

# NORTHEAST UTILITIES



THE CONNECTICUT LIGHT AND POWER COMPANY  
WESTERN MASSACHUSETTS ELECTRIC COMPANY  
NEW YORK WATER POWER COMPANY  
NORTHEAST UTILITIES SERVICE COMPANY  
NORTHEAST NUCLEAR ENERGY COMPANY

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October 11 1989  
MP-13607  
Docket No. 50-423

Document Control Desk  
U.S. Nuclear Regulatory Commission  
Washington, D.C. 20555

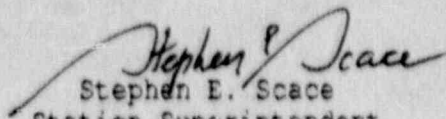
Millstone Nuclear Power Station Unit No. 3  
Transmittal of Startup Report

In accordance with Millstone Unit No. 3 Technical Specifications Section 6.9.1.1, Northeast Nuclear Energy Company (NNECo) hereby submits the Startup Report for Cycle 3 of operation within 90 days of completion of the Cycle 3 startup test program.

If you have any questions related to this submittal please contact Mr. David McDaniel at (203) 447-1791 directly.

Very truly yours,

NORTHEAST NUCLEAR ENERGY COMPANY

  
Stephen E. Scace

Station Superintendent  
Millstone Nuclear Power Station

SES:clc

Attachment: Startup Report

cc: Mr. William Russell  
Regional Administrator  
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Docket No. 50-423

MILLSTONE NUCLEAR POWER STATION

UNIT NO. 3

STARTUP TEST REPORT

CYCLE 3

OCTOBER 1989

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1. SUMMARY

Low power Physics Testing and Power Ascension Testing for Millstone 3 Cycle 3 identified no unusual situations or anomalies. All parameters measured were within their acceptance criteria and Technical Specification limits.

2. INTRODUCTION

The Millstone 3, Cycle 3 fuel loading was completed on June 13, 1989. The attached core map (Figure 1) shows the final core configuration. Seventy-six (76) new fuel assemblies were inserted into the core. Major changes from the Millstone 3 Cycle 2 core design are:

- a) Use of reconstitutable top nozzle.
- b) Use of debris filter bottom nozzle.
- c) Use of Six Silver - Indium - Cadmium Control Rods.
- d) Use of natural Uranium axial blankets and Integral Fuel Burnable Absorbers (IFBA).

Subsequent operation/testing milestones were completed as follows:

Initial Criticality	July 10, 1989
Low Power Physics Testing Completed	July 11, 1989
Main Turbine On-Line	July 13, 1989
30% Power Testing Completed	July 16, 1989
75% Power Testing Completed	July 17, 1989
100% Power Testing Completed	July 27, 1989

Cycle 3 operation is with 193 Westinghouse manufactured fuel assemblies. The Safety Analysis is supplied by Westinghouse.



3. LOW POWER PHYSICS TESTING RESULTS

Low Power Physics Testing was performed at a power level of  $<5 \times 10^{-2}$  power to avoid heat addition from the nuclear fuel.

3.1 Critical Boron Concentrations

Critical Boron Measurements were taken at two different Rod Control Cluster Assembly (RCCA) configurations, at All Rods Out (ARO) and with RCCA Control Banks D, C, B, and A inserted. Figure 2 shows RCCA locations.

The Critical Boron Concentration (CBC) measured with RCCA Bank D at 210 steps was 2010 ppm. Adjusted to All Rods Out, the CBC is 2012.8 ppm. Therefore,

Measured CBC at BCL-HZP-ARO = 2012.8 ppm Boron

Predicted CBC at BOL-HZP-ARO = 2031 ppm

$$\Delta = -18.2 \text{ ppm}$$

The Acceptance Criteria is  $\pm 50$  ppm.

Acceptance Criteria met? Yes.

The Critical Boron Concentration (CBC) measured with Control Banks D, C, B, & A inserted was 1551 ppm.

Measured CBC at BOL-HZP Bank D, C, B, A in = 1551 ppm Boron

Predicted CBC at BOL-HZP Bank D,C,B, A in = 1545 ppm

$$\Delta = 6 \text{ ppm}$$

The Acceptance Criteria is  $\pm 50$  ppm.

Acceptance Criteria met? Yes.

