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ARKANSAS NUCLEAR ONE

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ENGINEERING REPORT
FOR
ARKANSAS NUCLEAR ONE
RUSSELLVILLE, ARKANSAS

1	7/15/98	Revise Cycle 12 duration & Cycle 13 excore ratio	RWC	JTS	
0	11/1/96	Initial Issuance	RWC	J.A.S.	
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9811100255 981102
PDR ADOCK 05000368
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TITLE: **Revised Reactor Vessel Fluence Determination**

REPORT NO.: **96-R-2030-02**

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1.0 Background / Purpose

Reference 1 documents the change in the limiting reactor vessel beltline plate. Using the material properties of the new limiting plate and the fluence assumptions used in Reference 2, it was demonstrated that to maintain the bases of the current Technical Specification RCS Pressure/Temperature (P/T) limits, the period of applicability for those limits need to be revised (Reference 1).

Based on the information presented in Reference 1, the period of applicability needs to be revised from 21 EFPY to 17 EFPY. This poses a concern with the next scheduled surveillance capsule withdrawal. The next capsule is scheduled to be withdrawn at 19 EFPY (Reference 3, Table 4.4-5). With the required one year time frame to analyze and report the results of the capsule (Reference 4), there would be approximately one year to revise the PT curves and gain NRC approval for the revised limits prior to the expiration of the current limits.

There are three options for resolution of this issue:

- In the first option, the period of applicability of the current limits and the surveillance schedule could be revised such that the current two year difference was maintained. This would require a Technical Specification Change Request (TSCR) and its associated costs and would also mean the PT limits would have to be revised sooner with its associated TSCR.
- A second option would be to revise the period of applicability and leave the surveillance schedule as is. This would require one TSCR to be followed by another TSCR for the same specification (PT limits) in a relatively short time after the surveillance capsule has been analyzed. This is not a prudent option.
- The underlying bases for the current limits could be evaluated and unnecessary conservatisms could be identified and removed (Option 3). This calculation will center around this option.

The fluence estimates used to date are very conservative in nature. They are based on the one specimen capsule pulled at 1.69 EFPY (two cycles of operation) and linearly extrapolated to 21 EFPY (Reference 2). During the first six cycles of operation, ANO-2 operated with a high leakage core. In Cycle 7, the core was changed to a low leakage design, in part to reduce the vessel fluence. ANO-2 has operated with the low leakage design since that time; however, the fluence estimates were not revised.

According to the bases for the Pressure/Temperature Limits (Reference 3, Specification 3/4.4.9) the adjusted reference temperature (ART) for 21 EFPY at the 1/4T position is 111°F and 96°F at the 3/4T location. These values are based on a vessel inner surface fluence of 3.74 E+19 n/cm^2; 1/4T fluence is 2.33E +19 n/cm^2; and the fluence at the 3/4T location is 9.06 E+18 n/cm^2 (E > 1 MeV).

In the following evaluation, the fluence estimates have been revisited to take advantage of some of the conservatism in the simple linear extrapolation used as a basis for the current Technical Specification limits. Reference 2 provides an indication of how conservative these estimates are.

2.0 References

1. 96-R-2030-01, Revision 0, "Limiting Beltline Plate Determination"
2. 90-E-0097-01, Revision 1, "Reactor Vessel Fluence Determination"

3. ANO-2 Technical Specifications, Amendment 176

4. 10CFR50, Appendix H

5. 10CFR50.61

6. ABB-CE Calculation, AN-FE-0011, Revision 3, "ANO-2 Cycle Independent Data and Setpoint Assumption List"

7. Draft Regulatory Guide DG-1053, "Calculational and Dosimetry Methods for Determining Pressure Vessel Neutron Fluence"

8. NRC letter dated January 2, 1996, "Updated Values for Pressured Thermal Shock Reference Temperatures - Calvert Cliffs Nuclear Power Plant, Units Nos. 1 and 2," D.G. McDonald, Jr. (NRC) to R. E. Denton (Baltimore Gas and Electric)

9. Not Used 1

10. Procedure 2302.039, Revision 9, "Core Power Distribution Following Refueling"

11. ABB-CE letter dated May 18, 1978, "Power Ascension Test (PAPT) Predictions," H. H. Windsor and E. H. Smith, Jr. (ABB-CE) to E. C. Ewing (AP&L)

3.0 Assumptions

1. The axial averaged Relative Power Densities for an assembly is at the maximum acceptable value.

2. The ratio of the fast flux from one cycle to the next subsequent cycle is equal to the excore detector response ratio.

3. Subsequent of Cycle 12, the duration of the cycles is 490 EFPD.

4. With respect to the fast flux seen at the vessel wall, the core design for Cycle 13 and beyond will remain constant with Cycle 12's

4.0 Methodology

The bases of the Reference 3 limits is in the ART determination, as described above. The ART is based on the material's properties and fluence. The ART is determined by the following equation (Reference 5):

$$\text{ART} = \text{Initial RT}_{NDT} + \Delta \text{RT}_{NDT} + \text{Margin}$$

Initial RT_{NDT} is the reference temperature for the unirradiated material as defined in Section III of the ASME Code.

ΔRT_{NDT} is the mean value of the adjustment in reference temperature caused by irradiation and should be calculated as follows:

$$\Delta RT_{NDT} = (CF)f^{(0.28-0.10 \log f)}$$

The term, $f^{(0.28-0.10 \log f)}$, is the fluence factor and is determined by calculation or from a figure in Regulatory Guide 1.99, Revision 2. f is in terms of E+19. This term accounts for the fluence at distance from the inner surface of the vessel. In this case, the distance would be one-quarter and three-quarter thickness of the reactor vessel.

To determine the fluence at the 1/4T or the 3/4T location the following equation is used:

$$f(x) = f_{surface}e^{-\alpha x}$$

where $f_{surface}$ is the inner surface fluence
α is 0.24 (Reference 2)
x is the distance into the vessel wall, in this case x is 1/4T or 3/4T. T is the thickness of the wall or 7.875 inches (Reference 2).

CF is the chemistry factor which is a function of the copper and nickel content of the material in question.

The "Margin" term is the quantity that is added to obtain conservative, upper-bound values of ART for the calculations required by Appendix G to 10CFR50.

The Cycle 1 flux was derived from the surveillance specimen pulled at the end of the second cycle of operation. The subsequent beginning of a cycle's flux estimate is multiplied by the excore ratio for that cycle. This is the new flux used in determining the vessel fluence.

The "Excore Ratio" is the ratio of a cycle's Beginning of Cycle (BOC) 100% power flux at the excore detector locations to the previous cycle's BOC 100% power flux at the same location. These ratios provide an indication of the amount of leakage from the core from cycle to cycle.

5.0 Results

5.1 Material Properties

Based on the information contained in Reference 1, the revised limiting plate is C8010-1. This plate is limiting based on revised best estimate values for the copper and nickel content of the plate. The chemistry factor for the plate is 54.5 (Reference 1) and the initial RT_{NDT} for this plate is 12°F (Reference 1). The margin term for this plate is 34°F (Reference 1).

5.2 Excore Ratio

There are four excore detectors for ANO-2, one in each quadrant. When ANO-2 transitioned to the low-leakage cores, the excore ratio was developed to help calibrate the detectors. This ratio is the BOC, Equilibrium Xenon, All Rods Out (ARO) 100% power flux for Cycle N divided by the BOC, Equilibrium Xenon, ARO 100% power flux for Cycle N-1. It is assumed that the ratio of the fast flux from one cycle to the next is equal to this ratio.

There are 11 assemblies used in the calculation of the ratio. The QC location for these assemblies are 1, 2, 3, 4, 5, 6, 7, 9, 10, 11, and 12. Part of the information presented in Attachment 1 is the QC locations of these assemblies. Assembly weighting factors (Reference 6) are applied to the radial Relative Power Density (RPDs) to determine a QC Location's contribution to the excore detector response. A consistent set of weighting factors are used in this calculation.

The RPDs used in this calculation are from the Reload Reports for each cycle, except for Cycle 1. Cycle 1's data is from Startup predictions (Reference 11). These are predicted values. Attachment 1 provides a copy of each of the cycle's appropriate information.

In addition, as part of the startup testing for each cycle, the measured radial power distribution is compared to the predicted power distribution. The acceptance criteria in Reference 10 states that for a predicted RPD < 0.9, the measured and predicted RPD values shall agree within ± 15%. For a predicted RPD ≥ 0.9, the measured and predicted RPD values shall agree within ± 10%. This was done to address the differences in the RPDs in each quadrant. (In reviewing the startup data for each cycle, the acceptance criteria for the axially averaged RPD has not been violated.)

Tables 1 through 12 lists the weighting factor, the radial RPD for those QC locations, the "corrected" RPD (the RPD times the appropriate uncertainty - 10% or 15%), and the individual locations contribution to the detector's response (Corrected RPD times weighting factor). The individual contributions are then summed to get the total detector's response. This information is provided for each of the cycles. The flux ratio is also provided in each table.

ABB-CE has provided the excore ratio as part of the Startup Predictions for each cycle since Cycle 7. Table 13 compares the values provided by ABB-CE to the values calculated in Tables 6 through 12. As can be seen, there is good agreement between the two sets of numbers.

When more fresh fuel is located near the periphery in one cycle compared to the previous cycle, the excore ratio is greater than one.

