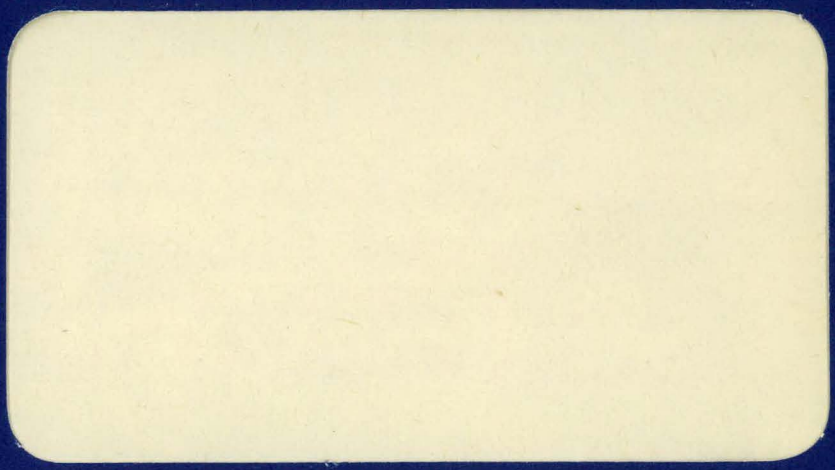

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SAXTON PLUTONIUM PROJECT

MASTER

QUARTERLY PROGRESS REPORT FOR THE PERIOD ENDING JUNE 30, 1971

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Project Engineer

Prepared for the New York Operations Office
U. S. Atomic Energy Commission
Under AEC Contract AT(30-1)-3385

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SECTION 1

INTRODUCTION AND SUMMARY

1.1. SCOPE

This quarterly report covers work completed on the Saxton Plutonium Project during the period April through June 1971.

1.2 OBJECTIVES

The overall objective of the Saxton Plutonium Project is to develop information concerning the utilization of plutonium enriched fuels in pressurized water reactor systems. The program includes design, fabrication, operation and post-irradiation examination of a partial plutonium core. The in-pile performance of the fuel will be evaluated and compared with analytical predictions.

1.3 PROJECT ADMINISTRATION

The quarterly report for the January-March, 1971, period was written, reviewed, and released.

The middle of life post-irradiation sampling plan was transmitted to the AEC.

Arrangements for midlife post-irradiation examination work were completed.

1.4 SUMMARY OF PROGRESS DURING THE PERIOD

The Saxton reactor was shutdown for the entire second quarter of 1971. The cumulative energy generated as of June 30, 1971 remains at 3,637 MWD, with a total of 464 load follow cycles. The peak burnups in the loose lattice region remain as reported in the last quarterly report.

The Core III midlife on-site fuel handling and examination operations were completed. Rods identified for hot cell examinations were shipped to the hot cell facility.

Clad hydrogen analyses and burnup analyses on rod RR were completed. Results are summarized in Section 3 of this report.

SECTION 2

CORE III OPERATIONS

(C. E. Palmer, R. L. Stover and T. E. Caye)

The Saxton reactor was shutdown for midlife examinations throughout the second quarter of 1971. The Core III cumulative energy generated and the total load follow cycles achieved remain at 3,637 MWD and 464 cycles, respectively, as reported in the last quarterly report.

A total of seven loose lattice fuel rods were removed and shipped to the hot cells for examination under this program. One of these rods, LZ, was removed from the center loose lattice subassembly. This rod was replaced by loose lattice rod PW. The remaining six rods were removed from loose lattice 9 x 9 assemblies 503-17-2 (D-2) and 503-17-9 (E-4). These rods and two others were replaced by four Core II mixed oxide rods and four fresh mixed oxide rods. The identities of removed rods, and replacement rods and assembly lattice locations, are summarized in Table 2-1. Figures 2-1, 2-2 and 2-3 show the subassembly and 9 x 9 assembly loadings for the operating period from MOL to EOL. The predicted powers (peak kw/ft, best estimate, thermal) for the replacement rods at the core reference design power of 23.5 MWT are included on Figures 2-1 and 2-3.

