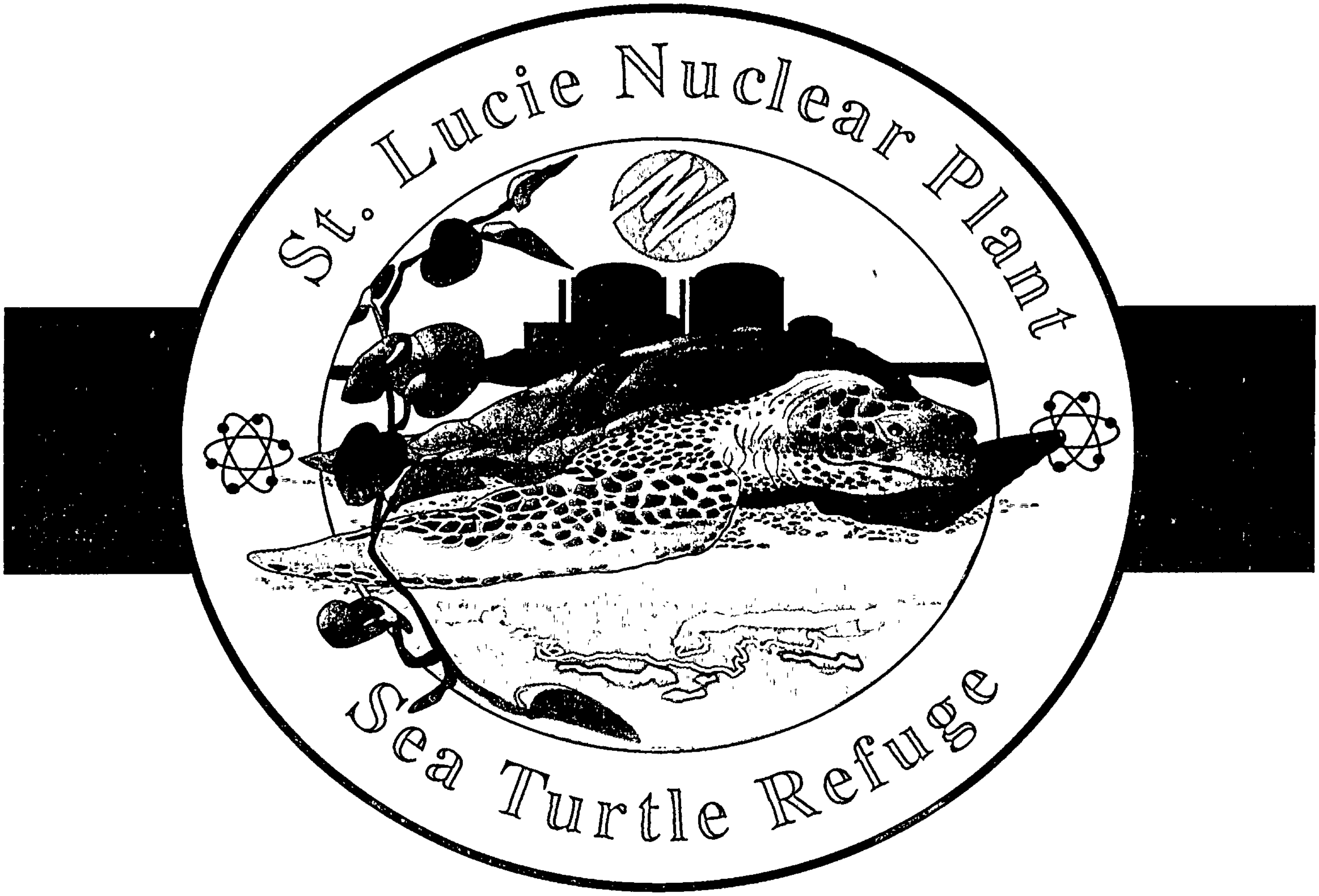
ST. LUCIE UNIT 2
CYCLE 9



STARTUP PHYSICS TESTING REPORT

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ST. LUCIE UNIT 2, CYCLE 9
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Startup Physics Testing Report

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I. Introduction

The purpose of this report is to provide a description of the fuel design, core load and to summarize the startup physics testing performed at St. Lucie Unit 2 following the cycle 9 refueling. Startup physics testing verifies that the models used in the safety analysis adequately predict the as-built core and that certain Technical Specifications are met. The major parts of this testing program include:

1) Initial criticality following refueling,

2) Zero power physics testing and

3) Power ascension testing.

II. Cycle 9 Fuel Design

The cycle 9 reload consists entirely of fuel manufactured by ABB Combustion Engineering (ABB/CE). The 217 assemblies of the cycle 9 core are comprised of 84 fresh Region L assemblies, 80 once burned Region K assemblies, and 53 twice burned Region J assemblies. Table 1 provides enrichment information for the cycle 9 reload sub-batches.