5.3 Initial Flux Determination

To remove some of the conservatisms in the fluence estimates and to use the excore ratios, the flux in Cycle 1 must be determined. ANO-2 has pulled only one material surveillance capsule to date. This capsule was pulled at the end of Cycle 2 or 1.69 EFPY. Reference 2 lists the maximum surface fluence for this time period as $3.01 \text{ E} + 18 \text{ n/cm}^2$.

This determination utilized the ENDF/B-IV cross-sectional library. In Reference 7, the NRC has noted that ENDF/B-IV libraries may underpredict the fluence the vessel wall is seeing due to an error in the Iron inelastic scattering cross-section. The ENDF/B-VI libraries corrected this deficiency. This underprediction could be significant (~20 - 30%) according to the NRC.

In a letter to Baltimore Gas and Electric, dated January 2, 1996 (Reference 8), the NRC stated concerning projected neutron fluence,

> "The methodology employed the CASK cross section set. CASK is based on an early ENDF/B version which is known to have an iron scattering cross section error, which was corrected in ENDF/B-VI. However, we know from experience that this error appears only during neutron transmission through significant amounts of iron, as for example the thermal shield or the vessel. Neither of the Calvert Cliffs units is equipped with a thermal shield; thus, the staff does not expect the results to have been affected by the use of the CASK cross sections."

ANO-2 does not have a thermal shield; therefore based on the above, it is not expected the maximum surface fluence would change if the analysis was reperformed using the ENDF/B-VI libraries.

There are two additional issues associated with the approach used in this report that may impact the determination of the initial flux. These issues are the use of Beginning of Cycle RPDs versus End of Cycle RPDs and the use of the RPDs from the Reload Reports versus As-Built RPD data. Each issue is discussed below.

1 As a cycle progresses, the assemblies' RPD changes as the power shifts from the center of the core to the periphery of the core. The excore ratio methodology was developed for the beginning of a cycle so the excores could be calibrated. The excore are periodically calibrated throughout the cycle. The shift in the RPDs from the beginning of a cycle to the end of a cycle is relatively small in magnitude.

The RPD information provided in each cycle's Reload Report is based on predictions for that cycle. The ratio that is provided by ABB-CE is based on As-Built data. As can be seen Table 13, the values calculated using the Reload Report predicted values versus the ratio using the As-Built data are very close.

To address the all three issues listed above (ENDF/B-IV versus B-VI, power shift, and the use of Reload Report predicted RPDs), the 1.69 EFPY calculated fluence was increased by 10%.

Therefore;

$$\phi_1(\text{Duration of Cycle 1}) + \phi_2(\text{Duration of Cycle 2}) = 3.01\ \text{E} + 18\ \text{n/cm}^2\ (1.1) = 3.311\ \text{E} + 18\ \text{n/cm}^2$$

$$\phi_2 = \phi_1 * \text{Excore Ratio for Cycle 2 or } 1.3417\phi_1$$

1

The duration of Cycle 1 was 324.68 EFPD and Cycle 2 was 292.77 EFPD long (see Attachment 2 for the documentation of the cycle lengths).

Based on this, the flux in Cycle 1 was then 4.6147 E +15 n/cm^2 - EFPD.

5.4 Subsequent Cycle's Flux and Vessel Inner Surface Fluence Determination

Table 14 and the following text provide a summary of the calculation to revise the fluence estimates.

The first column is the cycle number. The second column is the assumed BOC flux estimate, which for Cycle 2 through Cycle 19, is the corrected flux for the previous cycle.

The product of the second and third (excore detector ratio) columns is then the new flux for that cycle (column four). This value is then multiplied by the length of the cycle (column five) to determine the cycle's fluence (column six).

1 For Cycles 1 through 12, the duration of the cycle was taken from burnup data taken at the end of each cycle (see Attachment 2). The remaining cycle lengths are assumed to be 18 months in length (490 EFPD).

The "EFPY" column is just the "EFPD" value divided by 365 to convert the days to years. The last column is just a sum of the cycle fluences to that point.

1 Based on Table 14, the integrated fluence at 22.20 EFPY is 2.96 E + 19 n/cm^2 at the inner surface of the vessel. The fluence at 20.86 EFPY is 2.82 E + 19 n/cm^2. Linearly interpolating between these values for 21 EFPY, the inner surface fast fluence is 2.84 E + 19 n/cm^2. This is less than the inner surface value (3.74 E + 19 n/cm^2) used in the bases of the current limits.

6.0 Conclusions

6.1 1/4T and 3/4T Fluence Determination

Based on the above information, the fluence at the 1/4T location is:

1 $f(1/4T) = 2.84\, e^{-0.24(0.25)(7.875)} = 1.77\text{ E} + 19\text{ n/cm}^2$

The 3/4T fluence is:

1 $f(3/4T) = 2.84\, e^{-0.24(0.75)(7.875)} = 7.00\text{ E} + 18\text{ n/cm}^2$

Both the 1/4T and the 3/4T fluence values are less than the values listed in the basis of Technical Specification 3/4.4.9 (2.33 E + 19 n/cm^2 and 9.06 E + 18 n/cm^2, respectively)

6.2 ART Determination

The shift in the RT_{NDT} can then be determined. The value for the shift is at the 1/4T location

1 $\Delta RT_{NDT} = (54.5)1.77^{(0.28-0.10 \log 1.77)} = 63.0°$

The ART is then

1 $ART = 12 + 63.0 + 34 = 109.\ 0°$

This compares to the value listed in the basis of the Reference 3 limits for the 1/4T location of 111°.

The value for the shift is at the 3/4T location

1 $\Delta RT_{NDT} = (54.5)0.700^{(0.28-0.10 \log 0.700)} = 49.0°$

The ART is then

1 $ART = 12 + 49.0 + 34 = 95.0°$

This compares to the value listed in the basis of the Reference 3 limits for the 3/4T location of 96°.

Based upon the above conservative arguments, the limits listed in the Technical Specifications are still applicable and the period of applicability for the P/T limits can remain at 21 EFPY and the surveillance schedule does not need to be revised.

TABLE 1

CYCLE 12 EXCORE DETECTOR RESPONSE

QC Box Number	Assembly Weighting Factor	Cycle 12 Radial RPD	Cycle 12 Corrected RPD	Cycle 12 Detector Response	
1	0.3428	0.3200	0.3680	0.1262	
2	0.2459	0.4700	0.5405	0.1329	
3	0.1022	0.4700	0.5405	0.0552	
4	0.0991	0.3100	0.3565	0.0353	
5	0.0825	0.5800	0.6670	0.0550	
6	0.0406	1.1000	1.2100	0.0491	
7	0.0305	1.1700	1.2870	0.0393	
9	0.0176	0.3900	0.4485	0.0079	
10	0.0161	0.9900	1.0890	0.0175	
11	0.0150	1.0900	1.1990	0.0180	
12	0.0078	1.2200	1.3420	0.0105	
Totals	**1.0001**			**0.5469**	Cycle 13/12 Flux Ratio =
					0.8881

1

TABLE 2

CYCLE 11 EXCORE DETECTOR RESPONSE

QC Box Number	Assembly Weighting Factor	Cycle 11 Radial RPD	Cycle 11 Corrected RPD	Cycle 11 Detector Response	
1	0.3428	0.2300	0.2645	0.0907	
2	0.2459	0.3900	0.4485	0.1103	
3	0.1022	0.4700	0.5405	0.0552	
4	0.0991	0.3200	0.3680	0.0365	
5	0.0825	0.5500	0.6325	0.0522	
6	0.0406	0.8000	0.9200	0.0374	
7	0.0305	1.1000	1.2100	0.0369	
9	0.0176	0.4300	0.4945	0.0087	
10	0.0161	1.1100	1.2210	0.0197	
11	0.0150	1.1300	1.2430	0.0186	
12	0.0078	1.2900	1.4190	0.0111	
Totals	**1.0001**			**0.4772**	Cycle 12/11 Flux Ratio =
					1.1461

TABLE 1a

CYCLE 13 EXCORE DETECTOR RESPONSE

1

QC Box Number	Assembly Weighting Factor	Cycle 13 Radial RPD	Cycle 13 Corrected RPD	Cycle 13 Detector Response	
1	0.3428	0.2400	0.2760	0.0946	
2	0.2459	0.4400	0.5060	0.1244	
3	0.1022	0.5000	0.5750	0.0588	
4	0.0991	0.2800	0.3220	0.0319	
5	0.0825	0.5300	0.6095	0.0503	
6	0.0406	0.7300	0.8395	0.0341	
7	0.0305	1.1100	1.2210	0.0372	
9	0.0176	0.4300	0.4945	0.0087	
10	0.0161	0.9400	1.0340	0.0166	
11	0.0150	1.1400	1.2540	0.0188	
12	0.0078	1.1900	1.3090	0.0102	
Totals	**1.0001**			**0.4857**	

TABLE 3

CYCLE 10 EXCORE DETECTOR RESPONSE

QC Box Number	Assembly Weighting Factor	Cycle 10 Radial RPD	Cycle 10 Corrected RPD	Cycle 10 Detector Response	
1	0.3428	0.3700	0.4255	0.1459	
2	0.2459	0.7100	0.8165	0.2008	
3	0.1022	0.4700	0.5405	0.0552	
4	0.0991	0.3700	0.4255	0.0422	
5	0.0825	0.9200	1.0120	0.0835	
6	0.0406	1.1600	1.2760	0.0518	
7	0.0305	1.1500	1.2650	0.0386	
9	0.0176	0.4700	0.5405	0.0095	
10	0.0161	0.9800	1.0780	0.0174	
11	0.0150	1.2200	1.3420	0.0201	
12	0.0078	1.2500	1.3750	0.0107	
Totals	1.0001			0.6756	Cycle 11/10 Flux Ratio =
					0.7063