During the midlife fuel handling operations, an anomalous fretting condition was observed on loose lattice rod BI. This rod was removed from lattice position C-6 assembly 503-17-9 (E-4). The rod was removed to reduce the chances for fuel rod failure during post midlife operation. A solid Zircaloy-4 bar was inserted in place of rod BI. The nuclear analysis of this change showed the peak powers in the four adjacent fuel rods would be increased by an average of 8 percent, but the peak power in the assembly will be unchanged. Peak powers for the rods surrounding the Zircaloy bar are shown in Figure 2-3. The best estimate peak power in the assembly is calculated as 18.4 kw/ft for rod E4-A8 for the core reference design power of 23.5 MWt.

TABLE 2-1

LOOSE LATTICE ASSEMBLIES 503-17-2 and
503-17-9 MIDLIFE FUEL HANDLING DETAILS

9 x 9 Assembly Number	Lattice Position	Removed Rod I.D. Number	Replacement Rod I.D. Number/Type of Rod
503-17-2	D8	GL	C-2/Fresh PuO_2-UO_2
503-17-2	G3	RD	PG/Core II PuO_2-UO_2
503-17-2	H2	NI	TL/Core II PuO_2-UO_2
503-17-2	J1	BO	JA/Core II PuO_2-UO_2
503-17-2	J3	NE	BS/Core II PuO_2-UO_2
503-17-9	D5	FS	C-1/Fresh PuO_2-UO_2
503-17-9	G2	MQ	C-4/Fresh PuO_2-UO_2
503-17-9	J2	FP	C-3/Fresh PuO_2-UO_2
503-17-9	C6	B1	ZR-1/Solid Zr Bar

