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ARGONNE NATIONAL LABORATORY

IDAHO DIVISION

REPORT OF EBR-II OPERATIONS

January 1, 1967 through March 31, 1967

A R G O N N E N A T I O N A L L A B O R A T O R Y

IDAHO DIVISION

IDAHO FALLS, IDAHO

REPORT OF EBR-II OPERATIONS

January 1, 1967 through March 31, 1967

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TABLE OF CONTENTS

Page

I. Operations 1

A. Summary 1

B. Chronology of Principal Events 3

C. Production Summary 7

D. Plant Performance 8

1. Power Production 8

2. Primary System 8

a. Primary Pumps 8
b. Primary Auxiliary Pump 8
c. Coolant Temperatures 8
d. Primary Purification System 8
e. Argon and Sodium Chemistry 12

3. Copper in Primary Sodium 13

4. Secondary System 22

a. Secondary Sodium Pump 22
b. Argon and Sodium Chemistry 22

5. Steam System 23

a. Pressures and Temperatures 23
b. Water Treatment 23

1) Steam and Condensate 23
2) Cooling Water 23

II. Fuel Handling 24

A. Experimental Irradiations 24

B. Subassembly Inventory 24

C. Grid Loading Changes 24

D. Subassembly Utilization 25

TABLE OF CONTENTS (continued)

		Page
III.	Reactor Physics	36
IV.	Experimental Irradiations	37
	A. Experimental Subassembly Locations	37
	B. Experimental Subassembly Contents and Exposure Status	37
V.	Systems Maintenance, Improvements, and Tests	37
	A. Mechanical and Electrical	37
	1. Main Turbine Surface Condenser	37
	2. Turbine Driven Condensate Pump	37
	3. Condensate Minimum Flow Valve	37
	4. Nash Pump	37
	5. Main Turbine	49
	6. Main Generator Amplidyne	49
	7. Feedwater and Blowdown Systems	49
	8. Secondary Sodium Pump M-G Set	49
	9. Number 1 Primary Pump M-G Set Eddy Current Coupling	49
	10. Number 1 Primary Pump Blower	49
	11. Secondary System Sample Station	49
	12. Primary Purification System	49
	13. Primary Argon Purification System Blowers Numbers 1 and 2	50
	14. Reactor Building Equipment Air Lock	50

TABLE OF CONTENTS (continued)

Page

A. Mechanical and Electrical (continued):

[illegible]. Primary Auxiliary Pump Rectifier and Cooling System . . . . . [illegible]

[illegible]. Fuel Unloading Machine . . . . . [illegible]

[illegible]. [illegible] Cooling System . . . . . [illegible]

[illegible]. Primary Auxiliary Pump 50

B. Instrumentation and Control 51

1. Solid State Nuclear Channel 51

2. Secondary Sodium Sampling and Plugging Loops 51

3. Miscellaneous Modifications 51

4. Constant Power Supplies 52

5. Reactor Instrumentation 52

6. Nuclear Instrument Improvements 52

7. Reactor Systems Improvement 53

a. Temperature Monitoring Devices 53
b. Multi-Point Recorders 53
c. Miniature Recorders 53
d. Selected Parameter System 53

8. Major Maintenance 54

a. Feedwater Control System 54
b. Secondary Sodium System Level Probes 54
c. Large Plug Data Encoder 54
d. Control Rod Position Indicator Transmitters 54

C. Testing 54

1. Primary Auxiliary Pump 54

2. Primary Purification System 54

LIST OF TABLES

Page

I. Operating History Data (January 1967) 9

II. Operating History Data (February 1967) 10

III. Operating History Data (March 1967) 11

IV. Chemical Analysis Results for Copper in Special Samples of EBR-II Primary Sodium 14

V. Chemical Analysis Results for Copper in Historical Samples of EBR-II Primary Sodium 19

VI. Loading Changes for Run Number 25 26

VII. Summary of Capsule Irradiations in EBR-II 38

VIII. Primary Auxiliary Pump Test Data 56

LIST OF FIGURES

		Page
I.	Primary Pump No. 1 Performance (January 1967)	57
II.	Primary Pump No. 1 Performance (February 1967)	58
III.	Primary Pump No. 1 Performance (March 1967)	59
IV.	Primary Pump No. 2 Performance (January 1967)	60
V.	Primary Pump No. 2 Performance (February 1967)	61
VI.	Primary Pump No. 2 Performance (March 1967)	62
VII.	Primary Purification System Performance (January 1967)	63
VIII.	Primary Purification System Performance (February 1967)	64
IX.	Primary Purification System Performance (March 1967)	65
X.	Fission Rate Distribution Runs 25A and 25B	66
XI.	Fission Rate Distribution Run 25C	67
XII.	Fission Rate Distribution Run 25D	68
XIII.	Primary Auxiliary Pump Bus Bar After Four Years Service	69
XIV.	Primary Auxiliary Pump Repaired Bus Bar	70

I. Operations

A. Summary

There was no power operation during this quarter. Loading changes and investigations related to the presence of copper in the primary coolant sodium were the main activities during this quarter.

Following Run Number 24, which ended December 31, 1966, fuel handling operations were started to refuel and make necessary adjustments to enlarge the core to 91 subassemblies. Blanket subassemblies in the first row of the inner blanket (Row 6) were replaced with fueled subassemblies. Certain core locations, which are to be used for experimental irradiation, were fueled with "half-worth" driver subassemblies. These subassemblies were fabricated, using 46 fuel elements and 45 solid stainless steel elements (alternately spaced) to produce a subassembly that could be used to fill a grid location in lieu of an experimental subassembly. These subassemblies allowed the core to be enlarged to a reference size at an early date so that the flux profile of this core could be measured experimentally using flux wire subassemblies. Later as experiments become available they will replace the half-worth driver subassemblies and the reference reactor core size will remain relatively constant, independent of future experimental loading changes. Flux (gradients) profiles, control rod calibrations, etc., will be known once this reference core is studied and future loading changes should be predictable. During Runs 25A, 25B, 25C, and 25D, (8, 8, 6, and 9, respectively) flux wire subassemblies were irradiated to obtain fission distribution and plutonium production rate measurements in the core and blanket.

Surveillance measurements from the depleted uranium in the sixth, seventh, and eighth rows in the reactor revealed swelling of some blanket elements at the core midplane. Therefore, based on these measurements, the unalloyed depleted uranium breeder blanket subassemblies in Rows 7 and 8 were removed and replaced with subassemblies containing solid stainless steel rods.

The results of critical measurements revealed a gain of 219 inhours during the removal of seventh row depleted uranium and subsequent insertion of stainless steel reflector material. The similar exchange in the eighth row resulted in a 230 inhour increase.

During routine fuel handling operations following Run 25B the sensing rod on the rotating oscillator drive shaft required manual assistance to register proper sense. This indicated binding between the sense shaft and the jaw actuating sleeve. Inspection, following removal and disassembly revealed a broken bellows which allowed sodium to leak into the annulus between the shaft and sleeve and solidify or oxidize. Therefore the bellows will be replaced. All other parts of the oscillator drive were inspected and found to be normal, including the Stellite-Colmonoy journal bearings that operate under sodium.

Late in February, data from the primary plugging meter became very erratic and finally, it became impossible to establish flow through the plugging valve when it was closed. Following removal and cleaning, copper was observed to have precipitated in the flutes and other surfaces of the plugging valve and on the internal surfaces and valve stem of the throttle valve. In order to

a. Summary (continued)

determine the extent of the deposition of copper in the primary plugging loop, it was removed from the system for destructive examination and replaced with the loop which was removed from the secondary system for this purpose. Operation of this loop has been highly successful and its ability to perform in the primary system is of considerable interest. A new loop was installed in the secondary system.

An intensive sodium sampling program was started to determine the copper content of the primary sodium and of the effluent from the cold trap.

The ends of the auxiliary primary pump (dc electro-magnetic pump) bus bars were the largest potential source of copper so they were removed and inspected. Measurements revealed that 10 to 11 pounds of copper had been eroded away and undoubtedly had migrated to the primary sodium, over the last 4 years. The electrodes were repaired by cladding them with stainless steel sleeves to eliminate any future dissolution of copper. Testing of the auxiliary pump following repair revealed that only a slight adjustment of circuit resistance was necessary to return the pump current to normal. An extensive sodium sampling program was initiated. The average of many determinations revealed a probable content of about 1.2 ppm copper in the primary sodium at 700° F. Several samples showed concentration from 8-24 ppm which indicated some minute copper particulates are dispersed in the sodium. These samples were exceptions and raised the overall average value of all determinations.

The primary system cold trap was in continuous operation during the month of March to take advantage of its potential capacity for copper removal.

B. Chronology of Principal Events

Date	Event
1/ 1/67	Plant Status.
	Plant shutdown to start fuel loading change for Run Number 25.
	Primary sodium temperature = 700° F.
	Secondary sodium flow = 0.4%.
	Steam pressure = 1200 psig.
	Primary tank heat input = 240 kW.
1/10/67	Source thimble 1906 removed from reactor position (7-E-2).
1/12/67	Completed loading 15 new "C" type subassemblies into the reactor.
1/13/67	Experimental subassemblies X020 and X016 loaded into reactor.
1/14/67	Experimental subassembly X019 placed in the reactor.
1/15/67	Leak rate test of equipment air lock successfully completed.
	Completed loading 9 new "B" type subassemblies into the reactor.
1/14 to 1/16/67	Subcritical run made to determine reactivity.
1/16/67	Reactor loaded with eight (8) flux wire subassemblies.
	One hour irradiation at 30 kW completed (Run No. 25-A).
1/17 to 1/18/67	Ten control rods calibrated.
1/18 to 1/20/67	Reactor operated at 500 kW for training.
1/27/67	Reactor loaded with eight flux wire subassemblies.
	One hour irradiation at 30 kW completed (Run No. 25-B).
2/ 7/67	Reactor loaded with six flux wire subassemblies.
	Two hour irradiation at 50 kW completed (Run No. 25-C).

B. Chronology of Principal Events (continued)

Date	Event
2/ 8/67	Three flux wire subassemblies irradiated for 2 hours at 500 kW (Run No. 25-C).
	Started removing "A" type subassemblies from storage basket for shipment to Fuel Cycle Facility.
2/11/67	Conducted National Youth Science Day tour.
2/14/67	Finished unloading last "A" type subassemblies from basket.
2/17/67	Completed loading 12 stainless steel subassemblies into the storage basket.
	Primary pump number 1 magnetic clutch replaced and checked out.
2/18/67	Completed loading 8 stainless steel subassemblies into the storage basket.
	Completed loading 10 stainless steel subassemblies in Row 7 of reactor.
2/20/67	Removed XG06 from reactor and sent to Fuel Cycle Facility.
	Started cooldown of primary tank to 600° F in preparation for oscillator drive removal.
2/21/67	Completed loading 6 stainless steel subassemblies into the storage basket.
2/22/67	Oscillator rod drive removed from primary tank.
	Completed loading 6 stainless steel subassemblies into the storage basket.
2/23/67	Control rod drive installed in place of oscillator rod drive (Position Number 8).
2/24/67	Primary tank temperature back at 700° F.
2/25/67	Oscillator rod removed from the reactor and sent to Fuel Cycle Facility.
	Experimental subassembly X021 placed in reactor position (2-D-1).

B. Chronology of Principal Events (continued)

Date	Event
2/26/67	Experimental subassembly X022 placed in reactor position (7-C-2).
2/27/67	Reactor taken critical to determine reactivity (Run 25-D).
2/28/67	Reactor taken critical to determine excess reactivity and period calibrated No. 4 and No. 9 control rods.
	Completed loading eleven stainless steel subassemblies into the reactor.
3/ 1/67	Reactor taken critical for reactivity determination and control rod calibration.
3/ 2/67	Completed loading eleven stainless steel subassemblies into the reactor.
	Reactor taken critical for rod drop experiments and calibration of all control rods.
	Primary plugging loop taken out of service for maintenance.
	Copper deposit found on surface of plugging valve.
3/ 7/67	Primary auxiliary pump secured in preparation for removal of bus bars.
3/ 8/67	Primary system sodium sampling started on an around the clock basis for copper analysis.
3/ 9/67	Primary auxiliary pump bus bars removed from primary tank.
3/11/67	Primary purification system placed in operation.
3/17/67	Completed loading 25 stainless steel subassemblies into the storage basket.
	Started sodium sampling from primary tank transfer port on an around the clock basis for copper determination.
	Modified primary auxiliary pump bus bars returned to the primary tank.
3/18/67	Primary auxiliary pump placed in operation.
	Completed loading 8 stainless steel subassemblies into storage basket.

B. Chronology of Principal Events (continued)

Date	Event
3/20/67	Completed loading 23 stainless steel subassemblies into the reactor.
3/22/67	Completed loading 8 stainless steel subassemblies into the reactor.
	Completed sending 9 "U" type subassemblies to the Fuel Cycle Facility.
	Reactor taken critical to determine excess reactivity.
3/24/67	Completed loading 20 stainless steel subassemblies into the reactor.
3/26/67	Reactor loaded with 9 flux wire subassemblies.
	One hour irradiation at 50 kW completing Run 25-D.
3/28/67	Reactor taken critical for period calibration of No. 4 and No. 9 control rods.
3/31/67	Plant Status.
	Plant shutdown awaiting authorization for Run Number 25.
	Primary sodium temperature - 700° F.
	Secondary sodium flow - 0.2%.
	Steam drum pressure - 1250 psig.
	Primary tank heat input - 200 kW.
	Primary system sodium sampling continues on a three shift basis with samples being taken from the primary tank transfer port and the PI-A plugging loop.

C. Production Summary

	First Quarter	Second Quarter	Third Quarter	Total For Fiscal Year To Date
Maximum Possible Power Production (Days × 45 MWt)	4140	4185	4050	12375
Power Production (MWd)	1310	2366	0	3676
Plant Factor (%)	31.5	56.7	0	29.7
Power Production (Days)	35	60	0	95
Non-Power Production (Days)				
1) Fuel Handling (Days)		7	22	29
2) Low Power Tests (Days) (Physics, Kinetics, etc.)		6	12	18
3) Routine Maintenance (Days) (Also conducted concurrently with other categories)				
4) Fuel Surveillance (Days)	27			27
5) Special Maintenance Repairs, etc.				
Turbine Repair, Oscillator Rod Installation, Freeze Seal Trough Cleaning (days)	30	20		
Primary Auxiliary Pump Repair and Inspection (Days)			10	10
6) Manufacturing Row 7 & 8 Stainless Steel Subassemblies			46	46
Total Days	92	93	90	275

D. Plant Performance

1. Power Production

The plant was not operated at power during this quarter. Reactor operation was only for the purpose of making physics measurements of flux distribution and reactivity effects of loading changes. Tables I, II, and III give the production data.

2. Primary System

a. Primary Pump Performance

Primary pump performance data are presented in Figures I through VI. No significant changes in performance were noted.

b. Primary Auxiliary Pump Performance

Primary auxiliary pump performance was checked before and after the modification of bus bars. Details on the capping of the copper ends of these bus bars with stainless steel are given in Sections V.A.18 and V.C.1. Only minor adjustments of the power supply to the pump were made to achieve the same performance before and after the modifications.

c. Coolant Temperatures

The subassembly outlet temperatures have not been plotted this quarter since there was no power operation.

d. Primary Purification System

A review of the data taken through the four years of operation has been made. It was not possible to predict the end of useful life for the cold trap from this data, however, the pumping power required to produce a given flow rate has increased during the period of operation.

In order to observe the operation of the system more closely, portable recording instruments were installed to measure the flow, pressures, and pressure drop across the crystallizer and the crystallizer plus economizer. At the low flow rates where differential pressure measurements are effective the indication is that no plugging is occurring in the economizer.

Flow transients occur at irregular intervals. They are seen most frequently following the startup of the purification system. System flow will make a step increase (for example from 30 gpm to 60 gpm) and then decrease to the original value over a period of time varying from a few minutes to 1 or 2 hours. It has been postulated that upon precipitation, sodium oxide forms a bed in the "York" mesh of the crystallizer and that the flow transients occur when the bed is disturbed and channeling occurs temporarily.

