50-368

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April 18, 1984

2CAN948403

Director of Nuclear Reactor Regulation
ATTN: Mr. James R. Miller, Chief
Operating Reactors Branch #3
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Gentlemen:

In accordance with the commitment in Section 4.2.1.1.10 of the ANO-2 FSAR, attached are the results of the fuel inspections at the end of the third ANO-2 Cycle.

The results of the two previous inspections were provided by our letters dated June 2, 1982 (2CAN058209) and March 20, 1983 (2CAN038307).

Submission of the attached report completes our FSAR commitment for fuel inspection submittals.

Very truly yours,

for John R. Marshall
Manager, Licensing

JRM:JTE:gw

Attachment

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ATTACHMENT 1

ANO-2 CYCLE 3 REFUELING OUTAGE

FUEL EXAMINATION RESULTS

April 3, 1984

ANO-2 CYCLE 3 REFUELING OUTAGE
FUEL EXAMINATION RESULTS

1.0 INTRODUCTION

1.1 Arkansas Nuclear One-Unit 2 started its third cycle with initial criticality on November 10, 1982 and ended it September 26, 1983. All 177 fuel assemblies in the Cycle 3 core were off-loaded to the spent fuel pool by November 1 and fuel inspections were initiated. Two principal types of inspections were conducted: (1) visual examination and (2) shoulder gap measurement. Iodine-131 values measured during September, 1983 were about 0.06 µCi/g. This indicated that the number of failed rods was similar to the small number found during the Cycle 2 inspections (5 to 7 rods). Consequently, sipping examinations were not conducted. In the following sections of this report we shall discuss the results of the visual examinations and the shoulder gap measurements. Then we shall place our results in perspective with those obtained during the Cycle 1 and Cycle 2 refueling outages.

2.0 FUEL OFF-LOADING

2.1 The Cycle 3 core was off-loaded in a slab fashion as depicted in Figure 1. A Cycle 3 core map is presented in Figure 2. Since the Cycle 2 off-loading, the refueling machine has been re-worked to decrease its trip response time and a specific log of trips experienced is being kept. Information obtained from the trip log during the cycle 3 off-load is presented in Table I.

3.0 VISUAL INSPECTIONS

3.1 All fifty-six Batch C fuel assemblies plus one Batch D and three Batch E fuel assemblies were visually examined in the spent fuel pool by remote television. The examinations were performed to evaluate general fuel assembly appearance, overall structural integrity, fuel and poison rod condition, spacer grid wear or damage, and upper end fitting spring and post condition.

3.2 The first group of nineteen assemblies was examined on November 12 and 13 and nothing unusual was found. These results were verbally communicated to the NRC on November 16 prior to sealing the reactor vessel head as required by the SER supporting amendment No. 24 to operating license (Reference 1). However, when the balance of the assemblies were inspected in early December, fourteen assemblies were noted to have some grid wear on a total of eighteen faces, and eight fuel assemblies were observed to have

some grid damage. A ninth assembly, AKC303, inspected on November 12, had a missing lead-in tab that had been previously noted at the end of Cycle 2. Table II, which is extracted from the vendor's report, presents those assemblies on which grid wear or damage was observed. Tables III and IV, which are also from the vendor's report, summarize the grid wear and damage respectively. Several of the wear observations noted at poolside could not be confirmed by a review of the video tapes due to insufficient tape clarity. Those observations are included in Table III.

3.3 Of the eighteen faces with wear, fourteen cases could be attributed to interaction with the core shroud during Cycle 1. The remaining four faces were never adjacent to the core shroud. It is quite possible the visual wear indications on these four faces could be crud deposits instead of light wear. It should be noted that the previous outage examinations focused on the Batch A and B assemblies, and that none of those assemblies had occupied core positions against the shroud.

3.4 Although Table IV lists nine assemblies with grid damage, one of these, AKB021, was not present in the Cycle 3 core. The bent tabs on it were noted as part of another periscopic examination. If the bent tabs were not missed when AKB021 was examined at EOC-2, the damage may have occurred during assembly movements associated with the recent spent fuel pool reracking. The missing tab on AKC303, as previously mentioned, was detected at EOC-2. The cracked corner weld on AKC413 is not attributed to grid interaction while handling. Two of the remaining six assemblies, AKC504 and AKC214, had oxidation in their damaged grid areas indicating the wiper tabs were torn before the Cycle 3 off-loading. Another assembly, AKC208, was missing a grid lead-in tab on the east face that was adjacent to the damaged east face on AKC504 during Cycle 1; and it is probable that AKC208 was damaged during the Cycle 1 off-loading.