### 3.2 Moderator Temperature Coefficients

The Moderator/Isothermal/ Temperature Coefficients (MTC/ITC) was measured at two different RCCA configurations, at All Rods Out and with Control Bank D, C, B, & A inserted.

#### All Rods Out MTC Measurement

The measured MTC value with Control Bank D at 210 steps, an average RCS temperature of 554°F, and an RCS boron concentration of 2010 ppm was  $.238 \times 10^{-4} \Delta K/K/^{\circ}F$ .

Comparing MTC value to the predicted value yields:

Measured MTC at BOL, ARO =  $.238 \times 10^{-4} \Delta K/K/^{\circ}F$

Predicted MTC at =  $.167 \times 10^{-4} \Delta K/K/^{\circ}$

$\Delta = .071 \times 10^{-4} \Delta K/K/^{\circ}F$

The Acceptance Criteria is  $\pm 0.2 \times 10^{-4} \Delta K/K/^{\circ}F$

Acceptance Criteria met? Yes

In addition to comparing the measured MTC value to the predicted value, it was also required to verify that the Technical Specification MTC limit of  $<+.5 \times 10^{-4} \Delta K/K/^{\circ}F$  at ARO, HZP was met.

Control Banks D, C, B, and A Inserted ITC Measurement

The measured ITC value with Control Banks C, C, B, & A inserted at an average RCS temperature of 555°F and RCS boron concentration of 1546 ppm was  $-.785 \times 10^{-4} \Delta K/K/^\circ F$ .

Comparing the measured ITC value to the predicted value yields:

ITC at Control Bank D Inserted =  $-.785 \times 10^{-4} \Delta K/K/^\circ F$

Predicted ITC BOL, =  $-.789 \times 10^{-4} \Delta K/K/^\circ F$

Bank D Inserted  $\Delta$  =  $.004 \times 10^{-4} \Delta K/K/^\circ F$

The Acceptance Criteria is  $\pm 0.2 \times 10^{-4} \Delta K/K/^\circ F$

Acceptance Criteria met? Yes

3.3 Control Rod Reactivity Worths

Reactivity worth measurements were performed twice on Control Banks D, C, B, & A. The first measurement involved measuring the reactivity worth of each Bank individually. The second measurement involved measuring the reactivity worth of Control Banks A, B, C and D in their sequenced overlap mode of operation.

The results of the measurements were:

Individual Bank Measurement (by dilution)

Bank	Measured Worths ( $\Delta K/K$ )	Predicted Worths ( $\Delta K/K$ )	Delta (M-P)	% Difference ((M-P)/P)
CONTROL D	.475	.512	-.037	-7.2%
CONTROL C	.970	.999	-.029	-2.9%
CONTROL B	.967	.965	.002	.207%
CONTROL A	.979	1.067	-.088	-8.25%
Total	3.391	3.543	-.152	-4.3%

Overlap Measurements (by boration)

Control Bank Measured Worths ( $\Delta K/K$ ) in a Sequenced Overlap  
3.381



The Acceptance Criteria for the Total Worth of Measured Control and Shutdown Banks inserted is  $\pm 10\%$  of the predicted total worth. The Acceptance Criteria for any individual Control Bank is the greater of either  $\pm 0.1\% \Delta K/K$  or  $\pm 15\%$  of the predicted group worth.

Measurement of Control Rod Reactivity Worth also verified Technical Specification Surveillance requirements for SHUTDOWN MARGIN. Adequate SHUTDOWN MARGIN was verified to exist from the Hot Zero Power Rod Insertion Limit.

There is no acceptance criteria for the worth of control banks measured in sequenced overlap.

Acceptance Criteria met on all Banks? Yes

4. POWER ASCENSION TESTING RESULTS

4.1 Power Peaking, and Tilt Measurements

Flux Maps was performed to determine incore power distribution and tilt.

The measurements of these parameters including uncertainty were:

<u>Power Level</u>	<u>Rodded</u>			<u>Unrodde</u>			<u>Maximum Incore Tilt</u>
	<u>C Fxy</u>	<u>Limit Fxy</u>	<u>RTP Fxy</u>	<u>C Fxy</u>	<u>Limit Fxy</u>	<u>RTP Fxy</u>	
30%	1.69	2.03	1.79	1.69	1.90	1.67	1.009
50%	1.64	1.97	1.79	1.65	1.84	1.67	1.013
75%	1.59	1.88	1.79	1.65	1.75	1.67	1.008
100%	N/A	N/A	N/A	1.62	1.67	1.67	1.003

4.2 Boron Measurements

At 100% power, 212 MWD/MTU, Control Bank D at 221 steps and Equilibrium Xenon, the measured boron concentration was 1467 ppm.