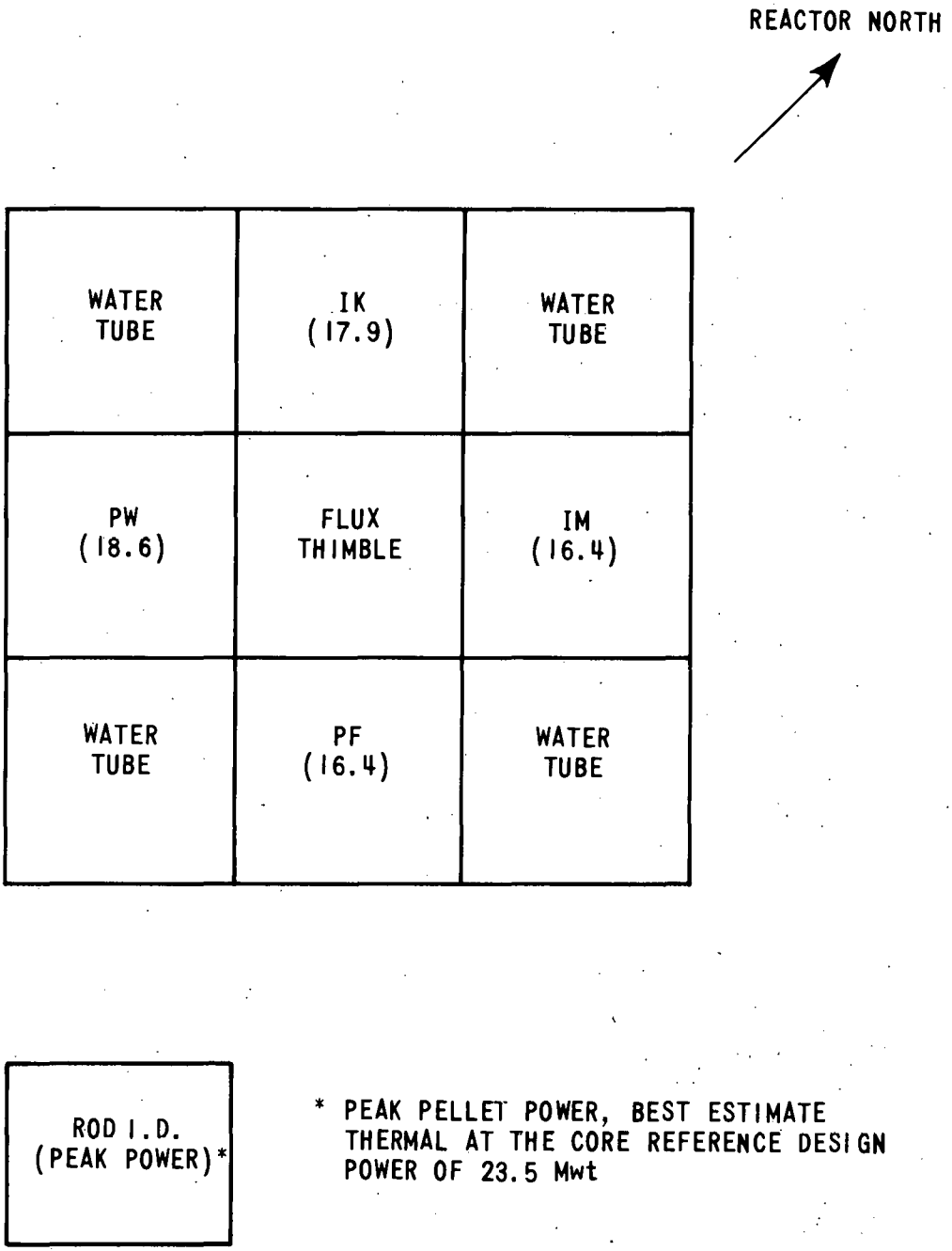


Figure 2-1. Saxton Core III Subassembly 503-4-31
Post-MOL Fuel Loading