TABLE I

OPERATING HISTORY DATA

January, 1967

Date	Reactor Critical Time Hrs	Cumulative Critical Time Hrs	Gross Thermal Energy MWht	Cumulative Gross Thermal Energy MWht	Gross Electrical Energy NWhe	Cumulative Gross Electrical Energy MWhe	Generator on Time Hrs	Cumulative Generator on Time Hrs	Thermal Power Range Max. MW	Thermal Power Range Min. MW
1	0	8358.3	0	293891	0	77323	0	5921.5	0	0
2	0	8358.3	0	293891	0	77323	0	5921.5	0	0
3	0	8358.3	0	293891	0	77323	0	5921.5	0	0
4	0	8358.3	0	293891	0	77323	0	5921.5	0	0
5	0	8358.3	0	293891	0	77323	0	5921.5	0	0
6	0	8358.3	0	293891	0	77323	0	5921.5	0	0
7	0	8358.3	0	293891	0	77323	0	5921.5	0	0
8	0	8358.3	0	293891	0	77323	0	5921.5	0	0
9	0	8358.3	0	293891	0	77323	0	5921.5	0	0
10	0	8358.3	0	293891	0	77323	0	5921.5	0	0
11	0	8358.3	0	293891	0	77323	0	5921.5	0	0
12	0	8358.3	0	293891	0	77323	0	5921.5	0	0
13	0	8358.3	0	293891	0	77323	0	5921.5	0	0
14	0	8358.3	0	293891	0	77323	0	5921.5	0	0
15	0	8358.3	0	293891	0	77323	0	5921.5	0	0
16	0	8358.3	0	293891	0	77323	0	5921.5	0	0
17	8	8366.3	2	293893	0	77323	0	5921.5	250 KW	0
18	24	8390.3	10	293903	0	77323	0	5921.5	500 KW	250 KW
19	24	8414.3	12	293915	0	77323	0	5921.5	500 KW	500 KW
20	20	8434.3	10	293925	0	77323	0	5921.5	500 KW	0
21	0	8434.3	0	293925	0	77323	0	5921.5	0	0
22	0	8434.3	0	293925	0	77323	0	5921.5	0	0
23	0	8434.3	0	293925	0	77323	0	5921.5	0	0
24	0	8434.3	0	293925	0	77323	0	5921.5	0	0
25	0	8434.3	0	293925	0	77323	0	5921.5	0	0
26	0	8434.3	0	293925	0	77323	0	5921.5	0	0
27	0	8434.3	0	293925	0	77323	0	5921.5	0	0
28	0	8434.3	0	293925	0	77323	0	5921.5	0	0
29	0	8434.3	0	293925	0	77323	0	5921.5	0	0
30	0	8434.3	0	293925	0	77323	0	5921.5	0	0
31	0	8434.3	0	293925	0	77323	0	5921.5	0	0

TABLE II

OPERATING HISTORY DATA

February, 1967

Date	Reactor Critical Time Hrs	Cumulative Critical Time Hrs	Gross Thermal Energy MWht	Cumulative Gross Thermal Energy MWht	Gross Electrical Energy MWhe	Cumulative Gross Electrical Energy MWhe	Generator on Time Hrs	Cumulative Generator on Time Hrs	Thermal Power Range Max. MW	Thermal Power Range Min. MW
1	0	8434.3	0	293925	0	77323	0	5921.5		
2	0	8434.3	0	293925	0	77323	0	5921.5		
3	0	8434.3	0	293925	0	77323	0	5921.5		
4	0	8434.3	0	293925	0	77323	0	5921.5		
5	0	8434.3	0	293925	0	77323	0	5921.5		
6	0	8434.3	0	293925	0	77323	0	5921.5		
7	2	8436.3	0	293925	0	77323	0	5921.5	50 KW	0
8	2	8438.3	1	293926	0	77323	0	5921.5	.05	0
9	0	8438.3	0	293926	0	77323	0	5921.5		
10	0	8438.3	0	293926	0	77323	0	5921.5		
11	0	8438.3	0	293926	0	77323	0	5921.5		
12	0	8438.3	0	293926	0	77323	0	5921.5		
13	0	8438.3	0	293926	0	77323	0	5921.5		
14	0	8438.3	0	293926	0	77323	0	5921.5		
15	0	8438.3	0	293926	0	77323	0	5921.5		
16	0	8438.3	0	293926	0	77323	0	5921.5		
17	0	8438.3	0	293926	0	77323	0	5921.5		
18	0	8438.3	0	293926	0	77323	0	5921.5		
19	0	8438.3	0	293926	0	77323	0	5921.5		
20	0	8438.3	0	293926	0	77323	0	5921.5		
21	0	8438.3	0	293926	0	77323	0	5921.5		
22	0	8438.3	0	293926	0	77323	0	5921.5		
23	0	8438.3	0	293926	0	77323	0	5921.5		
24	0	8438.3	0	293926	0	77323	0	5921.5		
25	0	8438.3	0	293926	0	77323	0	5921.5		
26	0	8438.3	0	293926	0	77323	0	5921.5		
27	1.0	8439.3	0	293926	0	77323	0	5921.5	.5	0
28	3.0	8442.3	1	293927	0	77323	0	5921.5	.5	0

TABLE III

OPERATING HISTORY DATA

March, 1967

Date	Reactor Critical Time	Cumulative Critical Time	Gross Thermal Energy	Cumulative Gross Thermal Energy	Gross Electrical Energy	Cumulative Gross Electrical Energy	Generator on Time	Cumulative Generator on Time	Thermal Power Range Max.	Thermal Power Range Min.
	Hrs	Hrs	MWht	MWht	MWhe	MWhe	Hrs	Hrs	MW	MW
1	0	8442.3	0	293927	0	77323	0	5921.5		
2	11.5	8453.8	4	293931	0	77323	0	5921.5	.5	0
3	12	8465.8	5	293936	0	77323	0	5921.5	.5	0
4	0	8465.8	0	293936	0	77323	0	5921.5		
5	0	8465.8	0	293936	0	77323	0	5921.5		
6	0	8465.8	0	293936	0	77323	0	5921.5		
7	0	8465.8	0	293936	0	77323	0	5921.5		
8	0	8465.8	0	293936	0	77323	0	5921.5		
9	0	8465.8	0	293936	0	77323	0	5921.5		
10	0	8465.8	0	293936	0	77323	0	5921.5		
11	0	8465.8	0	293936	0	77323	0	5921.5		
12	0	8465.8	0	293936	0	77323	0	5921.5		
13	0	8465.8	0	293936	0	77323	0	5921.5		
14	0	8465.8	0	293936	0	77323	0	5921.5		
15	0	8465.8	0	293936	0	77323	0	5921.5		
16	0	8465.8	0	293936	0	77323	0	5921.5		
17	0	8465.8	0	293936	0	77323	0	5921.5		
18	0	8465.8	0	293936	0	77323	0	5921.5		
19	0	8465.8	0	293936	0	77323	0	5921.5		
20	0	8465.8	0	293936	0	77323	0	5921.5		
21	0	8465.8	0	293936	0	77323	0	5921.5		
22	0.5	0466.3	0	293936	0	77323	0	5921.5	0	0
23	0	8466.3	0	293936	0	77323	0	5921.5		
24	0	8466.3	0	293936	0	77323	0	5921.5		
25	0	8466.3	0	293936	0	77323	0	5921.5		
26	3.0	8469.3	0	293936	0	77323	0	5921.5	50 KW	0
27	0	8469.3	0	293936	0	77323	0	5921.5		
28	0.9	8470.2	0	293936	0	77323	0	5921.5	.5	0
29	0	8470.2	0	293936	0	77323	0	5921.5		
30	0	8470.2	0	293936	0	77323	0	5921.5		
31	0	8470.2	0	293936	0	77323	0	5921.5	0	0

d. Primary Purification System (continued)

Plugging temperatures are normally determined twice each shift. Figures VII, VIII, and IX are graphs of primary purification parameters including the plugging temperatures. For the period from March 11 to March 17 it can be seen that the plugging temperature was reduced from 320° F to less than 225° F.

The conclusion of the study is that the cold trap is effectively precipitating and removing impurities from the primary coolant. A number of improvements in the instrumentation are planned, including the addition of pressure transmitters and modification or replacement of differential pressure transmitters which have too low a range. A proposal for automation of flow control is being considered.

e. Argon and Sodium Chemistry

Primary Argon

Two samples of the primary cover gas were submitted for activity measurement.

		Microcuries per Milliliter	
Date Sampled	Time Sampled	Xe 133	Xe 135
1/1/67	0955	1.9×10^{-3}	6.2×10^{-3}
1/2/67	1020	2.9×10^{-3}	4.0×10^{-3}

The reactor was not operated at power for the balance of this quarter and therefore no graphs of radioactive gas concentrations are included.

The analyses of primary cover gas samples from the laboratory are as follows:

	Hydrogen (ppm vol.)		Nitrogen (V/O)	
	Range	Average	Range	Average
January 1967	< 100	< 100	.8 - 1.1	1.0
February	23-54	40	.3 - 4.0	1.1
March	< 100	< 100	.6 - 1.7	1.0

The on-line chromatograph was in service but considerable difficulty was experienced in maintaining satisfactory performance.

e. Argon and Sodium Chemistry (continued)

Primary Sodium

A sample of primary sodium taken 1/31/67 contained:

4.0 ppm Ca
1.3 ppm Cr
5.0 ppm Fe
1.5 ppm Mo
1.0 ppm Ni

Samples of primary sodium were analyzed for hydrogen and oxygen content by the ANL Chemistry Division. The results were as follows:

Date Sampled	ppm Oxygen	ppm Hydrogen
10/26/66	11, 8	1.9, 3.9
11/17/66	7, 8	2.9, 1.6
12/ 7/66	6, 7	3.1, 4.6
1/26/67	4, 5	8.2, 4.4

3. Copper in Primary Sodium

In late February and early March, difficulty was experienced in obtaining satisfactory flow rates in the EBR-II primary sodium plugging loop (designated PI-A) upstream of the cold trap preparatory to making plugging temperature determinations. The plugging valve and the throttle valve in this loop were removed and disassembled on March 2, 1967. A substance, later identified as copper by qualitative chemical analysis, was found deposited on the stems and within the bodies of valves (after removal of sodium) by dissolution in ethanol.

In an effort to restore the primary plugging loop to operability and permit plugging temperature measurements and the taking of sodium samples for analysis, the valve stems and bodies were cleaned and the valves were reassembled and installed. The loop was put into operation on March 3 and plugging runs were attempted. The apparent plugging temperature was 230° F. However, a very low flow rate through the loop indicated that a flow restriction might exist in the loop economizer (regenerative heat exchanger).

On March 4, a small sodium leak was found at a weld just upstream of the loop throttle valve. The loop was secured and cooled.

TABLE IV

CHEMICAL ANALYSIS RESULTS FOR COPPER IN SPECIAL SAMPLES OF EBR-II PRIMARY SODIUM

March 1967

Date	Time	Sample Point	Sample Vessel	Coolant Pump Record	Copper (ppm)
3/ 4/67	0930	PI-A	Aluminum (approx. 100 grams Na	Intermittent pump operation	0.80
3/ 4/67	1245	PI-A	"	"	0.70
3/ 4/67	1915	FTP	Stainless Steel (100-300 grams Na)	"	0.74
3/ 6/67	1530	FTP	"	"	0.80
3/ 8/67	1445	FTP	"	"	0.51
3/ 8/67	1545	PI-A	Aluminum	"	0.67
3/ 8/67	2115	PI-A	"	"	0.60
3/ 9/67	0055	PI-A	"	"	0.48
3/ 9/67	0830	PI-A	"	"	0.46
3/ 9/67	1045	FTP	Stainless Steel	"	0.75
3/ 9/67	1630	PI-A	Aluminum	"	0.38
3/10/67	0055	PI-A	"	"	0.45
3/10/67	0815	PI-A	"	"	0.54
3/10/67	1640	PI-A	"	"	0.36
3/11/67	0045	PI-A	"	"	0.42
3/11/67	0930	FTP	Stainless Steel	"	1.03
3/12/67	0500	PI-A	Aluminum	"	0.81
3/15/67	1450	PI-A	Ni Sample Cup (approx. 10 g Na total sample analyzed)	"	0.94
3/15/67	1700	PI-A	SS Sample Cup (approx. 10 g Na total sample analyzed)	"	0.50
3/16/67	1000	PI-A	Ni Sample Cup	"	1.40
3/16/67	2000	PI-A	"	Intermittent power operation	1.00

TABLE IV (continued)

CHEMICAL ANALYSIS RESULTS FOR COPPER IN SPECIAL SAMPLES OF EBR-II PRIMARY SODIUM

March 1967

Date	Time	Sample Point	Sample Vessel	Coolant Pump Record	Copper (ppm)
3/17/67	0810	PI-A	SS Sample Cup	Intermittent power operation	0.11
3/17/67	1425	FTP	"	"	1.66
3/17/67	1600	PI-A	"	"	1.14
3/18/67	2000	PI-A	"	"	4.35
3/18/67	22.5	FTP	"	"	5.08
3/19/67	1315	FTP	"	"	0.65
3/19/67	1400	PI-A	"	"	1.78
3/20/67	0230	FTP	"	"	0.25
3/20/67	0300	PI-A	"	"	0.47
3/20/67	0515	PI-A	"	"	0.50
3/20/67	0600	FTP	"	"	2.11
3/20/67	0915	PI-A	"	"	1.00
3/20/67	1115	PI-A	"	"	0.62
3/20/67	1400	FTP	"	"	0.40
3/20/67	1515	FTP	"	"	0.81
3/20/67	2250	FTP	"	"	7.56
3/21/67	0150	PI-A	"	All pumps off	1.45
3/21/67	0200	PI-A	"	"	1.27
3/21/67	0545	FTP	"	"	0.63
3/21/67	0600	PI-A	"	"	3.66
3/21/67	1005	(Auxiliary Pump Started)			
3/21/67	1505	FTP	Stainless Steel Cup	Aux. pump on	0.54
3/21/67	1510	PI-A	"	"	1.29
3/21/67	1535	(Main Coolant Pumps Started)			
3/21/67	1745	FTP	Stainless Steel Cup	All pumps on	0.39
3/21/67	2030	PI-A	"	"	0.45

TABLE IV (continued)

CHEMICAL ANALYSIS RESULTS FOR COPPER IN SPECIAL SAMPLES OF EBR-II PRIMARY SODIUM

March 1967

Date	Time	Sample Point	Sample Vessel	Coolant Pump Record	Copper (ppm)
3/21/67	2130	FTP	Stainless Steel Cup	All pumps on	1.45
3/22/67	0145	FTP	"	"	1.42
3/22/67	0250	PI-A	"	"	6.05
3/22/67	0515	PI-A	"	"	2.52
3/22/67	0545	FTP	"	"	1.49
3/22/67	0900	PI-A	"	"	0.39
3/22/67	1115	FTP	"	"	2.38
3/22/67	1300	FTP	"	"	1.58
3/22/67	1330	PI-A	"	Pumps off	0.97
3/22/67	1715	PI-A	"	Pumps on	4.60
3/22/67	1820	FTP	"	"	1.98
3/22/67	2030	PI-A	"	"	1.15
3/23/67	0155	FTP	"	"	0.52
3/23/67	0210	PI-A	"	"	0.52
3/23/67	0300	PI-A	"	"	0.91
3/23/67	0600	FTP	"	"	1.21
3/23/67	1230	PI-A	"	Pumps off	1.26
3/23/67	1750	FTP	Pyrex Beaker	"	3.20
3/23/67	1850	PI-A	Stainless Steel	"	1.83
3/23/67	2015	FTP	Pyrex	"	0.38
3/23/67	2110	PI-A	Stainless Steel	"	0.52
2/23/67	2220	FTP	Pyrex	"	1.07
3/24/67	0050	PI-A	Stainless Steel	"	1.54
3/24/67	0115	FTP	Pyrex	"	0.74
3/24/67	0515	FTP	"	"	1.01
3/24/67	1145	FTP	"	"	0.50
3/24/67	1305	FTP	"	"	0.37

TABLE IV (continued)

CHEMICAL ANALYSIS RESULTS FOR COPPER IN SPECIAL SAMPLES OF EBR-II PRIMARY SODIUM

Date	Time	Sample Point	Sample Vessel	Coolant Pump Record	Copper (ppm)
3/24/67	1420	PI-A	Stainless Steel	Pumps off	0.31
3/24/67	1530	FTP	Pyrex	"	1.59
3/24/67	1600	PI-A	Stainless Steel	"	0.86
3/24/67	1745	FTP	Pyrex	"	0.51
3/24/67	2100	PI-A	Stainless Steel	"	0.87
3/24/67	2210	FTP	Pyrex	"	0.78
3/24/67	2245	PI-A	Stainless Steel	"	0.73
3/27/67	1300	FTP	Pyrex	Pumps on	1.99
3/27/67	1355	PI-A	Stainless Steel	"	0.88
3/27/67	1545	FTP	Pyrex	"	1.07
3/27/67	1730	PI-A	Stainless Steel	"	1.58
3/27/67	1910	FTP	Pyrex	"	0.94
3/27/67	2010	PI-A	Stainless Steel	"	0.95
3/27/67	2130	FTP	Pyrex	"	0.53
3/28/67	0130	FTP	"	"	1.09
3/28/67	0215	PI-A	Stainless Steel	"	0.99
3/28/67	0300	FTP	Pyrex	"	0.76
3/28/67	0530	FTP	"	"	0.84
3/28/67	1550	FTP	"	"	1.91
3/28/67	1730	FTP	"	"	1.01
3/28/67	1940	FTP	"	"	0.72
3/28/67	2125	FTP	"	"	2.02
3/29/67	0100	FTP	"	"	24.25
3/29/67	0230	FTP	"	"	3.09
3/29/67	0355	FTP	"	"	1.12
3/29/67	1825	FTP	"	"	0.77
3/29/67	2000	FTP	"	"	0.46
3/29/67	2230	FTP	"	"	3.32