TABLE 4

CYCLE 9 EXCORE DETECTOR RESPONSE

QC Box Number	Assembly Weighting Factor	Cycle 9 Radial RPD	Cycle 9 Corrected RPD	Cycle 9 Detector Response	
1	0.3428	0.3500	0.4025	0.1380	
2	0.2459	0.6900	0.7935	0.1951	
3	0.1022	0.4900	0.5635	0.0576	
4	0.0991	0.3400	0.3910	0.0387	
5	0.0825	0.8700	1.0005	0.0825	
6	0.0406	1.1100	1.2210	0.0496	
7	0.0305	1.1300	1.2430	0.0379	
9	0.0176	0.3300	0.3795	0.0067	
10	0.0161	0.9000	0.9900	0.0159	
11	0.0150	1.1600	1.2760	0.0191	
12	0.0078	1.2100	1.3310	0.0104	
Totals	1.0001			0.6516	Cycle 10/9 Flux Ratio =
					1.0369

TABLE 5

CYCLE 8 EXCORE DETECTOR RESPONSE

QC Box Number	Assembly Weighting Factor	Cycle 8 Radial RPD	Cycle 8 Corrected RPD	Cycle 8 Detector Response	
1	0.3428	0.3800	0.4370	0.1498	
2	0.2459	0.7300	0.8395	0.2064	
3	0.1022	0.5100	0.5865	0.0599	
4	0.0991	0.3800	0.4370	0.0433	
5	0.0825	0.9600	1.0560	0.0871	
6	0.0406	1.1400	1.2540	0.0509	
7	0.0305	1.0400	1.1440	0.0349	
9	0.0176	0.3800	0.4370	0.0077	
10	0.0161	1.0100	1.1110	0.0179	
11	0.0150	1.2200	1.3420	0.0201	
12	0.0078	1.2100	1.3310	0.0104	
Totals	1.0001			0.6885	Cycle 9/8 Flux Ratio =
					0.9464

TABLE 6

CYCLE 7 EXCORE DETECTOR RESPONSE

QC Box Number	Assembly Weighting Factor	Cycle 7 Radial RPD	Cycle 7 Corrected RPD	Cycle 7 Detector Response	
1	0.3428	0.3300	0.3795	0.1301	
2	0.2459	0.6900	0.7935	0.1951	
3	0.1022	0.5100	0.5865	0.0599	
4	0.0991	0.4000	0.4600	0.0456	
5	0.0825	0.9000	0.9900	0.0817	
6	0.0406	1.0900	1.1990	0.0487	
7	0.0305	1.1700	1.2870	0.0393	
9	0.0176	0.4500	0.5175	0.0091	
10	0.0161	1.0700	1.1770	0.0189	
11	0.0150	1.2500	1.3750	0.0206	
12	0.0078	1.2400	1.3640	0.0106	
Totals	1.0001			0.6597	Cycle 8/7 Flux Ratio =
					1.0437

TABLE 7

CYCLE 6 EXCORE DETECTOR RESPONSE

QC Box Number	Assembly Weighting Factor	Cycle 6 Radial RPD	Cycle 6 Corrected RPD	Cycle 6 Detector Response	
1	0.3428	0.4900	0.5635	0.1932	
2	0.2459	0.8600	0.9890	0.2432	
3	0.1022	0.6700	0.7705	0.0787	
4	0.0991	0.4400	0.5060	0.0501	
5	0.0825	0.9500	1.0450	0.0862	
6	0.0406	1.1700	1.2870	0.0523	
7	0.0305	1.3000	1.4300	0.0436	
9	0.0176	0.4700	0.5405	0.0095	
10	0.0161	1.0900	1.1990	0.0193	
11	0.0150	1.3100	1.4410	0.0216	
12	0.0078	1.0900	1.1990	0.0094	
Totals	1.0001			0.8071	Cycle 7/6 Flux Ratio =
					0.8173

TABLE 8

CYCLE 5 EXCORE DETECTOR RESPONSE

QC Box Number	Assembly Weighting Factor	Cycle 5 Radial RPD	Cycle 5 Corrected RPD	Cycle 5 Detector Response	
1	0.3428	0.7100	0.8165	0.2799	
2	0.2459	0.9700	1.0670	0.2624	
3	0.1022	1.0100	1.1110	0.1135	
4	0.0991	0.7800	0.8970	0.0889	
5	0.0825	1.0200	1.1220	0.0926	
6	0.0406	0.9200	1.0120	0.0411	
7	0.0305	1.2000	1.3200	0.0403	
9	0.0176	0.8700	1.0005	0.0176	
10	0.0161	1.2100	1.3310	0.0214	
11	0.0150	1.2100	1.3310	0.0200	
12	0.0078	0.8500	0.9775	0.0076	
Totals	1.0001			0.9852	Cycle 6/5 Flux Ratio =
					0.8192

TABLE 9

CYCLE 4 EXCORE DETECTOR RESPONSE

QC Box Number	Assembly Weighting Factor	Cycle 4 Radial RPD	Cycle 4 Corrected RPD	Cycle 4 Detector Response	
1	0.3428	0.5700	0.6555	0.2247	
2	0.2459	0.8100	0.9315	0.2291	
3	0.1022	0.9000	0.9900	0.1012	
4	0.0991	0.7900	0.9085	0.0900	
5	0.0825	1.0400	1.1440	0.0944	
6	0.0406	0.7200	0.8280	0.0336	
7	0.0305	0.9000	0.9900	0.0302	
9	0.0176	0.8600	0.9890	0.0174	
10	0.0161	1.1700	1.2870	0.0207	
11	0.0150	1.2800	1.4080	0.0211	
12	0.0078	1.0700	1.1770	0.0092	
Totals	1.0001			0.8716	Cycle 5/4 Flux Ratio = 1.1304

TABLE 10

CYCLE 3 EXCORE DETECTOR RESPONSE

QC Box Number	Assembly Weighting Factor	Cycle 3 Radial RPD	Cycle 3 Corrected RPD	Cycle 3 Detector Response	
1	0.3428	0.7300	0.8395	0.2878	
2	0.2459	1.0200	1.1220	0.2759	
3	0.1022	1.0600	1.1660	0.1192	
4	0.0991	0.7600	0.8740	0.0866	
5	0.0825	1.0500	1.1550	0.0953	
6	0.0406	0.9100	1.0010	0.0406	
7	0.0305	1.1900	1.3090	0.0399	
9	0.0176	0.8300	0.9545	0.0168	
10	0.0161	1.1000	1.2100	0.0195	
11	0.0150	1.0100	1.1110	0.0167	
12	0.0078	1.2800	1.4080	0.0110	
Totals	1.0001			1.0092	Cycle 4/3 Flux Ratio = 0.8636

TABLE 11

CYCLE 2 EXCORE DETECTOR RESPONSE

QC Box Number	Assembly Weighting Factor	Cycle 2 Radial RPD	Cycle 2 Corrected RPD	Cycle 2 Detector Response	
1	0.3428	0.7900	0.9085	0.3114	
2	0.2459	1.0700	1.1770	0.2894	
3	0.1022	1.1300	1.2430	0.1270	
4	0.0991	0.7800	0.8970	0.0889	
5	0.0825	1.1300	1.2430	0.1025	
6	0.0406	1.1300	1.2430	0.0505	
7	0.0305	1.1400	1.2540	0.0382	
9	0.0176	0.8000	0.9200	0.0162	
10	0.0161	1.0300	1.1330	0.0182	
11	0.0150	1.2200	1.3420	0.0201	
12	0.0078	1.0000	1.1000	0.0086	
Totals	1.0001			1.0712	Cycle 3/2 Flux Ratio =
					0.9422

TABLE 12

CYCLE 1 EXCORE DETECTOR RESPONSE

QC Box Number	Assembly Weighting Factor	Cycle 1 Radial RPD	Cycle 1 Corrected RPD	Cycle 1 Detector Response	
1	0.3428	0.5637	0.6483	0.2222	
2	0.2459	0.7618	0.8761	0.2154	
3	0.1022	0.8190	0.9419	0.0963	
4	0.0991	0.5351	0.6154	0.0610	
5	0.0825	0.7691	0.8845	0.0730	
6	0.0406	1.0163	1.1179	0.0454	
7	0.0305	0.9541	1.0495	0.0320	
9	0.0176	0.5537	0.6368	0.0112	
10	0.0161	0.9661	1.0627	0.0171	
11	0.0150	0.9623	1.0585	0.0159	
12	0.0078	1.0412	1.1453	0.0089	
Totals	1.0001			0.7984	Cycle 2/1 Flux Ratio =
					1.3417

TABLE 13

COMPARISON OF EXCORE RATIOS

Cycle Number	ABB-CE Provided	Calculated
12	1.1577	1.1461
11	0.70	0.7063
10	1.03	1.0369
9	0.98	0.9464
8	1.01	1.0437
7	0.84	0.8173

