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Dresden Nuclear Power Station
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Morris, Illinois 60450
June 20, 1975

Mr. James G. Keppler, Regional Director
Directorate of Regulatory Operations-Region III
U. S. Nuclear Regulatory Commission
799 Roosevelt Road
Glen Ellyn, Illinois 60137

SUBJECT: FOLLOW-UP REPORT TO ABNORMAL OCCURRENCE ENTITLED "CORRELATION OF FUEL
FAILURES AT DRESDEN-3 IDENTIFIED BY WET SIPPING TESTS TO CALCULATED
VIOLATIONS OF GE POLICIES"

Reference: NRC Exit Interview of May 20, 1975

Please find attached the above-mentioned report, provided per NRC request of
May 20, 1975.

B. B. Stephenson
Superintendent

BBS:smp

File/NRC

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TITLE

Fuel Failures Identified at D3-ECC3 by Wet Sipping Tests and Comments Regarding the PCICMR.

SUMMARY

724 assemblies were wet sipped out of core and total of 113 defective assemblies were identified. General Electric agreed they were defective as indicated by the fuel contract and were discharged. Twenty-seven high exposure assemblies were also discharged and a total of 140 new assemblies were inserted in the core for cycle 4. All the defective assemblies were 7X7 fuel enriched to 2.13 w/o U-235. The average fuel failure rate was 15.6%. The core was sipped at an average rate of 40 assemblies per day. Table 1 is a listing of the identified failures, their core locations and exposures.

DISCUSSION

Figure 1 is a core map indicating the location of the leakers. Figures 2 to 4 graph three power distributions (equilibrium xenon) typical of the preconditioned shape (2227-Figure 4 (a)) and the shape at 6:57 a.m. on 10-31-74 (1432-Figure 4 (b)). Xenon transients, depending on core location, will increase the bottom peaks by 0 to 25%.

Failures that don't appear to be related to 10-31-74 are reviewed as follows:

- (a) None of the Cycle 2 edge assemblies, including those moved to the center for Cycle 3, failed - Figure 6.
- (b) There were three assemblies from cells that had 3 out of 4 failures at ECC-1 that were moved to uncontrolled locations on the edge for Cycles 2 and 3. None of these three has failed yet.
- (c) Four edge assemblies failed during Cycle 3. One, DDO209, was classified as a suspect leaker at ECC-2.
- (d) Of 50 Cycle 3 assemblies that were reconstituted at ECC-1, six failed. All but one may be attributed to 10-31-74.

No GEB (7X7) or DDB (8X8) assemblies were classified as leakers. The average exposure of the GEB's was about 4000 MWD/T, and of the DDB's about 2000 MWD/T. Initially, one GEB (058) and two DDB's (008 and 011) sipped as leakers. The three were resipped twice and found to be sound. To resolve any questions concerning these assemblies, five other assemblies, initially sipped at approximately the same time and classified as leakers, were resipped. Again all five

were found to be defective. Of the 52 GEB's in the core, 29 exceeded the PCIOMR. Seven of these did so by more than 2 kW/ft, and were among the most severe variations. The differences from the original core 7X7's introduced in the GEB's include: different fill gas, lower exposure, thicker cladding, smaller pellet diameter, and shorter pellets with chamfered edges.

Figure 1 indicates that about 80% of the assemblies on the periphery (one assembly removed) of cells that experienced major rod movements (D7, C6, C8 and symmetric locations) failed. Figure 7 shows the local power distribution at about 15,000 MWD/T for a controlled and an uncontrolled D3 2.13 w/o assembly. A 2.13 w/o Gd assembly is included to compare the local factors of pins A7 and G1, which are about 25% higher for the D3 assemblies.

An analysis was done with a FLARE-type code to determine the kW/ft of nodes that exceeded 8 kW/ft on a pin. The study was done at equilibrium xenon for 12-inch nodes (a correction factor was applied to account for transient xenon). The results are summarized in Figure 8. Only original core fuel is included, and power changes were assumed to be instantaneous. Some comments on the results follow:

- (a) The failures do not appear to be related to previous cycle operation.
- (b) 22 Failures of 433 assemblies (5%) were at less than 8 kW/ft on 10/31/74. Thus, none of these was assumed to be related to the October 31, rod movements.
- (c) 5 of 74 assemblies (7%) failed when the envelope (or 8 kW/ft, which ever was greater) was violated by 1 kW/ft or less. The failure rate increased rapidly as the step change above the envelope increased.
- (d) The effect on fuel failures of more gradual increases in power, soak periods, exposure, and length of time fuel remains "preconditioned" requires more data than is currently available.

CONCLUSIONS

1. The fuel rod failures related to rod movements on 10/31/74 were probably caused by a pellet-clad interaction mechanism involving highly localized strain leading to cracking of cladding having a low strain-to-fracture capability. Some cracking could also have been promoted by a stress corrosion phenomenon.
2. GE's PCIOMR, based on the assumption that a minimum tensile stress is required to cause such cracking, were in part substantiated: the evidence appears to support the 8 KW/ft threshold and allows some margin above a "preconditioned" shape.
3. Based on past sipping experience and on the observed care with which sipping operations were conducted, the sipping program for D-3 EOC-3 was judged to be very successful, with an estimated effectiveness of at least 90%.

