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Dominion

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Docket No. 50-336
B18669

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555

Millstone Nuclear Power Station, Unit No. 2
Startup Test Report for Cycle 15

Pursuant to Section 6.9.1.3 of the Millstone Unit No. 2 Technical Specifications, Dominion Nuclear Connecticut, Inc. hereby submits the enclosed Startup Test Report for Cycle 15.

There are no regulatory commitments contained within this letter.

If you have any additional questions concerning this submittal, please contact Mr. David W. Dodson at (860) 447-1791, Ext. 2346.

Very truly yours,

DOMINION NUCLEAR CONNECTICUT, INC.

J. Alan Price
Site Vice President - Millstone

Enclosure (1)

cc: H. J. Miller, Region I Administrator
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NRC Senior Resident Inspector, Millstone Unit No. 2

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Enclosure

Millstone Nuclear Power Station, Unit No. 2
Startup Test Report for Cycle 15

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1. SUMMARY

The refueling outage preceding the Cycle 15 startup was approximately 45 days, starting on February 16, 2002 and ending on April 2, 2002.

The results of the Millstone 2, Cycle 15 low power physics testing and power ascension testing programs were in good agreement with the core design predictions and all measured parameters were within the acceptance criteria of the tests.

2. INTRODUCTION

The Millstone 2 Cycle 15 fuel loading was completed on March 2, 2002. The attached core map (Figure 6.1) shows the final core loading. The subsequent operation/testing milestones were completed as follows:

Initial Criticality	March 31, 2002
Low Power Physics Testing Complete	April 1, 2002
Turbine On-Line	April 2, 2002
65% Power Testing Complete	April 4, 2002
96% Power Testing Complete	April 18, 2002
100% Power Testing Complete	May 1, 2002

The Millstone 2 Cycle 15 core is comprised of 217 Framatome ANP manufactured fuel assemblies.

3. LOW POWER PHYSICS TESTING RESULTS

Low Power Physics Testing was conducted at a power level of approximately 2×10^{-2} % power.

3.1 Unrodded Critical Boron Concentration

The Critical Boron Concentration measured with CEA Group 7 at 134 steps withdrawn and an RCS temperature of 533.0°F was 1589 ppm.

Adjusted to the prediction conditions of Group 7 at 180 steps withdrawn and an RCS temperature of 532°F yields an adjusted, measured CBC of 1612 ppm.

Adjusted, measured unrodded CBC	=	1612 ppm
Predicted unrodded CBC	=	1619 ppm
Difference	=	-7 ppm

Acceptance Criteria is ± 50 ppm of the predicted CBC.

Acceptance Criteria met? Yes

3.2 Moderator Temperature Coefficient

The Moderator Temperature Coefficient (MTC) measurements were performed at a boron concentration of 1588 ppm, an average RCS temperature of 532.6°F, and CEA Group 7 at 134 steps.

The measured MTC at these conditions was $+0.221 \times 10^{-4}$ Δρ/°F.

Adjusted to the prediction conditions for an RCS boron concentration of 1600 ppm and an RCS temperature of 532°F yields an adjusted, measured MTC of $+0.236 \times 10^{-4}$ Δρ/°F.

Adjusted, measured MTC	=	$+0.236 \times 10^{-4}$ Δρ/°F
Predicted MTC	=	$+0.278 \times 10^{-4}$ Δρ/°F
Difference	=	-0.042×10^{-4} Δρ/°F

Acceptance Criteria is $\pm 0.2 \times 10^{-4}$ Δρ/°F of the predicted MTC.

Acceptance Criteria met? Yes

Additionally, per the Millstone 2 Technical Specifications, the MTC must be less positive than $+0.7 \times 10^{-4}$ $\Delta\rho/°F$ for power levels less than 70% power.

Technical Specification limit met? Yes

3.3 Control Element Assembly Rod Worth Parameters

Control Element Assembly (CEA) Rod Worth Parameters were measured using the "rod swap" method. Figure 6.2 shows the CEA group configuration.

CEA Group "A" was used as the "reference" group and its reactivity worth was measured using the "boron exchange" method (dilution results are shown below). The reactivity worth of the remaining CEA groups was measured by establishing a critical condition with the "test" group fully inserted and the "reference" group partially withdrawn.