TABLE 14

FLUENCE DETERMINATION

CYCLE "i"	Flux	Excore Ratio	New Flux	EFPD	Fluence "i"	EFPY	Integrated Fluence
1	4.61E+15	1.0000	4.61E+15	324.68	1.50E+18	0.89	1.50E+18
2	4.61E+15	1.3417	6.19E+15	292.77	1.81E+18	1.69	3.31E+18
3	6.19E+15	0.9422	5.83E+15	234.30	1.37E+18	2.33	4.68E+18
4	5.83E+15	0.8636	5.04E+15	355.91	1.79E+18	3.31	6.47E+18
5	5.04E+15	1.1304	5.69E+15	312.42	1.78E+18	4.16	8.25E+18
6	5.69E+15	0.8192	4.67E+15	443.63	2.07E+18	5.38	1.03E+19
7	4.67E+15	0.8173	3.81E+15	414.50	1.58E+18	6.52	1.19E+19
8	3.81E+15	1.0437	3.98E+15	419.74	1.67E+18	7.67	1.36E+19
9	3.98E+15	0.9464	3.77E+15	430.66	1.62E+18	8.85	1.52E+19
10	3.77E+15	1.0369	3.91E+15	481.00	1.88E+18	10.16	1.71E+19
11	3.91E+15	0.7063	2.76E+15	484.20	1.34E+18	11.49	1.84E+19
12	2.76E+15	1.1461	3.16E+15	478.93	1.51E+18	12.80	1.99E+19
13	3.16E+15	0.8881	2.81E+15	490.00	1.38E+18	14.14	2.13E+19
14	2.81E+15	1.0000	2.81E+15	490.00	1.38E+18	15.49	2.27E+19
15	2.81E+15	1.0000	2.81E+15	490.00	1.38E+18	16.83	2.40E+19
16	2.81E+15	1.0000	2.81E+15	490.00	1.38E+18	18.17	2.54E+19
17	2.81E+15	1.0000	2.81E+15	490.00	1.38E+18	19.51	2.68E+19
18	2.81E+15	1.0000	2.81E+15	490.00	1.38E+18	20.86	2.82E+19
19	2.81E+15	1.0000	2.81E+15	490.00	1.38E+18	22.20	2.96E+19

1

ATTACHMENT 1

nn BB
x.xx

nn = QC Location (Current Cycle 12)
BB = Batch Identifier for Assembly nn
x.xx=Assembly Relative Power Density

					1 M0 0.32	2 N2 0.47	3 N2 0.47
			4 M0 0.31	5 N2 0.58	6 P0 1.10	7 P1 1.17	8 P2 1.07
		9 M2 0.39	10 P0 0.99	11 P2 1.09	12 P2 1.22	13 N2 1.09	14 P2 1.23
	15 M0 0.31	16 P0 0.99	17 N3 1.02	18 P2 1.22	19 N2 1.10	20 P2 1.30	21 N3 1.11
	22 N2 0.59	23 P2 1.09	24 P2 1.22	25 N3 1.12	26 P2 1.34	27 N0 1.24	28 P2 1.37
29 M0 0.33	30 P0 1.11	31 P2 1.22	32 N2 1.10	33 P2 1.34	34 N1 1.23	35 P2 1.36	36 N2 1.15
37 N2 0.47	38 P1 1.17	39 N2 1.09	40 P2 1.30	41 N0 1.24	42 P2 1.36 X	43 N1 1.14	44 N1 1.06
45 N2 0.47	46 P2 1.07	47 P2 1.23	48 N3 1.11	49 P2 1.37	50 N2 1.15	51 N1 1.06	52 K2 0.81

X = Maximum 1–Pin Peak = 1.49

Arkansas Power & Light Co. Arkansas Nuclear One Unit 2	**Arkansas Nuclear One Unit 2 Cycle 12 Assembly Relative Power Density, BOC, HFP, Equilibrium Xenon, ARO EOC -11 = 460 EFPD**	**Figure 5-1**

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nn BB	BB = Batch Identifier for Assembly nn
x.xx	Assembly Relative Power Density

					1 N2 0.24	2 P2 0.44	3 P2 0.50
			4 N2 0.28	5 P2 0.53	6 P2 0.73	7 R1 1.11	8 R2 1.15
		9 P2 0.43	10 R1 0.94	11 R2 1.14	12 R3 1.19	13 P1 1.15	14 R4 1.24
	15 N2 0.28	16 R1 0.94	17 P2 1.07	18 R3 1.30	19 P2 1.21	20 R4 1.25	21 P0 1.21
	22 P2 0.52	23 R2 1.14	24 R3 1.29	25 P2 1.20	26 R4 1.27	27 P2 1.19	28 R4 1.27
29 N2 0.24	30 P2 0.73	31 R3 1.19	32 P2 1.20	33 R4 1.27	34 P0 1.28	35 R4 1.31	36 P2 1.26
37 P2 0.44	38 R1 1.11	39 P1 1.15	40 R4 1.24	41 P2 1.19	42 R4 1.32 X	43 P0 1.29	44 P0 1.24
45 P2 0.50	46 R2 1.15	47 R4 1.24	48 P0 1.21	49 R4 1.27	50 P2 1.26	51 P0 1.24	52 K2 0.96

X = Maximum 1-Pin Peak = 1.54

1

ARKANSAS POWER & LIGHT CO. ARKANSAS NUCLEAR ONE UNIT 2	ANO-2 CYCLE 13 BOC, HFP, EQUILIBRIUM XENON, ARO ASSEMBLY RELATIVE POWER DENSITY EOC12 = 461 EFPD	FIGURE 1-7

X	Y
A	
B	

X = QC Location (Cycle 11)
Y = Batch Identifier
A = Assembly Relative Power Density
B = Bank Identifier of Inserted CEA's

					1 L2 0.23	2 L0 0.39	3 M2 0.47
			4 L1 0.32	5 M2 0.55	6 M0 0.80	7 N1 1.10	8 N1 1.18
		9 L1 0.43	10 N0 1.11	11 M0 1.13	12 N3 1.29	13 M2 1.16	14 N2 1.30
	15 L1 0.32	16 N0 1.11	17 M1 1.21	18 N2 1.36	19 M2 1.18	20 N2 1.29	21 M1 1.16
	22 M2 0.55	23 M0 1.13	24 N2 1.36 X	25 M1 1.24	26 N2 1.31	27 M2 1.12	28 N2 1.26
29 L2 0.23	30 M0 0.80	31 N3 1.29	32 M2 1.18	33 N2 1.32	34 M1 1.16	35 N2 1.28	36 M2 1.13
37 L1 0.36	38 N1 1.11	39 M2 1.16	40 N2 1.29	41 M2 1.12	42 N2 1.28	43 M2 1.14	44 N3 1.32
45 M2 0.47	46 N1 1.18	47 N2 1.30	48 M1 1.14	49 N2 1.26	50 M2 1.13	51 N3 1.32	52 K2 0.90

NOTE: X = MAXIMUM 1–PIN PEAK = 1.51

Arkansas Power & Light Co. Arkansas Nuclear One Unit 2	**Arkansas Nuclear One Unit 2 Cycle 11 Assembly Relative Power Density, BOC, HFP, Equilibrium Xenon, ARO**	**Figure 5–1**

AA BB CC	

AA = QC Assembly Location
BB = Batch Identifier
CC = Assembly Relative Power Density

C
L

					1 K1 0.37	2 M0 0.71	3 K0 0.47
			4 K1 0.37	5 M0 0.92	6 M1 1.16 X	7 M2 1.15	8 L1 1.00
		9 L0 0.47	10 M1 0.98	11 M2 1.22	12 L2 1.25	13 L1 1.26	14 K2 0.93
	15 K1 0.37	16 M1 0.98	17 L0 1.03	18 L2 1.08	19 M2 1.30	20 L0 1.20	21 M2 1.30
	22 M0 0.92	23 M2 1.21	24 L2 1.08	25 K2 0.86	26 L0 1.10	27 M2 1.28	28 L0 1.17
29 K1 0.37	30 M1 1.16	31 L2 1.24	32 M2 1.30	33 L0 1.10	34 M2 1.20	35 L0 1.08	36 M2 1.20
37 M0 0.70	38 M2 1.14	39 L1 1.25	40 L0 1.19	41 M2 1.28	42 L0 1.08	43 K2 0.81	44 L1 1.00
45 K0 0.47	46 L1 0.97	47 K2 0.92	48 M2 1.30	49 L0 1.17	50 M2 1.20	51 L1 0.97	52 K2 0.75

C
L

NOTE: X = MAXIMUM 1-PIN PEAK = 1.49

ARKANSAS POWER & LIGHT CO. Arkansas Nuclear One - Unit 2	ARKANSAS NUCLEAR ONE - UNIT 2 CYCLE 10 ASSEMBLY RELATIVE POWER DENSITY, BOC, HFP, EQUILIBRIUM XENON, ARO	FIGURE 5-1

AA BB CC	AA = QC Assembly Location BB = Batch Identifier CC = Assembly Relative Power Density