TABLE IV (continued)

CHEMICAL ANALYSIS RESULTS FOR COPPER IN SPECIAL SAMPLES OF EBR-II PRIMARY SODIUM

March 1967

Date	Time	Sample Point	Sample Vessel	Coolant Pump Record	Copper (ppm)
3/30/67	0050	FTP	Pyrex	Pumps on	1.41
3/30/67	0220	FTP	"	"	0.23
3/30/67	0415	FTP	"	"	2.28
3/30/67	0620	FTP	"	"	0.65
3/30/67	1100	FTP	"	"	0.42
3/30/67	1300	FTP	"	"	0.41
3/30/67	2030	PI-A	Stainless Steel	"	1.21
3/30/67	2150	FTP	Pyrex	"	0.45
3/31/67	0200	FTP	"	"	1.41
3/31/67	0230	FTP	"	"	2.46
3/31/67	1530	FTP	"	"	0.63
3/31/67	2145	FTP	"	"	0.55

TABLE V

CHEMICAL ANALYSIS RESULTS FOR COPPER IN HISTORICAL SAMPLES OF EBR-II PRIMARY SODIUM

Date	Sample Point	Sample Vessel	Cu (ppm)
3/ 7/63	PI-A	Aluminum (100 g Na)	0.27
6/27/64	"	"	0.23
2/26/67	"	"	0.50
3/11/65	"	"	0.70
10/18/65	"	"	0.30
6/16/66	"	"	0.83
7/25/66	"	"	0.23
8/ 4/66	"	"	0.75
9/29/66	"	"	0.30
10/25/66	"	"	0.54
11/10/66	"	"	0.60
12/ 2/66	"	"	0.50
1/25/67	"	"	0.50
2/27/67	"	"	0.50

2. Copper in Primary Sodium (continued)

Work was initiated on March 4 to remove the entire primary plugging loop, PI-A, and to replace it with the plugging loop from the secondary sodium system. The installation was completed on March 8. This permitted continued measurement of primary plugging temperatures and taking of sodium samples for chemical analyses of copper content.

At the same time as the work on PI-A loop was in progress, the valves were removed from PI-B, the plugging loop downstream of the cold trap. These valves were made available for installation, with a newly fabricated economizer, in the secondary system. It was found impossible to remove the PI-B economizer because of severely limited accessibility.

A "dip sampler" was fabricated to permit taking of samples from the bulk primary sodium through the fuel transfer port.

A program was initiated on March 8 which involved sampling from the PI-A loop and from the fuel transfer port for comparative purposes. Relatively large sodium samples (100 to 300 grams each) were taken initially. A series of samples was taken with the cold trap secured, as they had been during the prior work in March.

The primary cold trap was put in service on March 10 and maintained in operation at flow rates mostly in the range 15 to 30 gallons per minute for the remainder of the month except for a short outage on April 1, 1967. Initially, plugging temperatures were about 280° to 300° F. They showed a continuing decrease with cold trap operation until, during the last half of March, they were consistently less than 250° F.

Sampling from PI-A and the fuel transfer port was continued to discover whether cold trap operation would reduce the copper concentration in the primary sodium.

The variations observed in the analyses for copper in portions of sodium taken from the large samples indicated that non-homogeneity of copper concentration probably exists in such samples. Since these variations were of about the same order as the expected real changes of copper concentration in the primary sodium, it was recognized that improved sampling methods were required.

To obviate the effects of possible segregation of copper in the cooled sodium sample, smaller samples (10 to 15 grams) were taken. All of this sample is analyzed; thus, the segregation of copper in the sample is eliminated as a factor in comparisons with subsequent determination.

Initial plans called for the use of nickel sample cups because it was expected that the copper content of the nickel would be low. However, because only a few nickel cups were available and material for fabrication of more could not be obtained readily, sample cups were fabricated of type 304 stainless steel.

3. Copper in Primary Sodium (continued)

Subsequent chemical analysis for copper content of the cup material in nickel and stainless steel cups indicated that the nickel contained 109 parts per million of copper and the stainless steel, 200 to 600 parts per million. Tests demonstrated that the nickel readily yields copper to the nitric acid solution used for dissolution of copper in the sodium samples. Stainless steel cups yielded no copper under the same conditions. Hence, stainless steel cups were used for sampling. Some information was obtained to the effect that higher concentrations might be found in sodium samples taken in stainless steel than in samples taken in Pyrex glass. Thereafter, Pyrex beakers were used for sampling from the bulk sodium (fuel transfer port). However, because glass beakers could not be used in the sodium sampling system, use of stainless steel cups for the PI-A samples was continued.

Chemical analyses for copper were performed in the Idaho Division Chemistry Laboratory during the first half of the month (samples taken through 3/12/67). The determinations of copper concentrations were made by the neo-cuproin colorimetric method. Samples taken on, and after, March 15 were analyzed in the Chemistry Laboratory of the Idaho Chemical Processing Plant (ICPP), by the same colorimetric method. Occasional check analyses were performed in the Idaho Division Laboratory.

Starting on March 20, a very intensive sampling program was conducted to check analytical precision and to better define the copper concentration in the primary sodium. Initially, the primary coolant pumps were operated only intermittently, between fuel handling periods. Starting on March 26, the pumps were maintained in operation at full reactor flow rate to provide maximum mixing of the primary sodium. Full flow was continued for the remainder of the month.

The throttle valve and the plugging valve were removed from the PI-A loop on March 28 to permit inspection for copper deposition. The valves had been in service since March 8. The valves were disassembled and sodium was dissolved from the stems and bodies by enthanol. There was no visual evidence of copper deposition on the valve surfaces. The PI-A loop was returned to service.

A sampling valve was installed at the PI-B location downstream of the primary cold trap, to permit sampling and analysis for copper in the cold trap effluent.

During attempts to sample from the PI-A loop on March 31, it was found that the sampling valve leaked in the closed position. Also, difficulties were encountered with the sampling system components.

A temporary sampling system was devised and constructed, comprised of an ambient pressure sampling chamber, argon-purged, and a large waste vessel for collecting overflow sodium. The sampler was designed to accommodate 10 millilitter Pyrex beakers of the same type as used for the dip samples from the fuel transfer port. This sampling system was put into operation successfully on April 1, for taking samples from cold trap influent and effluent.

3. Copper in Primary Sodium (continued)

Sampling from the fuel transfer port was continued in conjunction with these samples. Copper analysis results obtained in March are presented in Table IV. Results of copper analysis on portions of EBR-II historical sodium samples are given in Table V.

To check for copper deposition on reactor components a blanket subassembly removed from Row 6 of the reactor was "leached" in nitric acid. Great care was taken to eliminate spurious sources of copper and to measure copper contributions from sources which could not be eliminated. For comparative purposes, a newly fabricated stainless steel reflector subassembly, having about the same exposed stainless surface as the standard blanket subassembly, was also "leached". The copper concentration in the acid wash solution from the blanket subassembly contained 625 micrograms of copper whereas the solution from the new stainless steel subassembly contained 1969 micrograms. These results indicate that copper deposition on the blanket subassembly, if any, was insignificant.

The stainless steel strainers from experimental subassemblies X009 and X013 were separately leached in nitric acid and the solutions were analyzed for copper. These subassemblies had not been washed for sodium removal prior to disassembly. The surface area of the strainer is 220 sq. cm. Pertinent data are tabulated below:

Strainer From Subassembly	Time in Reactor	Cu Micrograms	Cu, Micrograms per sq. cm.
X009	3/20/66 - 12/21/66	120	0.55
X013	7/17/66 - 9/ 7/66	109	0.49

4. Secondary System

a. Secondary Sodium Pump

The secondary sodium pump was only operated at standby flow this quarter since there was no power operation.

b. Argon and Sodium Chemistry

The on-line chromatograph analyzing argon from the surge tank showed less than 10 ppm hydrogen and 1,000 to 1,400 ppm nitrogen. Samples of argon taken from the supply, surge tank, and storage tank and analyzed in the laboratory showed less than 100 ppm hydrogen and less than 100 ppm nitrogen. Air contamination of samples taken for this analysis continues to be a problem.

b. Argon and Sodium Chemistry (continued)

The following results were received from the ANL Chemistry Division's analysis for oxygen and nitrogen:

Date Sampled	ppm Oxygen	ppm Hydrogen
11/17/66	6, 6	2.1, 4.7
12/28/66	7, 6	5.1, 2.9
1/25/67	4, 7	6.1, 3.5

5. Steam System

a. Pressures and Temperatures

No steam was produced by reactor operation during this quarter.

b. Water Treatment

1) Steam and Condensate

There was no operation during this quarter.

2) Cooling Water

The pH of the cooling water ranged from 5.5 to 8.0. The pH control was impractical most of the period as the cooling water circulation was limited to Plant Services demand. The CrO_4 content varied from 5 to 20 ppm.

A test unit was installed to investigate the possibility of chromate reduction using sulfur dioxide.

II. Fuel Handling

The reactor was not operated except for low power physics experiments during this quarter, however extensive fuel handling was accomplished. The reactor was loaded for power run 25.

Surveillance examination of the fertile elements in subassemblies installed in Rows 7 and 8 indicated that the fertile (depleted uranium) material had substantial growth and in some cases was in contact with the clad. The subassemblies in Rows 7 and 8 were replaced with subassemblies loaded with stainless steel.

Four measurements of fission rate distribution were made in Runs 25A, 25B, 25C, and 25D, requiring the installation and removal of several flux wire subassemblies for each run.

A total of 564 individual transfers of subassemblies either to or from the reactor grid or the storage basket were made.

A. Experimental Irradiations

Five experimental subassemblies were installed in the reactor grid. Two (X019, X020) contained oxide fuel materials and three (X016, X021, X022) containing only structural materials.

The irradiation of experimental subassemblies XG06 and X014 was completed and they were removed from the reactor grid and transferred to the Fuel Cycle Facility for examination.

B. Subassembly Inventory

A total of 21 subassemblies which include one experimental subassembly (XG06) were transferred to the Fuel Cycle Facility for examination, disassembly, and reprocessing of the spent subassemblies.

Thirty-nine reprocessed subassemblies were received from the Fuel Cycle Facility.

Five experimental subassemblies were received and installed in the reactor.

Twenty-four subassemblies were available on March 31 and eight were available on December 31.

C. Grid Loading Changes

The reactor grid was loaded for Run 25 and loading changes were made for four flux mapping physics low power runs.

C. Grid Loading Changes (continued)

A summary of the core loading for Run 25 is given below:

Core Size	[illegible]
Experimental Irradiation Subassemblies	16

D. Subassembly Utilization

The average utilization of the subassemblies removed for the power run 25 loading is 94%. The average utilization of the twenty spent subassemblies transferred to the Fuel Cycle Facility is also 94%.

TABLE VI

LOADING CHANGES FOR RUN NUMBER 25

Remove	Maximum Burnup	From	Install
C=252	1.19	2A1	C=298
C=270	.48*	2C1	C=292
X014	==	2D1	X021
C=254	1.197	2E1	C=297
S=610	1.11	3A1	S=612
C=255	1.11	3B1*	C=286
C=286	==	3B1*	C=2035
C=256	1.16	3C2	C=291
C=258	1.11	3E1	C=296
C=259	1.16	3E2	C=293
C=278	.02*	4A3	C=2002
C=271	.43*	4B3	C=2003
C=260	1.10	4D2*	C=2000
C=2000	==	4D2*	C=282
C=282	.20*	4D2	C=2000
C=282	==	4D3	X016
XG06	5.81	4E2*	C=2000
C=2000	==	4E2*	X014
C=275	.43*	4E3	C=2004
C=246	1.17	4F3	C=2001
C=238	1.15	5A2*	C=237
C=237	1.00	5A2*	C=294
OSR=2	==	5A3	L=437
C=245	1.145	5A4	C=278
C=247	1.15	5B2	C=271
L=436	1.08	5C3	L=446
C=236	1.14	5D4	C=295

Remove	Maximum Burnup	From	Install
C=243	1.15	5E2	C=226
C=239	1.15	5E4	C=275
C=244	1.15	5F2	C=265
C=240	1.15	5F4	C=287
A=740	.056	6A1*	B=352
B=352	==	6A1*	A=834
A=731	.056	6B1*	B=355
B=355	==	6B1*	A=808
A=706	.044	6B5	X020
A=768	.056	6C1	B=356
A=724	.01	6C2	B=357
A=707	.056	6D1	B=351
B=351	.16*	6D2	X019
B=319	.99	6D4	B=354
A=767	.056	6D1*	B=358
B=358	==	6E1*	A=832
A=729	.033	6E2	B=359
A=742	.056	6F1	B=360
A=771	.056	6F2	B=325

Source Transfers

Remove	From	Install
SO=1915	7E2	A=747
====	8E5	SO=1915

TABLE VI (continued)

LOADING CHANGES FOR RUN NUMBER 25

Run 25-A

Remove	From	Install & Remove	From	Install
C-283	1A1	W-13	1A1	C-283
C-263	3A2	W-15	3A2	C-263
C-291	3C2	W-14	3C2	C-291
C-267	4B1	W-16	4B1	C-267
B-342	6B4	W-12	6B4	B-342
A-769	7C4	W-6	7C4	A-769
U-1145	8C4	W-7	8C4	U-1145
C-274	5C4	W-17	5C4	C-274

Run 25-B

Remove	From	Install & Remove	From	Install
C-265	5F2	W-17	5F2	C-265
C-268	4C1	W-16	4C1	C-268
C-266	3F2	W-15	3F2	C-266
C-293	3E2	W-14	3E2	C-293
C-219	3D2	W-13	3D2	C-219
B-348	6D3	W-12	6D3	B-348
U-1332	8F4	W-7	8F4	U-1332
A-769	7C4	W-6	7C4	A-769

Run 25-C

Remove	From	Install & Remove	From	Install
A-762	7A4	W-6	7A4	A-762
U-1337	9A4	W-7	9A4	U-1337
U-1123	11A7	W-8	11A6	U-1123
U-1070	13A7	W-9	13A7	U-1070
U-1047	15A8	W-10	15A8	U-1047
U-1289	14A1	W-11	14A1	U-1289

Run 25-D

Remove	From	Install & Remove	From	Install
C-283	1A1	W-13	1A1	C-283
C-263	3A2	W-16	3A2	C-263
C-268	4C1	W-15	4C1	C-268
C-274	5C4	W-14	5C4	C-274
B-350	6A3	W-12	6A3	B-350
U-1337	9A4	W-10	9A4	U-1337
U-1009	11C6	W-9	11C6	U-1009
U-1605	8A4	W-8	8A4	U-1605
U-1317	9C5	W-7	9C5	U-1317

TABLE VI (continued)

LOADING CHANGES FOR RUN NUMBER 25

Spent Subassemblies Transferred to FCF

Subassembly Number	Grid Position	Maximum Burnup	Date
B-319	6D4	.99	2/ 4/67
C-236	5D4	1.14	1/26/67
C-238	5A2	1.15	1/24/67
C-239	5E4	1.15	1/25/67
C-240	5F4	1.15	1/30/67
C-243	5E2	1.15	1/31/67
C-244	5F2	1.15	1/23/67
C-245	5A4	1.145	1/31/67
C-246	4F3	1.17	1/16/67
C-247	5B2	1.15	1/25/67
C-252	2A1	1.19	1/16/67
C-254	2E1	1.197	1/16/67
C-255	3B1	1.11	1/31/67
C-256	3C2	1.16	1/31/67
C-258	3E1	1.11	1/24/67
C-259	3E2	1.16	1/17/67
C-260	4D2	1.10	1/30/67
L-436	5C3	1.08	2/ 3/67
S-607	3D1	1.145	2/ 5/67
S-610	3A1	1.11	2/ 3/67
XG06	4E2	5.81	2/20/67

TABLE VI (continued)