The mechanical design for the fresh fuel Region L assemblies differs from Regions J and K in the following ways:

1) Gadolinia burnable absorbers are used in Region L in lieu of the Alumina - Boron Carbide burnable absorbers used in Regions J and K. The mechanical design features of the gadolinium poison rods are identical to that of the fuel rods, and

2) A change from tungsten inert gas to laser welded zircaloy intermediate spacer grids was employed for Region L.

The entire cycle 9 fuel load, Regions J, K, and L, consists of the debris resistant fuel assembly design. This design has long fuel rod lower end caps which provide protection against debris induced fretting in the lower end-fitting region.

The cycle 9 core map is represented in Figure 1. The assembly serial numbers and control element assembly (CEA) serial numbers are given for each core location. The fuel is arranged in a low leakage pattern with no significant differences between the cycle 8 loading pattern. Twenty four twice-irradiated Region J assemblies, sixteen once-irradiated Region K assemblies, and eight fresh Region L assemblies were placed on the core periphery and the remaining irradiated and fresh fuel was loaded inboard.

III. CEA Drop Time Testing

Following the core reload and prior to the approach to criticality, CEA drop time testing was performed. The objective of this test is to measure the time of insertion from the fully withdrawn position (upper electrical limit) to the 90% inserted position under hot, full flow conditions. The average CEA drop time was found to be 2.69 seconds with maximum and minimum times of 2.83 seconds and 2.53 seconds, respectively. All drop times were within the requirements of Technical Specification 3.1.3.4 and the reload PC/M 112-295 (Reference 5).

IV. Approach to Criticality

The approach to criticality involved diluting from a non-critical boron concentration of 1749 ppm to a predicted critical boron concentration of 1496 ppm. Inverse count rate ratio (ICRR) plots were maintained during the dilution process using startup channels 1 and 2. Refer to Figures 2 and 3 for ICRR information. Table 2 summarizes the dilution rates and times, as well as beginning and ending boron concentrations.

Initial criticality for St. Lucie Unit 2, Cycle 9, was achieved on January 1, 1996 at 0328 with CEA group 5 at 61 inches withdrawn and all other CEAs at the all-rods-out (ARO) position. The actual critical concentration was observed to be 1506 ppm.

V. Zero Power Physics Testing

To ensure that the operating characteristics of the cycle 9 core were consistent with the design models, the following tests were performed:

1) Reactivity Computer Checkout,

2) All Rods Out Critical Boron Concentration,

3) Isothermal Temperature Coefficient Measurement and

4) CEA Group Rod Worth Measurements.

Proper operation of the reactivity computer was verified through the performance of two tests. In the first, reactor power was elevated sufficiently high to ensure maximum sensitivity of the reactivity measuring system and at the same time preserve adequate margin to the point of adding heat. The second test ascertained the response to a known value of positive or negative reactivity by measuring the values of positive or negative reactor periods that result. The results of the reactivity computer checkout were compared to the appropriate predictions supplied in the reload PC/M 112-295 (Reference 5). Satisfactory agreement was obtained.

The measurement of the all-rods-out critical boron concentration was performed. The measured value was 1561 ppm which compared favorably with the design value of 1547 ppm. This was within the acceptance limits of ± 100 ppm.

The measurement of the isothermal temperature coefficient was performed and the resulting moderator temperature coefficient (MTC) was obtained. The MTC was determined to be 0.56 pcm/°F which fell well within the acceptance criteria of ± 2.0 pcm/°F of the design MTC of -0.044 pcm/°F (corrected). Additionally, this satisfies the Unit 2 Technical Specification which states that the MTC shall be less positive than 5.0 pcm/°F.

The final section of interest for zero power physics testing is in the measurement of CEA group worths. Rod worth measurements were performed using the rod swap methodology. This method involves exchanging the reference group, which is measured by the boration dilution technique, with each of the remaining test groups. A comparison of the measured and design CEA reactivity worths is provided in Table 3. The following acceptance criteria applies to the measurements made:

1) The measured value of each test group is within ± 15% or ± 100 pcm of the design CEA worths, whichever is greater, and

2) The measure worth of the reference group and the total worth for all the CEA groups measured is within ± 10% of the total design worth.

All acceptance criteria were met.

VI. Power Ascension Program

During power ascension, the fixed incore detector system is utilized to verify that the core is loaded properly and that there are no abnormalities occurring in various core parameters (core peaking factors, linear heat rate, and tilt) for power plateaus at 25%, 50%, 80% and greater than 98%

rated thermal power. Additionally, calorimetric, nuclear, and ΔT power calibrations were performed at each of the plateaus prior to advancing reactor power to the next higher level. A summary of the results of the flux maps at each power level is provided in Figures 4, 5, 6, and 7.