C
L

					1 J0 0.35	2 L1 0.69	3 J2 0.49
			4 J1 0.34	5 L1 0.87	6 L2 1.11	7 L0 1.13	8 K2 1.02
		9 J0 0.33	10 L2 0.90	11 L0 1.16	12 K2 1.21	13 K1 1.24	14 K0 1.20
	15 J1 0.34	16 L2 0.90	17 K0 0.98	18 K0 1.08	19 L0 1.31	20 J3 1.03	21 L0 1.34
	22 L1 0.87	23 L0 1.16	24 K0 1.08	25 J2 0.92	26 K2 1.24	27 K1 1.32	28 K0 1.25
29 J0 0.35	30 L2 1.11	31 K2 1.21	32 L0 1.31	33 K2 1.25	34 L0 1.30 X	35 J3 0.99	36 L0 1.25
37 L1 0.69	38 L0 1.13	39 K1 1.24	40 J3 1.03	41 K1 1.32	42 J3 0.99	43 K0 1.04	44 K0 1.02
45 J2 0.49	46 K2 1.02	47 K0 1.20	48 L0 1.34	49 K0 1.25	50 L0 1.25	51 K0 1.02	52 J0 0.76

C
L

NOTE: X = MAXIMUM 1-PIN PEAK = 1.49

ARKANSAS POWER & LIGHT CO. Arkansas Nuclear One - Unit 2	ARKANSAS NUCLEAR ONE - UNIT 2 CYCLE 9 ASSEMBLY RELATIVE POWER DENSITY, BOC, HFP, EQUILIBRIUM XENON, ARO	FIGURE 5-1

AA BB CC

AA = QC Assembly Location
BB = Batch Identifier
CC = Assembly Relative Power Density

C
L

						1 H2 0.38	2 K1 0.73	3 H3 0.51
				4 H2 0.38	5 K1 0.96	6 K2 1.14	7 J1 1.04	8 K2 1.15
			9 H3 0.38	10 K2 1.01	11 J3 1.22	12 J0 1.21	13 K0 1.26	14 H1 0.90
		15 H2 0.38	16 K2 1.01	17 K0 1.25	18 J0 1.18	19 K0 1.31	20 J0 1.14	21 J0 1.08
		22 K1 0.96	23 J3 1.22	24 J0 1.18	25 J2 1.13	26 F0 0.90	27 J4 1.14	28 F0 0.94
	29 H2 0.38	30 K2 1.14	31 J0 1.22	32 K0 1.31 X	33 F0 0.91	34 K0 1.25	35 J3 1.17	36 K0 1.28
	37 K1 0.73	38 J1 1.04	39 K0 1.27	40 J0 1.15	41 J4 1.16	42 J3 1.17	43 F0 0.87	44 J2 1.05
C L —	45 H3 0.51	46 K2 1.15	47 H1 0.90	48 J0 1.08	49 F0 0.94	50 K0 1.28	51 J2 1.05	52 F0 0.81

NOTE: X = MAXIMUM 1-PIN PEAK = 1.51

ARKANSAS POWER & LIGHT CO. Arkansas Nuclear One - Unit 2	ARKANSAS NUCLEAR ONE - UNIT 2 CYCLE 8 ASSEMBLY RELATIVE POWER DENSITY, BOC, HFP, EQUILIBRIUM XENON, ARO	**FIGURE** 5-1

ZZZ	QUARTER-CORE ASSEMBLY NUMBER
1.00	ASSEMBLY RELATIVE POWER DENSITY

X = LOCATION OF MAXIMUM 1-PIN PEAK = 1.52

C
L

					01 0.33	02 0.69	03 0.51
			04 0.40	05 0.90	06 1.09	07 1.17	08 1.04
		09 0.45	10 1.07	11 1.25	12 1.24	13 1.27	14 1.20
	15 0.40	16 1.07	17 1.09	18 0.99	19 1.34	20 1.10	21 1.37
	22 0.90	23 1.25	24 0.99	25 1.10	26 1.18	27 1.20	28 1.17
29 0.33	30 1.09	31 1.24	32 1.34	33 1.18	34 1.20 X	35 0.90	36 1.14
37 0.69	38 1.17	39 1.27	40 1.10	41 1.20	42 0.90	43 0.91	44 0.88
45 0.51	46 1.04	47 1.20	48 1.37	49 1.17	50 1.14	51 0.88	52 0.67

C
L — —

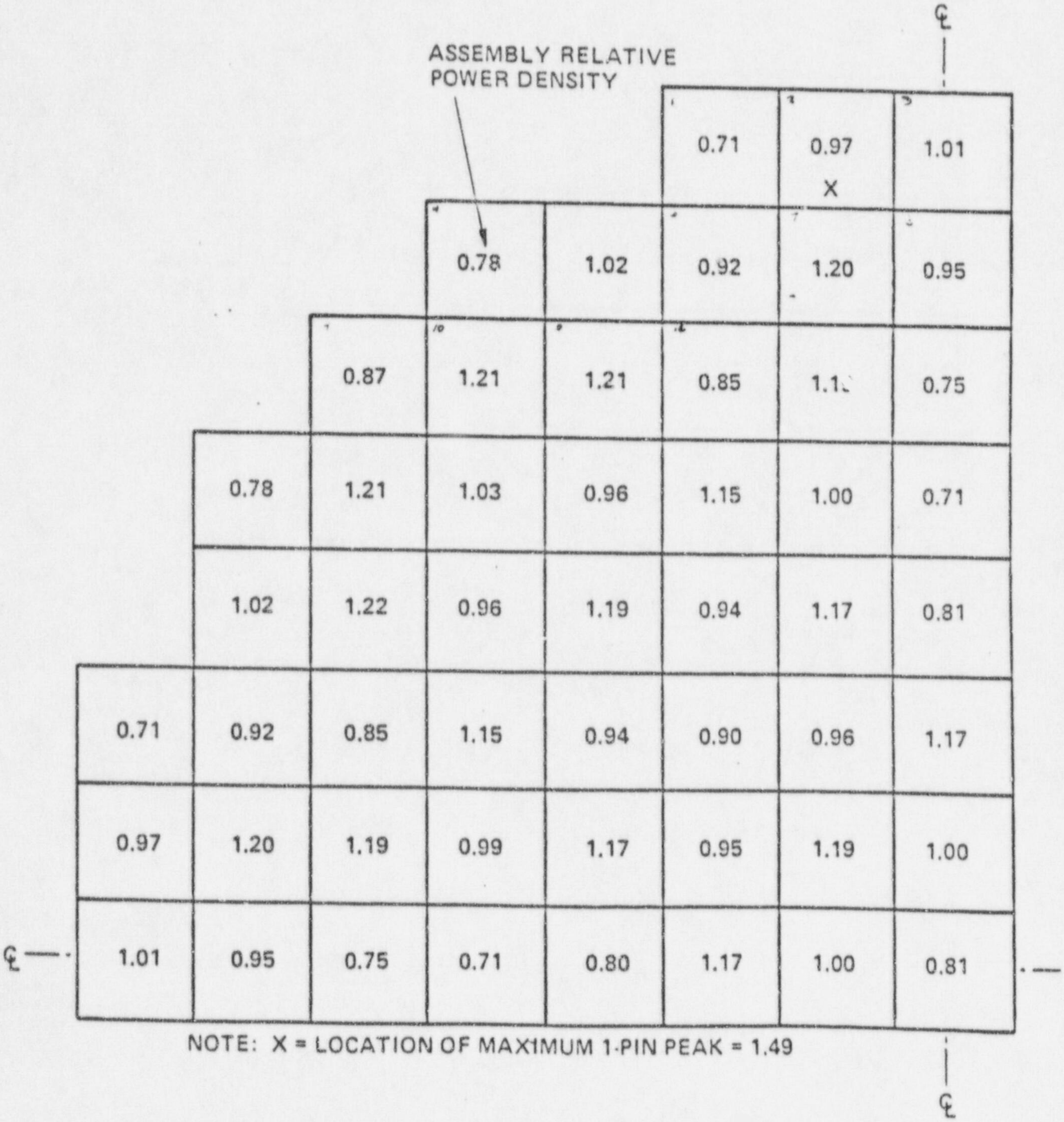
ARKANSAS POWER & LIGHT CO. Arkansas Nuclear One - Unit 2	ARKANSAS NUCLEAR ONE - UNIT 2 CYCLE 7 ASSEMBLY RELATIVE POWER DENSITY, BOC, HFP, EQUILIBRIUM XENON, ARO	FIGURE 5-1