TABLE 1

Defective Fuel Assemblies Identified at
Dresden-3, End-of-Cycle 3

<u>Assembly Number</u>	<u>Core Location</u>	<u>Exposure (MWD/t)</u>
DD 001	09-30	12,686
021	13-28	13,018
025	13-38	13,420
036	13-34	13,008
037	31-48	13,576
053	47-34	12,990
064	51-30	12,814
073	09-34	12,891
079	45-32	13,015
081	53-20	12,882
089	11-30	12,805
090	13-32	13,027
093	47-24	13,439
102	13-30	13,030
107	47-32	13,044
111	09-38	12,580
120	39-20	13,321
121	45-26	13,100
127	09-28	12,906
128	51-34	12,928
129	43-38	13,368
132	09-32	12,790
134	47-20	13,298

<u>Assembly Number</u>	<u>Core Location</u>	<u>Exposure (MWD/t)</u>
142	47-42	13,292
151	01-30	11,531
161	31-12	13,731
162	45-06	11,671
163	11-36	13,061
173	49-32	12,966
175	13-20	13,327
181	49-36	13,101
188	13-42	13,294
191	13-24	13,569
196	47-30	13,044
200	49-30	12,923
204	51-28	12,925
209	47-06	11,342
214	21-20	13,327
229	29-42	12,822
233	47-38	13,437
270	47-28	13,114
286	09-36	10,563
287	09-22	10,622
295	07-24	12,653
296	23-30	12,633
300	17-56	11,936
301	53-36	12,966
319	05-26	11,945

<u>Assembly Number</u>	<u>Core Location</u>	<u>Exposure (MWD/t)</u>
331	51-38	12,536
332	25-38	12,287
343	31-20	12,978
350	43-30	12,317
351	43-26	9,465
364	09-42	12,385
378	11-40	12,741
401	51-42	11,244
406	07-26	12,958
424	27-32	11,941
425	19-06	11,774
431	51-36	10,501
433	09-44	11,332
436	45-36	12,788
440	53-26	12,619
450	07-32	12,678
455	51-26	10,568
457	35-24	12,303
460	43-34	12,679
465	11-16	12,858
474	17-26	9,442
475	39-28	12,550
480	15-50	12,904
483	13-44	10,353
487	35-32	12,149

<u>Assembly Number</u>	<u>Core Location</u>	<u>Exposure (MWD/t)</u>
488	07-36	12,530
491	17-28	12,671
493	53-24	12,678
499	51-22	10,652
511	07-40	12,594
518	53-22	12,663
529	11-18	12,939
531	07-44	11,798
537	27-30	11,944
542	11-22	12,820
544	07-22	12,636
566	47-26	10,088
573	07-38	12,022
587	25-24	12,309
613	07-30	12,863
617	11-44	12,897
618	09-40	10,593
623	53-38	12,667
624	45-26	12,789
633	49-44	12,949
639	13-26	10,075
646	13-36	10,060
652	13-40	10,467
663	49-16	12,865
669	33-30	11,945
688	49-22	12,802

<u>Assembly Number</u>	<u>Core Location</u>	<u>Exposure (MWD/t)</u>
693	13-22	10,502
698	47-22	10,503
699	49-40	12,791
700	15-36	12,764
705	05-34	12,099
706	09-26	10,585
710	09-24	12,519
714	51-40	10,627
716	15-26	12,778
721	17-14	10,356
730	51-20	10,653
745	47-40	10,492
750	53-40	12,648
752	51-24	12,542

Average exposure of 113 defective assemblies - 12,294 MWD/t.