LOADING CHANGES FOR RUN NUMBER 25

Reprocessed Subassemblies Received From FCF

Subassembly Number	Date	Subassembly Number	Date
B-358	1/ 3/67	C-2003	1/ 6/67
B-359	1/ 3/67	C-2004	1/ 7/67
B-360	1/ 3/67	C-2025	2/ 1/67
B-361	3/ 3/67	C-2027	2/ 2/67
B-362	3/31/67	C-2028	2/ 4/67
B-363	3/31/67	C-2030	2/ 4/67
B-364	3/31/67	C-2031	2/ 5/67
B-365	3/31/67	C-2035	2/25/67
B-366	3/31/67	L-450	3/ 9/67
B-367	3/31/67	L-451	3/10/67
C-291	1/ 4/67	L-452	3/10/67
C-292	1/ 5/67	L-453	3/16/67
C-293	1/ 5/67	L-454	3/16/67
C-294	1/ 5/67	L-455	3/16/67
C-295	1/ 5/67	L-456	3/16/67
C-296	1/ 5/67	S-604	3/14/67
C-297	1/10/67	S-606	3/15/67
C-298	1/11/67	X016	1/11/67
C-299	2/ 2/67	X019	1/14/67
C-2000	1/ 7/67	X020	1/11/67
C-2001	1/ 6/67	X021	2/25/67
C-2002	1/ 6/67	X022	2/25/67

TABLE VI (continued)

LOADING CHANGES FOR RUN NUMBER 25

Stainless Steel "A" Type Subassemblies Changed

Remove	From	Install	Remove	From	Install
A-712	7A2	A-800	A-761	7A5	A-818
A-763	7B3	A-801	A-753	7B5	A-819
A-754	7C1	A-802	A-769	7C4	A-820
A-765	7D2	A-803	A-746	7C5	A-821
A-700	7E1	A-804	A-716	7D5	A-822
A-717	7F1	A-805	A-738	7E4	A-823
A-730	7A3	A-806	A-728	7E5	A-824
A-745	7B2	A-807	A-726	7F2	A-825
A-770	7C2	X022	A-702	7A6	A-826
A-710	7D3	A-809	A-708	7C6	A-827
A-747	7E2	A-810	A-755	7C6	A-828
A-747	7F4	A-811	A-732	7D6	A-829
A-762	7A4	A-812	A-721	7E6	A-830
A-733	7B4	A-813	A-741	7F6	A-833
A-775	7C3	A-814	B-358	6E1	A-832
A-772	7D4	A-815	B-355	6B1	A-808
A-722	7E3	A-816	B-352	6A1	A-834
A-714	7F5	A-817			

TABLE VI (continued)

LOADING CHANGES FOR RUN NUMBER 25

Stainless Steel "U" Type Subassemblies Changed

Remove	From	Install	Remove	From	Install
U-1480	8E4	U-1600	U-1406	8D3	U-1622
U-1502	8E6	U-1601	U-1385	8E2	U-1623
U-1063	8B4	U-1602	U-1040	8B2	U-1624
U-1332	8F4	U-1603	U-1404	8F2	U-1625
U-1145	8C4	U-1604	U-1164	8C2	U-1626
U-1419	8A4	U-1605	U-1154	8A2	U-1627
U-1021	8D4	U-1606	U-1450	8D2	U-1628
U-1324	8B5	U-1607	U-1171	8E7	U-1629
U-1334	8F5	U-1608	U-1072	8B7	U-1630
U-1438	8C5	U-1609	U-1539	8F7	U-1631
U-1468	8A5	U-1610	U-1425	8C7	U-1632
U-1026	8D5	U-1611	U-1315	8A7	U-1633
U-1073	8B6	U-1612	U-1255	8D7	U-1634
U-1335	8C6	U-1613	U-1043	8E1	U-1635
U-1316	8C6	U-1614	U-1436	8B1	U-1636
U-1407	8A6	U-1615	U-1039	8F1	U-1637
U-1517	8D6	U-1616	U-1295	8C1	U-1638
U-1386	8E3	U-1617	U-1293	8A1	U-1639
U-1506	8B3	U-1618	U-1235	8D1	U-1640
U-1430	8F3	U-1619	U-1339	9A5	U-1479
U-1116	8C3	U-1620	U-1094	10A5	U-1280
U-1402	8A3	U-1621			

TABLE VI (continued)

LOADING CHANGES FOR RUN NUMBER 25

Inner and Outer Blanket Subassemblies to FCF

Subassembly Number	Grid Position	Date	Subassembly Number	Grid Position	Date
A-700	7E1	3/13/67	A-742	6E1	2/10/67
A-702	7A6	3/ 8/67	A-743	6A2	2/ 9/67
A-703	7F3	2/11/67	A-745	7B2	3/10/67
A-706	6B5	2/10/67	A-746	7C5	3/11/67
A-707	6D1	2/12/67	A-747	7E2	3/ 1/67
A-708	7B6	3/ 4/67	A-749	6D5	2/ 9/67
A-710	7D3	3/11/67	A-751	6C2	2/ 8/67
A-712	7A2	3/ 7/67	A-752	7A3	2/15/67
A-713	6B2	2/13/67	A-753	7E5	3/13/67
A-714	7F5	3/ 1/67	A-754	7C1	3/ 1/67
A-716	7D5	3/ 7/67	A-755	7C6	3/17/67
A-717	7F1	3/13/67	A-756	6E5	2/11/67
A-719	6F5	2/12/67	A-757	7A1	2/ 9/67
A-720	6D3	2/12/67	A-758	6D2	2/12/67
A-721	7E6	3/ 6/67	A-760	7F4	1/27/67
A-722	7E3	3/15/67	A-761	7A5	3/ 8/67
A-724	6C2	2/14/67	A-762	7A4	3/ 6/67
A-725	7B1	2/ 8/67	A-763	7B3	3/16/67
A-726	7F2	3/10/67	A-764	6F3	2/13/67
A-728	7E5	3/ 3/67	A-765	7D2	3/15/67
A-729	6E2	2/11/67	A-767	6E1	2/ 8/67
A-730	7A3	3/11/67	A-768	6C1	2/14/67
A-731	6B1	2/14/67	A-769	7C4	3/ 8/67
A-732	7D6	3/10/67	A-770	7C2	3/ 2/67
A-733	7B4	3/ 4/67	A-771	6F2	2/10/67
A-738	7E4	3/ 6/67	A-772	7D4	3/ 2/67
A-740	6A1	2/ 9/67	A-774	7F4	3/ 3/67
A-741	7F6	3/15/67	A-775	7C3	3/ 7/67

TABLE VI (continued)

LOADING CHANGES FOR RUN NUMBER 25

Inner and Outer Blanket Subassemblies to FCF (continued)

Subassembly Number	Grid Position	Date	Subassembly Number	Grid Position	Date
A-808	7C2	3/18/67	U-1339	9A5	2/23/67
A-831	---	3/18/67	U-1386	8E3	3/30/67
U-1021	8D4	3/22/67	U-1402	8A3	3/31/67
U-1026	8D5	3/24/67	U-1407	8A6	3/29/67
U-1049	8A5	2/ 2/67	U-1419	8A4	3/22/67
U-1063	8B4	3/20/67	U-1430	8F3	3/30/67
U-1073	8B6	3/23/67	U-1438	8C5	3/30/67
U-1094	10A5	3/18/67	U-1468	8A5	3/23/67
U-1124	12E6	2/16/67	U-1480	8E4	3/20/67
U-1145	8C4	3/21/67	U-1502	8E6	3/21/67
U-1206	---	3/ 1/67	U-1506	8B3	3/29/67
U-1316	8C6	3/26/67	U-1517	8D6	3/29/67
U-1324	8B5	3/22/67	U-1548X	9B5	1/ 7/67
U-1332	8F4	3/21/67	U-1549X	11B6	1/ 9/67
U-1334	8F5	3/22/67	U-1550X	13B7	1/ 9/67
U-1335	8F6	3/28/67	U-1551X	15B8	1/10/67

TABLE VI (continued)

LOADING CHANGES FOR RUN NUMBER 25

Stainless Steel Subassemblies From FCF

Subassembly Number	Date	Subassembly Number	Date
A-800	2/16/67	A-827	2/22/67
A-801	2/16/67	A-828	2/23/67
A-802	2/16/67	A-829	2/23/67
A-803	2/16/67	A-830	2/23/67
A-804	2/16/67	A-831	2/23/67
A-805	2/16/67	A-832	2/23/67
A-806	2/16/67	A-833	3/ 1/67
A-807	2/16/67	A-834	3/24/67
A-808	2/17/67	U-1280	3/ 2/67
	3/23/67	U-1468	2/ 1/67
A-809	2/17/67	U-1479	2/ 1/67
A-810	2/17/67	U-1600	3/14/67
A-811	2/17/67	U-1601	3/14/67
A-812	2/17/67	U-1602	3/14/67
A-813	2/17/67	U-1603	3/14/67
A-814	2/17/67	U-1604	3/14/67
A-815	2/17/67	U-1605	3/14/67
A-816	2/17/67	U-1606	3/14/67
A-817	2/18/67	U-1607	3/14/67
A-818	2/18/67	U-1608	3/15/67
A-819	2/18/67	U-1609	3/15/67
A-820	2/18/67	U-1610	3/15/67
A-821	2/21/67	U-1611	3/15/67
A-822	2/21/67	U-1612	3/15/67
A-823	2/21/67	U-1613	3/15/67
A-824	2/21/67	U-1614	3/15/67
A-825	2/21/67	U-1615	3/16/67
A-826	2/21/67	U-1616	3/16/67

TABLE VI (continued)

LOADING CHANGES FOR RUN NUMBER 25

Stainless Steel Subassemblies From FCF (continued)

Subassembly Number	Date
U-1617	3/16/67
U-1618	3/16/67
U-1619	3/16/67
U-1620	3/16/67
U-1621	3/17/67
U-1622	3/17/67
U-1623	3/17/67
U-1624	3/17/67
U-1625	3/18/67
U-1626	3/18/67
U-1627	3/18/67
U-1628	3/18/67
U-1629	3/18/67
U-1630	3/18/67
U-1631	3/18/67
U-1632	3/18/67
U-1633	3/22/67
U-1634	3/22/67
U-1635	3/22/67
U-1636	3/22/67
U-1637	3/22/67
U-1638	3/22/67
U-1639	3/22/67
U-1640	3/22/67

III. Reactor Physics

During the times that the reactor was loaded for Run 25, the opportunity was taken to measure the fission rate distribution throughout the core and blanket of EBR-II. The measurements were made in order to clearly establish the power distribution for the large core, verify 1D and 2D calculations, and to obtain fission and capture rate distribution in the blanket. The latter is to be used in determining the breeding ratio of EBR-II.

In order to obtain these measurements, special fueled subassemblies were designed to permit continued reuse in low power measurements. The special subassemblies are standard EBR-II fuel subassemblies with the exception that 6 fuel elements from the outer row, one on each flat, have been replaced with a stainless steel tube of the same outer dimension as a fuel element but which runs from the bottom of the core to the top of the subassembly. Into these tubes, sealed capsules containing U^{235} or U^{238} wires were inserted for irradiation at levels of from 10-50 kW for 1 to 2 hours. There are 6 of these subassemblies available, one of which is usable in Row 6 and one of which contains 2 tube psoitions per flat instead of one.

Four irradiations labelled 25A, B, C, and D were made under the following conditions:

25A and 25B: These runs were made with a uranium blanket with wire detector measurements in 12 different core positions.

25C: Measurements made in the uranium blanket, Rows 7 through 15.

25D: Core and reflector measurements with the stainless steel reflectors in Rows 7 and 8.

The results of these measurements are given in Figure X through Figure XII.

Figure X gives the fission rate distribution for Runs 25A and 25B. The Data were normalized to the calculated value of a SNARG calculation at the radial distance of 30.5 cm. The wide scatter of the data is indicative of the heterogeneity of the core. These positions were purposefully chosen to be near experimental subassemblies, and to measure their perturbations.

Figure XI shows the results of Run 25C.

The data are in good agreement with calculations for both U^{235} and U^{238}. The calculated curves reflect fission rates from pure U^{238}, whereas the measured values were obtained from natural U wires. The corrected data are shown as (+). Since the blanket material is natural uranium, the uncorrected data reflect the true power distribution in the blanket. The relative increase near the outer edge of the reactor is attributed to the moderating effect of the graphite neutron shield which surrounds the blanket.

Figure XII shows the results of the U^{235} and U^{238} fission rate distributions with stainless steel reflectors in Rows 7 and 8. The solid curve is the SNARG

III. Reactor Physics (continued)

calculation with a stainless steel reflector. It is obvious that while the calculations are adequate for the core region, the region at the core-stainless steel interface and within the stainless steel reflector is not adequately described by calculations. Considerable effort is now being expended to clarify this discrepancy.

IV. Experimental Irradiations

A. Experimental Subassembly Locations

See previous Report of EBR-II Operations (October 1, 1966 through December 31, 1966) for location of experimental subassemblies during last power run number 24.

B. Experimental Subassembly Contents and Exposure Status

Descriptions of experimental capsules and exposures in the experimental subassemblies that have been resident in the reactor to date are given in Table VII.

V. Systems Maintenance, Improvements, and Tests

A. Mechanical and Electrical

1. Main Turbine Surface Condenser

Thirty-one brass studs in the tube sheet divider plates in the main surface condenser were found broken. All of the broken studs were replaced with new ones. A number of these studs had to be removed by drilling and retapping.

2. Turbine Driven Condensate Pump

The inspection of the turbine driven condensate pump and steam inlet valve was completed. The valve seat was reground due to steam cuts. The bearing on the outboard end of the turbine was wiped. All clearances were checked, new carbon seals and a new bearing were installed.

3. Condensate Minimum Flow Valve

The condensate minimum flow control valve (VC-553) was relocated in accordance with plant modification number 81.

4. Nash Pump

The Nash pump cooling water supply was changed from the plant cooling water system to the potable well water supply. This change was made due to chronic plugging of the strainers in the plant cooling water system. This change was made as a test and will be included as a plant modification if the changeover proves satisfactory.

TABLE VII
SUMMARY OF CAPSULE IRRADIATIONS IN EBR-II
3-31-67

IRRADIATED TO 3-31-67

CAPSULES, FUEL - 194 MK-A
CAPSULES, MTLS. - 106 MK-A
21 MK-B-7
19 MK-B-19
TOTAL 340

NO. OF SUBASSY'S 23

EBR-II ASSEMBLY	GRID LOCATION	EXPERIMENTER	GOAL EXPOSURE MWd	ACTUAL FINAL EXPOSURE MWd	STATUS AS OF 3-31-67 MWd	DATE INSTALLED	DATE REMOVED	FUEL CAPSULES: FUEL	NO. OF CAPS & DESIGNATION	POWER GENERATION KW/FT MAX	POWER GENERATION KW/FT MIN	MID-PLANE BURNUP RATES $\times 10^{-4}$ MWd MAX	MID-PLANE BURNUP RATES $\times 10^{-4}$ MWd MIN	STATUS AS OF 3-31-67 LBU MAX	MATERIAL CAPSULES: NO. OF CAPS & DESIGNATION	MATERIAL	TYPE OF SAMPLE: BURST TEST	TYPE OF SAMPLE: TENSILE	TYPE OF SAMPLE: CREEP RUPTURE	STATUS AS OF 3-31-67 NVT $\times 10^{-22}$ TOTAL FLUX
XA01	8D2	ANL-MET	14,000	3,940*		5-6-65	3-24-66	U-Pu-Fz	19- C93 C97 C98 C99 C100 C101 CA01 CB02 CB03 CB04 CD01 CD02 CG02 CG03 CJ01 CM01 LA02 PA01 PB02	2.7	2.0	1.23	.91	0.48						
XG01	4F2	GE	700	381*		5-6-65	5-23-65	UO_2-20PuO_2	6- F1A F1B F1C F1D F1E F1F	16	14	5.78	5.08	0.22						
		GE													4- P1A P1B MT1 MT2	347 347 HAST X INCO-625 I-800 HAST-X INCO-625 I-800	X X 	X X X X		0.14
XG02	7A1	GE	13,600		9744	7-16-65		UO_2-PuO_2	1- F0E	5.3		1.99		1.9						
XG03	7D1	GE	19,450		9744	7-16-65		UO_2-PuO_2	2- F0A F0C	5.3	4.6	1.99	1.83	1.9						

TABLE VII (Cont.)