3.5 The remaining three assemblies with grid damage listed in Table IV are AKC101, AKC104, and AKC307. The shiny appearance of the torn tab regions indicates that the damage was done during the EOC-3 outage. A review of the off-loading overload trips presented in Table I shows that trips on AKC101 and AKC307 were experienced at heights consistent with the grid-to-grid interaction. The damaged grid tabs on the south face of AKC307 when the trip occurred were adjacent to the north face of AKE111. However, the west face of AKC101, on which the damaged grid tabs were found, was not facing an assembly when the overload trip occurred. Furthermore, the damaged lead-in tabs and perimeter strip on the north face of AKC104 cannot be explained by grid-to-grid interaction since AKC104 was removed without a trip. An adjacent assembly, AKD007, did experience a trip, but it did not adjoin the north face of AKC104. It is probable, then, that AKC307 was damaged on the EOC-3 off-load, but no likely explanation presents itself for the damage to AKC101 and AKC104.

3.6 The video tapes of 41 of the 56 "C" assemblies were reviewed for rod fretting indications. The tape clarity of the remaining 15 was insufficient to permit a quantitative appraisal. Of the 41 reviewed, 29 were against the shroud in Cycle 1; and 15 of the 29 were observed to have fret marks of some of the fuel rods. The fret marks were observed between grids 6 and 10. (Grids are numbered 0 through 11 starting with the bottom grid). Fret marks were also observed, but to a lesser degree, on assemblies adjacent to the peripheral assemblies in Cycle 1. The visual examinations also revealed some local variability of rod length due to growth and other anomalies. The assemblies involved and the features noted are presented in Table V.

4.0 SHOULDER GAP MEASUREMENTS

4.1 Shoulder gap is the distance between the top of the fuel rods and the bottom of the upper end fitting. When the fuel rods grow faster with irradiation exposure than the assembly guide tubes, the shoulder gap decreases until eventually the rod contacts the flow plate. Further rod growth would probably be accommodated by fuel rod bowing until rod-to-rod contact was made which would increase the chance of clad burnout. Measurements at the end of Cycle 2 indicated that gap closure might occur on some Batch "C" assemblies during Cycle 3. A shimming procedure to increase the available shoulder gap was devised and applied to thirty "C" assemblies. References 2 and 3 present further details of the effort.

4.2 A safety concern over adequate gap clearance for Cycle 4 operations was raised by the NRC (Reference 4) and, in response, an inspection plan for the Cycle 4 outage was prepared and transmitted (Reference 5). Since Batch "D" fuel would be the only fuel batch in the Cycle 4 core to be receiving its third exposure, ensuring the gap adequacy of the 60 "D" assemblies became the principal objective. To establish a gap change versus exposure model, plans were formulated to measure selected Batch "C" and Batch "D" assemblies. Some Batch "E" measurements would also be made to provide data for Cycle 5 evaluation.

4.3 The actual measurements taken on sixteen Batch D fuel assemblies using the C-E Comprehensive Fuel Inspection Stand (CFIS) were reported in Reference 6. Even including the worst case, Niobia-doped fuel rods in AKD039, only about 50% of the shoulder gap has been lost in any of the sixteen assemblies while receiving cumulative exposures that ranged from 18,500 to 24,200 MWD/MTU. Since the highest exposure of a Batch D assembly during Cycle 4 is expected to be on the order of 13,650 MWD/MTU, it can be concluded that, using burnup as the correlation variable for a rough approximation, adequate shoulder gap exists for Cycle 4.

4.4 In addition to the sixteen "D" assemblies, eight Batch "C" and seven Batch "E" assemblies were measured for shoulder gap. An evaluation of the results was presented in Reference 7. Using fast neutron fluence (≧0.821 MeV) as the correlation parameter it was found that:

1) Batch C rods with high gap closure rates in their initial exposure cycles continued to have high closure rates in Cycle 3. However, those rods which had low or moderate closure rates in their initial cycles continued to exhibit similar rates in their third cycle.

2) The maximum closure rates used to determine if C assemblies required modification for Cycle 3 were indeed conservative, and all eight of the measured "C" assemblies had adequate shoulder gap remaining.

3) The maximum gap closure rates in the Batch D assemblies, through their first two cycles, were lower than those of the Batch C fuel through their first two cycles.

4) Using the criterion that, at the 95% probability level, the worst rod in the fuel assembly will not have shoulder gap closure at the end of Cycle 4, none of the Batch D assemblies required modification. However, since an additional exposure in Cycle 5 of DOE high burnup program test assembly AKD040 is planned, it was decided to shim the assembly to increase its shoulder gap by 0.4 in., and to remove six test fuel rods which contained Niobia-doped fuel pellets. The test rods had been exhibiting higher gap closure rates than either Batch C or D fuel rods. The test rods were replaced with stainless steel-filled Zircaloy rods.