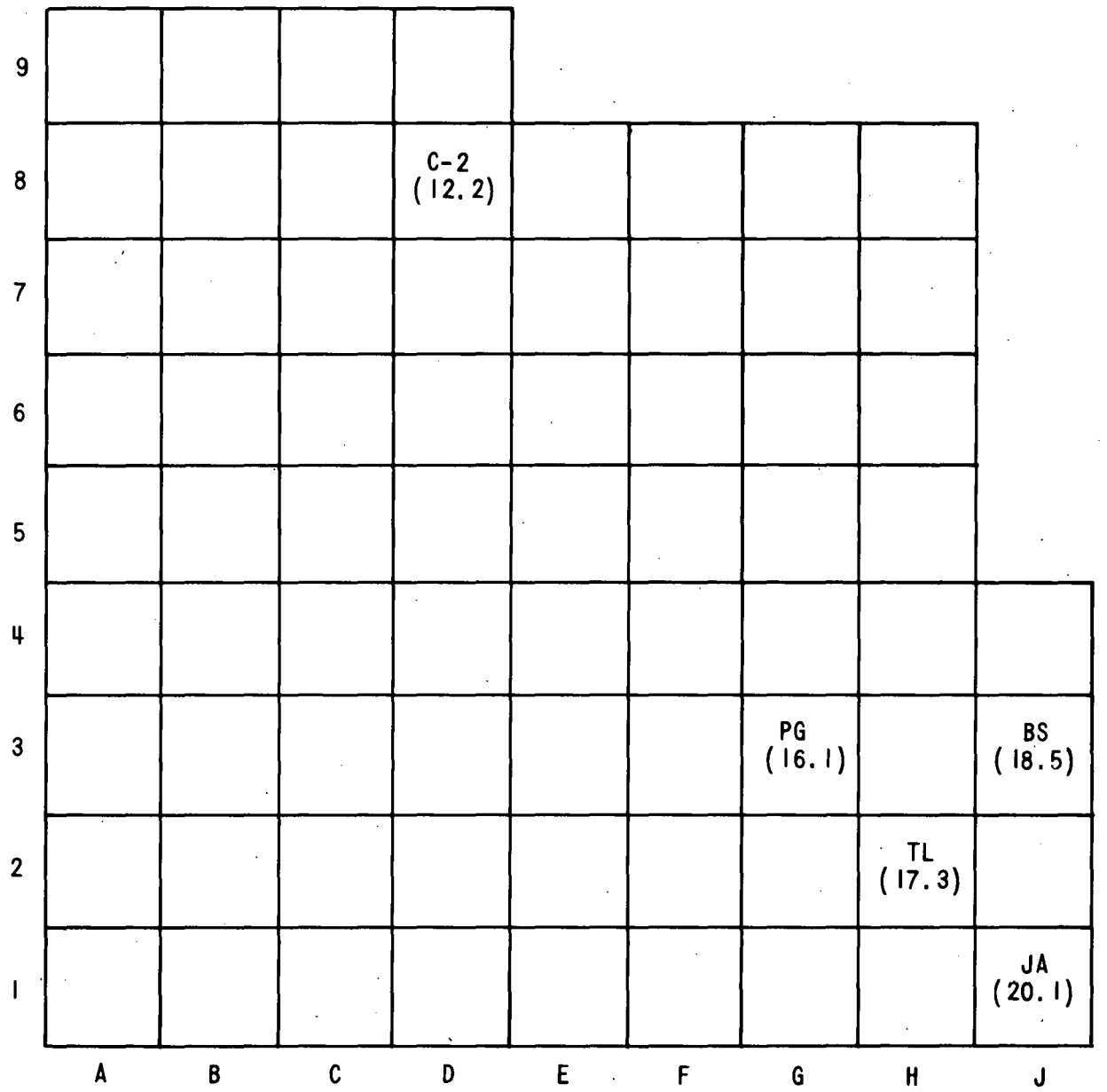


Figure 2-2. Saxton Rods Inserted at MOL in Core III
Assembly 503-17-2 (D-2)

