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NORTHEAST UTILITIES SERVICE COMPANY
NORTHEAST NUCLEAR ENERGY COMPANY

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April 30, 1985

Docket No. 50-423
B11532

Director of Nuclear Reactor Regulation
Mr. B. J. Youngblood, Chief
Licensing Branch No. 1
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Reference: (1) B. J. Youngblood to W. G. Counsil, Request for Additional Information, Questions 492.8 through 492.12, dated March 7, 1985.

Dear Mr. Youngblood:

Millstone Nuclear Power Station, Unit No. 3
Transmittal of Responses to Questions 492.8 through 492.12

Enclosed are Northeast Nuclear Energy Company's responses to NRC - Core Performance Branch questions concerning three-loop operation of Millstone Unit No. 3 contained in Reference (1). These responses should fully resolve the Staff's concern regarding these questions.

If there are any questions, please contact our licensing representative directly.

Very truly yours,

NORTHEAST NUCLEAR ENERGY COMPANY
et. al.

BY NORTHEAST NUCLEAR ENERGY COMPANY
Their Agent

W. G. Counsil
W. G. Counsil
Senior Vice President

J. F. Opeka
By: J. F. Opeka
Vice President

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STATE OF CONNECTICUT)
) ss. Berlin
COUNTY OF HARTFORD)

Then personally appeared before me J. F. Opeka, who being duly sworn, did state that he is Vice President of Northeast Nuclear Energy Company, an Applicant herein, that he is authorized to execute and file the foregoing information in the name and on behalf of the Applicants herein and that the statements contained in said information are true and correct to the best of his knowledge and belief.

Lorraine J. D'Amico
Notary Public

My Commission Expires March 31, 1988

RESPONSE TO NRC QUESTIONS ON THREE-LOOP OPERATION

Question 492.8

During three-loop operation of Millstone Unit No. 3, temperature differences in the active cold legs of a few degrees could exist. Therefore, a radial power tilt and an increase in enthalpy rise factor could result. Provide the following information for justifying the design for three-loop operation:

1. The method of accounting for differences (if any) in the three- and four-loop thermal-hydraulic design;
2. Any special monitoring procedures required during three-loop operation;
3. The reactor protective system setpoints related to DNBR protection and how they are generated;
4. The effects of anticipated operational occurrences on the cold leg temperature distributions and how this effect is included in the design.

Response:

1. The thermal-hydraulic safety analysis performed for three-loop operation assumes that the isolation valves are closed. No temperature difference is induced as the result of isolating a loop. The quadrant power tilt is restricted to 2% as stated in the Millstone Unit No. 3 Technical Specifications (Section 3.2.4). Exceeding this value would require the necessary actions as described in the Technical Specifications. Given the above, there is no difference in thermal-hydraulic methodology in evaluating four- and three-loop operation.

2. No special monitoring procedures are required for three-loop operation.

3. The setpoints used for three-loop and four-loop operation are discussed in FSAR Section 15.0.6. All setpoints listed in Table 15.0-4 are applicable to both three- and four-loop operation with the exception of the power range neutron flux high setting and the OTDT, high trip functions. The power range neutron flux setting for the three-loop analyses is 89%. The three-loop OTDT setpoints are illustrated on FSAR Figures 15.0-1A.

   The methodology used to determine the DNB protection setpoints is the same for both three- and four-loop configurations. All of the setpoints are selected to ensure the DNBR iimit value is met for all DNBR events.

4. The safety analysis performed for three-loop operation assumes that the loop isolation valves are closed. No temperature maldistribution is induced by an isolated loop. Given this, there is no difference in the safety analysis methodology in evaluating four- and three- loop operation.

Question 492.9

Provide a thermal-hydraulic design comparison table similar to Table 4.4-1 in the SER for three- and four-loop operation. This comparison should include all the items presently in Table 4.4-1 including the core pressure drop, the critical heat flux correlation used, the minimum DNBR limit, and the minimum DNBR for both the typical and thimble (cold wall) flow channel at nominal conditions.

Response:

Table 492.9-1 provides a thermal-hydraulic design comparison for four- and three-loop operation for Millstone Unit No. 3.