4.5 After reviewing the shoulder gap situation and the information obtained at EOC-3, primarily references 6 and 7, the NRC concluded that sufficient justification had been provided for the adequacy of ANO-2 fuel assembly shoulder gaps for Cycle 4 operation (Reference 8).

4.6 Gap measurements on seven Batch E assemblies were taken to be able to eventually evaluate closure rates of Cycle 4. The Batch E assemblies were fabricated with 0.15 in. more gap than the Batch C and 0.15 in. less than Batch D. However, the guide tube heat treatment for Batch E was changed from recrystalization annealed (RXA) to stress relief annealed and partially cold worked (SRA). The Batch E guide tubes are expected to grow more with radiation exposure and cause the shoulder gap to close at a slower rate. Batch F assemblies have a 0.85 in. bigger gap than the "C" assemblies and also cold worked (SRA) guide tubes.

5.0 REVIEW OF 16x16 FUEL ASSEMBLY BEHAVIOR

5.1 The visual inspections of the Batch C assemblies already covered in this report did detect some grid wear that was attributed to core shroud interaction during the first cycle. However, the wear did not appear serious; and it was observed on discharge, after the "C" assemblies had successfully completed three cycles of operation. The failed fuel rods found in the two leaking "C" assemblies at the end of cycle one did not appear related to grid to shroud wear (Reference 9). The two "C" assemblies found leaking at the end of Cycle 2 were not located against the shroud in Cycle 2 and, in one case, AKC212, the failed rod was in an interior location. In the other case, AKC401, the rod was severed between grids (Reference 3). In summary, although grid-to-shroud wear has been observed, it has not been serious enough to adversely affect the performance of the worn grids.

5.2 Significant spacer grid perimeter strip damage on three assemblies and minor damage on two assemblies was found during the visual examinations of the Batch A assemblies at the end of Cycle 1 (References 9 and 10). Increased awareness of personnel as to the possibility of grid damage during handling was ensured prior to the end of Cycle 2. The visual examinations of the "B" assemblies at the end of Cycle 2 found five more assemblies with damaged grids. The damage in two cases was minor, however, and in all cases the damage appeared to have occurred during handling at the end of cycle 1 (Reference 3).

5.3 As discussed earlier, examination of the "C" assemblies at the end of Cycle 3 detected minor grid damage on eight assemblies. In another, unrelated inspection, grid damage on a "B" assembly was detected that had not been observed at the end of Cycle 2. In three of the eight Batch C cases, the damage appeared fresh.

5.4 Of the remaining five cases, it appears likely that three: AKC 208, AKC214, and AKC504, occurred during the Cycle 1 off-load. They have been added to the Cycle 1 core map from Reference 3 to reflect all the assemblies with grid damage attributed to Cycle 1 handling. The result is presented in Figure 3. The operations in which the damage occurred to the weld of AKC413 or to the tab of AKC303 remain unknown.

5.5 In the three cases of fresh grid damage found during this outage, one might be attributed to a hang up on off-loading that did not activate the overload trip soon enough. In the other two cases, the way in which the damage occurred is unknown. The refueling machine has been reworked to improve its trip response time since the Cycle 2 off-load and it should be noted that, of the 11 "C" assemblies listed in Table I which caused overload trips, fresh damage was probably avoided in ten cases. A thicker and stronger grid was introduced with the Batch E fuel. It is expected that this grid will be more resistant to hang up damage. However, it is obvious that continued care in handling is appropriate.

5.6 The possibility of shoulder gap closure on Batch C assemblies during their third exposure, in Cycle 3, was countered by: 1) modeling and statistical analysis to detect the assemblies at risk and 2) increasing their available shoulder gaps with shims. The examination results from this outage indicate that the analysis approach was appropriate and conservative, and that the shimming modification did not cause any assembly structural problems to occur during the cycle exposure. A similar approach was applied to the Batch D assemblies for Cycle 4 and it was found that the shoulder gap was adequate without shimming. At the end of Cycle 4 it will be necessary to evaluate the Batch E assemblies and assembly AKD040 for shoulder gap adequacy. However, the larger gap of Batch F assemblies and later batches, coupled with the change to cold worked guide tubes, should eventually resolve the problem.

REFERENCES

1. Robert A. Clark to William Cavanaugh, Docket No. 50-368, Letter No. 2CNAØ681Ø3, dated June 19, 1981: (Transmitting Amendment No. 24 to OL No. NPF-6 including SER and Notice of Issuance).

2. J. R. Marshall to Robert A. Clark, Docket No. 50-368, Letter No. 2CAN1282Ø7, dated December 10, 1982.

3. J. R. Marshall to Robert A. Clark, Docket No. 50-368, Letter No. 2CANØ383Ø, dated March 30, 1983.

4. Robert A. Clark to John Griffin, Docket No. 50-368, Letter No. 2CNA068301, dated June 8, 1983.

5. J. R. Marshall to Robert A. Clark, Docket No. 50-368, Letter No. 2CANØ883Ø8, dated August 19, 1983.

6. J. R. Marshall to J. E. Gagliardo, Docket No. 50-368, Letter No. 2CAN11831Ø, dated December 2, 1983. (Transmittal of report CEN-260(A)-P).