Full Failures Identified at Wesden 3

EOC 3 by Sipping Tests

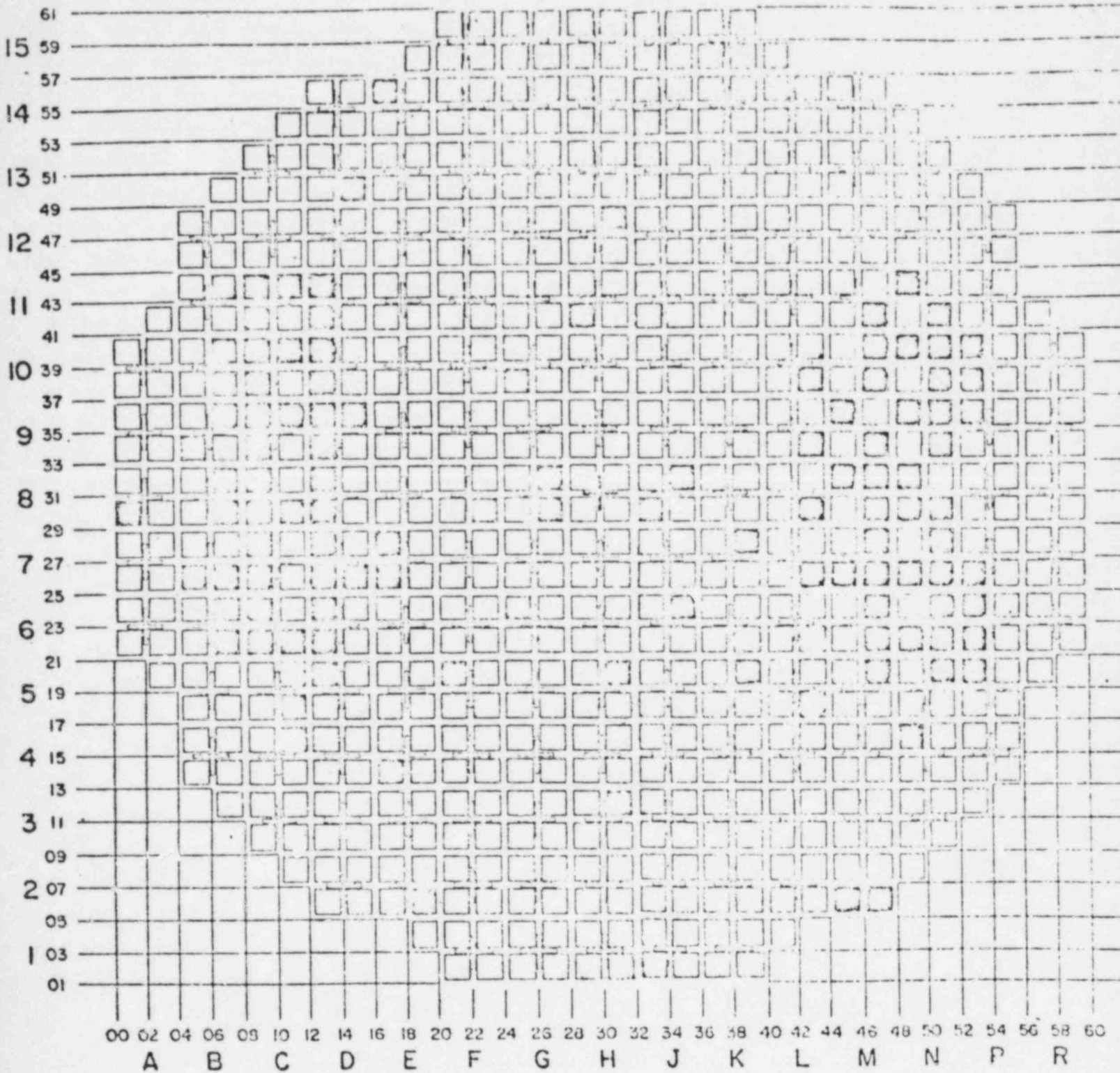