FIGURE 5-1
ARKANSAS NUCLEAR ONE - UNIT 2 CYCLE 6
ASSEMBLY RELATIVE POWER DENSITY
BOC, HFP, EQUILIBRIUM XENON, ARO

```
KEY TO MAP
 !------!
 ! ZZZ  !      QUARTER-CORE ASSEMBLY NUMBER
 ! 1.00 !      ASSEMBLY RELATIVE POWER DENSITY
 !      !
 !------!

   X = LOCATION OF MAXIMUM 1-PIN PEAK = 1.52

                                                          C
                                                          L
                                                          !
                                                          !
                                         !------!------!------!
                                         !  01  !  02  !  03  !
                                         ! 0.49 ! 0.86 ! 0.67 !
                                         !      !      !      !
                           !------!------!------!------!------!
                           !  04  !  05  !  06  !  07  !  08  !
                           ! 0.44 ! 0.95 ! 1.17 ! 1.30 ! 1.27 !
                           !      !      !      !      !      !
                    !------!------!------!------!------!------!
                    !  09  !  10  !  11  !  12  !  13  !  14  !
                    ! 0.47 ! 1.09 ! 1.31 ! 1.09 ! 1.33 ! 1.07 !
                    !      !      !      !      !      !      !
             !------!------!------!------!------!------!------!
             !  15  !  16  !  17  !  18  !  19  !  20  !  21  !
             ! 0.44 ! 1.09 ! 1.30 ! 1.29 ! 1.26 ! 1.11 ! 1.23 !
             !      !      !  X   !      !      !      !      !
             !------!------!------!------!------!------!------!
             !  22  !  23  !  24  !  25  !  26  !  27  !  28  !
             ! 0.95 ! 1.30 ! 1.29 ! 0.84 ! 0.81 ! 1.11 ! 0.82 !
             !      !      !      !      !      !      !      !
      !------!------!------!------!------!------!------!------!
      !  29  !  30  !  31  !  32  !  33  !  34  !  35  !  36  !
      ! 0.49 ! 1.17 ! 1.09 ! 1.26 ! 0.81 ! 1.06 ! 0.93 ! 1.03 !
      !      !      !      !      !      !      !      !      !
      !------!------!------!------!------!------!------!------!
      !  37  !  38  !  39  !  40  !  41  !  42  !  43  !  44  !
      ! 0.86 ! 1.29 ! 1.32 ! 1.10 ! 1.11 ! 0.93 ! 0.83 ! 0.69 !
      !      !      !      !      !      !      !      !      !
      !------!------!------!------!------!------!------!------!
      !  45  !  46  !  47  !  48  !  49  !  50  !  51  !  52  !
      ! 0.66 ! 1.26 ! 1.06 ! 1.22 ! 0.82 ! 1.03 ! 0.69 ! 0.46 !
CL--  !      !      !      !      !      !      !      !      !
      !------!------!------!------!------!------!------!------!
```



					0.71	0.97 X	1.01
			0.78	1.02	0.92	1.20	0.95
		0.87	1.21	1.21	0.85	1.19	0.75
	0.78	1.21	1.03	0.96	1.15	1.00	0.71
	1.02	1.22	0.96	1.19	0.94	1.17	0.81
0.71	0.92	0.85	1.15	0.94	0.90	0.96	1.17
0.97	1.20	1.19	0.99	1.17	0.95	1.19	1.00
1.01	0.95	0.75	0.71	0.80	1.17	1.00	0.81

NOTE: X = LOCATION OF MAXIMUM 1-PIN PEAK = 1.49

ARKANSAS POWER & LIGHT CO. Arkansas Nuclear One - Unit 2	ARKANSAS NUCLEAR ONE - UNIT 2 CYCLE 5 ASSEMBLY RELATIVE POWER DENSITY, HFP AT BOC, EQUILIBRIUM XENON, ARO	Figure 5-1

ASSEMBLY RELATIVE POWER DENSITY

℄

					0.57	0.81	0.90
			0.79	1.04	0.72	0.90	1.07
		0.86	1.17	1.28	1.07	1.27	0.81
	0.79	1.17	1.00	1.34	1.27	1.01	0.81
	1.04	1.28	1.34	0.96	1.02	1.26	0.77
0.57	0.72	1.07	1.27	1.02	0.97	0.98	0.90
0.81	0.90	1.27 X	1.01	1.26	0.98	1.09	0.92
℄ 0.90	1.07	0.81	0.81	0.77	0.90	0.91	0.67 ℄

℄

NOTE: X = LOCATION OF MAXIMUM 1-PIN PEAK = 1.53
C IN CORE CENTER

ARKANSAS POWER & LIGHT CO. Arkansas Nuclear One - Unit 2	ARKANSAS NUCLEAR ONE - UNIT 2 CYCLE 4 ASSEMBLY RELATIVE POWER DENSITY, HFP AT BOC, EQUILIBRIUM XENON, ARO (EOC3 OF 8819 MWD/T)	Figure 5-1

ASSEMBLY RELATIVE POWER DENSITY

					0.73	1.02	1.06
			0.76	1.06	0.91	1.19	0.93
		0.83	1.10	1.01	1.28	0.97	1.00
	0.76	1.10	1.13	1.28	0.90	1.23	0.91
	1.06	1.01	1.29	0.88	0.97	0.86	1.08
0.73	0.91	1.27	0.90	0.97	1.11	0.82	0.93
1.02	1.19	0.97	X 1.23	0.86	0.83	1.11	0.84
1.06	0.93	1.00	0.90	1.07	0.94	0.89	0.72

℄ ℄ ℄ ℄

X = LOCATION OF MAXIMUM 1-PIN PEAK = 1.45

ARKANSAS POWER & LIGHT CO. Arkansas Nuclear One - Unit 2	ARKANSAS NUCLEAR ONE - UNIT 2 CYCLE 3 ASSEMBLY RELATIVE POWER DENSITY, HFP AT BOC, EQUILIBRIUM XENON, ARO	Figure 5-3

Assembly Relative Power Density

					0.79	1.07	1.13
			0.78	1.13	1.13	1.14	1.18
		0.80	1.03	1.22	1.00	1.14	0.97
	0.78	1.03	1.14	0.98	1.31	0.92	1.24
	1.14	1.22	0.99	1.03	0.87	0.79	0.80
0.79	1.14	1.01	1.32	0.87	1.12	0.76	1.03
1.07	1.14	1.14	0.92	0.79	0.76	0.79	0.65
1.13 X	1.19	0.97	1.25	0.80	1.03	0.65	0.54

NOTE: X = Location of Maximum 1-Pin Peak = 1.50

ARKANSAS POWER & LIGHT CO. ARKANSAS NUCLEAR ONE - UNIT 2	ARKANSAS NUCLEAR ONE - UNIT 2 CYCLE 2 ASSEMBLY RELATIVE POWER DENSITY, HFP AT BOC, EQUILIBRIUM XENON	FIGURE 5-2

```
      EIGENVALUE     .997729, REACTIVITY  -.002277
   FORMAT IS  BOX TYPE,NO.    MAX.VALUE IN BOX       BATCH BOXES   PWR.FP.   AVG.P
                  BOX,RPD          1.2652    44           C1     8   .044786   1.0157
                MAX 4-PIN          1.3613    44           C2    16   .076477    .8672
                MAX 1-PIN          1.4311    44           C3    12   .053888    .7800
  WITH CORE AVERAGE POWER           .9999                 C4    16   .050327    .5486
```

RADIAL POWER DISTRIBUTION

1K MWD/MT, 100% POWER

EQUILIBRIUM XENON

FIG 6

```
                                                C4   1     C3   2     C3   3
                                                .5637      .7618      .8190
                                                .9161     1.0627     1.1204
                                                .9644     1.1138     1.1676

                            C4   4     C2   5     C1   6     B2   7     A3   8
                            .5351      .7691    1.0163      .9541      .9778
                            .8826     1.0933    1.2100     1.1057     1.0659
                            .9307     1.1441    1.2795     1.1595     1.1201

                 C5   9     C2  10     A3  11     B2  12     A2  13     B2  14
                 .5537      .9661      .9623    1.0412     1.0566     1.0949
                 .9048     1.2211     1.0687    1.1770     1.1459     1.2086
                 .9592     1.2871     1.1305    1.2359     1.2061     1.2678

       C4  15    C2  16     A3  17     B2  18     A2  19     B2  20     A2  21
       .5348     .9611     1.0003     1.0893     1.1055     1.1540     1.1388
       .8816    1.2195     1.0990     1.2127     1.1945     1.2711     1.2291
       .9299    1.2854     1.1609     1.2745     1.2569     1.3352     1.2903

       C2  22    A3  23     B2  24     A2  25     B1  26     A2  27     B1  28
       .7728     .9617     1.0935     1.1230     1.1848     1.1810     1.2140
      1.0934    1.0682     1.2134     1.2103     1.2959     1.2712     1.3183
      1.1443    1.1290     1.2753     1.2735     1.3623     1.3357     1.3848

  C4  29    C1  30    B2  31     A2  32     B1  33     A2  34     B1  35     A1  36
  .5610    1.0152    1.0357     1.1048     1.1795     1.1940     1.2351     1.2162
  .9142    1.2075    1.1747     1.1938     1.2944     1.2832     1.3424     1.3068
  .9623    1.2769    1.2334     1.2561     1.3607     1.3492     1.4111     1.3729

  C3  37    B2  38    A2  39     B2  40     A2  41     B1  42     A1  43     B1  44
  .7601     .9520    1.0547     1.1577     1.1804     1.2400     1.2292     1.2652
 1.0604    1.1031    1.1441     1.2713     1.2703     1.3435     1.3179     1.3613
 1.1114    1.1568    1.2042     1.3353     1.3352     1.4123     1.3855     1.4311

  C3  45    A3  46    B2  47     A2  48     B1  49     A1  50     B1  51     A1  52
  .8172     .9753    1.0893     1.1376     1.2094     1.2159     1.2600     1.2399
 1.1179    1.0631    1.2057     1.2279     1.3166     1.3065     1.3600     1.3288
 1.1650    1.1171    1.2647     1.2890     1.3930     1.3726     1.4297     1.3970

THIS CEDIT(CERISE-12 (7/SEP/77) CASE RUN AT 18.41 ON  04/19/78

SOME NON-ZERO AND NON-UNITY PIN FACTORS HAVE BEEN USED
SOME NON-UNITY BOX FACTORS HAVE BEEN USED
```

CYCLE 1

C-E PREDICTION

ATTACHMENT 2

(A) Fuel Cycle for which calculation is being performed: 1

> **NOTE**
> If this calculation uses an actual end-of-cycle burnup, check ACTUAL. If this calculation uses a projected end-of-cycle burnup, check PROJECTED.