VII. Summary

All measurement to prediction acceptance criteria were met and compliance with the applicable Unit 2 Technical Specifications was satisfactory.

VIII. References

1) *"Initial Criticality,"* Pre-Operational Procedure 2-3200088, Revision 10.

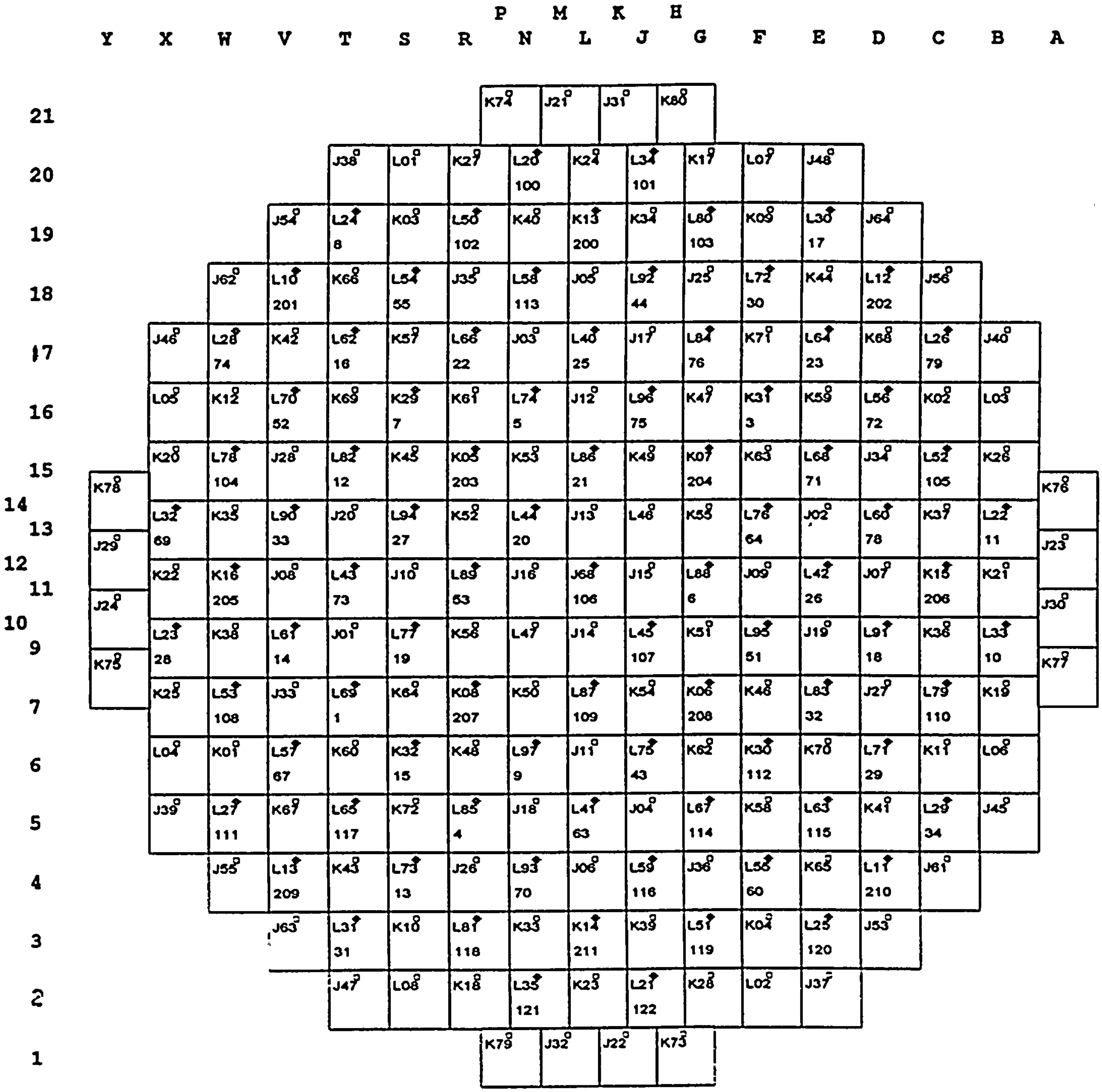
2) *"Reload Startup Physics Testing,"* Pre-Operational Procedure 3200091, Revision 7.

3) *"Reactor Engineering Power Ascension Program,"* Pre-Operational Procedure 3200092, Revision 9.

4) St. Lucie Unit 2 Technical Specifications.

5) St. Lucie Unit 2, Cycle 9 Fuel Reload PC/M 112-295.