FIGURE 1

FIGURE 2

C10 WITHDRAWN

CORNER PIN

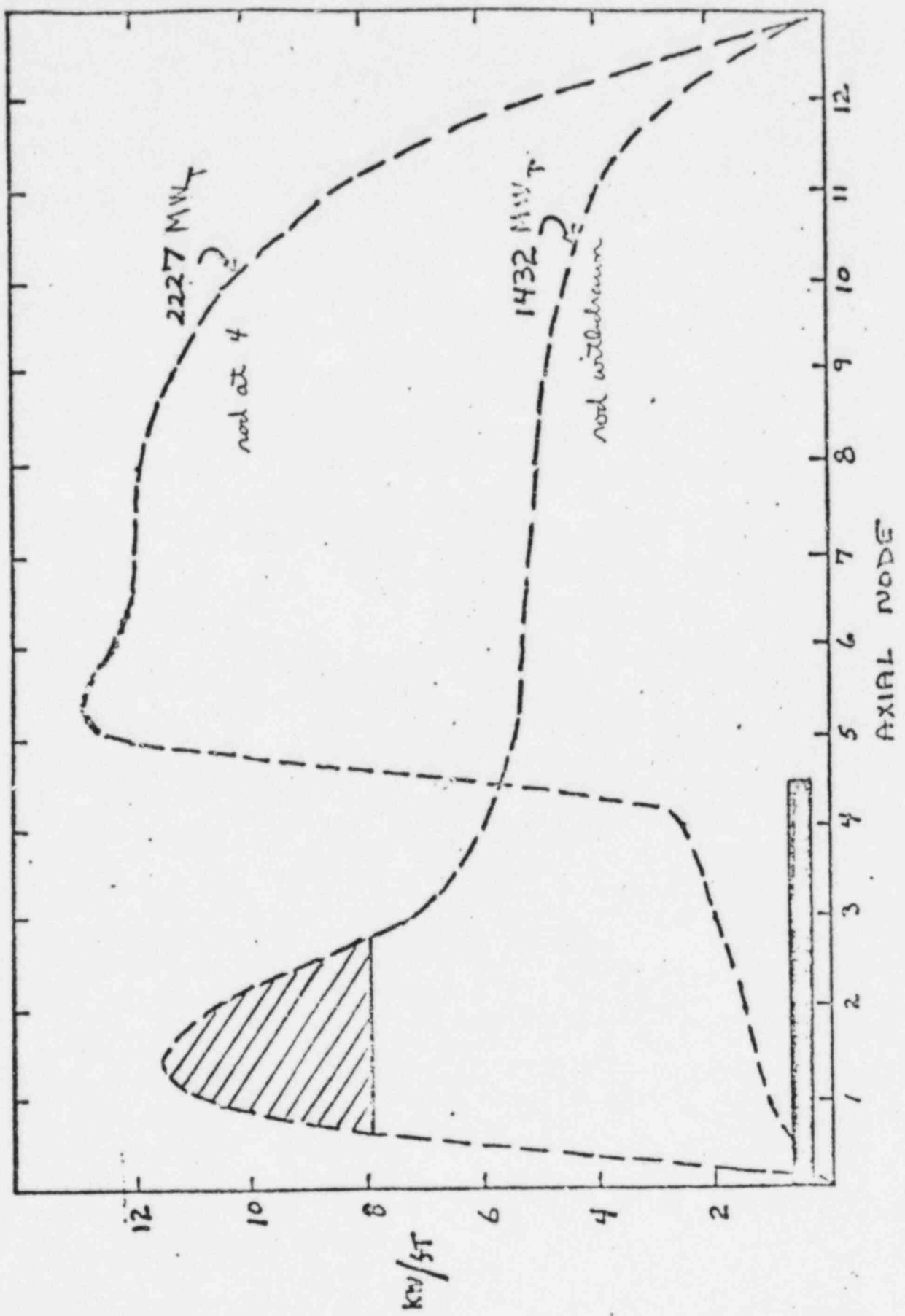


FIGURE 3