(B) Type of calculation: ACTUAL ✓ PROJECTED ---

(C) Cycle (A) end-of-cycle burnup: 324.6836 EFPD

(D) Cumulative core burnup prior to Cycle (A): 0 EFPD

(E) Cumulative burnup at End-of-Cycle (A) = (C) + (D) EFPD

= 324.6836 + 0 = 324.6836 EFPD

(F) Conversion to EFPY: [(E)/365] = EFPY

= [324.6836 / 365] = .8895 EFPY

> **NOTE**
> If the cumulative burnup value in (F) is 17.75 EFPY or greater,* reactor vessel irradiation surveillance specimen 2 shall be removed at the end of the cycle for examination, and step (G) may be marked "N/A".

(G) Number of cycles* remaining until specimen removal:

= [19-(F)]/1.26 = [19 - .8895]/1.26 = 14 cycles

* Assuming an average cycle length of 1.26 EFPY (460 EFPD)

Calculated By Ward D. Cook Date 3/15/93

Reviewed By Michael R. Mek Date 3-15-93

Approved By Frank Philpott Date 3/15/93
Reactor Engineering Supt.

FORM TITLE: CALCULATION OF CUMULATIVE ANO-2 BURNUP | FORM NO. 1022.013A | REV. 5

(A) Fuel Cycle for which calculation is being performed: 2

NOTE
If this calculation uses an actual end-of-cycle burnup, check ACTUAL. If this calculation uses a projected end-of-cycle burnup, check PROJECTED.

(B) Type of calculation: ACTUAL ✓ PROJECTED ______

(C) Cycle (A) end-of-cycle burnup: 292.7713 EFPD

(D) Cumulative core burnup prior to Cycle (A): 324.6836 EFPD

(E) Cumulative burnup at End-of-Cycle (A) = (C) + (D) EFPD

= 292.7713 + 324.6836 = 617.4549 EFPD

(F) Conversion to EFPY: [(E)/365] = EFPY

= [617.4549 / 365] = 1.6917 EFPY

NOTE
If the cumulative burnup value in (F) is 17.75 EFPY or greater,* reactor vessel irradiation surveillance specimen 2 shall be removed at the end of the cycle for examination, and step (G) may be marked "N/A".

(G) Number of cycles* remaining until specimen removal:

= [19-(F)]/1.26 = [19 - 1.6917]/1.26 = ~~14~~ 13 MRM 3-15-93 cycles Rounded down

* Assuming an average cycle length of 1.26 EFPY (460 EFPD)

Calculated By Ward A. Cook Date 3/15/93
Reviewed By Michael R. McKinney Date 3-15-93
Approved By Frank Philpott Date 3/15/93
Reactor Engineering Supt.

FORM TITLE:	FORM NO.	REV.
CALCULATION OF CUMULATIVE ANO-2 BURNUP	1022.013A	5

(A) Fuel Cycle for which calculation is being performed: 3

> NOTE
> If this calculation uses an actual end-of-cycle burnup, check ACTUAL. If this calculation uses a projected end-of-cycle burnup, check PROJECTED.

(B) Type of calculation: ACTUAL ✓ PROJECTED ____

(C) Cycle (A) end-of-cycle burnup: 234.2950 EFPD

(D) Cumulative core burnup prior to Cycle (A): 617.4549 EFPD

(E) Cumulative burnup at End-of-Cycle (A) = (C) + (D) EFPD

= 234.2950 + 617.4549 = 851.7499 EFPD

(F) Conversion to EFPY: [(E)/365] = EFPY

= [851.7499 / 365] = 2.3336 EFPY

> NOTE
> If the cumulative burnup value in (F) is 17.75 EFPY or greater,* reactor vessel irradiation surveillance specimen 2 shall be removed at the end of the cycle for examination, and step (G) may be marked "N/A".

(G) Number of cycles* remaining until specimen removal:

= [19-(F)]/1.26 = [19 - 2.3336]/1.26 = 13 cycles

* Assuming an average cycle length of 1.26 EFPY (460 EFPD)

Calculated By Ward D. Cook Date 3/15/93

Reviewed By Michael R. McKin Date 3-15-93

Approved By Frank Philpott Date 3/15/93
Reactor Engineering Supt.

FORM TITLE:	FORM NO.	REV.
CALCULATION OF CUMULATIVE ANO-2 BURNUP	1022.013A	5

(A) Fuel Cycle for which calculation is being performed: 4

> **NOTE**
> If this calculation uses an actual end-of-cycle burnup, check ACTUAL. If this calculation uses a projected end-of-cycle burnup, check PROJECTED.

(B) Type of calculation: ACTUAL ✓ PROJECTED ____

(C) Cycle (A) end-of-cycle burnup: 355.9101 EFPD

(D) Cumulative core burnup prior to Cycle (A): 851.7499 EFPD

(E) Cumulative burnup at End-of-Cycle (A) = (C) + (D) EFPD

= 355.9101 + 851.7499 = 1207.6600 EFPD

(F) Conversion to EFPY: [(E)/365] = EFPY

= [1207.6600 / 365] = 3.3087 EFPY

> **NOTE**
> If the cumulative burnup value in (F) is 17.75 EFPY or greater,* reactor vessel irradiation surveillance specimen 2 shall be removed at the end of the cycle for examination, and step (G) may be marked "N/A".

(G) Number of cycles* remaining until specimen removal:

= [19-(F)]/1.26 = [19 - 3.3087]/1.26 = 12 cycles

* Assuming an average cycle length of 1.26 EFPY (460 EFPD)

Calculated By Ward D. Cook Date 3/15/93

Reviewed By Michael R. Mc[illegible] Date 3-15-93

Approved By Frank Philpott Date 3/16/93
Reactor Engineering Supt.

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(A) Fuel Cycle for which calculation is being performed: 5

> NOTE
> If this calculation uses an actual end-of-cycle burnup, check ACTUAL. If this calculation uses a projected end-of-cycle burnup, check PROJECTED.

(B) Type of calculation: ACTUAL ✓ PROJECTED ______

(C) Cycle (A) end-of-cycle burnup: 312.4209 EFPD

(D) Cumulative core burnup prior to Cycle (A): 1207.6600 EFPD

(E) Cumulative burnup at End-of-Cycle (A) = (C) + (D) EFPD

= 312.4209 + 1207.6600 = 1520.0809 EFPD

(F) Conversion to EFPY: [(E)/365] = EFPY

= [1520.0809 / 365] = 4.1646 EFPY

> NOTE
> If the cumulative burnup value in (F) is 17.75 EFPY or greater,* reactor vessel irradiation surveillance specimen 2 shall be removed at the end of the cycle for examination, and step (G) may be marked "N/A".

(G) Number of cycles* remaining until specimen removal:

= [19-(F)]/1.26 = [19 - 4.1646]/1.26 = 11 cycles Rounded Down

* Assuming an average cycle length of 1.26 EFPY (460 EFPD)

Calculated By Ward D. Cook Date 3/15/93

Reviewed By Michael R. McKinney Date 3-15-93

Approved By Frank Philpott Date 3/16/93
Reactor Engineering Supt.

(A) Fuel Cycle for which calculation is being performed: 6

NOTE
If this calculation uses an actual end-of-cycle burnup, check ACTUAL. If this calculation uses a projected end-of-cycle burnup, check PROJECTED.

(B) Type of calculation: ACTUAL ✓ PROJECTED ______

(C) Cycle (A) end-of-cycle burnup: 443.6319 EFPD

(D) Cumulative core burnup prior to Cycle (A): 1520.0809 EFPD

(E) Cumulative burnup at End-of-Cycle (A) = (C) + (D) EFPD

= 443.6319 + 1520.0809 = 1963.7128 EFPD

(F) Conversion to EFPY: [(E)/365] = EFPY

= [1963.7128 / 365] = 5.3800 EFPY

NOTE
If the cumulative burnup value in (F) is 17.75 EFPY or greater,* reactor vessel irradiation surveillance specimen 2 shall be removed at the end of the cycle for examination, and step (G) may be marked "N/A".

(G) Number of cycles* remaining until specimen removal: 10 MRM 3-15-93

= [19-(F)]/1.26 = [19 - 5.3800]/1.26 = ~~11~~ cycles

Rounded down

* Assuming an average cycle length of 1.26 EFPY (460 EFPD)

Calculated By Ward D. Cook Date 3/15/93

Reviewed By Michael R. McKinney Date 3·15·93

Approved By Frank Philpott Date 3/15/93
Reactor Engineering Supt.

FORM TITLE:	FORM NO.	REV.
CALCULATION OF CUMULATIVE ANO-2 BURNUP	1022.013A	5

(A) Fuel Cycle for which calculation is being performed: 7

> **NOTE**
> If this calculation uses an actual end-of-cycle burnup, check ACTUAL. If this calculation uses a projected end-of-cycle burnup, check PROJECTED.