FIGURE 1
CYCLE 9 CORE LOADING PATTERN



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FIGURES 2 & 3
INVERSE COUNT RATIO PLOTS

FIGURE 2
STARTUP CHANNEL "1" BORON DILUTION

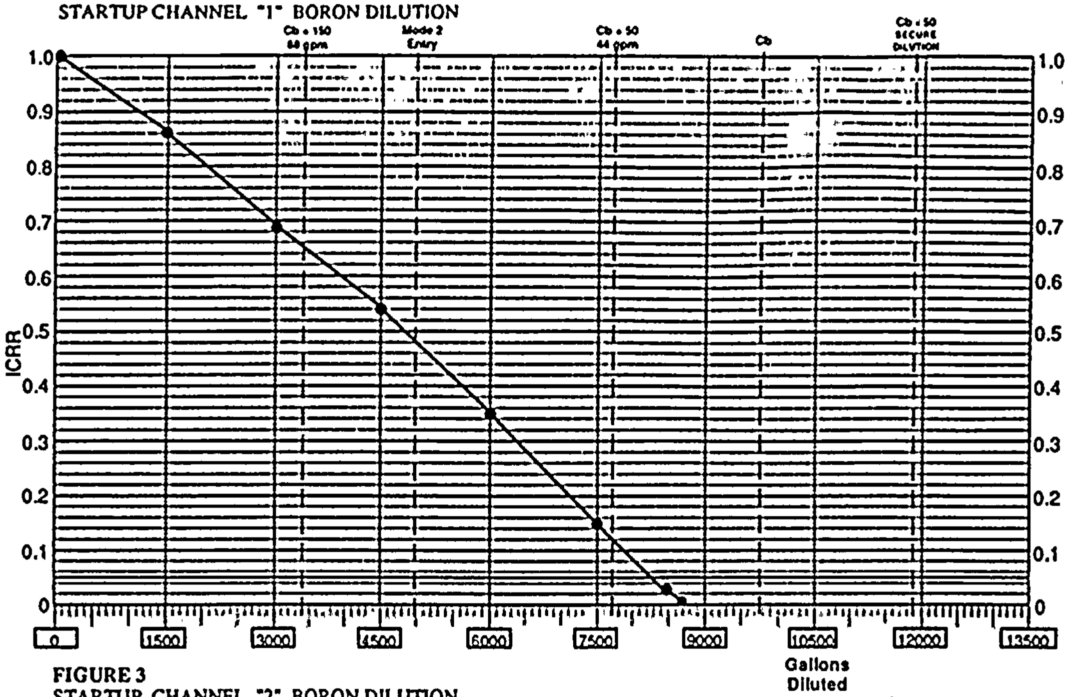

FIGURE 3
STARTUP CHANNEL "2" BORON DILUTION

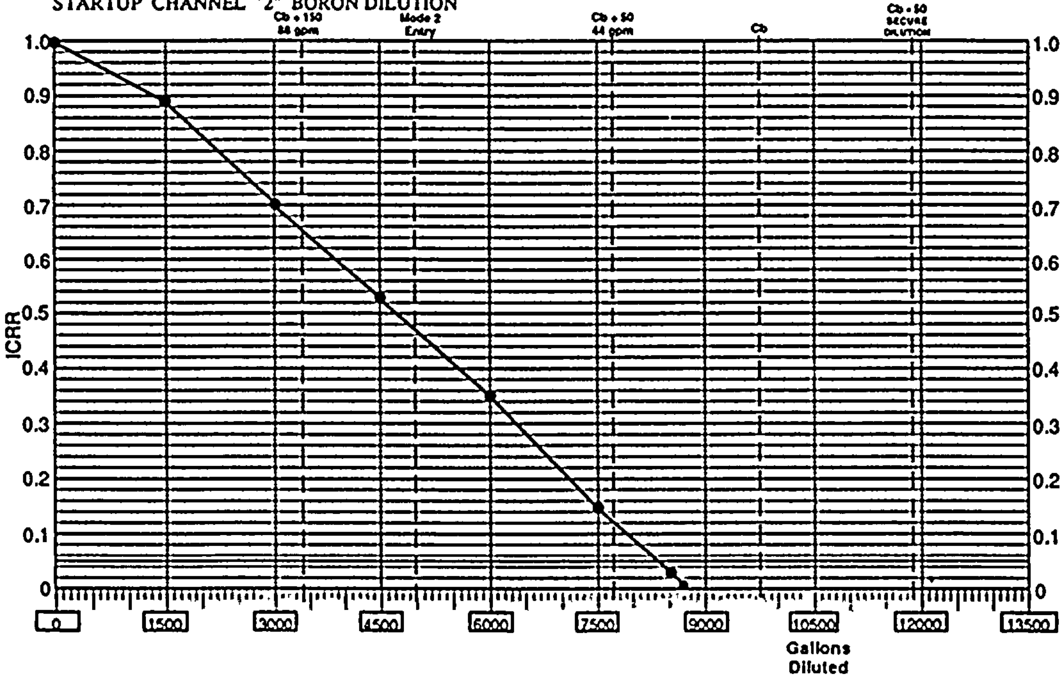