Adjusted, Measured boron concentration 100% power, = 1481 ppm.

212 MWD/MTU, ARO, EQ. Xenon

Predicted boron concentration 100% power, = 1495 ppm

212 MWD/MTU, ARO, EQ. Xenon

$$\Delta = - 14 \text{ ppm}$$



Subsequent boron measurements made at 2269 MWD/MTU yielded the following results:

Adjusted measured boron concentration 100% power, = 1377.6 ppm  
2269 MWD/MTU, ARO, EQ. Xenon

Predicted boron concentration, 100% power, = 1375 ppm  
2269 MWD/MTU, ARO, EQ. Xenon

$$\Delta = \frac{2.6}{\text{ppm}}$$

The Acceptance Criteria is  $\pm 130$  ppm Boron ( $\pm 1\%$   $\Delta K/K$ )

Acceptance Criteria met? Yes

#### 4.3 Doppler Only Power Coefficient

A Doppler Only Power Coefficient verification factor ( $C^M$ ) was calculated at 100% and compared to the predicted doppler only power coefficient verification factor ( $C^P$ ). Measurements were taken at an average power of 98.9%, 587.5°F and RCS boron concentration of 1467 ppm.

Measured

Predicted

$C^M$  Average  
-1.214 °F/%

$C^P$   
-.855 °F/%

Acceptance Criteria

The absolute difference between  $C^M$  and  $C^P$  is  $< 0.5$  °F/%

$$|-1.214| - |-.855| = .359$$

Acceptance Criteria met? Yes

4.4 RCS Flow

The measured RCS flow at 75% power was 404,620 GPM.

The Acceptance Criteria per Millstone 3 Technical Specifications, is that RCS flow must be greater than 385,210 GPM prior to exceeding 75% power.

Acceptance Criteria met? Yes

4.5 Power Distribution

Power Distribution Maps are shown for 30% and 100% power conditions in Figures 3 and 4. The agreement between the measurements and the predictions is good.

The Acceptance Criteria is that all locations are within  $\pm 10\%$  of the predicted value.

Acceptance Criteria met? Yes

5. REFERENCES

- 5.1 In-Service Test 3-89-008, Initial Criticality/Low Power Physics Test - Cycle 3.
- 5.2 In-Service Test 3-89-13, Power Ascension Test - Cycle 3.
- 5.3 Westinghouse Nuclear Design Report - Cycle 3.
- 5.4 ANSI/ANS - 19.6.1 - 1985 Reload Startup Physics Tests for Pressurized Water Reactors.