Table 492.9-1

Millstone 3 Reactor Design Comparison

Parameter	Four-Loop	Three-Loop
Performance Characteristics		
Reactor core heat output, MWt	3,411	2,560
System pressure, psia	2,250	2,250
Minimum DNBR (Nominal Conds)		
Typical cell	2.10	2.42
Thimble cell	1.74	2.02
Design Limit DNBR	1.30	1.30
Critical heat flux correlation	W-3 "R-Grid"	W-3 "R-Grid"
Coolant Flow		
Total flow rate, 10^6 lb/hr	140.8	112.2
Effective flow rate for heat transfer 10^6 lb/hr	132.4	105.5
Average velocity along fuel rods, fps	16.4	12.9
Effective core flow area, ft^2	51.1	51.1
Coolant Temperature, °F		
Nominal reactor inlet	557.0	550.6
Average rise in core	62.6	61.4
Pressure drop across core, psi	25.41 ± 2.5	16.33 ± 1.6
Heat Transfer, 100% Power		
Active heat transfer surface area, ft^2	59,700	59,700
Average heat flux, Btu/hr-ft^2	189,000	142,400
Maximum heat flux, Btu/hr-ft^2	440,300	330,400
Average linear heat rate, kw/ft	5.44	4.1
Maximum thermal output, kw/ft	12.6	9.5

Note: LOCA analysis results currently limits the guaranteed core thermal power to 2,217 MWt. The core design transients were performed at 2,560 MWt and therefore are conservative.

Question 492.10

What are the DNBR limited transients? Provide information on these transients including the minimum DNBR values for both three- and four-loop operation.

Response:

The design transient which is treated as limiting in DNBR space for Millstone Unit No. 3 is loss of flow. A description of the transient along with figures of plant conditions as a function of time are given in the FSAR for both three-loop and four-loop operation. The DNBR for the loss of flow transient can be found on Figures 15.3-8 and 15.3-8a for four-loop and three-loop operation respectively.

As these figures indicate the four-loop case is limiting in terms of DNBR.

Question 492.11

Inlet flow maldistribution is a possibility with three-loop operation. Have flow model tests or analytical studies been made for this effect? If so, provide the reference and results and also provide the following information.

1. What asymmetries exist (if any) in the core flow due to isolation of one loop? Provide inlet flow distribution maps for three- and four-loop operation and show the location of the active and inactive loop inlet positions relative to the flow distribution maps.

2. What is the effect of any inlet flow distribution on the hot channel DNBR?

3. What impact do any asymmetries have on power distribution, DNB limits and fuel integrity?

4. Provide information on flow instability with three-loop operation.

Response:

The core inlet flow distribution criteria used in the THINC analysis (DNBR evaluation) are based on 1/7 scale hydraulic reactor model tests (References 1 and 2). THINC analyses using this data have indicated that a conservative design basis is to consider a five percent (5%) reduction in the flow of the hot assembly. Studies made with the improved THINC model (Reference 3) show that it is appropriate to use the 5% reduction in inlet flow to the hot assembly for one loop out of service based on the experimental data in Reference 1 and 2.

The inlet flow distributions (from Reference 2) for three and four loops in operation have been provided for comparison (Figures 492.11-1 and 492.11-2).

Any asymmetries that exist due to three-loop operation have little or no impact on power distribution, DNB limits and fuel integrity. Even with extreme inlet flow maldistributions, hot channel enthalpy rise and DNBR are only slightly affected (Reference 3). Generic radial power distributions and a 5% flow reduction into the hot assembly used in safety analyses account for any inlet flow maldistributions. All restrictions that are placed on the fuel to ensure fuel integrity are applicable to both four- and three-loop operation. The various criteria that must be met are explained in the FSAR.

The current model used in analyzing flow instabilities (Reference 4) shows that the margin to the inception of thermohydrodynamics instability increases with a decrease in exit quality. The exit quality for three-loop operation is less than for four-loop operation, and therefore, a greater margin to flow instability exists for three-loop operation.

References

1. G. Hestroni, "Hydraulic Tests of the San Onofre Reactor Model," WCAP-3269-8, June, 1984.

2. G. Hestroni, "Studies of the Connecticut Yankee Hydraulic Model," WCAP-2761, June 1965.

3. L. E. Hochreiter, "Application of the THINC IV Program to PWR Design," WCAP-8054, October, 1973 (proprietary), and WCAP-8195 October, 1973 (nonproprietary).

4. P. Saha, M. Ishii and N. Zuber, "An Experimental Investigation of the Thermally Induced Flow Oscillations in Two-Phase Systems," Journal of Heat Transfer November 1976, pages 616-622.