SUB ASSEMBLY	GRID LOCATION	EXPERIMENTER(S)	GOA EXPOSURE MWd	ACTUAL FINAL EXPOSURE MWd	STATUS AS OF 3-31-67 MWd	DATE INSTALLED	DATE REMOVED	FUEL CAPSULES: FUEL	NO. OF CAPS & DESIGNATION	POWER GENERATION KW/FT MAX	POWER GENERATION KW/FT MIN	MID-PLANE BURNUP RATES MWd/kg MAX	MID-PLANE BURNUP RATES MWd/kg MIN	STATUS AS OF 3-31-67 MAX	STATUS AS OF 3-31-67 MIN	MATERIAL CAPSULES: NO. OF CAPS & DESIGNATION	MATERIAL	TYPE OF SAMPLE: BURST TEST	TYPE OF SAMPLE: TENSILE	TYPE OF SAMPLE: CREEP RUPTURE	STATUS AS OF 3-31-67 NVT x 10^{-22} TOTAL FLUX
XG04	7B1	GE	39,000		9744	7-16-65		UO_2-PuO_2	2- F0B F0D	5.3	4.6	1.99	1.83	1.9							
XG05	4C2	GE	10,300		9317	9-3-65		UO_2-PuO_2	9- F2C F2D F2G F2H F2O F2R F2T F2V F2X	14.6	12.8	5.78	5.08	5.4	5- L2A L2C L2E L2G L2I	1-800 316 L 347 304 321	X X X X X	X X X X X		3.4
		ANL			9317			UC-PuC	3- HMV-5 HMV-11 SMV-2	18.3	17.8	5.38	5.20	5.0							
		ANL			9317			U-15Pu-10Zr	2- NC-17 ND-24	8.1	8.0	4.97	4.89	4.6							
XG06	4E2	GE	20,600			9-3-65	2-20-67	UO_2-PuO_2	12- F2A F2B F2E F2F F2N F2P F2Q F2S F2U F2W F2Y F2Z	14.6	12.8	5.78	5.08	5.4	5- L-2'-K L-2'-M L-2'-O L-2'-P L-2'-Q	1-800 316 L 347 321 304	X X X X X	X X X X X		3.4
		ANL						U-15Pu-10Zr	2- NC-23 ND-23	8.7	8.1	5.32	4.97	5.0							

TABLE VII (Cont.)

SUB ASSEMBLY	UNIT LOCATION	EXPERIMENTER(S)	GROSS EXPOSURE MWd	ACTUAL FINAL EXPOSURE MWd	STATUS 3-31-67 MAb	DATE INSTALLED	DATE REMOVED	FUEL	FUEL CAPSULE DESIGNATION	POWER GENERATION KW/FT MAX	POWER GENERATION KW/FT MIN	WG-PLANE BURNUP RATES $\times 10^4$ MWd/MT MAX	WG-PLANE BURNUP RATES $\times 10^4$ MWd/MT MIN	STATUS 3-31-67	MATERIAL CAPSULE DESIGNATION	MATERIAL	TEST TYPE TEST	TEST TYPE TENSILE	TEST TYPE CREEP RUPTURE	STATUS 3-31-67 NET EXPOSURE TOTAL FLUX
XA07	4D3	AML	18,600	7950		10-27-65	12- 5- 66	U-15Pu-9Zr	16- ND-25 ND-26 ND-27 ND-28 ND-29 ND-30 ND-31 ND-32 ND-33 ND-34 ND-35 ND-37 ND-39 ND-41 ND-43 ND-44	8.9	7.8	5.48	4.81	4.35	3- As-9 As-10 As-11	 V-20Ti HAST-X 304			 X X X	3.0
XA08	4F2	AML GE	19,800		7495	12-13-65		(Pu-U)C	8- HMV-1 HMV-4 HWMP-1 HWMV-1 NMP-2 NMV-4 NMV-7 NMV-12	25.0	16.2	5.83	5.10	4.4	9- As-1 As-2 As-3 As-4 As-5 As-6 As-7 As-8 As-12 2- MT-3 MT-4	 V-20Ti V-20Ti HAST-X HAST-X 304 V-20Ti HAST-X 304 V-20Ti I-800 I-800	 X X X X X X	 X X	 X X X X X X X X X	2.8 2.8
X009	4A2	UNC AML AML PNWL (ANL)	5,130	5355	7495	3-24-66	11-14-66	PuC-UC PuC-UC UO_2-PuO_2 PuO_2-S/S	3- UNC-78 UNC-79 UNC-80 3- SMP-1 SMV-1 VMV-1 2- SOV-5 SOV-6 2- SP-13 SP-14	26.5 25.5 14.0 9.6	18.5 17.1 13.3 6.1	5.74 5.83 5.33 6.19	5.56 5.10 5.16 6.19	3.07 3.12 2.86 3.21	3- As-14 As-15 As-27 4- A-1 A-2 A-5 A-6	 V-20Ti V-20Ti 304 304		X X X X X X X	 X X X X	2.0 2.0

TABLE VII (Cont.)

SUB ASSEMBLY	GRID LOCATION	UPPER [illegible]	[illegible]	ACTUAL EXPOSURE MWd	BATCH BURNUP AS OF 3-31-67 MWd	DATE INSTALLED	DATE REMOVED	FUEL	NO. OF CAPS & DESIGNATION	FUEL CAPSULES: 1 HOUR GENERATION KW/FT MAX	1 HOUR GENERATION KW/FT MIN	MID-PLANE BURNUP RATES MAX	MID-PLANE BURNUP RATES MIN	STATUS AS OF 3-31-67	MATERIAL CAPSULES: NO. OF CAPS & DESIGNATION	MATERIAL	TYPE OF SAMPLE: BURST TEST	TENSILE	CREEP RUPTURE	STATUS AS OF 3-31-67 NVT x 10^{-22} TOTAL FLUX
2009 (CONT.)		[illegible]													2-					2.0
															L-4-C	316	X	X		
															L-4-D	316	X			
X010	7F3		[illegible]		6675	[illegible]		UO_2-PuO_2	4- FOJ FOK FOL FOM	8.1	7.3	3.00	2.77	1.9						
		[illegible]			6675										11-					1.1
															As-16	V-20Ti		X		
															As-17	V-20Ti		X		
															As-18	V-20Ti		X		
															As-19	HAST-X			X	
															As-20	V-20Ti, 304 HAST-X			X	
															As-21	V-20Ti	X			
															As-22	304				
															As-23	304				
															As-24	304				
															As-25	304				
															As-26	304				
		[illegible]			[illegible]										4-					1.1
															A-3	304		X	X	
															A-4	304		X	X	
															A-7	304		X	X	
															A-8	304		X	X	
X011	7F4	[illegible]	8,300		5104	5-[illegible]-66		UO_2-20PuO_2	7- HOV-4 HOV-10 HOV-15 SOV-1 SOV-3 SOV-7 TVOV-1	19.2	16.2	6.11	5.81	3.1						

TABLE VII(Cont.)

SUB ASSEMBLY	GRID LOCATION	EXPERIMENTER OR [illegible]	[illegible]	ACTUAL FINAL EXPOSURE MWd	STATUS AS OF 3-31-67 MWd	DATE INSTALLED	DATE REMOVED	FUEL CAPSULES: FUEL	NO OF CAPS & DESIGNATION	POWER GENERATION KW/FT MAX	POWER GENERATION KW/FT MIN	MID-PLANE BURNUP RATES [illegible] MAX	MID-PLANE BURNUP RATES [illegible] MIN	STATUS AS OF 3-31-67 [illegible] MAX	MATERIAL CAPSULES: NO OF CAPS & DESIGNATION	MATERIAL	TYPE OF SAMPLE: BURST TEST	TYPE OF SAMPLE: TENSILE	TYPE OF SAMPLE: CREEP RUPTURE	STATUS AS OF 3-31-67 NVT X 10^{-22} TOTAL FLUX
X011 (CONF.)		GE			5104			UO_2-20PuO_2	9- F4A F4D F4E F4F F4G F4H F4J F4K F4L	16.9	15.5	6.11	5.81	3.1						
		PNW			5104			PuO_2-S/S	2- 5P-9 5P-12	10.9	7.1	7.10	7.04	3.6						
		PNW			5104			UO_2-S/S	1- 5U-14	5.6	5.6	5.78		3.0						
X012	482	RUMEC	20,600		2975	8-10-66		UO_2-20PuO_2	19- C-1 C-2 C-3 C-4 C-6 C-7 C-8 C-9 C-10 C-11 C-12 C-13 C-14 C-15 C-16 C-17 C-18 C-19 D-5	14.6	12.7	5.74	5.08	1.7						
X013	301	ANL	1,200	1,309		7-17-66	9- 7-66								19- As-34 As-35 As-36	HAST-X INCO-625 V-20Ti INCO-625 V-20Ti	X X X X X	X X		0.57

TABLE VII (Cont.)

SUB ASSEMBLY	GRID LOCATION	EXPERIMENTER	GOAL FLUENCE MWd	ACTUAL FINAL EXPOSURE MWd	STATUS AS OF 3-31-67 MWd	DATE METALLED	DATE REMOVED	FUEL CAPSULES: FUEL	FUEL CAPSULES: NO. OF CAPS & DESIGNATION	FUEL CAPSULES: LINEAR GENERATION KW/FT MAX	FUEL CAPSULES: LINEAR GENERATION KW/FT MIN	FUEL CAPSULES: WT. % FISSILE BURNUP RATES MAX	FUEL CAPSULES: WT. % FISSILE BURNUP RATES MIN	FUEL CAPSULES: STATUS AS OF 3-31-67	MATERIAL CAPSULES: NO. OF CAPS & DESIGNATION	MATERIAL CAPSULES: MATERIAL	MATERIAL CAPSULES: TYPE OF SAMPLE: BURST TEST	MATERIAL CAPSULES: TYPE OF SAMPLE: TENSILE	MATERIAL CAPSULES: TYPE OF SAMPLE: DEEP RUPTURE	MATERIAL CAPSULES: STATUS AS OF 3-31-67 NVT X 10^{-22} TOTAL FLUX
X013 (CONT)															As-37	HAST-X	X	X		
															As-38	V-15Ti 7.5 CR	X			
																V-20Ti		X		
															As-39	V-15Ti 7.5 CR	X			
																V-20Ti		X		
															As-40	V-15Ti 7.5 CR	X			
																V-20Ti		X		
															As-41	V-15Ti 7.5 CR	X			
																V-20Ti		X		
															As-42	V-15Ti 7.5 CR	X	X		
															As-43	V-15Ti 7.5 CR	X	X		
															As-44	V-15Ti 7.5 CR	X	X		
															As-45	INCO-625 V-15Ti 7.5 CR	X	X		
															As-46	HAST-X	X	X		
															As-47	304	X	X		
															As-48	304	X	X		
															As-49	304	X	X		
															As-54	V-15Ti 7.5 CR	X	X		
															As-55	INCO-625 V-15Ti 7.5 CR	X	X		
		PNWL			1309										1-BG-1	GRAPHITE				.57
X014	4-2	PNWL	**		3674	7-17-66									5-A-9	304		X		1.7
															A-10	348		X		
															A-11	348		X		
															A-12	304		X		
															A-13	304 & 348				

TABLE VII (Cont.)

SUB ASSEMBLY	GRID LOCATION	EXPERIMENTERS	[illegible]	[illegible] FINAL EXPOSURE MWd	STATUS AS OF 3-31-67 MWd	DATE INSTALLED	DATE REMOVED	FUEL CAPSULES: FUEL	FUEL CAPSULES: NO. OF CAPS & DESIGNATION	FUEL CAPSULES: POWER GENERATION KW/FT MAX	FUEL CAPSULES: POWER GENERATION KW/FT MIN	FUEL CAPSULES: [illegible] RATES [illegible] MAX	FUEL CAPSULES: [illegible] RATES [illegible] MIN	FUEL CAPSULES: STATUS AS OF 3-31-67 [illegible] MAX	MATERIAL CAPSULES: [illegible]	MATERIAL CAPSULES: [illegible]	MATERIAL CAPSULES: TYPE OF EXAMINE: [illegible]	MATERIAL CAPSULES: TYPE OF EXAMINE: TENSILE	MATERIAL CAPSULES: TYPE OF EXAMINE: CREEP RUPTURE	MATERIAL CAPSULES: STATUS AS OF 3-31-67 NVT X 10^{-22} TOTAL FLUX
X014 (CONT)		GE			3674										5-					1.7
															L4A	1-800	X	X		
															L4B	1-800	X	X		
															L4E	347	X	X		
															L4F	304	X	X		
															L4G	321	X	X		
		NRL			3674										5-					
															NRL-1	1-800		X		1.7
																HAST-X		X		
																304, 316		X		
															NRL-2	1-800		X		
																316		X		
															NRL-3	1-800				
																304		X		
																316		X		
															NRL-4	1-800				
																304		X		
																316		X		
															NRL-5	INCO-625		X		
																HAST-X				
																316		X		
		PRWR			3674										2-					
															BG-2	GRAPHITE				1.7
															BG-3	GRAPHITE				
		GE			3674										2-					
															MT-5	1-800	X	X		1.7
															MT-6	1-800	X	X		
X015	4A2	HUMET	11,000		1320	11-15-66		UO_2-20PuO_2	11- B-1 B-2 B-3 B-4 B-5 B-6 B-7 B-8 B-9 B-10 B-11	14.5	13.2	5.70	5.25	0.8						
		GE			1320			UO_2-20PuO_2	2- F7C F7D	13.2	13.2	5.25	5.2[illegible]	0.7						

TABLE VII (Cont.)

SUB ASSEMBLY	GRID LOCATION	EXPERIMENTER	GOAL EXPOSURE NVT	ACTUAL FINAL EXPOSURE MWd	STATUS AS OF 3-31-67 MWd	DATE INSTALLED	DATE REMOVED	FUEL CAPSULES: FUEL	NO OF CAPS & DESIGNATION	POWER GENERATION KW/FT MAX	POWER GENERATION KW/FT MIN	MID-PLANE BURNUP RATES MAX	MID-PLANE BURNUP RATES MIN	STATUS AS OF 3-31-67	MATERIAL CAPSULES: NO OF CAPS & DESIGNATION	MATERIAL	TENSILE SAMPLE: PLANE TEST	TENSILE SAMPLE: TENSILE	TENSILE SAMPLE: CREEP RUPTURE	STATUS AS OF 3-31-67 NVT x 10^{-22} TOTAL FLUX
		[illegible]			1320			$(U_{.8}Pu_{.2})C$	4– NMV-3 JVVV-1 HMV-2 NMP-1	25.0	17.6	5.74	3.87	0.8						
		[illegible]			1320			MK-1A (METAL)	2– BF02 BF03	7.2	7.2	2.98	2.98	0.4						
X016	4D3	GE	3,600		0	1-13-67									10 L-10-A	1-800	X	X		0
															L-10-B	1-800	X	X		
															L-10-C	1-800	X	X		
															L-10-D	316	X	X		
															L-10-E	316	X	X		
															L-10-F	316	X	X		
															L-10-G	304	X	X		
															L-10-H	304	X	X		
															L-10-I	347	X	X		
															L-10-J	321	X	X		
		ANL													9 AS-29	304	X	X		0
															AS-30	Vi-Ti-Cr	X	X		
															AS-31	In-625	X	X		
															AS-32	Hast-X	X	X		
															AS-33	In-625	X	X		
															AS-50	Vi-Ti-Cr	X	X		
															AS-51	304	X	X		
															AS-52	Hast-X	X	X		
															AS-53	Hast-X	X	X		
X017	4C3	NuHEC	6,500		1320	11-15-66		UO_2-20PuO_2	11 A1 A2 A3 A4 A5 A6 A7 A8 A9	14.5	12.7	5.70	5.08	0.8						

TABLE VII (Cont.)

SUB ASSEMBLY	GRID LOCATION	EXPERIMENT CENTERLINE	[illegible]	ACTUAL [illegible] PRESSURE PSIG	STATION AS OF 3-31-67 MWd	DATE INSTALLED	DATE REMOVED	FUEL CAPSULES: FUEL	NO OF CAPS & DESIGNATION	POWER GENERATION KW/FT MAX	POWER GENERATION KW/FT MIN	MID-PLANE BURNUP RATES MWd x 10^4 MAX	MID-PLANE BURNUP RATES MWd x 10^4 MIN	STATUS AS OF 3-31-67 (% BU MAX)	MATERIAL CAPSULES: NO OF CAPS & DESIGNATION	MATERIAL	TYPE OF SAMPLE: BURST TEST	TENSILE	REEP RUPTURE	STATUS AS OF 3-31-67 NVT x 10^-22 TOTAL FLUX
X017 CONT.																				
		UN			1920			$(U, Pu)_{[illegible]}O_2$	A10 A11 3 87 89 90	26.8	25.2	5.83	5.46	0.8						
		[illegible]			1320			MK-1A METAL	5 BF04 BF05 BF08 BF09 BF11	7.9	7.7	3.24	3.18	0.0						
X018	23[illegible]	OF	31,[illegible]		630	12-0-66									3 a b c	1800,316 304,316 304,321 347	Y Y Y	Y Y X		0.30
		A[illegible]			630										3 AS56 AS57 *AS58	V20Ti, V15 Ti-7.5Cr HAST-X 304 V20Ti, V15Ti-7.5 CR	Y Y Y X	X Y Y X	X Y X	0.30
		PNW			630										BNWL 7-1	304, 316 321, 348		X	X	
[illegible]	FB[illegible]	C	7,500		0	1-13-67		UO_2-20PuO$_2$	7 F8A F8B F8C F8D F8E F8F F8G	8[illegible]	7	3.4	2.9	0						
		P[illegible]						$(U, Pu)_2O$	3 UNC81 UNC82 UNC83	20	19	8.0	3.7	0						

TABLE VII (Cont.)