The results of the CEA worth measurements were:

Group	Measured	Prediction	Difference	% Difference
A	1.114 %Δρ	1.091 %Δρ	-0.023 %Δρ	-2.11 %
B	0.430 %Δρ	0.433 %Δρ	0.003 %Δρ	0.69 %
1	0.793 %Δρ	0.808 %Δρ	0.015 %Δρ	1.86 %
2	0.892 %Δρ	0.880 %Δρ	-0.012 %Δρ	-1.36 %
3	0.512 %Δρ	0.486 %Δρ	-0.026 %Δρ	-5.35 %
4	0.736 %Δρ	0.696 %Δρ	-0.040 %Δρ	-5.75 %
5	0.364 %Δρ	0.379 %Δρ	0.015 %Δρ	3.96 %
6	0.409 %Δρ	0.363 %Δρ	-0.046 %Δρ	-12.67 %
7	0.910 %Δρ	0.858 %Δρ	-0.052 %Δρ	-6.06 %
Total	6.160 %Δρ	5.994 %Δρ	-0.166 %Δρ	-2.77 %

The Acceptance Criteria are:

1. The measured "reference" group worth is within ± 10% of the predicted worth.
2. The measured worth of the individual CEA groups is within ± 0.1%Δρ **or** ± 15% of the predicted worth, *whichever is larger.*
3. The sum of the measured CEA worths is within ± 10% of the sum of the predicted CEA worths.

Acceptance Criteria met for "reference" CEA group? Yes

Acceptance Criteria met for individual CEA groups? Yes

Acceptance Criteria met for sum of CEA group worths? Yes

3.4 Rodded Critical Boron Concentration

The Critical Boron Concentration measured with CEA Group A at 0 steps withdrawn and an RCS temperature of 532.2°F was 1472 ppm.

Adjusted to the prediction conditions of Group A at 0 steps withdrawn and an RCS temperature of 532°F yields an adjusted, measured CBC of 1472 ppm.

Adjusted, measured rodded CBC	=	1472 ppm
Predicted rodded CBC	=	1484 ppm
Difference	=	-12 ppm

Acceptance Criteria is ± 50 ppm of the predicted CBC.

Acceptance Criteria met? Yes

3.5 Control Rod Drop Time Measurements

The Millstone 2 Technical Specifications require that all CEAs drop in less than or equal to 2.75 seconds to the 90% inserted position, with RCS conditions at greater than or equal to 515°F and full flow (all reactor coolant pumps operating).

Control rod drop time testing was done at an RCS temperature of 535°F with all 4 reactor coolant pumps operating. The average control rod drop time was 2.26 seconds to 90% insertion, with the fastest and slowest drop times being 2.18 seconds and 2.36 seconds, respectively.

Technical Specification limits met? Yes

4. POWER ASCENSION TESTING RESULTS

4.1 Power Peaking, Linear Heat Rate and Incore Tilt Measurements

The following core power distribution parameters were measured during the power ascension to ensure compliance with the Technical Specifications:

- Total Unrodded Integrated Radial Peaking Factor (F_r^T) is the ratio of the peak fuel rod power to the average fuel rod power in an unrodded core. This value includes the effect of Azimuthal Power Tilt.
- Linear Heat Rate is the amount of power being produced per linear length of fuel rod.
- Azimuthal Power Tilt is the maximum difference between the power generated in any core quadrant (upper or lower) and the average power of all quadrants in that half (upper or lower) of the core divided by the average power of all quadrants in that half (upper or lower) of the core.

The measurements of these parameters were:

Power Level	F_r^T	Peak Linear Heat Rate	Incore Tilt
65%	1.662	8.83 KW/ft	0.0169
96%	1.622	12.50 KW/ft	0.0134
100%	1.609	12.84 KW/ft	0.0130

The corresponding Technical Specification limits for all power levels for these parameters are:

- $F_r^T \leq 1.69$ (Note - larger values of F_r^T are permissible at less than 100% power)
- Peak Linear Heat Rate $\leq$ 15.1 KW/ft
- Azimuthal Power Tilt $\leq$ 0.02

Technical Specification limits met? Yes

4.2 Critical Boron Measurements

Critical Boron Concentration (CBC) measurements were performed at 96% power and 100% power at equilibrium xenon conditions.

The CBC measured at 96% power with CEA Group 7 at 154 steps withdrawn and an RCS temperature of 570.5°F was 1122 ppm. The cycle average exposure at the time of this measurement was 184 MWD/MTU.