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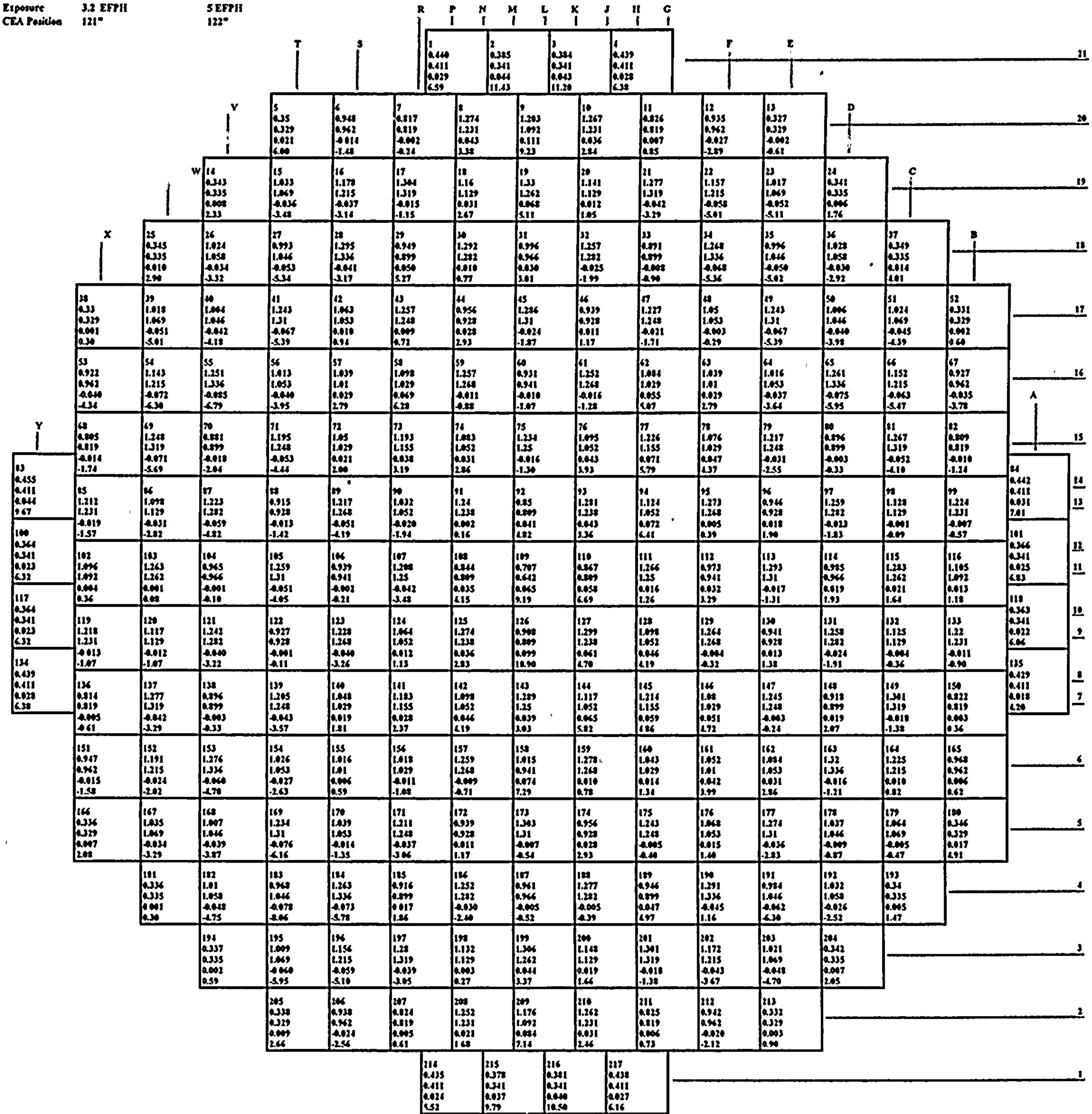
FIGURE 4
POWER DISTRIBUTION COMPARISON WITH DESIGN - 25% POWER

Measured:	(CECOR/INPAX)	Design:
Source		PCM 112-295
Power Level	25%	25%
Exposure	3.2 EFPH	5 EFPH
CEA Position	121"	122"