SUB ASSEMBLY	GRID LOCATION	EXPERIMENTER	TOTAL EXPOSURE TIME	ACTUAL TOTAL EXPOSURE TIME	STATUS AS OF 3-31-67 MWd	DATE INSTALLED	DATE REMOVED	FUEL CAPSULES: FUEL	NO OF CAPS & DESIGNATION	POWER GENERATION KW/FT MAX	POWER GENERATION KW/FT MIN	W/D-PLANE BURNUP RATES MWd/MT x 10^4 MAX	W/D-PLANE BURNUP RATES MWd/MT x 10^4 MIN	STATUS AS OF 3-3-67 (% BU MAX)	MATERIAL CAPSULES: NO OF CAPS & DESIGNATION	MATERIAL	TYPE OF SAMPLE: BURST TEST	TENSILE	CREEP RUPTURE	STATUS AS OF 3-31-67 NVT x 10^{-22} TOTAL FLUX
XC10 CONT.		PNNL													8					C
															A26	304,316, 348		X		
															A27	304,316, 348		X		
															A28	304,316, 348		X		
															A29	304,316, 348		X		
															A32	304,316, 348		X		
															A33	304,316, 348		X		
															A34	304,316, 348		X		
															A35	304,316, 348		X		
		PNNL													1					
XC08	1C	GE	7.5MW		0	1-12-67		UO_2-20PuO_2	9 FAH FBI FBJ FBK FBL FBM FBN FBO FBP	8	7	3.4	2.9	0	BG5	Graphite				C
		UNC						$(U, Pu)_2C_2$	3 UNCB4 UNCB5 UNCB6	20	19	4.0	3.7	0						
		PNNL													4					C
															A10	304,316 348		X		
															A15	304,316, 348		X		

TABLE VII (Cont.)

SUB ASSEMBLY	GRID LOCATION	EXPERIMENTER	[illegible] MAX	ACTUAL FINAL EXPOSURE MWd	STATUS AS OF 3-31-67 MWd	DATE INSTALLED	DATE REMOVED	FUEL CAPSULES: FUEL	NO. OF CAPS & DESIGNATION	POWER GENERATION KW/FT MAX	POWER GENERATION KW/FT MIN	[illegible] MAX	[illegible] MIN	[illegible] 3-31-67	MATERIAL CAPSULES: [illegible]	[illegible]	TYPE OF SAMPLE: BURST TEST	TENSILE	CREEP RUPTURE	STATUS AS OF 3-31-67 NVT x 10^{-22} TOTAL FLUX
X020 CONT.															A30	304,316, 348		Y		
															A31	304,316, 348		Y		
															1					0
															B_{60}	Graphite				
															2					C
															AS59	304 Vi-Ti	Y	Y		
															AS60	Haste-X, Vi-Ti	X	X		
X021	201	PWR	21,500		0	2-25-67									7					
															BNWL-7-2	304,316,321	X	X		0
															7-3	348, INC-X	X	X		
															7-4	INC-600, INC-800,	X	X		
															7-5	INC-718	X	X		
															7-6	INC-625	X	X		
															7-7	HAST-X	X	X		
															7-8		X	X		
X021	201	PWR	8,000		0	2-26-67									7					
															BNWL-7-9	304,316,321	X	X		
															7-10	348, INC-X	X	X		
															7-11	INC-600	X	X		
															7-12	INC-800	X	X		
															7-13	INC-718	X	X		
																HAST-X	X	X		
															7-14	INC-625				
															7-15		X	X		

5. Main Turbine

The overspeed governor for the main turbine-generator was received from the vendor's shop and has been reinstalled. The checkout of the unit has not been completed.

6. Main Generator Amplidyne

New bearings were installed in the amplidyne for the main generator, every third commutator bar was found to be burnt. The reason for the burning has not been found at this time.

7. Feedwater and Blowdown Systems

Work was started on the feedwater and blowdown trace heating system, plant modification number 72.

8. Secondary Sodium Pump M-G Set

The secondary M-G set generator was "wired in" as a motor and run up to speed. This was done in order to verify that its electrical center was properly located. The unit centered-in properly between the two thrust bearings, so there appears to be nothing wrong with the electrical center. Further investigation of the "thumping" will be conducted when the unit is loaded in its normal manner.

9. Number 1 Primary Pump M-G Set Eddy Current Coupling

The spare primary M-G set eddy current coupling was installed in place of the original number 1 coupling. This was done to minimize primary system downtime in the 10,000 hour running time inspection for the number 1 coupling.

10. Number 1 Primary Pump Blower

Heavy duty mounting plates were fabricated for the primary pump blowers. The plate was installed on the number 1 primary pump. The vibration of the blower reduced from 5 to 10 mils to less than 1 mil.

11. Secondary System Sample Station

Work was started on the improved secondary system sample station, plant modification number 84. The panel work was about completed. The system tie-in, leak testing, trace heating, and insulating remain to be completed.

12. Primary Purification System

Essentially, all of the prefabrication work for the replacement of the primary purification system, plant modification number 86, has been completed.

13. Primary Argon Purification System Blowers Number 1 and Number 2

The annual inspection of the blowers was completed. New bearings were installed in the number 2 unit and both units were put back in service.

14. Reactor Building Equipment Air Lock

The equipment air lock inner and outer doors were given an annual leak rate test. The test indicated a leak rate well below the allowable leak rate of 20 ft^3/day. The outer door and lock had an average leak rate of 6.87 ft^3/day, the inner door had an average leak rate of 1.98 ft^3/day.

15. Primary Auxiliary Pump Rectifier and Cooling System

The primary auxiliary pump rectifier and cooling fans were inspected. Bearings were replaced in two cooling fans and a spare blower and motor were installed for a third unit.

16. Fuel Unloading Machine

The FUM port was cleaned and new "O" rings were installed twice during this report period. A complete IBC to FUM alignment check was made. The fan gripper was cleaned about once every 7 to 10 days.

17. FUM Argon Cooling System

The FUM argon cooling system vapor trap was replaced four times during this report period. About 15 pounds of sodium can be accumulated in the trap before replacement is necessary.

The system was leak tested several times resulting in finding numerous minor leaks. The valve bonnets appear to be the major source of chronic leakage. New bonnets have been received and with minor modifications appear to be much tighter than the original ones. A two inch manual ball valve was installed in the IBC return line. This will act as a backup for the quick disconnect closure which cannot be kept leak tight.

18. Primary Auxiliary Pump

The copper ends of both bus bars for the primary auxiliary pump were found to be eroded when removed from the primary tank. See Figure XII. The repair was made by machining the copper ends to a smooth surface which left the copper 2.625 inches in diameter (original diameter was 3-3/8 inches). A stainless steel collar was made to match the 3-3/8 inch o.d. and, to provide an interference fit with the copper on the i.d., the steel was heated to 700° F to provide a tight shrink fit as assembled.

The upper edge of the collar was made to match the original stainless steel shell of the bus bar, so that a stainless-to-stainless weld could be made to seal this joint.

18. Primary Auxiliary Pump (continued)

The collar was made so that, when assembled, it extended 3/4 inch beyond the lower end of the copper. A fillet weld using copper-silver rod was made in this space to provide additional assurance of a good current path in operation. A stainless steel end plate was then welded to the collar to complete the closure over the copper end where the copper-silver weld was made.

The repair is such that no copper or copper alloy is exposed to sodium, and a relatively heavy (minimum of 1/4 inch thickness) covering of stainless steel is provided.

Figure XIII is a photograph of an as repaired bus bar.

The original seal welds to prevent leakage of sodium up into the bus bars were still sound when the bus bars were removed from the primary tank. These were left intact in addition to the new seal welds provided by the modification, therefore, a double barrier to sodium leakage is now provided. All seal welds were dye-checked.

B. Instrumentation and Control

1. Solid State Nuclear Channel

The solid state nuclear channel has been subjected to a series of tests to determine drift, reproducibility, loading characteristics, time constants, and trip point set repeatability and relay reliability. The equipment exceeds manufacturer's specifications in all categories. Life testing of reed relays for control functions is in progress. One form of the reed relay failed following 1,858, 321 operations while driving a heavy duty Clark relay of 0.750 amperes inductive loading. For the second set of relays, two contacts in series are used to break the inductive relay load. To date, approximately 1.67 million relay operations have occurred without failure. The relay will be considered acceptable providing 100 million or more operations are possible. The work performed here is applicable to WP 1741 Nuclear Instrument Improvements.

2. Secondary Sodium Sampling and Plugging Loops

An instrument panel for the secondary sodium sampling and plugging loops has been assembled and mounted in the Sodium Boiler Plant Control Room. The panel has a six point trace heating system for temperature control of the plugging meter, sampling system, piping, and a liquid metal oxygen meter. Final control alignment has been deferred until the completion of the heavy electrical circuits and the piping.

3. Miscellaneous Modifications

Eight new elapsed time meters were installed as follows:

AC Argon Cooling System Blower
DC Argon Cooling System Blower

3. Miscellaneous Modifications (continued)

Primary Tank Argon Blower #1
Primary Tank Argon Blower #2
Emergency Argon Blower
Turbine Feedwater Pump
Cooling Water Pump #1
Cooling Water Pump #2

Six new signals were added to the card punch for plant analysis.

The tape recorder was modified to increase capacity to fourteen write channels and for a continuous tape loop.

All wiring associated with the rotary rod oscillator was disconnected. Circuits necessary for a normal control rod operation in position number 8 were reconnected. Systems for rod drop and trapezoidal reactivity change testing were interconnected.

4. Constant Power Supplies (WP 1726)

A part shipment of meters has been received from the manufacturer. Among these was the synchroscope necessary for the parallel operation. Preliminary drawings covering outline details and terminations have been received from the switch manufacturer. Delivery on this equipment remains scheduled for 6/10/67.

5. Reactor Instrumentation (WP 1728)

The primary tank level device has been assembled, tests have been performed using water as the level variable, helium leak tests were completed and the tank area was cleared for installation. Installation of the thimble insert is scheduled for the week of April 17, 1967, and system operation the following week. From tests performed, the float is sensitive to a change of level of less than 1/8 inch of sodium at 700° F and a system stability of ± 1/7 inch of sodium.

6. Nuclear Instrument Improvements (WP 1741)

The specifications for three source range channels, three power range channels, one linear channel, and the compensated ion chambers were prepared and submitted for bids. Bids were received from General Electric Company and Edgerton, Germeshausen and Grier, Inc. (EG&G). The bids were evaluated and the contract awarded to EG&G on the basis of low bid meeting specification. Equipment delivery is scheduled to start June 30 and to be completed prior to August 15, 1967.

7. Reactor Systems Improvements (WP 1742)

a. Temperature Monitoring Devices

The bids for the converters and monitoring switches have been evaluated. Equipment delivery is scheduled for May 15, 1967.

The engineering work necessary to modify the systems has started and is 30% complete. All systems to be modified have been reviewed to assure that an extended reactor shutdown will not be required for installation.

b. Multi-Point Recorders

Duplicate equipment has been ordered and equipment delivery is scheduled for May 15, 1967. Alarms and control functions have been removed from existing recorders where required.

c. Miniature Recorders

The miniature recorders have been placed on order and equipment delivery is scheduled for May 15, 1967. Because the systems to be modified will not require a reactor shutdown, the engineering work has been given a lower priority.

d. Selected Parameter System

Considerable effort has been placed on the alarm portion of the selected parameter system. To date the cabinet has been built, the alarm scanning system has been fabricated and installed, the input signal wires have been connected to the master patch panel, and the system checkout is nearing completion. All signals have been checked back to their sources and cleared for reactor operation. Work is in progress setting and checking the alarm system for the twenty-five core subassembly thermocouples, four bulk sodium thermocouples and pre-scram alarms on reactor outlet temperature and outlet plenum pressure. Final alignment of alarm points will be made as soon as the reactor is operated at power.

The specifications for the data acquisition system have been prepared and submitted for bids. Four companies submitted bids with Monsanto submitting the lowest bid satisfying the specifications. Equipment delivery is scheduled for May 15, 1967. The present schedule includes a checkout of the system at the place of manufacture and one at the site. Approximately two weeks run-in time will be required prior to interconnection with the system. This system will be interconnected to the reactor system through a master patch board. Signals will have been preconnected to the master patch board prior to equipment delivery. Every effort is being made to connect those signals to the master patch board that could alter the reactor operating schedule.

8. Major Maintenance

a. Feedwater Control System

The feedwater system pressure sensor supplying the pressure signal for the control system failed. A new unit was used to replace the failed unit. Because the original equipment was panel mounted the unit was subjected to considerable panel vibration. The new unit was mounted external to the panel on a structural member free from equipment vibration.

b. Secondary Sodium System Level Probes

The power supply furnishing low level voltage at high current rates has failed. This unit is the second of three to have failed by essentially complete self-destruction. These units are being replaced by a power supply using static components.

c. Large Plug Data Encoder

The data encoder on the large plug for positioning of the plug failed in service and was immediately replaced with the spare encoder. The failed encoder was returned to the factory for repair. The factory has reported a brush failed. Repairs will be made at the factory and the unit returned for a spare.

d. Control Rod Position Indicator Transmitters

The control rod position indicator transmitters located on the control rod rack drive have malfunctioned. The problem was traced to poor brush contact in the transmitter. The manufacturer of the transmitter was contacted for brushed and/or to repair the units. The manufacturer would not release brushes or repair the units. To make repairs the brushes were removed, rotated 180 degrees and reinstalled. Seven of the 24 total units have been repaired in this manner.

C. Testing

1. Primary Auxiliary Pump

A number of tests were performed on the primary auxiliary pump prior to and immediately following the electrode repairs. Table VIII contains the data obtained during those tests. Included for comparison are previous data dating back to the initial tests performed on the pump. A section of the series resistor was replaced to increase the current through the pump increasing the flow to that rate measured prior to the electrode repair. The data taken on 3/22/67 corresponds to a period of adjustment of the series resistor.

2. Primary Purification System

The DCEM pump head characteristics were checked by by-passing the cold trap and throttling the by-pass valve manually. The data obtained

2. Primary Purification System (continued)

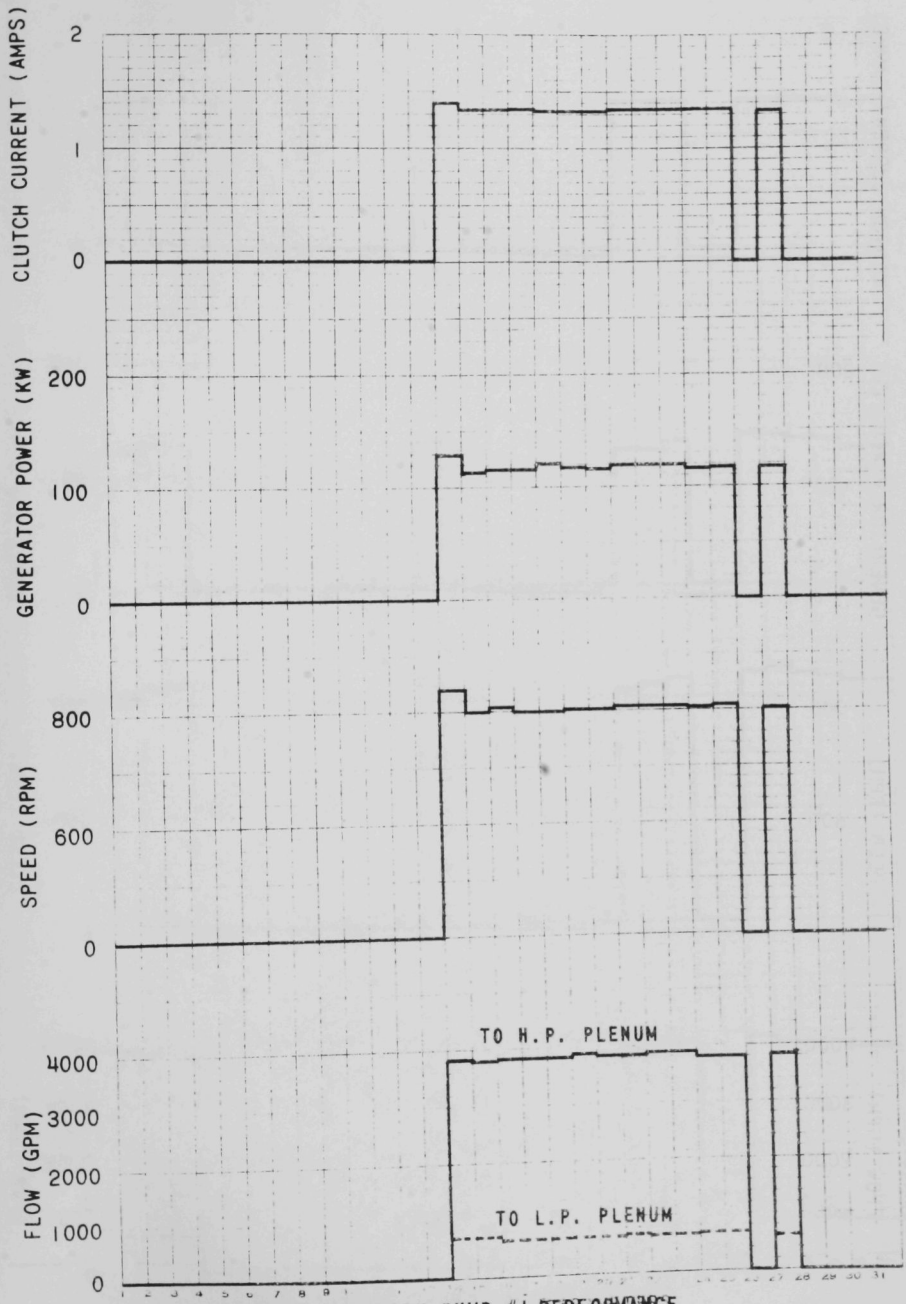
matched reasonably well with that data taken during tests on the pump prior to installation in the purification system.