7. J. R. Marshall to J. E. Gagliardo, Docket No. 50-368, Letter No. 2CAN1283Ø6, dated December 16, 1983. (Transmittal of report CEN-261(A).

8 James R. Miller to John Griffin, Docket No. 50-368, Letter No. 2CNA028401, dated February 24, 1984. (With attached SER on adequacy of Arkansas Unit No. 2 Fuel Assembly Shoulder Gaps for Cycle 4 operation).

9. J. R. Marshall to Robert A. Clark, Docket No. 50-368, Letter No. 2CANØ582Ø9, dated June 2, 1982.

10. D.C. Trimble to Robert A. Clark, Docket No. 50-368, Letter No. 2CANØ681Ø4, dated June 4, 1981.

TABLE I

Overload Trips During Cycle 3 Fuel Off-Loading

ASSEMBLY BEING RAISED[1]	CORE LOCATION	OVERLOAD READING[2] (lbs.)	HEIGHT RAISED (in.)	ADJACENT ASSEMBLIES
E023	A6	1700	105	E012, C407
C414	B10	1787	29	D012, D017
C303	B8	1761	25	D030, D108
D030	B7	1764	90	C407, D039
D034	C4	1715	30	D115, C408
D039	C6	1782	29	A021, C306
D017	C10	1750	90	A026, C416
C416	C11	1745	45	D032, D027
E017	E2	1756	90	C409, C413
C413	E3	1787	29	D016, D026
D026	E4	1786	29	A041, C101
C101	E5	1791	29	D119, D120
C210	E7	1744	29	C206, D021
D021	E8	1732	29	D114, C203
C308	G3	1779	29	D103, E110
E110	G4	1783	29	C102, C212
C212	G5	1795	29	D015, C214
E107	G9	1611	25	C503, C208
A105	H8	1761	45	C504, C502
D005	J2	1782	105	C411, C307
C307	J3	1760	8	D033, E111
E104	J7	1774	68	C201, C502
E007	K15	1777	90	C406
C108	L5	1752	16	D010, D107
D107	L6	1766	105	A043, C205
D007	L8	1761	119	C104,,C216
D117	L10	1777	127	A051, C106
C402	N11	1748	104	E019, D036

[1]All assembly designations are preceded by AK, i.e. AKE023

[2]Fuel assembly (approx. 1300 lbs.) + PLCEA (90 lbs.) if present, + Grapple (180 lbs.) ≅1570 lbs. in water.

TABLE II

Summary of EOC-3 Visual Fuel Examination

ASSEMBLY	DATE EXAMINED	TAPE NO.	SHIMMED	GRID DAMAGE	GRID WEAR
AKC101	12-3-83	83-4	X	X	
AKC102	11-13-83	83-3			
AKC103	12-3-83	83-4			
AKC104	12-3-83	83-4	X	X	
AKC105	11-13-83	83-3	X		
AKC106	12-4-83	83-4	X		
AKC107	12-4-83	83-5	X		
AKC108	12-4-83	83-5	X		
AKC201	12-4-83	83-5	X		
AKC202	12-4-83	83-5	X		X
AKC203	12-4-83	83-5	X		
AKC204	11-13-83	83-3	X		
AKC205	12-4-83	83-6			
AKC206	12-4-83	83-5	X		X
AKC207	12-4-83	83-6	X		
AKC208	12-4-83	83-6	X	X	
AKC209	11-12-83	83-3			
AKC210	12-4-83	83-6	X		X
AKC211	11-13-83	83-3	X		
AKC212	11-12-83	83-3	X		
AKC213	12-4-83	83-6			
AKC214	12-4-83	83-6		X	
AKC215	11-13-83	83-3			
AKC216	11-13-83	83-3			
AKC301	11-13-83	83-3			
AKC302	12-4-83	83-6	X		X
AKC303	11-12-83	83-3		X	
AKC304	12-4-83	83-7			X
AKC305	12-4-83	83-7			
AKC306	12-4-83	83-7			
AKC307	12-4-83	83-7		X	
AKC308	11-13-83	83-3			
AKC309	12-5-83	83-7	X		X
AKC310	12-5-83	83-7	X		
AKC311	12-5-83	83-7	X		
AKC312	11-12-83	83-3	X		
AKC401	12-5-83	83-7	X		
AKC402	12-5-83	83-7			
AKC403	12-5-83	83-8	X		X
AKC404	12-5-83	83-8			X
AKC405	12-5-83	83-8			X
AKC406	12-6-83	83-8	X		X
AKC407	12-6-83	83-8			