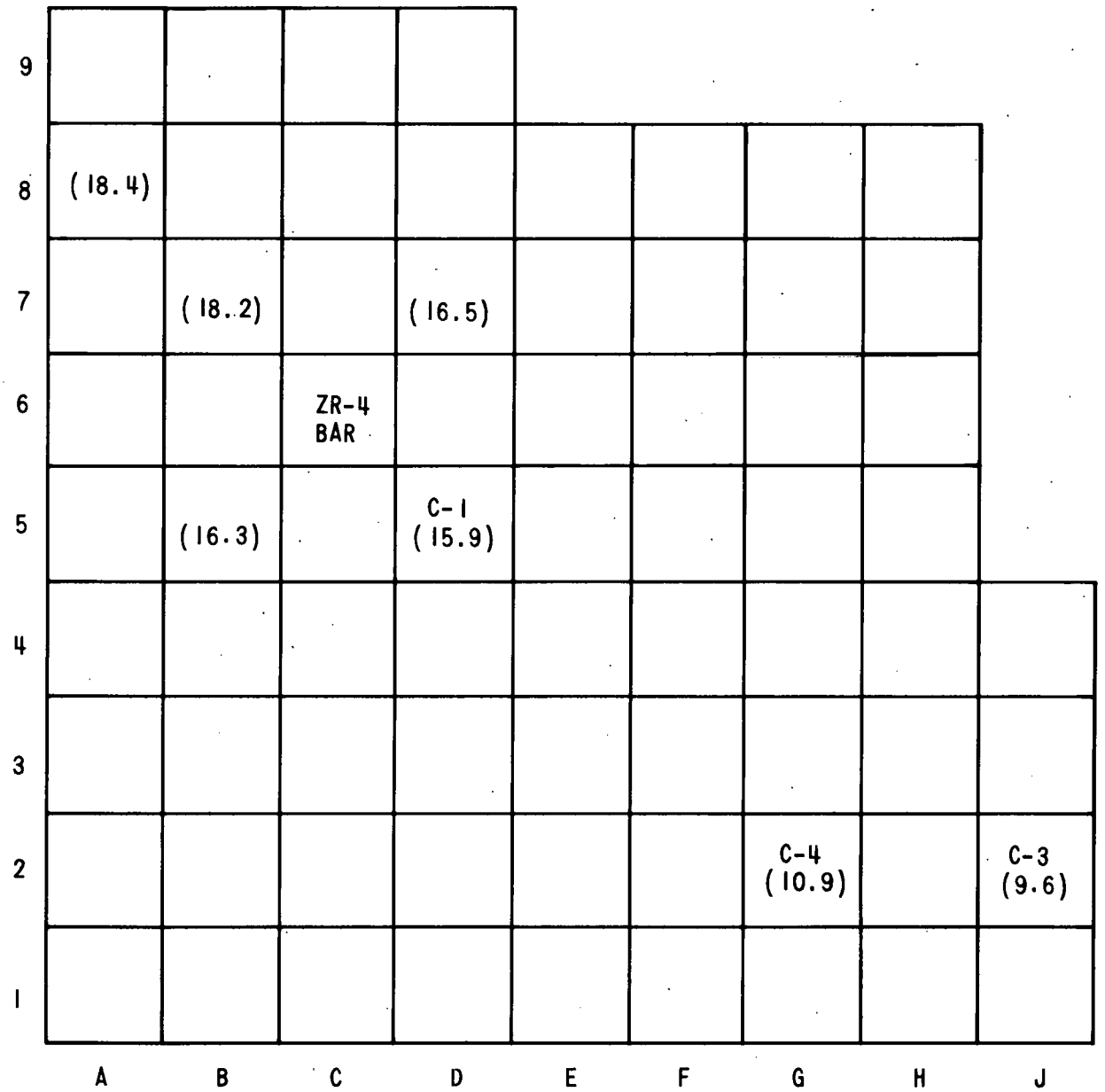
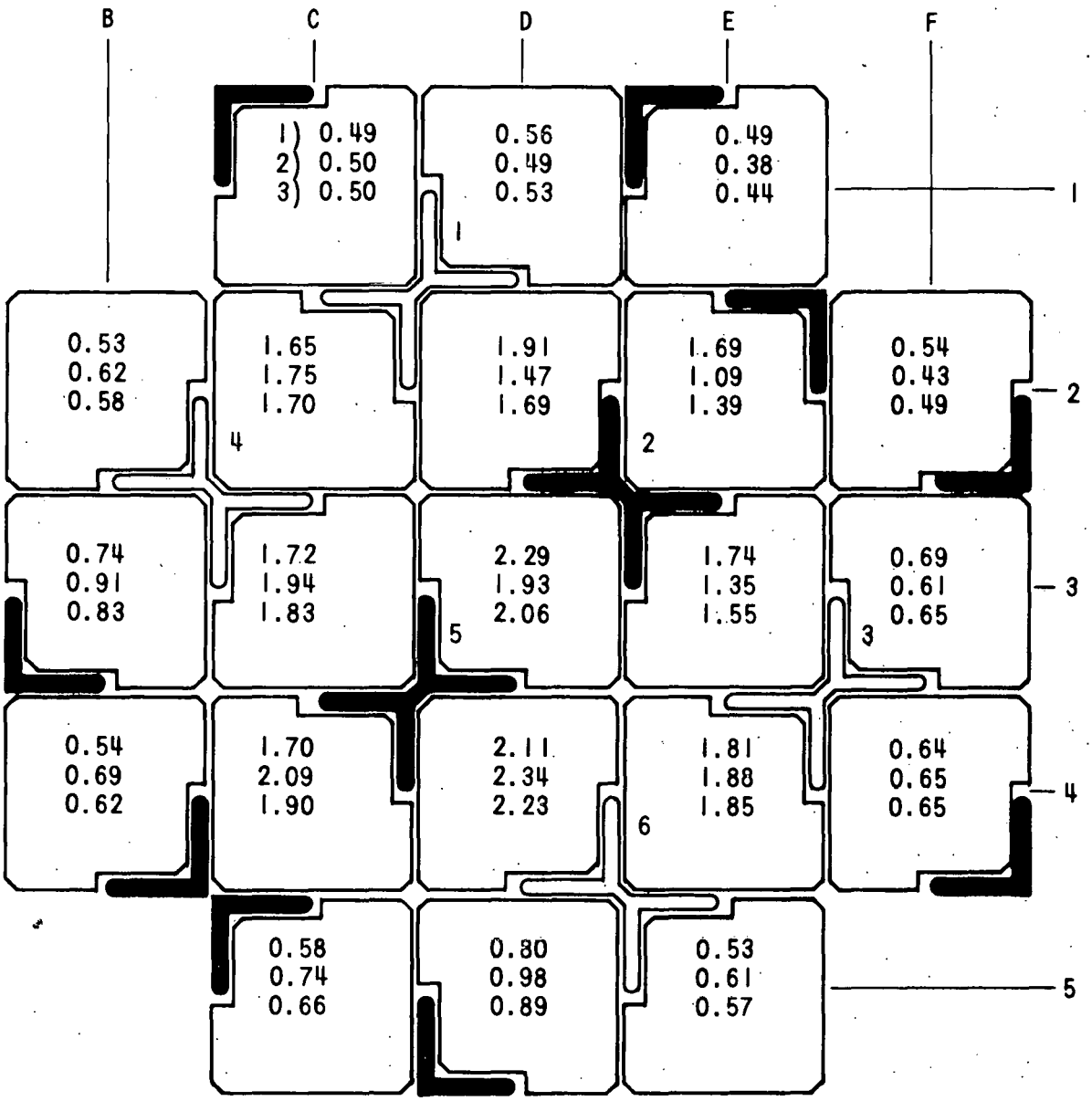