The purification flows, differential pressures across economizer and crystallizer, and system pressures were all placed on continuous recording instrumentation for checking of the cold trap. Head checks were performed on both pressure transducers.

TABLE VIII

PRIMARY AUXILIARY PUMP TEST DATA

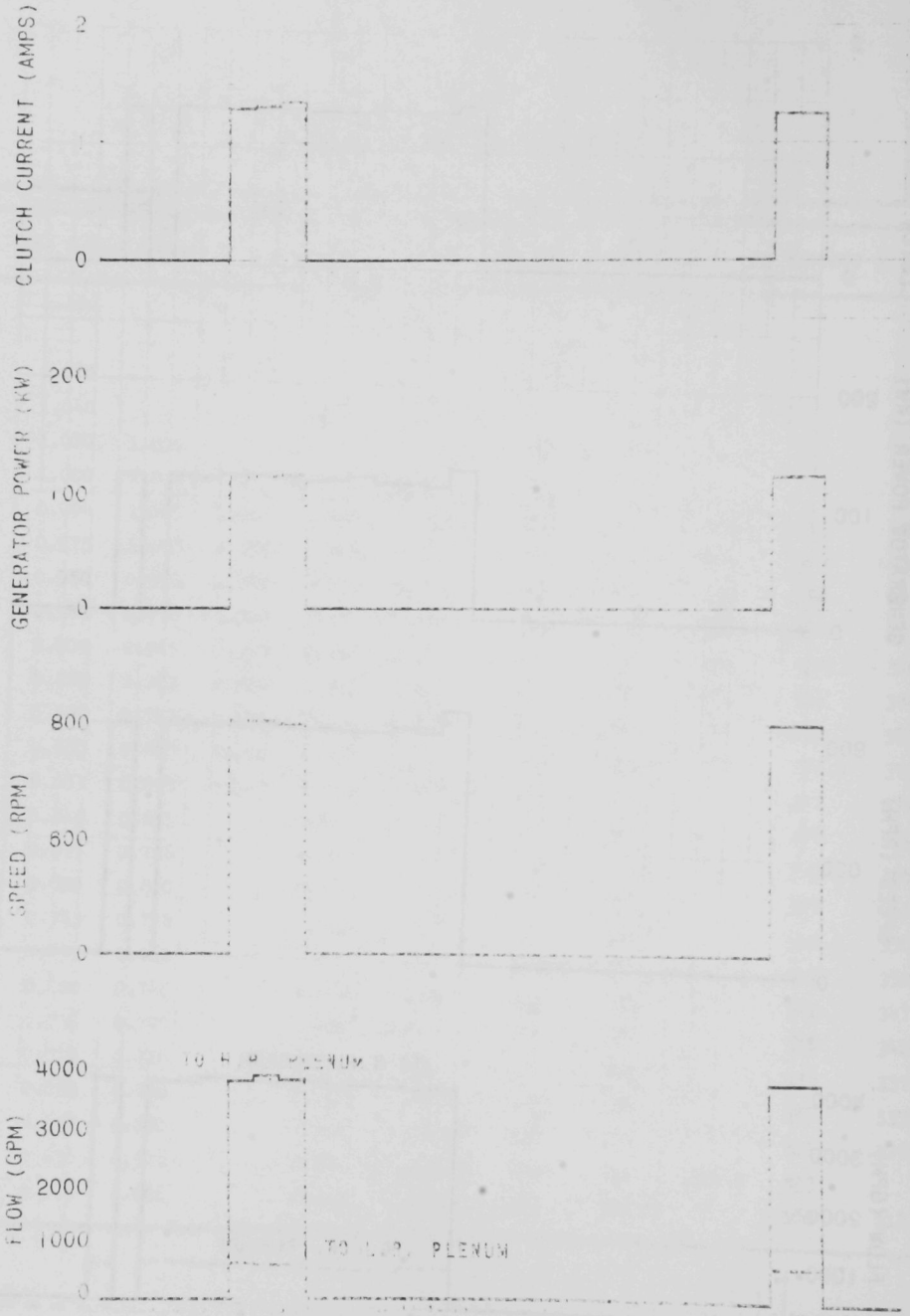
Amps	Volts					Flow (GPM)				
	5/ 2/62	5/12/66	3/ 6/67	3/18/67	3/22/67	5/ 2/62	5/12/66	3/ 6/67	3/18/67	3/22/67
6600	1.100					623				
6500										
6400	1.070					451				
6300	1.040									
6200	1.020	1.090				439	417			
6100	1.000	1.045			0.900	434	415			
6000	0.994	1.025	1.060	0.880	0.888	432	413	406	401	407
5900	0.975	1.008	1.050	0.868	0.880	427	410	402	397	402.5
5800	0.950	0.989	1.040	0.858	0.860	424	406	396	396	398
5700	0.945	0.970	1.010	0.850	0.850	419	403	390	394	394
5600	0.905	0.945	0.997	0.847	0.840	415	397	386	390.5	390.5
5500	0.895	0.922	0.968	0.838	0.825	411	393	383	386	386
5400	0.888	0.900	0.955	0.810	0.805	406	388	377	380	382
5300	0.880	0.890	0.942	0.790	0.798	400	383	373.5	375.5	378
5200	8.863	0.878	0.917	0.775	0.776	396	379		371	374
5100	0.848	0.855		0.770	0.760	391	375.5		366	369
5000	0.835	0.738		0.752	0.744	385	371		362	365
4900	0.810	0.800		0.738	0.720	380	367		357	361
4800	0.785	0.778		0.730	0.714	371	362.5		352.5	356
4700	0.774	0.760		0.710	0.698	368.5	358		348	352
4600	0.750	0.745		0.700	0.680	363	353		342	347
4500	0.730	0.727		0.688	0.670	358	348		338	342
4400	0.710	0.716		0.670	0.654	351	343		333	337.5
4300	0.685	0.700		0.658	0.640	345	338		327	333
4200	0.670	0.690		0.640	0.620	338	335		321	328
4100	0.650	0.678		0.620	0.608	332	332	314.5	323	
4000	0.625	0.668		0.610	0.690	326	329.5		308	318.5