TABLE II (Continued)

ASSEMBLY	DATE EXAMINED	TAPE NO.	SHIMMED	GRID DAMAGE	GRID WEAR
AKC408	12-6-83	83-8			X
AKC409	11-13-83	83-3			
AKC410	11-13-83	83-3	X		
AKC411	12-6-83	83-8	X		X
AKC412	12-6-83	83-8	X		
AKC413	12-6-83	83-8		X	
AKC414	12-6-83	83-8			
AKC415	12-6-83	83-8	X		
AKC416	12-6-83	83-9	X		
AKC501	12-6-83	83-9			X
AKC502	12-6-83	83-9			X
AKC503	11-13-83	83-3			
AKC504	12-6-83	83-9	X	X	X
AKD037	11-12-83	83-3			
AKE002	11-12-83	83-3			
AKE021	11-12-83	83-3			
AKE032	11-12-83	83-3			
AKB021	N/A	N/A		X	

TABLE III

SUMMARY OF GRID WEAR OBSERVED @ EOC-3

Assembly	Face (1)	Grid (2)	Comments (3)
AKC202	N	5, 6, & 7	Damage probably sustained in Cycle 1 when face was adjacent to core shroud.
AKC206	N	6	Face never adjacent to shroud probably crud deposits.
AKC210	E	6	Damage probably sustained in Cycle 1 when face was adjacent to core shroud.
AKC302	N	7 & 8	Damage probably sustained in Cycle 1 when face was adjacent to core shroud.
ACK304	N	5,6,7,8, & 9	Damage probably sustained in Cycle 1 when face was adjacent to core shroud.
AKC304	W	8	Face never adjacent to shroud probably crud deposits.
AKC309	N	7 & 8	Damage probably sustained in Cycle 1 when face was adjacent to core shroud.
AKC403	W	8	Damage probably sustained in Cycle 1 when face was adjacent to core shroud.
AKC404	N	7,8, & 9	Damage probably sustained in Cycle 1 when face was adjacent to core shroud.
AKC404	S	6 & 7	Face never adjacent to shroud probably crud deposits.
AKC405	W	7,8, & 9	Damage probably sustained in Cycle 1 when face was adjacent to core shroud.
AKC406	N	5,6 & 7	Damage probably sustained in Cycle 1 when face was adjacent to shroud.

TABLE III (Continued)

SUMMARY OF GRID WEAR OBSERVED @ EOC-3

Assembly	Face (1)	Grid (2)	Comments (3)
AKC408	N	8	Damage probably sustained in Cycle 1 when face was adjacent to core shroud.
AKC411	W	5	Periscope inspection revealed significant wear on NW corner of grid perimeter strip. Wear extends from rods 1 to 4. An axially oriented separation (approximately .03 to .05 inches wide by approx. 90% of perimeter strip width) exists at the edge of the perimeter strip corner weld. The edge of the perimeter strip, as seen from assembly North, appeared to be worn to a knife edge. The wear region appeared oxidized indicating damage probably occurred in Cycle 1 when face was adjacent to core shroud.
AKC501	W	6,7, & 8	Damage probably occurred in Cycle 1 when face was adjacent to core shroud.
AKC501	N	9	Damage probably occurred in Cycle 1 when face was adjacent to core shroud.
AKC502	W	7,8,9 & 10	Damage probably occurred in Cycle 1 when face was adjacent to core shroud.
AKC504	W	7 & 8	Damage probably occurred in Cycle 1 when face was adjacent to core shroud.
AKC504	E	4	Face never adjacent to shroud probably crud deposits.

(1) Assembly serial numbers located on NE corner.
(2) Grids numbered 0-11 from bottom to top.
(3) Fuel rods numbered from left to right as one views the face.

TABLE IV

SUMMARY OF ANO-2 GRID DAMAGE OBSERVED @ EOC-3

Assembly	Face(1)	Grid(2)	Insp(3)	Comments (4)
AKC303	S	2	P/V	Top wiper tab 14 torn away. Old damage previously observed @ EOC-2.
AKC504	E	11	P/V	Top wiper tab 1 torn away. Damaged region appears oxidized adjacent to damaged grid of assembly AKC208 in Cycle 1 indicating damage sustained during Cycle 1 fuel handling.
AKC413	S/E	5	P/V	Cracked corner weld with small piece of weld material missing from bottom of weld region. No deformation of grid discernible.
AKB021	W	0	P	Wiper tabs bent inward. From visual exam it could not be determined when the damage was sustained. This assembly was examined at EOC-2 by T.V. but no damage was noted at that time.
AKC208	E	6	V	Piece of wiper tab 15 missing on bottom of grid. Damage noted during video tape review at Windsor. No periscope inspection was accomplished. Assembly was located adjacent to damaged grid of assembly AKC504 in Cycle 1 indicating damage probably sustained during Cycle 1 fuel handling.