RMS Deviation: 3.7%
Max Deviation: 11.4%

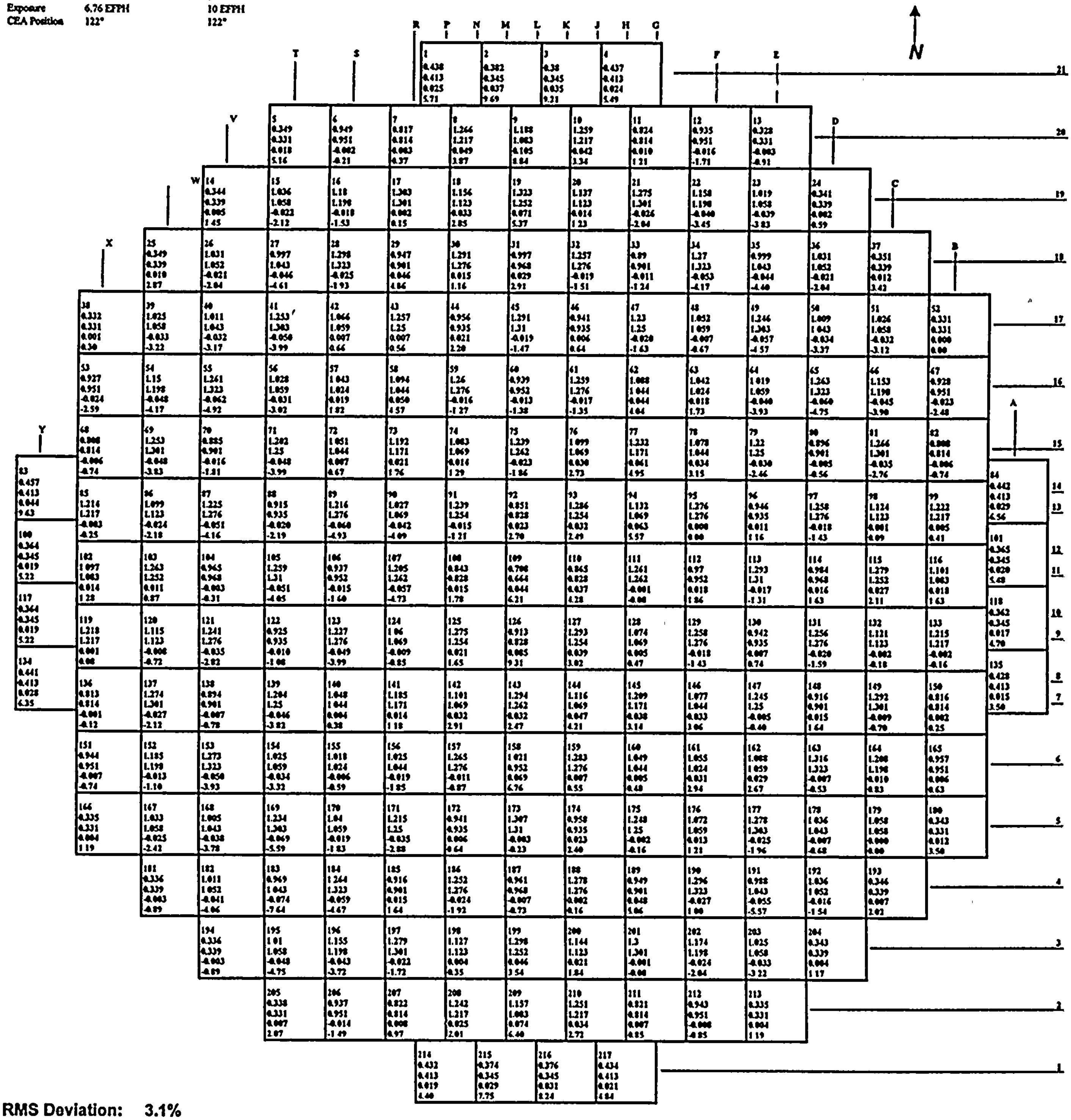
The incore detection system is operable per Appendix A, RMS deviation should be less than or equal to 5.0% and meet the requirements of 4.7.1 if performed at the 25 and 98 percent power test plateaus during the power ascension test program.

Key:

Box #
Measured
Design
Delta
% Diff.

FIGURE 5
POWER DISTRIBUTION COMPARISON WITH DESIGN - 50% POWER

Measured: (CECOR/INPAX)		Design:
Source		PCM 112-295
Power Level	42.4%	50%
Exposure	6.76 EFPH	10 EFPH
CEA Position	122"	122"