PRIMARY PUMP #1 PERFORMANCE

JANUARY 67 FIG. 1

EUGENE DIETZGEN CO.
MADE IN U.S.A.
NO. 340R-T6 DIETZGEN GRAPH PAPER
ONE MONTH BY DAYS

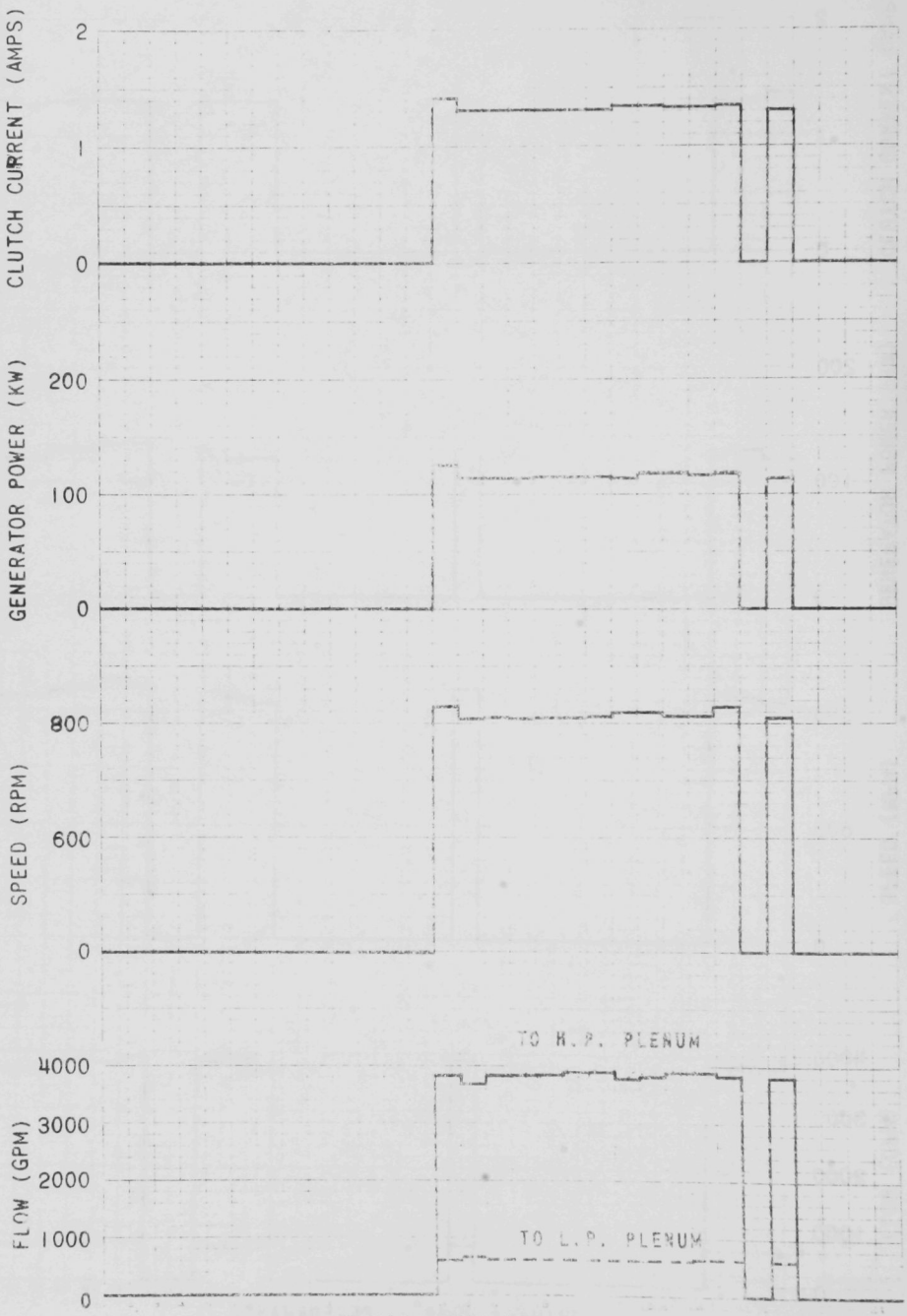


PRIMARY PUMP #1 PERFORMANCE
REBRUAR

PRIMARY PUMP #1 PERFORMANCE

MONTH MARCH 1967

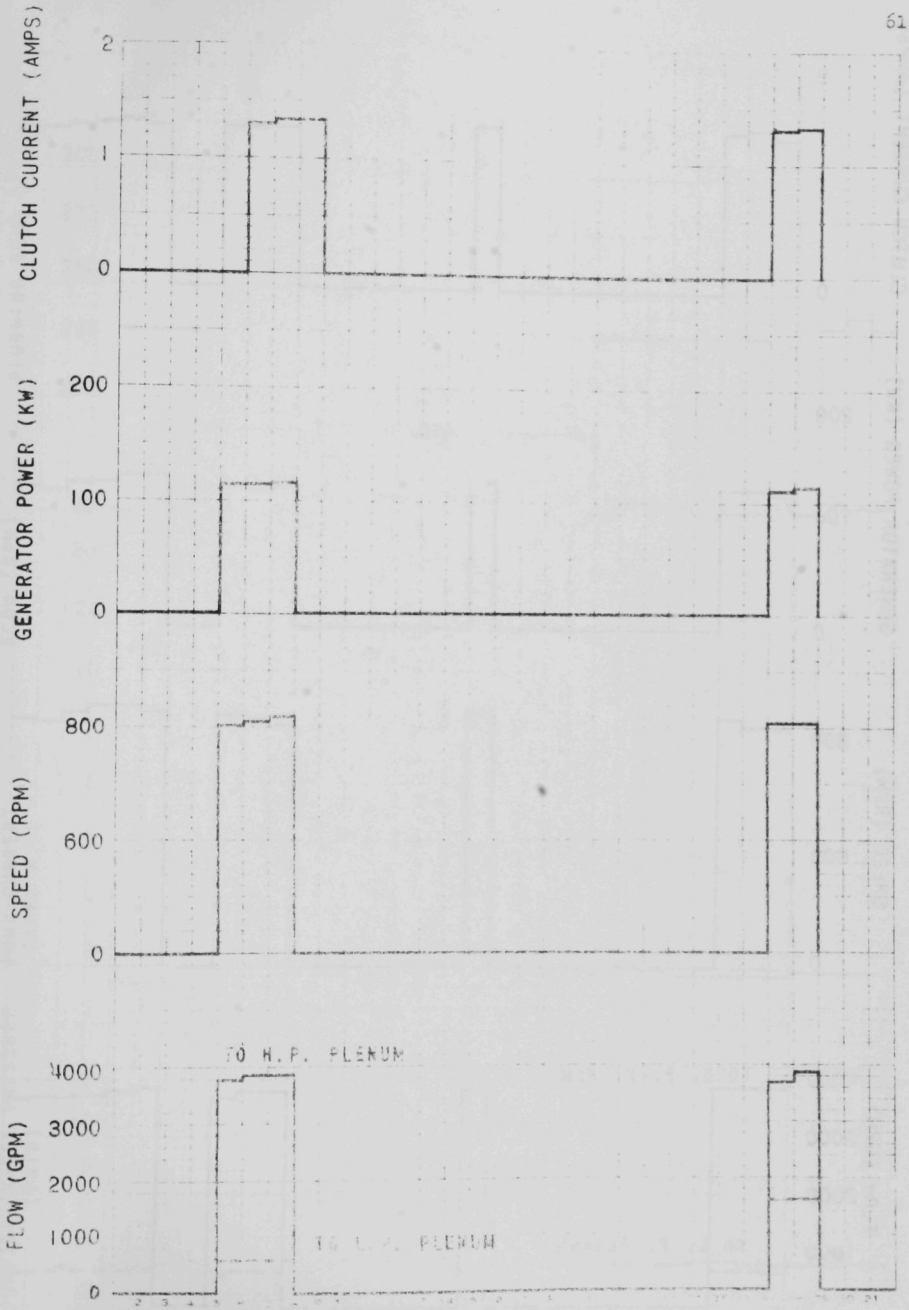
FIG. 111



PRIMARY PUMP #2 PERFORMANCE

JANUARY

EUGENE DIETZGEN CO.
MADE IN U.S.A.
NO. 340R - DIETZGEN GRAPH PAPER
ONE MONTH BY DAYS

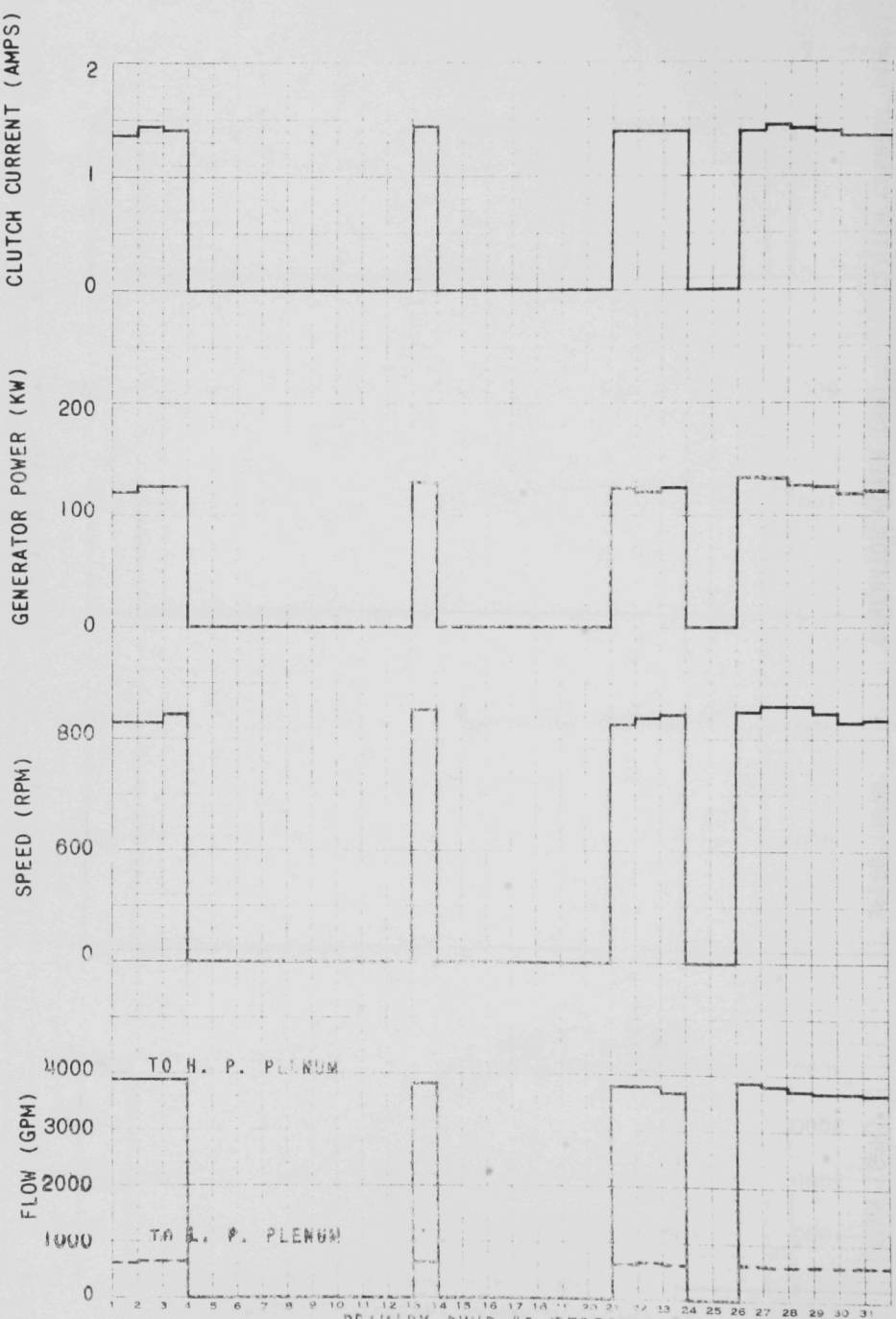


PRIMARY PUMP #2 PERFORMANCE

FEBRUARY 1967

FIG. 1

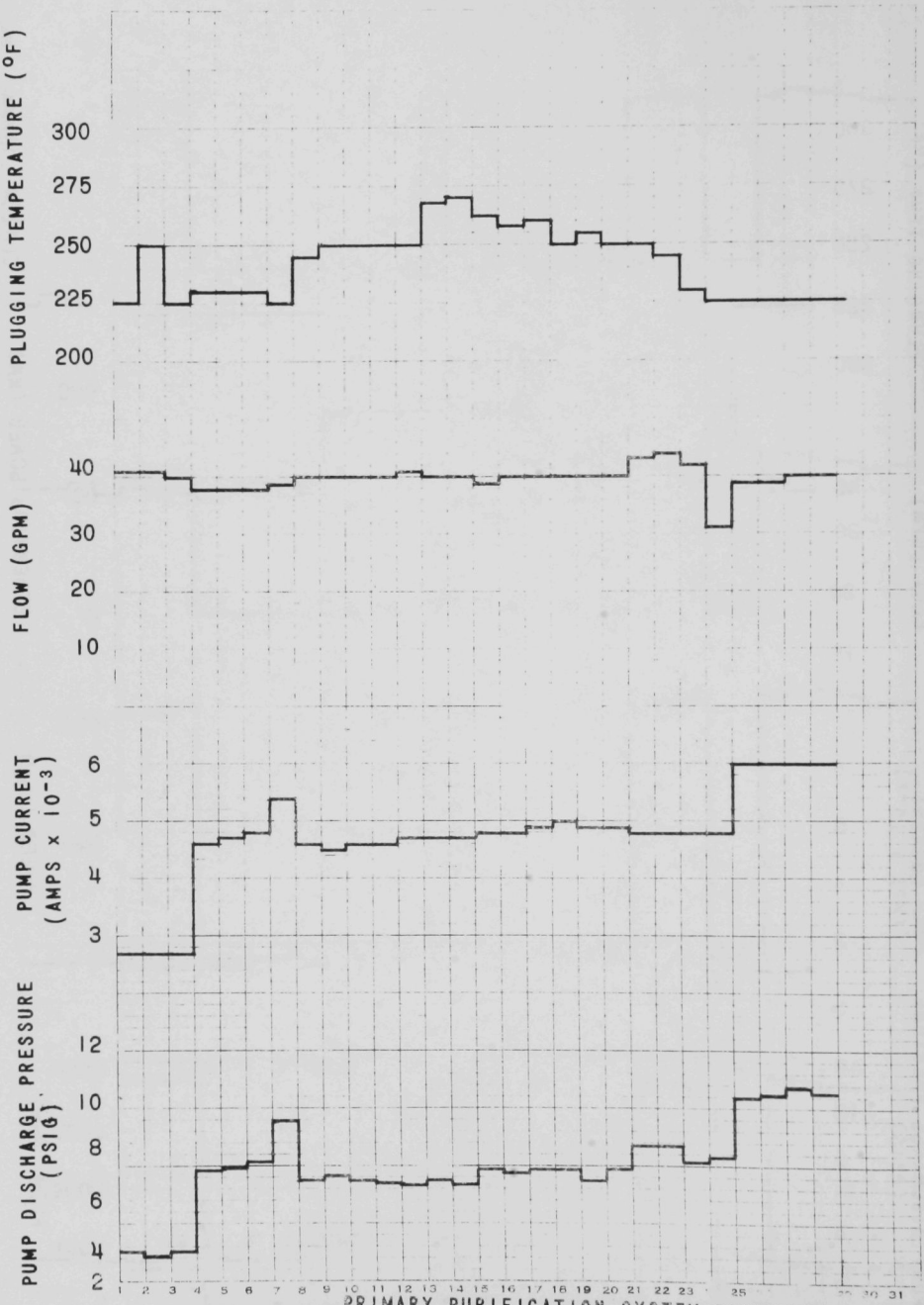
NO. 340R-T6 DIETZGEN DRAFTING
ONE MONTH 6/7 DAYS
EUGENE DIETZGEN CO.
MADE IN U. S. A.



PRIMARY PUMP #2 PERFORMANCE

EUGENE DIETZGEN CO.
MADE IN U.S.A.
NO. 340-R10 DIETZGEN GRAPH PAPER
ONE MONTH BY DAYS

EUGENE DIETZGEN CO.
CHICAGO
NO. 340R-T6 DIETZGEN GRAPH PAPER
ONE MONTH BY DAYS



PRIMARY PURIFICATION SYSTEM PERFORMANCE

MONTH FEBRUARY 19 67

MADE IN U. S. A.
ONE MONTH BY DAYS

PRIMARY PURIFICATION SYSTEM PERFORMANCE

MARCH 67 FIG. IX

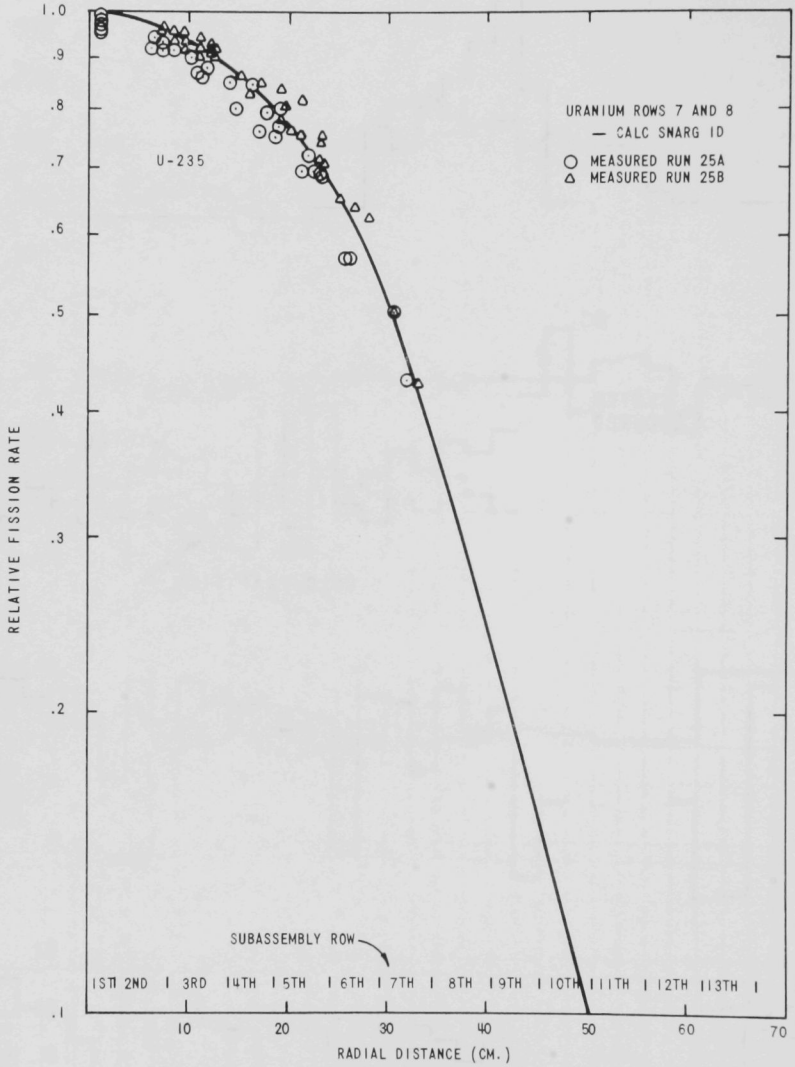


FIG. X
FISSION RATE DISTRIBUTION
RUN 25A & 25B

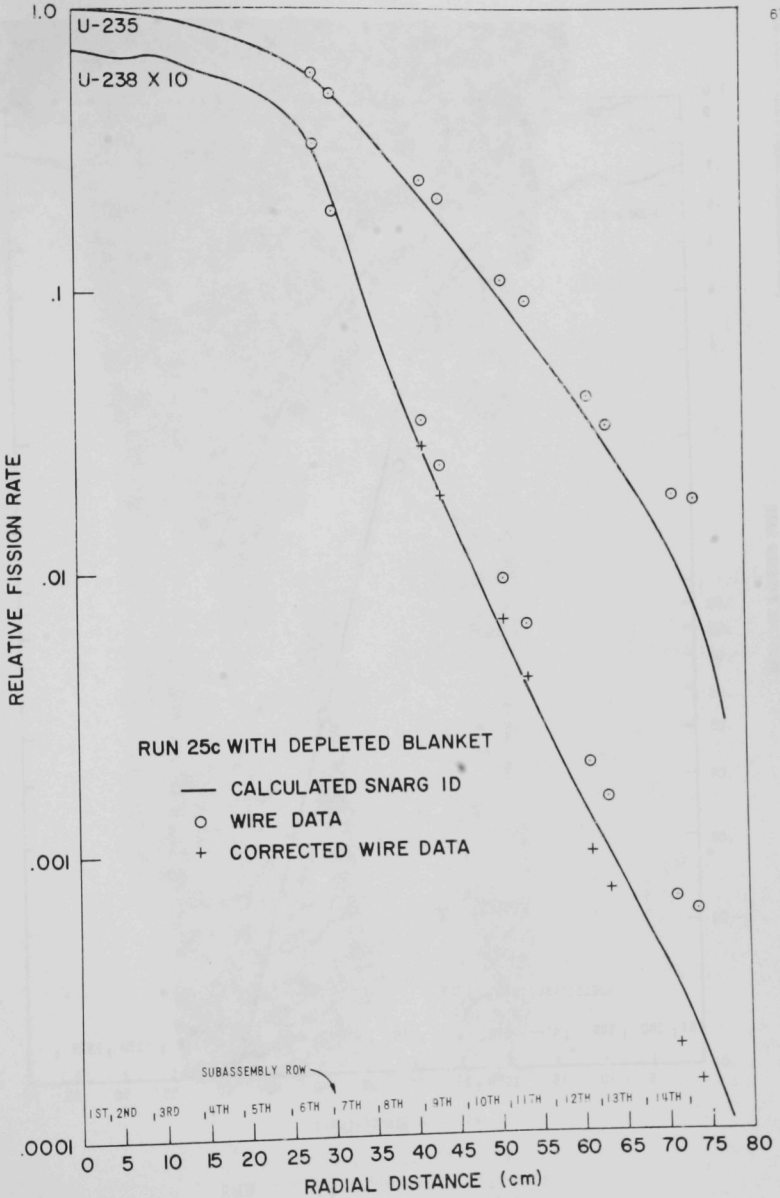


FIG XI

EBR II
FISSION RATE DISTRIBUTION

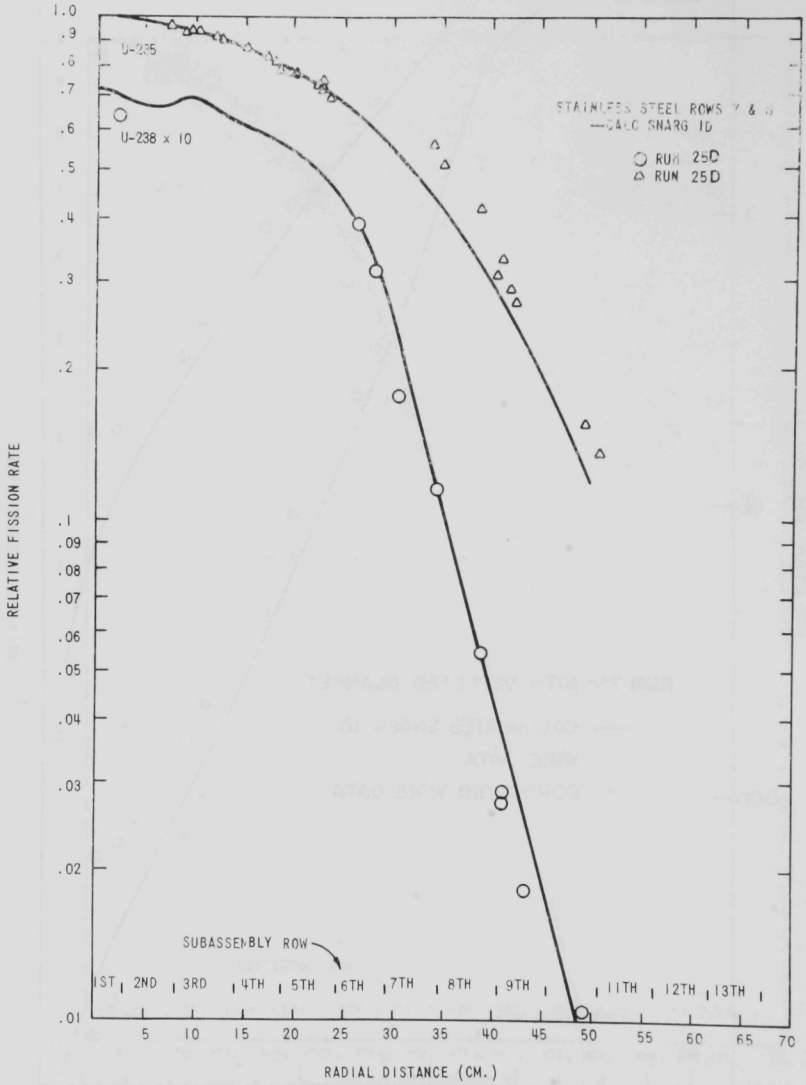


FIG. XII

FISSION RATE DISTRIBUTION

RUN 25 D

FIG. XIII

PRIMARY AUXILIARY PUMP
BUS BAR AFTER 4 YEARS SERVICE

FIG. XIV
PRIMARY AUXILIARY PUMP
REPAIRED BUS BAR

ARGONNE NATIONAL LAB WEST
3 4444 00033794 9

B