Figure (1) 442.11-1

CONN. YANKEE MODEL TEST - RUN 81 - 4 LOOPS (EQUAL) 29.10 GPM/ASSY

********* NORMALIZED FLOW DISTRIBUTION *********

I142 I140

						1.01	0.91	0.90						
				1.34	0.96	0.91	0.93	1.10	0.99	1.01				
			0.95	0.96	0.99	0.89	0.99	1.02	1.02	0.96	0.97			
		0.99	1.10	1.03	0.92	0.99	1.07	1.05	1.07	1.04	0.95	1.11		
	1.00	1.01	1.01	0.92	1.05	0.98	1.14	1.10	1.11	1.00	1.07	1.04	0.89	
	0.99	1.00	0.93	0.89	1.02	1.09	1.19	1.01	0.94	1.10	1.03	1.01	1.08	
0.93	1.36	0.96	0.95	1.05	1.01	0.96	1.06	1.00	1.00	0.93	1.00	1.02	0.96	0.78
0.94	0.92	0.89	0.99	0.86	1.04	1.12	1.07	1.11	0.98	0.95	0.95	0.94	0.84	0.97
1.29	1.05	1.01	0.95	0.99	0.90	1.02	1.13	1.00	0.96	1.10	1.01	0.95	0.96	0.95
	0.99	1.02	0.99	1.04	0.95	0.97	0.95	1.07	1.09	0.91	1.08	0.96	1.00	
	1.01	1.05	1.04	0.98	1.00	0.98	1.05	0.88	1.09	0.95	0.93	1.02	0.84	
		0.94	0.99	0.90	1.04	0.95	1.03	0.98	1.00	1.18	1.10	0.81		
			0.99	1.00	0.99	0.99	0.99	0.98	1.00	1.07	0.97			
				0.91	0.99	0.96	1.07	0.95	1.07	0.96				
						0.87	1.03	0.93						

I150 (left) I140 (right) L142 (lower left) I137 (lower right)

I135 I150

Normalized flow distribution with four loops operating without the dummy instrumentation tubes.

Figure ② 492-11-2

CONN. YANKEE MODEL TEST - RUN 71 - 3 LOOPS (1, 3, and 4 EQUAL) 23.91 GPM/ASSY

********* NORMALIZED FLOW DISTRIBUTION *********

1255 1251

1250 1247

						1.02	0.91	0.91						
				1.04	0.97	0.93	0.94	1.09	1.00	1.02				
			0.98	0.97	1.00	0.90	0.98	1.02	1.03	0.98	0.98			
		1.00	1.06	0.99	0.92	0.99	1.06	1.05	1.07	1.02	0.95	1.11		
	1.00	0.97	0.97	0.92	1.04	0.98	1.10	1.08	1.10	1.00	1.03	0.98	0.90	
	0.97	1.07	0.98	0.89	1.00	1.08	1.13	0.98	0.94	1.08	0.98	1.01	0.92	
0.94	0.98	0.98	1.00	1.04	1.04	0.97	1.08	0.98	1.03	0.94	1.01	1.01	0.93	0.80
0.92	0.93	0.87	1.00	0.88	1.04	1.05	1.06	1.10	1.01	1.01	0.99	0.94	0.97	0.99
1.27	1.00	0.97	0.95	0.98	0.88	1.01	1.08	0.99	1.02	1.13	1.05	0.98	0.97	0.99
	1.01	1.04	1.01	1.02	0.92	0.95	0.94	1.08	1.08	0.92	1.12	0.98	1.00	
	1.02	1.06	1.03	0.96	0.98	1.00	1.04	0.97	1.04	0.95	0.95	1.03	0.89	
		0.97	1.00	0.93	0.98	0.94	1.02	1.01	1.02	1.19	1.13	0.88		
			1.03	1.00	0.98	0.98	1.14	0.97	1.02	1.09	0.98			
				0.93	1.00	0.98	1.09	1.00	1.08	1.01				
						0.92	1.04	0.95						

1255

1250

Normalized flow distribution with three loops operating (equal flows), without dummy instrumentation tubes.

Question 492.12

Provide the following information relative to the Technical Specifications for three-loop operation.

1. What changes (if any) are required for safety limits, DNB parameters and overtemperature and overpower delta-T setpoint parameters?

2. What is the required minimum flow rate for three-loop operation?

Response:

1. Safety Limits

   The maximum RCS pressure will be the same for three- and four-loop operation. The different plant configurations however, require different core limits.

   DNB Parameters

   The minimum RCS pressure will be the same. The maximum indicated Tavg will be different because different initial Tavgs were assumed in the four- and three-loop analyses. The three-loop initial Tavg is lower than the value assumed in the four-loop analyses. This is because the power used in the three-loop analyses was lower than the four-loop analyses.

   OTDT Setpoint Parameters

   The KT will be lower for three-loop operation. The three-loop core limits are different from the four-loop core limits due to the difference in plant configuration.

   OPDT Setpoint Parameters

   No changes are required for three-loop operation. The four-loop OPDT setpoint parameters provide the necessary protection for three-loop operation.

2. The required minimum flow for three-loop operation is the three-loop thermal design flow (298800 gpm) plus flow measurement uncertainty (2.1%): 305074 gpm.