Figure 2-3. Saxton Rods Inserted at MOL in Core III Assembly 503-17-9 (E-4)

Loose lattice assembly 503-17-9 was dropped approximately four inches into the fuel rod storage rack during the midlife fuel handling operations. This incident caused a slight (∿30 mils) buckling of the stainless steel can. Evaluation of mechanical and thermal-hydraulic effects of the buckle showed the assembly acceptable for continued irradiation.

Table 2-2 summarizes the operating history of key rods in the loose lattice region of Core III. Figure 2-4 shows the expected assembly relative powers after midlife startup. These powers are based on control rod #2 inserted 50 percent.



LEGEND:

(1) PREDICTED POWER, ALL RODS OUT
(2) PREDICTED POWER, ROD 2 IN
(3) PREDICTED RELATIVE POWER ROD 2 IN 50% = $\frac{(1)+(2)}{2.0}$

Figure 2-4. Relative Assembly Powers for Saxton Core III at Mid-Life Startup

TABLE 2-2

SUMMARY OF SAXTON CORE III OPERATING HISTORY
THROUGH JUNE 30, 1971

	Through March 31, 1971	During April, May, June	Cumulative to June 30, 1971
Energy generated, MWD	3,637	0	3,637
Number of load cycles	464	0	464
Peak Linear Power, kw/ft[(a)]			
1. Peak power rod	18.4	----	----
2. Peak burnup rod (in center 3 x 3)	15.7	----	----
3. Peak burnup rod (outside center 3 x 3)	12.2	----	----
Peak Pellet Burnup, MWD/MTM[(b)(c)]			
1. Peak power rod	32,900	----	----
2. Peak burnup rod	41,900	----	----
3. Peak burnup rod (outside center 3 x 3)	36,400	----	----

(a) Best estimate, thermal basis (thermal = 0.974 of fission)
(b) Best estimate, fission basis
(c) Burnup estimates reflect Core II EOL burnup adjustment

SECTION 3

EVALUATION OF CORE III FUEL

(M. G. Balfour)

3.1 EXAMINATION OF ROD RR

Clad hydrogen analysis (vacuum hot extraction) was completed on two sections, previously delayed because of other priorities at the Technical Service Laboratories, Waltz Mill. The results are 20 1/2 - 20 3/4 inches from the rod bottom: 88 ppm (avg.) and 10 3/4 - 11 inches: 73 ppm (avg.). These values fall within the observed range of Core II fuel rods* and confirm the metallographic investigations that showed no unusual concentrations of hydrogen in the clad, despite a thick O.D. oxide film.