(1) Assembly serial numbers located in NE corner.
(2) Grids numbered 0-11 from bottom to top.
(3) P-Periscope inspection V-video inspection.
(4) Wiper tabs numbered from left to right as one views the face.

TABLE IV (CONTINUED)

SUMMARY OF ANO-2 GRID DAMAGE OBSERVED @ EOC-3

Assembly	Face(1)	Grid(2)	Insp(3)	Comments (4)
AKC101	W	7	P/V	Wiper tab 1 missing on bottom of grid. Wiper tabs 7,8, & 9 on bottom of grid bent inward. Fracture surface of torn region appears shiny and unoxidized indicating damage sustained at EOC-3.
AKC101	N	7	P/V	Hole in perimeter strip weld between rods 1 & 2. Hole at bottom portion of weld bead.
AKC104	N	7	P/V	Bottom wiper tabs 1 & 2 and 50% of the perimeter strip width at rods 1-3 torn away. Fracture surface appears unoxidized indicating damage sustained at EOC-3.
AKC307	S	0	P/V	Top wiper tab 14 torn away and tab 15 bent inward and cracked. Damage area appears shiny indicating damage sustained at EOC-3.
AKC214	S	1	P/V	Bottom wiper tab is torn away. Damage area appears oxidized indicating damage sustained prior to EOC-3.

(1) Assembly serial numbers located in NE corner.
(2) Grids numbered 0-11 from bottom to top.
(3) P-Periscope inspection V-video inspection.
(4) Wiper tabs numbered from left to right as one views the face.

TABLE V

SUMMARY OF ROD HEIGHT VARIABILITY AND ANOMALIES OBSERVED @ EOC-3

Assembly	Face	Observation
AKC213	W	Rods in rows 10 through 16 around the guide tube are taller than the surrounding rods.
AKC214	N	No. 11 rod in second row taller than adjacent rods.
AKC204	S	The SE corner rods are taller than the SW corner.
AKC309	N	Rod 10 has a fret mark with depth about 1/2 inch above grid 7.
AKC402	W	Rods 12 & 14 have wear marks about 1/2 inch above grid 7.
AKC405	S	The SE corner rods are taller than the SW corner.
AKC405	E	The SE corner rods are taller than the NE corner.
AKC403	N	The center guide tube has a black area possibly a crack just under the flow plate shimmed section.
AKC408	E	Some rods about 1/2 inch above grid 8 have fret marks or scratches.
AKC502	S	Rod 1 (a poison rod) has a through-wall fret mark about 1/2 inch above each of grids 6 and 7 and, in addition, a longitudinal through-wall opening about 2-1/4 inches long beginning 4 inches below grid 7.
AKC501	E	Rod 14 (a poison rod) has a heavy fret mark at grid 4 (less than half of wall thickness).
AKC501	S	Rod 1 (a poison rod) has heavy fret marks at grids 5 and 6 (less than half of the wall thickness).

Rods are numbered 1-16, left to right across the assembly face.

TABLE VI

FUEL BATCH MANAGEMENT & BURNUPS

FUEL BATCH (%Enrich/#Shims)	CYCLE 1 No. Exposed-Burnup(MWD/MTU)	CYCLE 2 No. Exposed-Burnup(MWD/MTU)	CYCLE 3 No. Exposed-Burnup(MWD/MTU)	CYCLE 4 No. Being Exposed
A-(1.93/0)	43 - 13,596			
	1 - 13,208	1 - 8000.	1 - 6827	
	8 - 12,182	...	8 - 8327	
	9 - 12,905	...	...	9
	All 61 - 13,302			
B-(2.25/12[1])	60 - 14,112	60 - 10,511		
C1XX-(2.94/12[2])	8 - 13,381	8 - 11,376	8 - 8,424	
C2XX-(2.94/12[3])	16 - 11,431	16 - 12,218	16 - 8,518	
C3XX-(2.94/2[1])	12 - 9,482	12 - 11,457	12 - 8,450	
C4XX-(2.94/3[1])	16 - 7,063	16 - 12,318	16 - 8,193	
C5XX-(2.94/12[4])	4 - 7,372	4 - 12,672	4 - 8,906	
	All 56 - 9754	12,008	8,498	
D0XX-(3.48&3.03[5]/0)	...	40 - 9,661	40 - 10,075	40
D1XX-(3.03&2.73[6]/0)	...	20 - 14,412	20 - 9,246	20
		All 60 - 12,037	All 60 - 9,661	
E0XX-(3.48&2.78[7]/0)	...	...	40 - 7,396	40
E1XX-(2.78&2.28[8]/0)	...	...	12 - 10,960	12
			All 52 - 9,178	
F0XX-(4.05&3.30[9]/0)				40
F1XX-(3.30&2.78[10]/0)				16
Cycle Burnup:	12,451	11,219	8,819	13,000 Planned
Start:	Commercial:3/25/80	I.Crit:6/29/81	I.Crit:11/10/82	I.Crit:1/25/84
End:	EOC1: 3/28/81	EOC2: 8/20/82	EOC3: 9/26/83	