RMS Deviation: 3.1%
Max Deviation: 9.7%

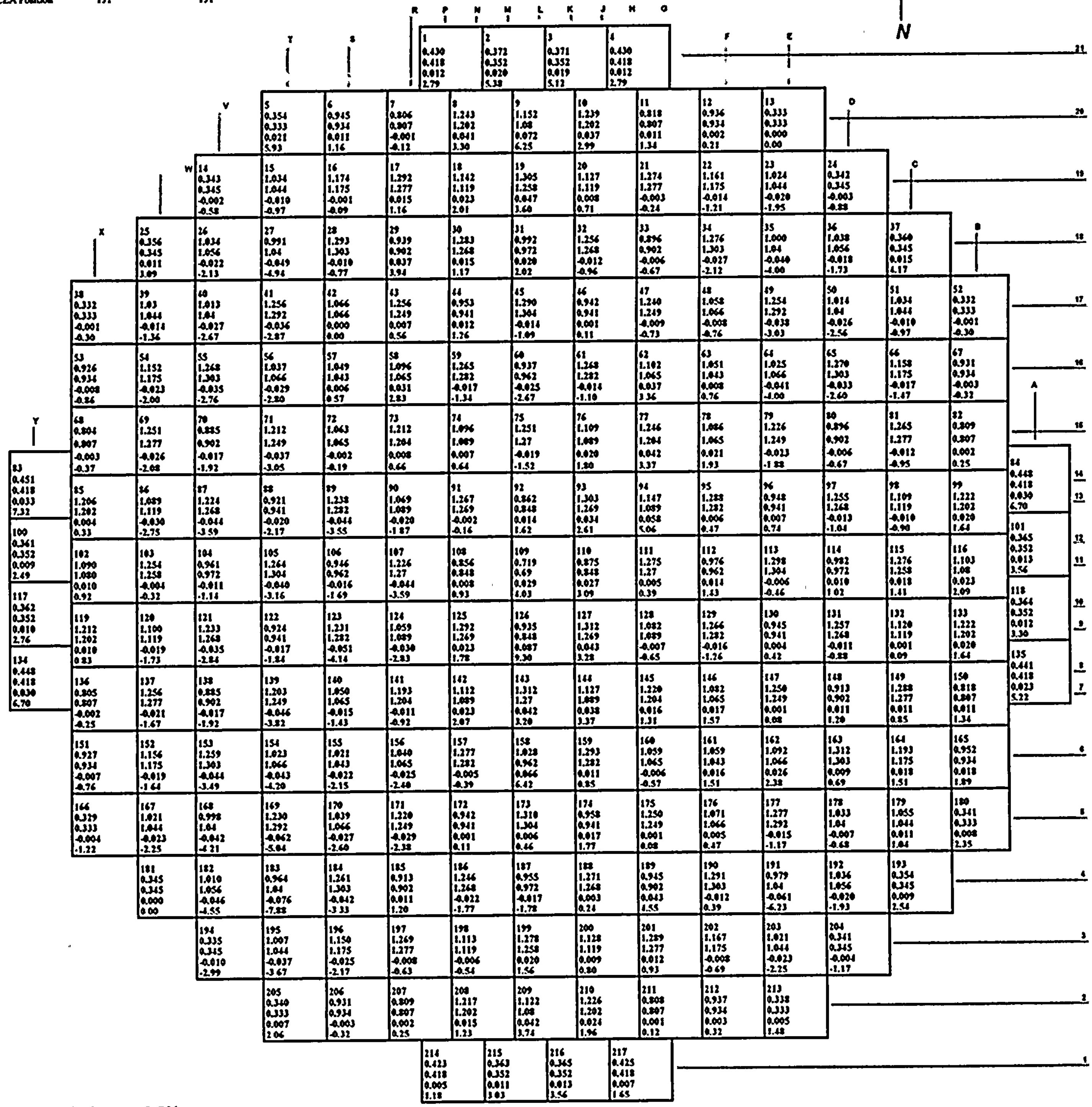
The incore detection system is operable per Appendix A. RMS deviation should be less than or equal to 5.0% and meet the requirements of 4.7.1 if performed at the 25 and 98 percent power test plateaus during the power ascension test program.

Key:

Box #
Measured
Design
Delta
% Diff.

FIGURE 6
POWER DISTRIBUTION COMPARISON WITH DESIGN - 80% POWER

	Measured: (CECOR/INPAX)	Design:
Source		PCM 112-295
Power Level	80%	80%
Exposure	28.51 EFPH	30 EFPH
CEA Position	131"	131"