FIGURE 1  
Reference Core Loading Pattern  
MILLSTONE UNIT 3 CYCLE 3

R P N M L K J H G F E D C B A

180°

					4A D-51 D-11	5B E-34	4B D-60 F-15	5B E-36	4B D-62 K-15	5B E-37	4A D-27 M-11				1		
		4B D-74 J-14	4A D-32 F-11	5B E-46	4A D-36 C-04	5B E-55	4A D-26 F-03	5B E-60	4A D-43 N-04	5B E-48	4A D-14 K-11	4B D-71 G-14				2	
	4B D-65 B-07	5A E-01	5B E-62	4A D-42 H-11	5A E-07	3 C-49 B-10	4B D-82 H-15	3 C-53 P-10	5A E-12	4A D-10 J-08	5B E-71	5A E-02	4B D-70 P-07				3
	4A D-19 E-10	5B E-72	3 C-38 A-09	5A E-14	2 B-15 K-07	5B E-54	4A D-12 D-07	5B E-75	2 B-61 N-05	5A E-23	3 C-50 J-15	5B E-56	4A D-06 L-10			4	
4A D-07 E-12	5B E-49	4A D-45 H-09	5A E-24	4A D-05 D-09	4B D-79 E-14	4A D-13 J-06	3 C-35 B-12	4A D-48 G-06	4B D-84 L-14	4A D-21 J-12	5A E-06	4A D-50 L-08	5B E-50	4A D-15 L-12		5	
5B E-42	4A D-39 M-13	5A E-27	2 B-10 J-06	4B D-75 B-11	4A D-23 K-03	5A E-06	3 C-56 B-04	5A E-18	4A D-36 C-06	4B D-80 P-11	2 B-31 B-06	5A E-19	4A D-03 D-13	5B E-43		6	
4B D-81 A-10	5B E-66	3 C-29 F-14	5B E-67	4A D-37 K-07	5A E-15	3 C-58 J-01	5A E-29	3 C-09 A-07	5A E-16	4A D-45 F-07	5B E-63	3 C-44 K-14	5B E-64	4B D-63 R-10		7	
5B E-33	4A D-40 N-06	4B D-57 A-08	4A D-53 J-04	3 C-48 D-02	3 C-16 M-02	5A E-30	2 B-32 E-08	5A E-31	3 C-63 D-14	3 C-36 M-14	4A D-08 G-12	4B D-67 R-08	4A D-28 C-10	5B E-44		8	
4B D-69 A-06	5B E-59	3 C-26 F-02	5B E-61	4A D-47 K-09	5A E-11	3 C-34 R-09	5A E-32	3 C-43 G-13	5A E-13	4A D-55 F-09	5B E-53	3 C-27 K-02	5B E-70	4B D-73 R-06		9	
5B E-35	4A D-04 M-03	5A E-05	2 B-23 J-10	4B D-72 B-05	4A D-54 N-10	5A E-22	3 C-46 P-12	5A E-10	4A D-17 F-13	4B D-61 P-05	2 B-01 B-10	5A E-09	4A D-41 D-03	5B E-40		10	
4A D-35 E-04	5B E-51	4A D-44 E-08	5A E-26	4A D-11 G-04	4B D-83 E-02	4A D-18 J-10	3 C-17 P-04	4A D-09 G-10	4B D-77 L-02	4A D-56 M-07	5A E-25	4A D-34 H-07	5B E-45	4A D-02 L-04		11	
	4A D-46 E-06	5B E-58	3 C-14 G-01	5A E-21	2 B-38 L-08	5B E-57	4A D-29 M-08	5B E-74	2 B-02 F-05	5A E-28	3 C-39 R-07	5B E-73	4A D-20 L-06			12	
	4B D-84 B-09	5A E-03	5B E-69	4A D-24 D-08	5A E-20	3 C-45 B-06	4B D-66 H-01	3 C-06 P-06	5A E-17	4A D-22 H-05	5B E-76	5A E-04	4B D-76 P-09			13	
	4B D-78 J-02	4A D-25 F-05	5B E-52	4A D-16 C-12	5B E-68	4A D-52 K-13	5B E-65	4A D-30 K-12	5B E-47	4A D-33 K-05	4B D-58 G-02					14	
				4A D-01 D-05	5B E-41	4B D-68 F-01	5B E-38	4B D-59 K-01	5B E-39	4A D-31 M-05						15	

90°

0°

REGION # ASSEMBLIES W/O U-235

2	9	2.9
3	31	3.4
4A	208	3.5
4B	208	3.6
5A	32	4.1
5B	44	4.5

LEGEND

REGION ASSEMBLY ID PREV. LOC.
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FIGURE 2

Reference Core Control Rod and Burnable Absorber Pattern  
MILLSTONE UNIT 3 CYCLE 3

R P N M L K J H G F E D C B A

180°

90°

				4A	5B	4B SDE	5B	4B	5B	4A					1
		4B	4A SDA	5B	4A B	5B	4A C	5B	4A B	5B	4A SDA	4B			2
	4B	5A	5B	4A SDD	5A	3 SDB	4B SS	3 SDB	5A	4A SDC	5B	5A	4B		3
	4A SDA	5B	3 D	5A	2 SP	5B	4A SDA	5B	2 SP	5A	3 D	5B	4A SDA		4
4A	5B	4A SDC	5A	4A A	4B	4A	3	4A SP	4B	4A A	5A	4A SDD	5B	4A	5
5B	4A B	5A	2 SP	4B	4A C	5A	3 A	5A	4A C	4B	2 SP	5A	4A B	5B	6
4B	5B	3 SDB	5B	4A SF	5A	3	5A	3	5A	4A	5B	3 SDB	5B	4B SDE	7
5B	4A C	4B	4A SDB	3	3 A	5A	2 D	5A	3 A	3A	4A SDB	4B	4A C	5B	8
4B SDE	5B	3 SDB	5B	4A	5A	3	5A	3	5A	4A SP	5B	3 SDB	5B	4B	9
5B	4A B	5A	2 SP	4B	4A C	5A	3 A	5A	4A C	4B	2 SP	5A	4A B	5B	10
4A	5B	4A SDD	5A	4A A	4B	4A SP	3	4A	4B	4A A	5A	4A SDC	5B	4A	11
	4A SDA	5B	3 D	5A	2 SP	5B	4A SDA	5B	2 SP	5A	3 D	5B	4A SDA		12
	4B	5A	5B	4A SDC	5A	3 SDB	4B SS	3 SDB	5A	4A SDD	5B	5A	4B		13
		4B	4A SDA	5B	4A B	5B	4A C	5B	4A B	5B	4A SDA	4B			14
				4A	5B	4B	5B	4B SDE	5B	4A					15