CORNER PIN G-8 FROM 12 TO 1.5 INSERTED

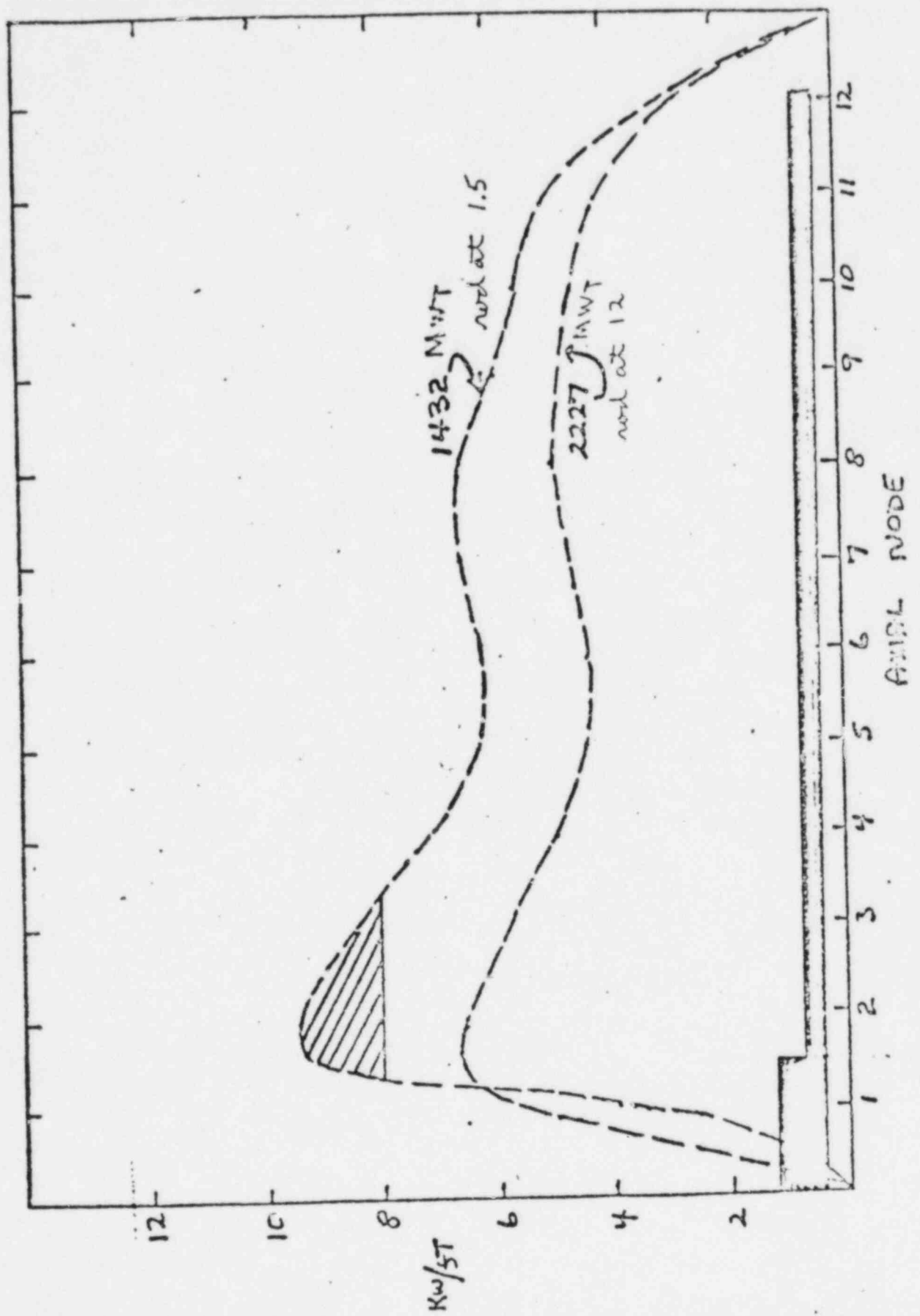
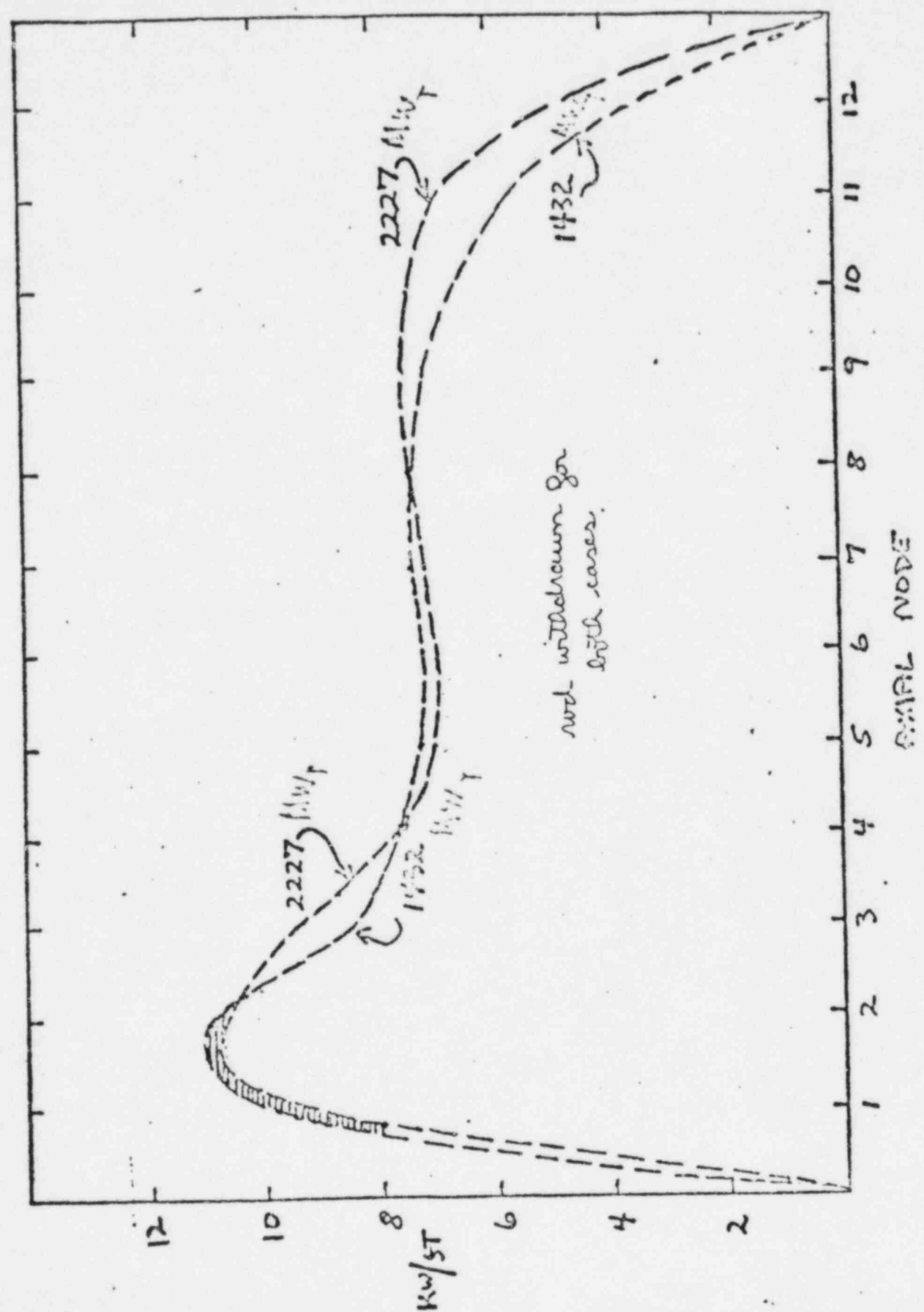