(B) Type of calculation: ACTUAL ✓ PROJECTED ____

(C) Cycle (A) end-of-cycle burnup: 414.4970 EFPD

(D) Cumulative core burnup prior to Cycle (A): 1963.7128 EFPD

(E) Cumulative burnup at End-of-Cycle (A) = (C) + (D) EFPD

= 414.4970 + 1963.7128 = 2378.2098 EFPD

(F) Conversion to EFPY: [(E)/365] = EFPY

= [2378.2098 / 365] = 6.5156 EFPY

> **NOTE**
> If the cumulative burnup value in (F) is 17.75 EFPY or greater,* reactor vessel irradiation surveillance specimen 2 shall be removed at the end of the cycle for examination, and step (G) may be marked "N/A".

(G) Number of cycles* remaining until specimen removal:

= [19-(F)]/1.26 = [19 - 6.5156]/1.26 = ~~10~~ 9 MRM 3-15-93 cycles Rounded down

* Assuming an average cycle length of 1.26 EFPY (460 EFPD)

Calculated By Ward D. Cook Date 3/15/93

Reviewed By Michael R. McKinney Date 3-15-93

Approved By Frank Philpott Date 3/15/93
Reactor Engineering Supt.

FORM TITLE: CALCULATION OF CUMULATIVE ANO-2 BURNUP	FORM NO. 1022.013A	REV. 5

(A) Fuel Cycle for which calculation is being performed: 8

NOTE
If this calculation uses an actual end-of-cycle burnup, check ACTUAL. If this calculation uses a projected end-of-cycle burnup, check PROJECTED.

(B) Type of calculation: ACTUAL ✓ PROJECTED ____

(C) Cycle (A) end-of-cycle burnup: 419.7405 EFPD

(D) Cumulative core burnup prior to Cycle (A): 2378.2098 EFPD

(E) Cumulative burnup at End-of-Cycle (A) = (C) + (D) EFPD

= 419.7405 + 2378.2098 = 2797.9503 EFPD

(F) Conversion to EFPY: [(E)/365] = EFPY

= [2797.9503 / 365] = 7.6656 EFPY

NOTE
If the cumulative burnup value in (F) is 17.75 EFPY or greater,* reactor vessel irradiation surveillance specimen 2 shall be removed at the end of the cycle for examination, and step (G) may be marked "N/A".

(G) Number of cycles* remaining until specimen removal:

= [19-(F)]/1.26 = [19 - 7.6656]/1.26 = ~~9~~ 8 MRM 3-15-93 cycles Rounded down

* Assuming an average cycle length of 1.26 EFPY (460 EFPD)

Calculated By Ward D. Cook Date 3/15/93
Reviewed By Michael R. McKinney Date 3-15-93
Approved By Frank Philpott Date 3/15/93
Reactor Engineering Supt.

(A) Fuel Cycle for which calculation is being performed: 9

> NOTE
> If this calculation uses an actual end-of-cycle burnup, check ACTUAL. If this calculation uses a projected end-of-cycle burnup, check PROJECTED.

(B) Type of calculation: ACTUAL ✓ PROJECTED ____

(C) Cycle (A) end-of-cycle burnup: 430.6551 EFPD

(D) Cumulative core burnup prior to Cycle (A): 2797.9503 EFPD

(E) Cumulative burnup at End-of-Cycle (A) = (C) + (D) EFPD

= 430.6551 + 2797.9503 = 3228.6054 EFPD

(F) Conversion to EFPY: [(E)/365] = EFPY

= [3228.6054 / 365] = 8.8455 EFPY

> NOTE
> If the cumulative burnup value in (F) is 17.75 EFPY or greater,* reactor vessel irradiation surveillance specimen 2 shall be removed at the end of the cycle for examination, and step (G) may be marked "N/A".

(G) Number of cycles* remaining until specimen removal:

= [19-(F)]/1.26 = [19 - 8.8455]/1.26 = ~~8.1~~ 8 MRA 3-15-93 cycles

* Assuming an average cycle length of 1.26 EFPY (460 EFPD)

Calculated By Ward D. Cook Date 3/10/93

Reviewed By Michael R. Date 3.12.93

Approved By Frank Philpott Date 3/15/93
Reactor Engineering Supt.

(A) Fuel Cycle for which calculation is being performed: 10

NOTE
If this calculation uses an actual end-of-cycle burnup, check ACTUAL. If this calculation uses a projected end-of-cycle burnup, check PROJECTED.

(B) Type of calculation: ACTUAL ✓ PROJECTED ______

(C) Cycle (A) end-of-cycle burnup: 480.9983 EFPD

(D) Cumulative core burnup prior to Cycle (A): 3228.6054 EFPD

(E) Cumulative burnup at End-of-Cycle (A) = (C) + (D) EFPD

= 480.9983 + 3228.6054 = 3709.6037 EFPD

(F) Conversion to EFPY: [(E)/365] = EFPY

= [3709.6037 / 365] = 10.1633 EFPY

NOTE
If the cumulative burnup value in (F) is 17.75 EFPY or greater,* reactor vessel irradiation surveillance specimen 2 shall be removed at the end of the cycle for examination, and step (G) may be marked "N/A".

(G) Number of cycles* remaining until specimen removal:

= [19-(F)]/1.26 = [19 - 10.1633]/1.26 = 7 cycles

* Assuming an average cycle length of 1.26 EFPY (460 EFPD)

Calculated By Charles H. Hanford Date 3/15/94

Reviewed By Michael R. McKinney Date 3-16-94

Approved By Frank Philpott Date 3/16/94
Reactor Engineering Supt.

(A) Fuel Cycle for which calculation is being performed: 11

> NOTE
> If this calculation uses an actual end-of-cycle burnup, check ACTUAL. If this calculation uses a projected end-of-cycle burnup, check PROJECTED.

(B) Type of calculation: ACTUAL ✓ PROJECTED ______

(C) Cycle (A) end-of-cycle burnup: 484.195 EFPD

(D) Cumulative core burnup prior to Cycle (A): 3709.6037 EFPD

(E) Cumulative burnup at End-of-Cycle (A) = (C) + (D) EFPD

= 484.195 + 3709.6037 = 4193.799 EFPD

(F) Conversion to EFPY: [(E)/365] = EFPY

= [4193.799 / 365] = 11.490 EFPY

> NOTE
> If the cumulative burnup value in (F) is 17.75 EFPY or greater,* reactor vessel irradiation surveillance specimen 2 shall be removed at the end of the cycle for examination, and step (G) may be marked "N/A".

(G) Number of cycles* remaining until specimen removal:

= [19-(F)]/1.26 = [19 - 11.490]/1.26 = 5.960 cycles

* Assuming an average cycle length of 1.26 EFPY (460 EFPD)

Calculated By Todd Ewing Date 1/11/96

Reviewed By Ryan R Little Date 1/11/96

Approved By Frank Philpott Date 1/11/96
Reactor Engineering Supt.

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Entergy

Inter-Office
Correspondence

Date: May 12, 1997

Number: ANO-97-2-00093

To: F.T. Philpott

From: T.A. Erskine

Subject: ANO-2 Monthly Performance Report

1

Attached is the monthly performance report for ANO Unit 2 for the period of May 1, 1997 to May 31, 1997. The Unit shutdown for 2R12 at 2332 on May 9. If there are any questions or comments, please contact me at extension 5526.

Todd Erskine

TAE/tae
Attachments
cc:

J.H. Willoughby (GSB/3W)
R.B. Lang (ECH 37)
P.B. Brown (ECH 681)
K. Fitzsimmons (L-ENT-11B)
D. Doucet (L-ENT-11B)
ANO-DCC

REACTOR THERMAL POWER HISTORY - FORM NO. 1022.011A

Unit 2 Month May Year 1997

1

DAY	AVERAGE POWER		CUMULATIVE OUTPUT		BORON -PPMB	COMMENTS
	%FP	MWt	EFPD	MWD		
1	97.34	2740.06	471.964	1328579.73		
2	97.39	2741.60	472.938	1331321.32	71	
3	97.35	2740.41	473.912	1334061.73		
4	97.35	2740.50	474.885	1336802.23		
5	97.32	2739.70	475.859	1339541.93	60	
6	96.49	2716.32	476.824	1342258.24		
7	77.60	2184.49	477.600	1344442.73	73	
8	69.50	1956.36	478.295	1346399.09		
9	63.62	1790.83	478.931	1348189.92	138	Trip from
10	0.00	0.00	478.931	1348189.92		19% @2332
11	0.00	0.00	478.931	1348189.92		
12	0.00	0.00	478.931	1348189.92		
13	0.00	0.00	478.931	1348189.92		
14	0.00	0.00	478.931	1348189.92		
15	0.00	0.00	478.931	1348189.92		
16	0.00	0.00	478.931	1348189.92		
17	0.00	0.00	478.931	1348189.92		
18	0.00	0.00	478.931	1348189.92		
19	0.00	0.00	478.931	1348189.92		
20	0.00	0.00	478.931	1348189.92		
21	0.00	0.00	478.931	1348189.92		
22	0.00	0.00	478.931	1348189.92		
23	0.00	0.00	478.931	1348189.92		
24	0.00	0.00	478.931	1348189.92		
25	0.00	0.00	478.931	1348189.92		
26	0.00	0.00	478.931	1348189.92		
27	0.00	0.00	478.931	1348189.92		
28	0.00	0.00	478.931	1348189.92		
29	0.00	0.00	478.931	1348189.92		
30	0.00	0.00	478.931	1348189.92		
31	0.00	0.00	478.931	1348189.92		
	AVERAGE	AVERAGE	TOTAL	TOTAL		
	25.61	720.98	7.940	22350.58		