0°

BANK # OF ROD CLUSTERS

SDA	10
SDB	10
SDC	4
SDD	4
SDE	4
D	4
C	5
B	8
A	8

LEGEND

REGION
ROD BANK

FIGURE 3

	R	P	N	M	L	K	J	H	G	F	E	D	C	B	A		
1					446	896	831	1007	846	937	470						
2			392	629	1173	1098	1330	1092	1342	1115	1197	616	383				
3			387	987	1216	1100	1335	978	1181	977	1337	1098	1192	978	383		
4			616	1190	846	1203	925	1300	1053	1304	955	1268	881	1168	594		
5			449	1175	1090	1335	999	1049	1008	939	1016	1071	1030	1236	1080	1155	449
6			902	1086	1282	937	1047	1025	1199	958	1219	1044	1068	951	1314	1072	892
7			840	1327	956	1281	999	1196	899	1082	915	1216	1010	1292	975	1320	825
8			1007	1081	1163	1033	922	944	1082	748	1106	961	932	1045	1175	1094	1012
9			827	1318	973	1276	1011	1208	902	1091	913	1210	1012	1276	959	1333	838
10			892	1090	1318	929	1061	1037	1274	961	1213	1024	1050	920	1255	1122	916
11			457	1201	1026	1208	1009	1059	1013	932	1010	1038	1007	1207	1043	1212	461
12			631	1112	857	1215	934	1275	1043	1278	909	1206	853	1168	628		
13			392	938	1143	1047	1279	955	1170	968	1308	1071	1157	961	386		
14			390	610	1161	1068	1306	1072	1310	1065	1153	608	382				
15					454	883	820	997	824	869	438						

LEGEND: :.....: SCALE: :.....:  
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INCORE ASSEMBLY POWER DISTRIBUTION 30% POWER

FIGURE 4

	R	P	N	M	L	K	J	H	G	F	E	D	C	B	A
1					435	837	774	922	775	850	445				
2			403	630	1122	1041	1241	1021	1241	1040	1125	612	391		
3			401	999	1229	1096	1294	953	1133	951	1288	1079	1194	976	391
4			625	1216	974	1251	947	1281	1042	1281	967	1293	997	1184	604
5	436	1122	1085	1273	1045	1082	1036	964	1035	1091	1066	1276	1076	1104	435
6	838	1027	1257	957	1081	1065	1257	1014	1258	1073	1095	970	1273	1016	829
7	778	1243	946	1280	1037	1253	985	1208	991	1265	1040	1294	959	1238	771
8	918	1017	1132	1045	967	1010	1203	947	1224	1021	969	1053	1144	1028	931
9	766	1235	955	1286	1051	1263	980	1213	999	1264	1043	1279	952	1255	783
10	826	1026	1268	947	1083	1066	1264	1021	1266	1069	1087	954	1249	1063	854
11	440	1136	1013	1252	1033	1073	1028	969	1041	1079	1052	1261	1054	1160	449
12	632	1226	963	1230	930	1259	1049	1280	945	1257	979	1174	625		
13	403	1001	1192	1030	1230	932	1136	959	1283	1073	1184	967	387		
14	403	618	1100	1008	1226	1010	1234	1023	1111	617	391				
15					437	821	761	911	768	821	430				

LEGEND: :.....: SCALE: :.....:  
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INCORE ASSEMBLY POWER DISTRIBUTION 100% POWER