Adjusted to the prediction conditions of 96% power with CEA Group 7 at 155 steps withdrawn and an RCS temperature of 573.3°F yields an adjusted, measured CBC of 1120 ppm.

Adjusted, measured 96% power CBC = 1120 ppm

Predicted 96% power CBC = 1136 ppm

Difference = -16 ppm

Acceptance Criteria is ± 50 ppm of the predicted CBC

Acceptance Criteria met? Yes

The CBC measured at 100% power with CEA Group 7 at 170 steps withdrawn and an RCS temperature of 571.9°F was 1099 ppm. The cycle average exposure at the time of this measurement was 470 MWD/MTU.

Adjusted to the prediction conditions of 100% power at an All Rods Out (ARO) condition and an RCS temperature of 572°F yields an adjusted, measured CBC of 1102 ppm.

Adjusted, measured 100% power CBC	=	1102 ppm
Predicted 100% power CBC	=	1107 ppm
Difference	=	-5 ppm

Acceptance Criteria is ± 50 ppm of the predicted CBC

Acceptance Criteria met? Yes

4.3 Flux Symmetry Measurements

The core neutron flux symmetry was measured at approximately 30% power using the fixed incore detector monitoring system. The measured deviation between the highest and lowest values in operable symmetric incore detector locations ranged from 0.2% to 20.6%.

Review Criteria is ± 10% (deviation between the highest and lowest values in symmetric incore locations).

Review Criteria met? No. The measurement is performed to provide an early indication of the degree of tilt which could lead to exceeding the azimuthal tilt limit and to ensure the core is loaded properly. The azimuthal tilt at this low power level was determined to be within the 2% limit and core loading was verified. Continuation of the power ascension is not contingent on this review criteria.

4.4 Moderator Temperature Coefficient

The Moderator Temperature Coefficient (MTC) measurements were performed at a power level of 96%, an RCS boron concentration of 1122 ppm, an average RCS temperature of 567.1°F, and CEA Group 7 at 154 steps.

The measured MTC at these conditions was -0.385×10^{-4} $\Delta\rho$/°F.

Adjusted to the prediction conditions for an RCS boron concentration of 1136 ppm and an RCS temperature of 573.3°F yields an adjusted, measured MTC of -0.432×10^{-4} Δρ/°F.

Adjusted, measured MTC	=	-0.432×10^{-4} Δρ/°F
Predicted MTC	=	-0.590×10^{-4} Δρ/°F
Difference	=	0.158×10^{-4} Δρ/°F

Acceptance Criteria is $\pm 0.3 \times 10^{-4}$ Δρ/°F of the predicted MTC.

Acceptance Criteria met? Yes

4.5 Reactor Coolant System Flow

The RCS flow rate was measured using the secondary calorimetric method, in which the RCS flow rate is inferred by performing a heat balance around the steam generators and RCS to determine reactor power, and measuring the differential temperature across the reactor core to determine the enthalpy rise.

The measured RCS flow rate at 100% power was 383,781 GPM.

When 13,000 GPM is subtracted from the measured flow rate to account for measurement uncertainties, the Minimum Guaranteed Safety Analysis RCS Flow Rate is 370,781 GPM. This value is used to satisfy the Technical Specification surveillance requirement.

The Millstone 2 Technical Specifications require the RCS flow rate to be greater than 360,000 GPM.

Technical Specification limit met? Yes

4.6 Core Power Distributions

The core power distribution measurements were inferred from the signals obtained by the fixed incore detector monitoring system. These measurements were performed at 65% power and 100% to determine if the measured and predicted core power distributions are consistent.

The core power distribution map for 65% power, cycle average exposure of 21 MWD/MTU, *non*-equilibrium xenon conditions is shown in Figure 6.3.

This map shows that there is good agreement between the measured and predicted values.

The core power distribution map for 100%, cycle average exposure of 470 MWD/MTU, equilibrium xenon conditions is shown in Figure 6.4. This map also shows that there is good agreement between the measured and predicted values.

The Acceptance Criteria for these measurements are:

1. The difference between the measured and predicted Relative Power Densities (RPDs) for core locations with an operable incore detector is less than 0.1.
2. The Root Mean Square (RMS) of all of the differences between the measured and predicted RPDs is less than 5%.