FIGURE 4

CORNER PIN H3 UNCONTROLLED



03

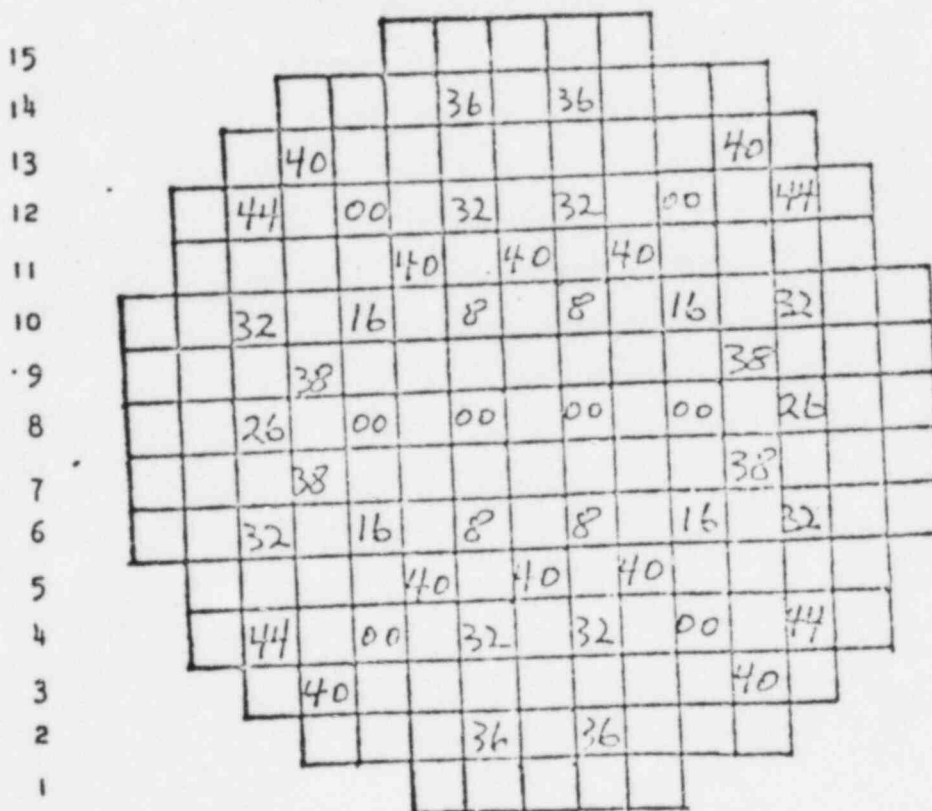
- 13 -

10-31-74

Prior to reducing power.

K EFF		<u>1.00073</u>	
26 S =		<u>2.062</u>	(A+R)
POWER LEVEL		<u>2227</u>	MW _{TH}
CORE INLET SUBCOOLING		<u>21.5</u>	BTU/lb
TOTAL CORE FLOW		<u>86.7</u>	M-lb/hr (in channel)
PRESSURE		<u>1015</u>	PSIA
CRD		<u>B2</u>	0.121
DATE OF LAST SE- QUENCE CHANGE		<u>9-28-74</u>	

-ROD PATTERN:



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

FIGURE 4(a)