RMS Deviation: 2.5%
Max Deviation: 9.3%

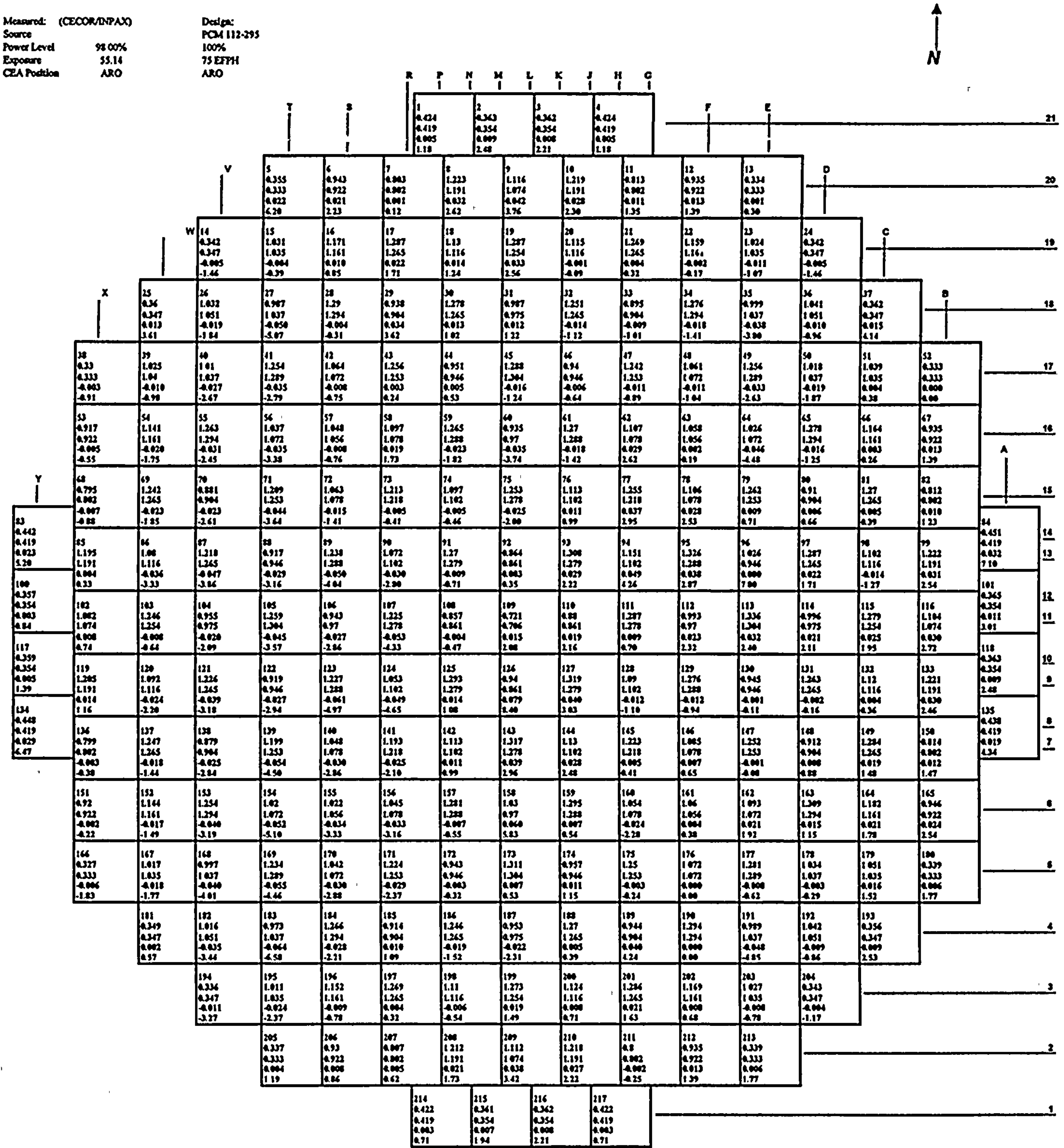
The incore detection system is operable per Appendix A, RMS deviation should be less than or equal to 5.0% and meet the requirements of 4.7.1 if performed at the 25 and 98 percent power test plateaus during the power ascension test program.

Key:

Box #
Measured
Design
Delta
% Diff.

FIGURE 7
POWER DISTRIBUTION COMPARISON WITH DESIGN - 100% POWER

	Measured: (CECOR/INPAX)	Design:
Source		PCM 112-295
Power Level	98.00%	100%
Exposure	55.14	75 EFPH
CEA Position	ARO	ARO



RMS Deviation: 2.4%
Max Deviation: 8.4%

The incore detection system is operable per Appendix A. RMS deviation should be less than or equal to 5.0% and meet the requirements of 4.7.1 if performed at the 25 and 98 percent power test plateaus during the power ascension test program.

Key:

Box #
Measured
Design
Delta
% Diff.

Table 1

Cycle 9 Reload Sub-Batch ID

Sub-Batch	Number of Assemblies	Enrichment
L	8	4.30
L*	4	4.30/2.30
L/	8	4.30/2.30
LX	48	4.30/2.30
LY	16	4.30/2.30
K	12	4.10
K*	4	3.60
K/	8	3.60
KX	32	3.60
K+	16	3.60
KY	8	4.10
J	20	4.10
J/	16	3.70
JX	17	3.70

Table 2

Approach to Criticality

Dilution Rate	Initial Boron Concentration	Final Boron Concentration	Dilution Time (minutes)
132 gpm	1749	1671	30
88 gpm	1671	1532	60
44 gpm	1532	1506	30

Table 3

CEA Group Worth Summary

CEA Group	Measured Worth (pcm)	Design * Worth (pcm)	Percent Difference
Reference Group	1992	1947	-2.3
A	1481	1451	-2.0
1,2	1641	1581	-3.7
3,4,5	1783	1665	-6.6
Total	6897	6644	-3.7

*Reference 5.

Percent difference = (Design/Measured) - 1 x 100