The mass spectrometric analysis** for rod RR has been confirmed by cross checking a burnup aliquot at the G.E. Vallecitos Nuclear Laboratory. The reduced burnup data are given in Table 3-1. The axial burnup shape inferred from the post-irradiation gamma scan was normalized to the Nd-148 data to give a best estimate rod average burnup of 25,100 MWD/MTM and a best-estimate peak pellet burnup of 33,200 MWD/MTM (17.4 inches from the bottom of the rod).

3.2 MIDLIFE EXAMINATIONS

Examinations of the two loose lattice assemblies confirmed that the design modifications made for Core III have successfully eliminated the assembly buckling observed at the end of Core II operation. Fuel rod LZ from the center 3 x 3 subassembly, loose lattice rods FS and MQ from assembly A-17-9, and BO, GL, NI and RD from assembly A-17-2 were removed at the midlife shutdown. Visual (T.V.) examination of these rods indicated that there were no

* W. R. Smalley, "Saxton Plutonium Semi-Annual Progress Report for the Period Ending December 31, 1969," WCAP-3385-22, March 1970.

**T. E. Caye and W. R. Smalley, "Saxton Plutonium Project Quarterly Progress Report for the Period Ending December 31, 1969," WCAP-3385-26, March 1970.

TABLE 3-1

BURNUP DATA FOR FUEL ROD RR[a]

Sample Location (Inches From Bottom of Fuel Rod)	Atom Ratio		Burnup, MWD/MTM		
	$Nd\text{-}148/U\text{-}238$ $(\times 10^{-4})$	$Pu\text{-}239/U\text{-}238$ $(\times 10^{-2})$	Heavy Isotope	Nd-148	Percent Difference[b]
11.0-11.5	5.943	3.097	33,690	31,990	+5.3
18.5-19.0	6.062	2.972	34,440	32,640	+5.5

(a) Complete isotopic data given in WCAP-3385-26.

(b) $\frac{\text{H.E.} - \text{Nd}}{\text{Nd}} \times 100\%$

clad or end plug anomalies. Crud deposits were moderately heavy (several) mils maximum) near the peak heat flux region and relatively light near the fuel rod ends. These fuel rods have been shipped to the hot cells for further post-irradiation examinations, due to begin in mid-July. Details of the examinations to be performed were summarized in the AEC sampling plan which is included as Table 3-2.

TABLE 3-2

SAXTON PLUTONIUM PROGRAM CORE III MIDLIFE POST-IRRADIATION EXAMINATION SAMPLING PLAN

Rod I. D. #	Assembly Location	Rod Location	Estimated Rod Peak Burnup	Met.	Tensile	Burst	Mn-54	Clad H_2	α Autoradiog.	β-γ Autoradiog.	Nd-148	HE[3]
RR[1]	D-3	E-6	35,000	3	----	---	---	2	1	1	2	2
LZ	D-3	F-5	41,000	2	----	---	---	1	1	1	2	2
BO	D-2	J-1	34,000	2	2	1	1	1	1	1	1	1
NI	D-2	H-2	33,500	2	----	2	1	1	---	---	1	1
RD	D-2	G-3	32,000	2	2	1	1	1	---	---	1	1
FS	E-4	D-5	32,000	2	1	1	3	1	---	---	1	1
GL	D-2	D-8	33,000	2	1	2	1	1	---	---	1	1
MQ	E-4	G-2	36,000	2	2	1	1	1	1	1	2*	2*

NOTES: 1. This rod was removed and examined at the 7/70 reactor shutdown.

2. All rods receive: visual examination with photos as needed; profilometry and length measurements; fission gas sampling and analysis; single-channel gamma scan.

3. HE package includes U-234, -235, -236, and -238; Pu-239, -240, -241 and -242; and Pu-239/U-238.

*One of the burnup samples on rod MQ is a radial sample including 10 samples drilled from different radii with analyses for HE and Nd-148. In addition α and β-γ autoradiographs and a metallurgical mount will be prepared before drilling.