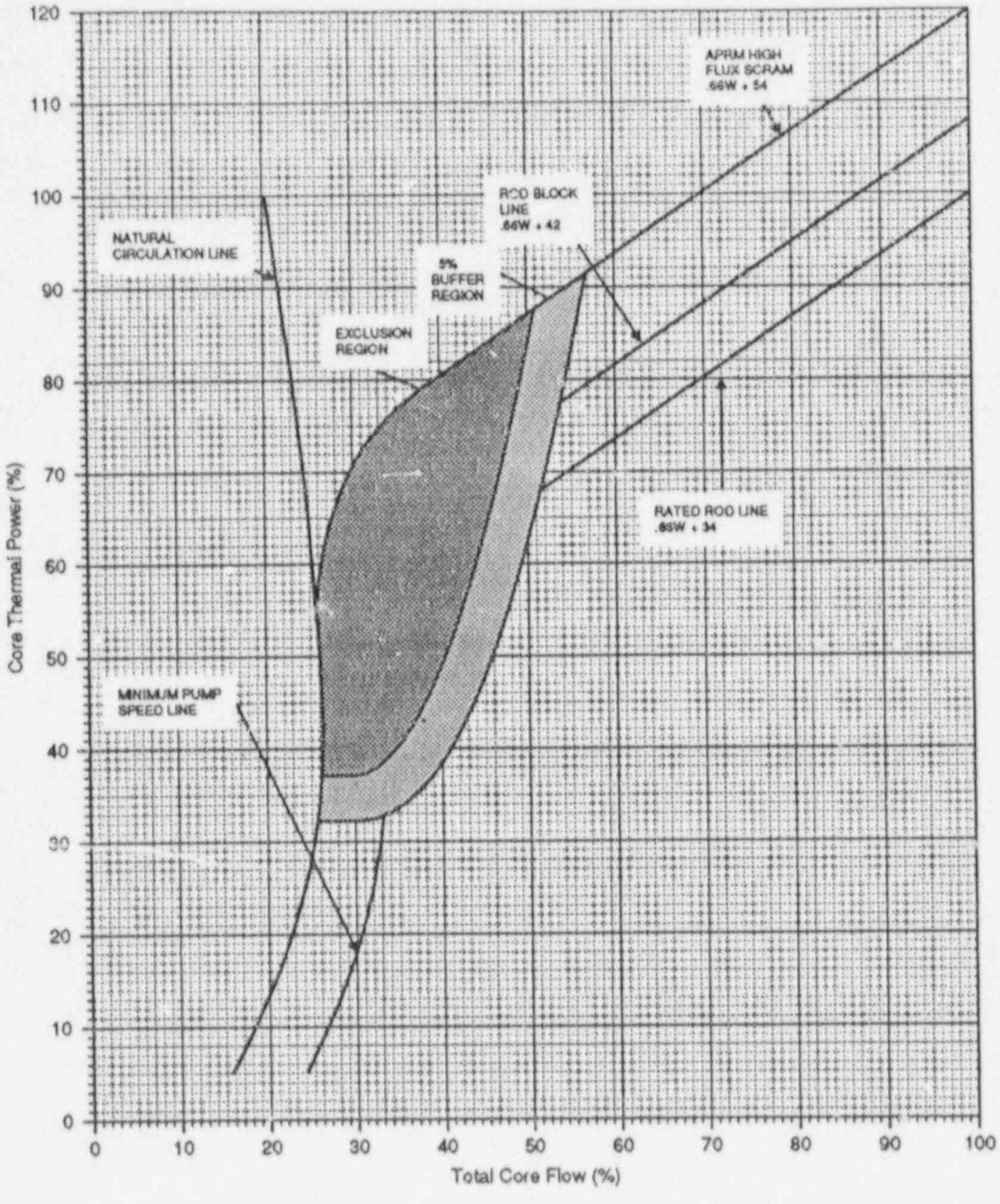


Figure 2.2-1

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



Exclusion Region Boundary Equation

For Flow ≥30%

$POWER = 133.7831 - 6.61\ (FLOW - 0.5) + 0.113\ (FLOW - 0.5)^2$

For Flow ≥26% and <30%

$POWER = 37.1$

Figure 2.4-1

Stability Power and Flow Exclusion Region
(Technical Specification Reference 3.6.J)

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