Acceptance Criteria met? Yes, for both 65% and 100% power

4.7 Reactor Coolant System Radiochemistry

RCS radiochemistry analysis during the power ascension testing program and during subsequent power operation indicate slightly elevated activity levels with Iodine-131 values of about 2×10^{-3} μCi/ml. These RCS activity levels are indicative of cladding failure of one fuel rod.

5. REFERENCES

5.1 SPROC ENG00-2-02, "Cycle 15, Low Power Physics Test"

5.2 SPROC ENG00-2-01, "Cycle 15, Power Ascension Test"

5.3 EMF-2714, "Millstone Unit 2, Cycle 15, Startup and Operations Report"

5.4 SP 21010, "CEA Drop Times"

6. FIGURES

6.1 Cycle 15 Core Loading Map

6.2 CEA Group Configuration

6.3 65% Core Power Distribution Map

6.4 100% Core Power Distribution Map

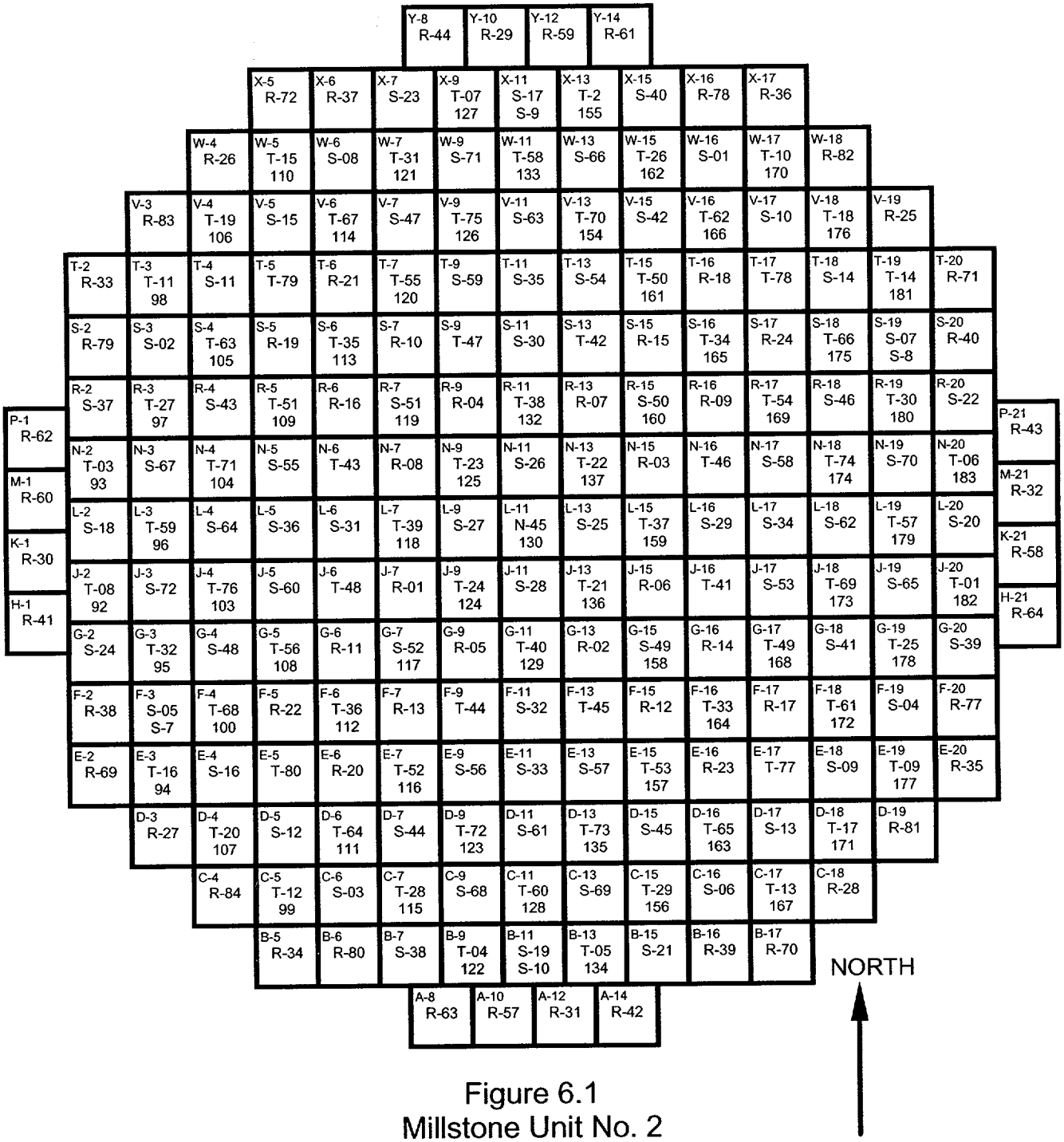


Figure 6.1
Millstone Unit No. 2
Cycle 15 Core Map

Source	Core Location	Guidetube
7	F-3	SW
8	S-19	SE
9	X-11	NW
10	B-11	SW

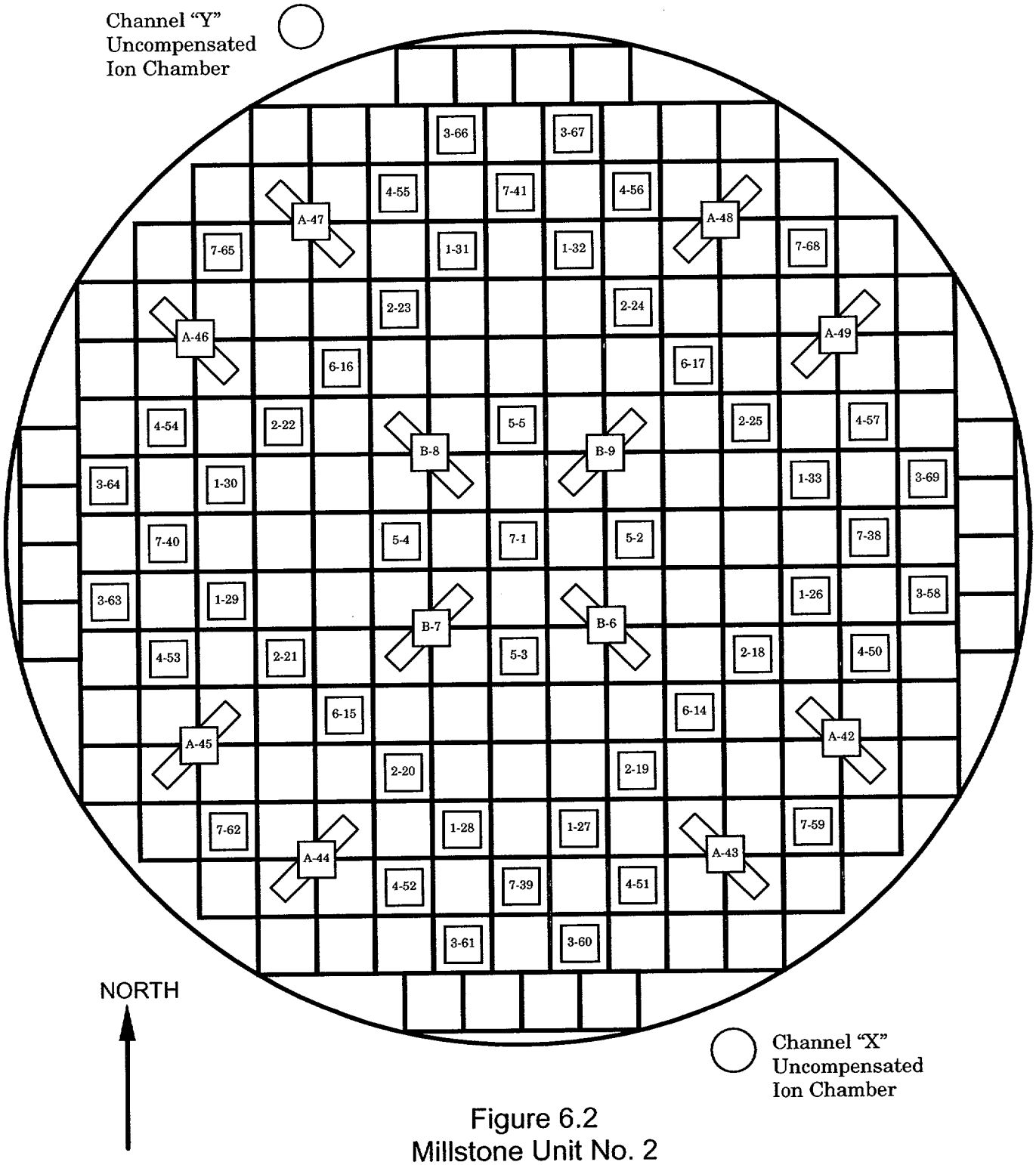
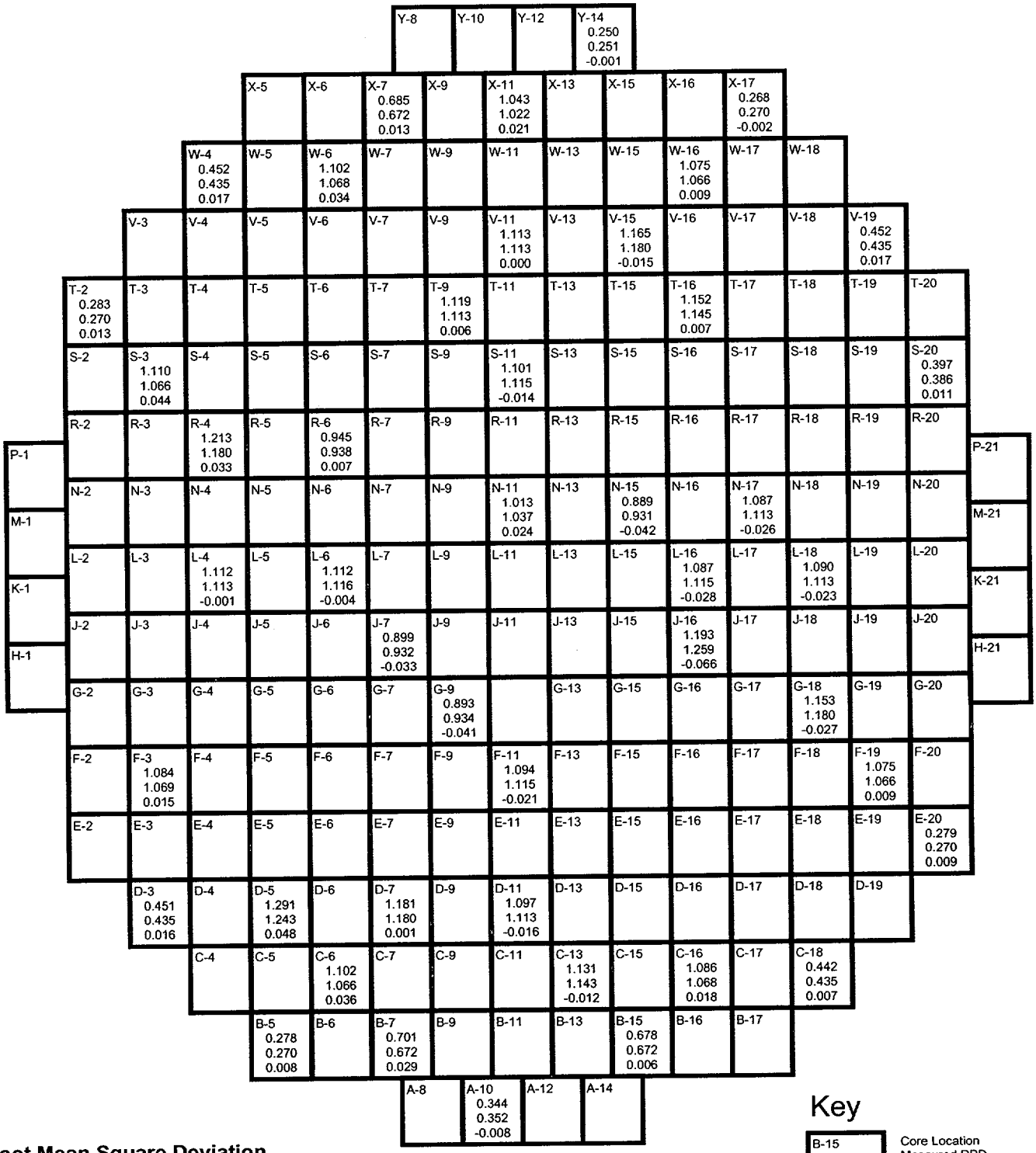
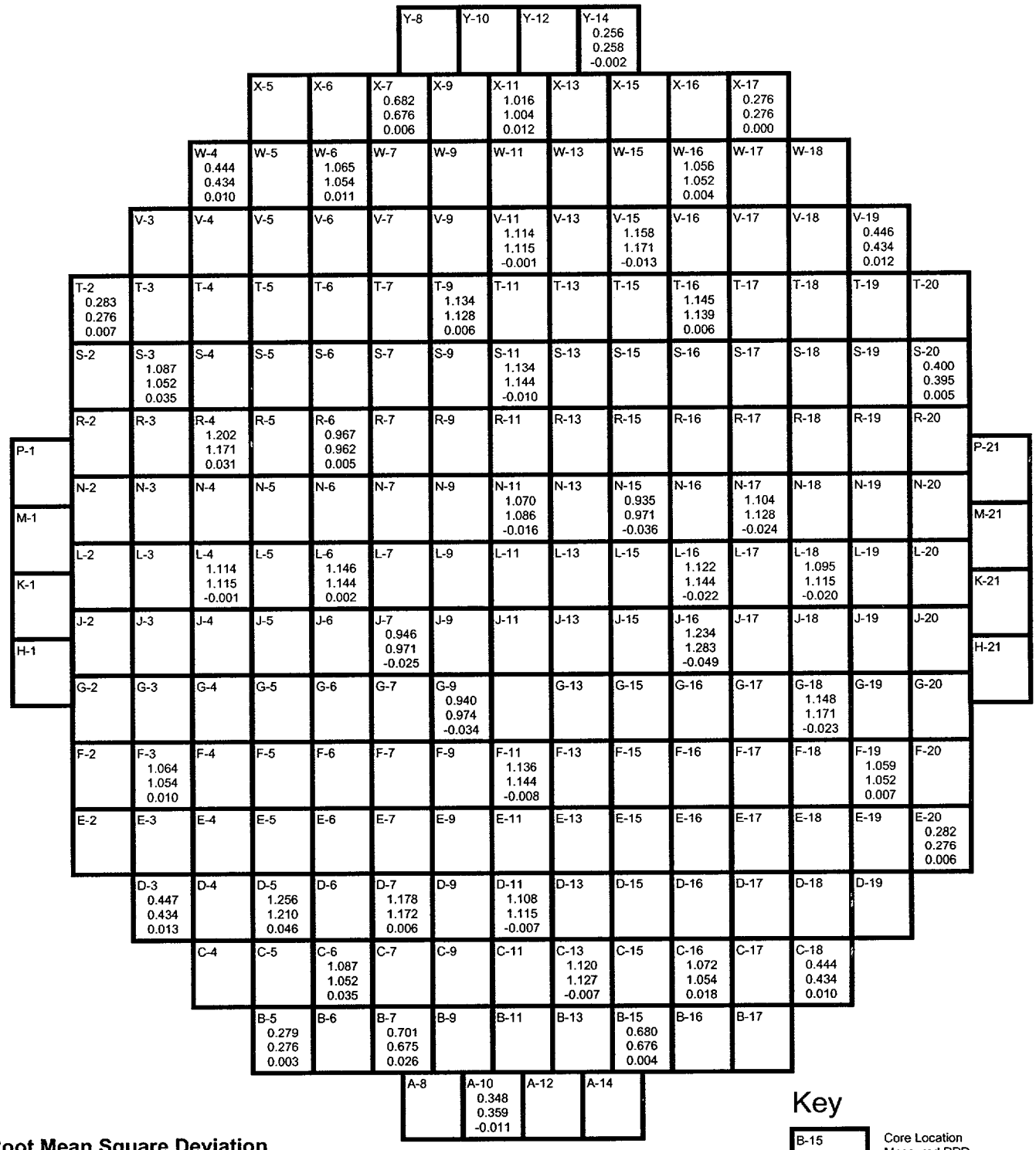


Figure 6.2
Millstone Unit No. 2
CEA Group Configuration



Root Mean Square Deviation for all Core Locations = 1.94 %

Figure 6.3
65% Power Distribution Map
All Rods Out, Non-Equilibrium Xenon, 21 MWD/MTU



Root Mean Square Deviation for all Core Locations = 1.50 %

Figure 6.4
100% Power Distribution Map
170 Steps, Equilibrium Xenon, 470 MWD/MTU