TABLE VI (Continued)

FOOTNOTES

1. Poison rod loading: 0.0087g B-10/cm

2. Poison rod loading: 0.0028g B-10/cm

3. Poison rod loading: 0.0047g B-10/cm

4. 9 poison rods with 0.0047g B-10/cm and
3 poison rods with 0.0087g B-10/cm

5. 184 rods with 3.48 and 52 rods with 3.03 for an average enrichment of 3.38%

6. 184 rods with 3.03 and 52 rods with 2.73 for an average enrichment of 2.96%

7. 184 rods with 3.48 and 52 rods with 2.78 for an average enrichment of 3.33%

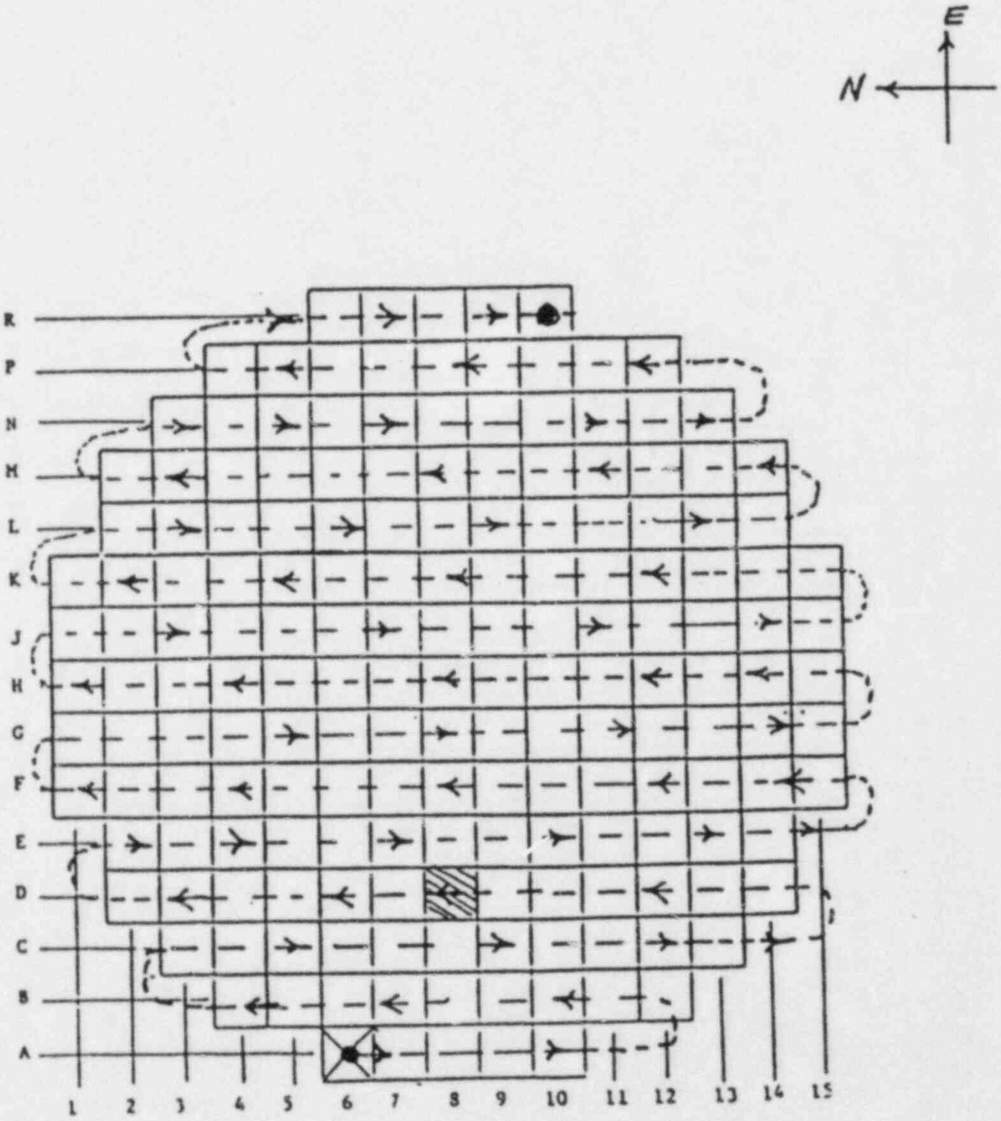
8. 224 rods with 2.78 and 12 rods with 2.28 for an average enrichment of 2.75%

9. 184 rods with 4.05 and 52 rods with 3.30 for an average enrichment of 3.88%

10. 224 rods with 3.30 and 12 rods with 2.78 for an average enrichment of 3.27%

FIGURE 1

OFF-LOAD AT EOC3



AKC105 at D-8 first assembly removed to verify weight readings. Then to A-6.