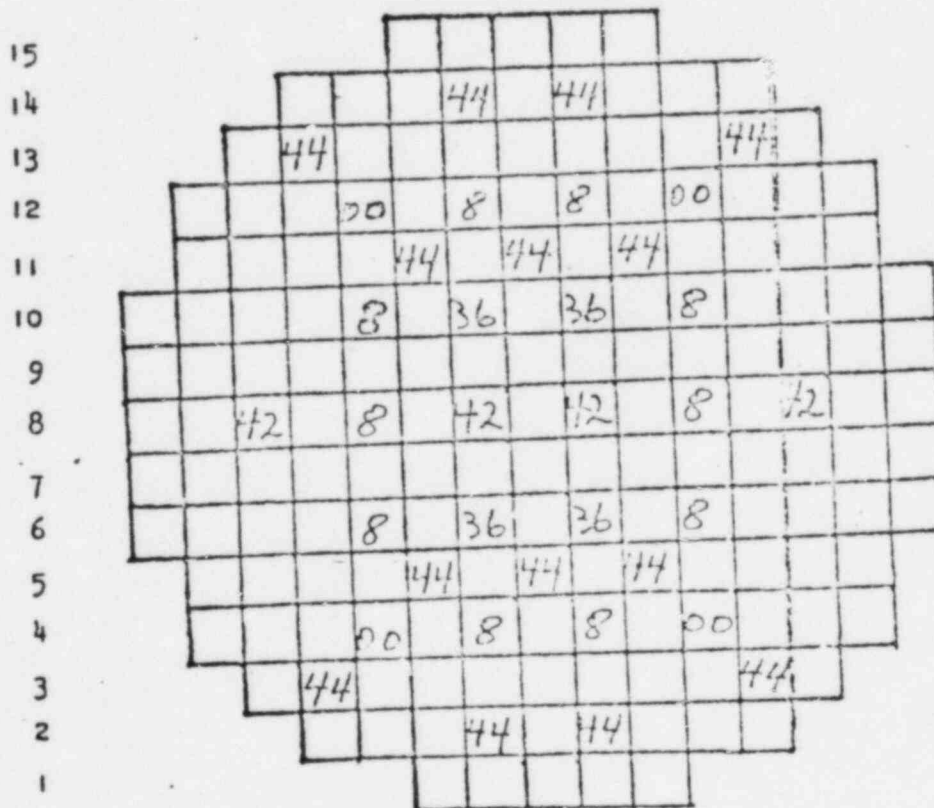
B

10-31-74

6:57 AM conditions

K EFF	<u>1.00967</u>	
SE S =	<u>2.655 (12, 6, 2)</u>	(AX ?)
POWER LEVEL	<u>1432</u>	NW _{TH}
CORE INLET SUBCOOLING	<u>23.5</u>	BTU/lb
TOTAL CORE FLOW	<u>48.0</u>	M-lb/hr (in channel)
PRESSURE	<u>976</u>	PSIA
CRD	<u>0.034</u>	
DATE OF LAST SE- QUENCE CHANGE	<u> </u>	

-ROD PATTERN:



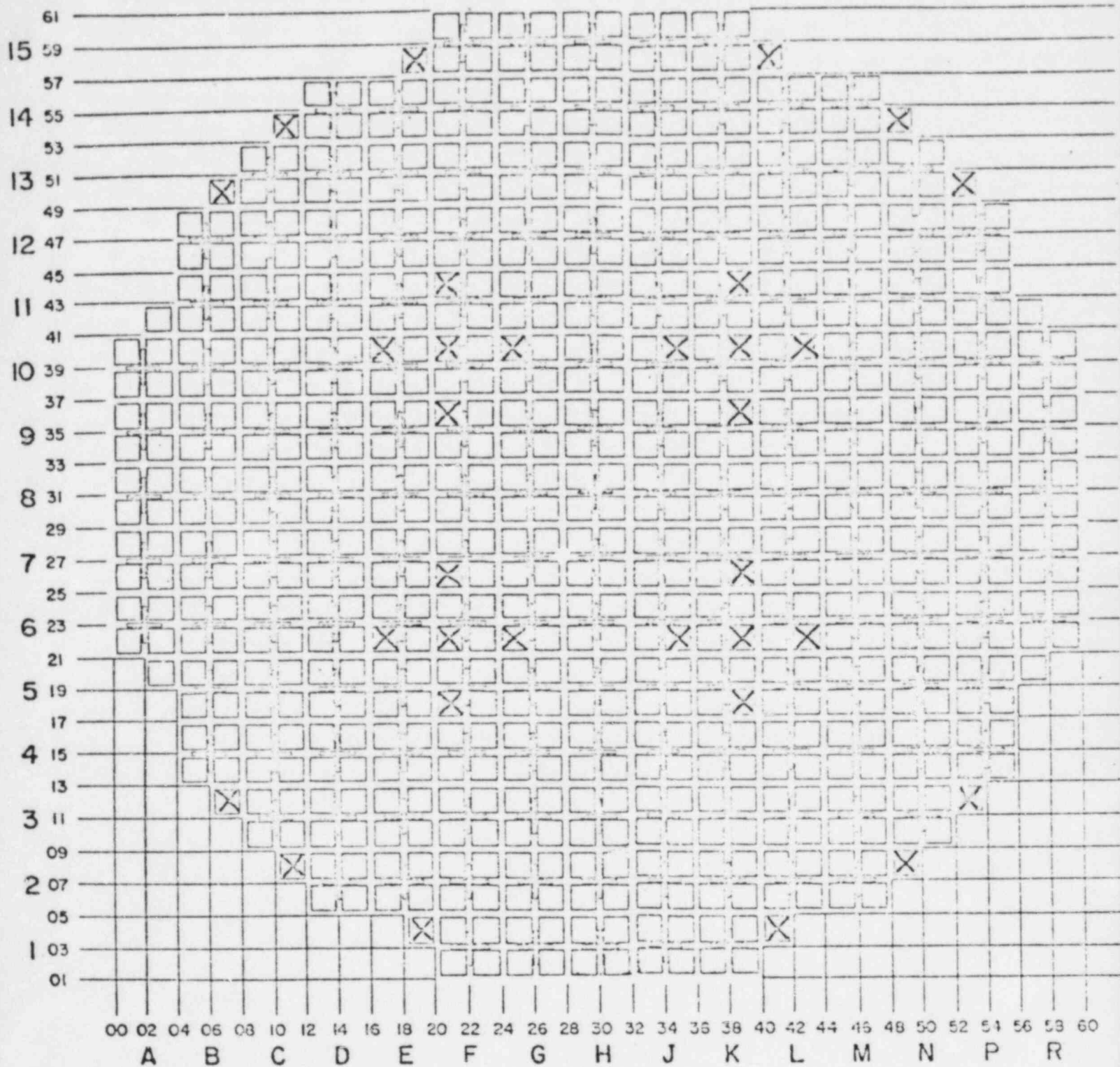
A B C D E F G H J K L M N P R

FIGURE 4(b)