FIGURE 2

Cycle 3

FINAL REACTOR CORE LOADING PLAN

	A	B	C	D	E	F	G	H	J	K	L	M	N	P	R
1						E038	E039 67	E032	E014 68	E024					
2				E027	E017	C409 57	D031	C311 52	D005	C411 58	E037	E036			
3			E020 66	D028	C413 45	D016	C308 33	D103	C307 34	D033	C412 46	D037	E029 69		
4		E002	D034	D115 39	D026	A041 25	E110	C102 C	E111	A102 26	D011	D104 40	D006	E018	
5		E006	C408 44	D019	C101 F	D119	C212 17	D015	C209 18	D110	C108 G	D010	C410 47	E040	
6	E023	C407 56	D039	A021 24	D120	D024 11	C214	D102 8	C213	D035 12	D107	A043 27	D029	C404 59	E008
7	E012 65	D030	C306 32	E103	C210 16	C206	E112 3	C504	E104 4	C201	C205 19	E109	C310 35	D004	E016 70
8	E034 501	C303 51	D108	C105 8	D021	D114 7	C501	A105 1	C502	D101 9	D007	C104 D	D113	C305 53	E033 502
9	E010 64	D012	C312 31	E108	C203 15	C215	E107 2	C503	E102 5	C204	C216 20	E105	C304 36	D001	E011 71
10	E005	C414 55	D017	A026 23	D118	D003 10	C208	D116 6	C207	D023 13	D117	A051 28	D040	C401 60	E030
11		E013	C416 43	D032	C107 E	D105	C211 14	D008	C202 21	D106	C106 H	D025	C402 48	E019	
12		E028	D027	D111 38	D022	A029 22	E106	C103 A	E101	A045 29	D009	D112 41	D036	E004	
13			E026 63	D014	C415 42	D018	C302 30	D109	C301 37	D038	C403 49	D002	E025 72		
14				E035	E003	C405 54	D013	C309 50	D020	C406 61	E001	E022			
15						E021	E015 62	E031	E009 73	E007					

North ↑

FIGURE 3

ANO-2 CORE LOADING PLAN

CYCLE 1

FUEL TRANSFER CANAL →

	A	B	C	D	E	F	G	H	J	K	L	M	N	P	R
1						C409	C308 67	C311	C307 68	C411					
2				C413	C202	C106 57	B006	A044 52	B003	C103 56	C211	C412			
3			C503 66	C213	A041 45	B031	A050 33	B001	A101 34	B053	A102 46	C214	C501 69		
4		C408	C215	A006 39	B017	A048 25	B030	A103 C	B032	A030 26	BT06	A049 40	C204	C410	
5		C216	A021 44	B041	A047 F	B009	A015 17	BT03	A109 18	B021	A004 G	B029	A043 47	C203	
6	C407	C104 56	B043	A104 24	B011	A024 11	B023	A107 6	B049	A003 12	B035	A110 27	B002	C107 59	C404
7	C306 65	B042	A007 32	B033	A010 16	BT01	A019 3	B050	A042 4	B010	A046 19	B037	A023 35	B013	C310 70
8	C303 S01	A014 51	B007	A001 B	B020	A009 7	B026	A005 1	B027	A037 9	B048	A038 D	B045	A011 53	C305 S02
9	C312 64	BT04	A040 31	B034	A028 15	B038	A039 2	B008	A034 5	B025	A008 20	B015	A031 36	B005	C304 71
10	C414	C108 55	B039	A022 23	B051	A106 10	B028	A033 6	B024	A016 13	B036	A020 28	B012	C105 60	C401
11		C205	A026 43	B054	A018 E	B052	A012 14	B022	A036 21	B019	A017 H	BT02	A051 48	C210	
12		C416	C206	A002 36	B016	A013 22	BT05	A035 A	B014	A106 29	B018	A027 41	C201	C402	
13			C502 63	C207	A029 42	B046	A032 30	B040	A105 37	B044	A045 43	C208	C504		
14				C415	C209	C102 54	B004	A025 50	B047	C101 61	C212	C403			
15						C405	C302 62	C309	C301 73	C406					

Grid Damage Shown Is Attributed To Cycle 1 Handling

Grid Damage Found EOC3

Leaking Assembly EOC1

Grid Damage Found EOC1

Grid Damage Found EOC2

→ Side of Grid Damage

↑ NORTH