D3

Edge assemblies during cycle 2

(+ 52 GEBs)



10-31-74 average exposure
 $\approx 7400 \text{ mwd/T}$

FIGURE 6

2.13 UNCHAINED CONTROLLED

2.13 UNCHAINED ASSEMBLY

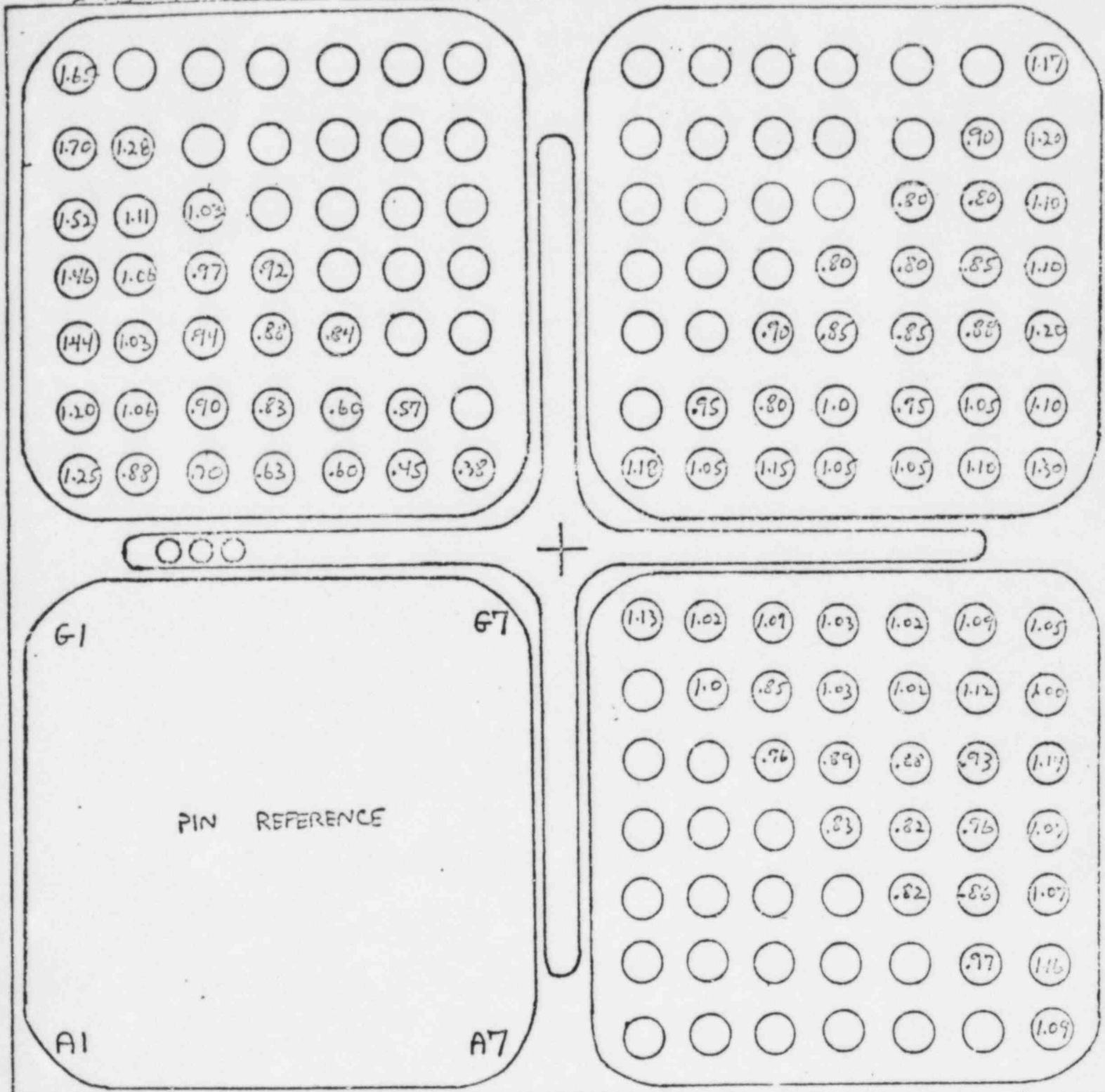


FIGURE 7

MADE IN U.S.A.

% FAILED OF THOSE ASSEMBLIES
WITH CERTAIN Δ KW/FT ABOVE
THE ENVELOPE AT 6:57 A.M.

% FAILED OF THOSE ASSEMBLIES
WITH CERTAIN PEAK KW/FT AT
6:57 A.M.

