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RESULTS OF PRODUCTION TEST IP-528-I
F REACTOR HIGH TANK DRAWDOWN TEST

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RESULTS OF PRODUCTION TEST IP-528-I
F REACTOR HIGH TANK DRAWDOWN TEST

by

L. C. Lessor
Process Engineering Unit
Process Technology Sub-Section
Research and Engineering Section
IRRADIATION PROCESSING DEPARTMENT

October 21, 1962

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RESULTS OF PRODUCTION TEST IP-528-1
F REACTOR HIGH TANK DRAWDOWN TEST

I. Introduction

A continued decrease in flow as measured during the periodic high velocity flushes indicated that corrosion buildup in the high tank discharge lines was decreasing backup flow to the reactor. An accurate determination of the high tank flow rate to the reactor was needed to evaluate present backup adequacy. Riser pressure and flow rate were also measured with throttled high tank discharge lines to establish the low flow and critical portion of the reactor hydraulic characteristic curve. This report presents the numerical results of the test that was conducted on October 4, 1962.

II. Test Results

A. Loading and Drifing Status

There were 1,984 flow tubes during the test. Of these tubes, 1,734 were fitted with 0.320 venturis, 234 were fitted with double orifices (0.222" primary and 0.323" secondary), and 16 were PCCF tubes. The fuel loading consisted of:

<u>No. of Pieces and Load Type</u>	<u>No. of Tubes</u>
32 OIIN	1641
28 OIIN	28
34 OIIEB	128
34 OIIE	30
43 OIIE	75
62 OVN	52
Inactive	30

B. Riser Pressure and Reactor Flow Data

During normal reactor operating conditions prior to the test, a flow of 89,000 gpm and a TORP of 560 psig were recorded.

Data listed in Table I were obtained during the test. This data were used to construct the TORP vs flow curve shown in Figure 2. The data agree favorably with that obtained from Production Test IP-461 E conducted on January 19, 1962, and documented in HW-75375. The curve shown in Figure 2 is also in near accord with the F Reactor TORP vs. flow curve shown in HW-72699.⁽¹⁾

⁽¹⁾ Jones, S. S., Morrissey, J. E., Manuel, J. L., "Reactor Process Flow Technical Data," HW-72699, February 15, 1962, (SECRET).

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B. Riser Pressure and Reactor Flow Data (Continued)Table I

<u>TORP, psig</u>	<u>Flow, gpm</u>	<u>Condition</u>
535	83,000	Normal startup pressure and flow from 8 electric-driven pumps with cone valves throttled.
73.6	27,937	From 7 steam-driven pumps.
62.9	25,900	From 6 steam-driven pumps.
16.7	9,700	From high tanks alone.
8.1	3,630	From high tanks with valves throttled.

The flow of 83,000 gpm was measured by the 105 Control Room flow recorder. The flows of 27,937 and 25,900 are average flows as determined from data listed in Table II.

The TORP of 16.7 psig and a flow of 9,700 gpm were calculated from data obtained while the high tanks dropped about five feet, starting from the top of the straight vertical portion. This flow rate is considered to be accurate within $\pm 2\%$. A TORP of 17.3 psig is obtained by plotting the test TORP versus the high tank level data (Figure 1 in appendix) and extrapolating the line to full high tank level. A flow rate of 10,200 gpm from full high tanks is then determined from the reactor hydraulics demand curve (Figure 2 in appendix) at a TORP of 17.3 psig.

A TORP of 8.1 psig and a flow of 3,630 were calculated from data obtained while the high tank discharge lines were throttled. This flow rate is considered to be accurate within $\pm 4\%$.

III. General Test Procedure

The 190 Building electric-driven pumps were stopped during all of the test. The raw water Grove's valve was pinned to prevent automatic opening. Riser pressure, flow, pump suction pressure, pump discharge pressure, and pump speed were measured as the seven 190 steam-driven pumps provided flow to the reactor.

One steam-driven pump was then stopped and data taken as the six steam-driven pumps supplied flow to the reactor.

The high tank check valves opened as another steam-driven pump was stopped. The remaining five steam-driven pumps were then stopped.

High tank level drop and riser pressure data were taken as the high tanks supplied all of the flow to the reactor. Both high tank discharge valves were then throttled to provide a reduced flow and high tank level drop and riser pressure data were again taken. The test was terminated by starting the electric-driven pumps to provide normal shutdown flow.

IV. Detailed Test DataA. Steam-driven Pump Steady State Data.Table II

	<u>TORP, psig</u>		<u>Flow, gpm</u>	
	<u>Measured at 105</u>	<u>105 Control Room recorder</u>	<u>Sum of 190 pump flow gauges</u>	<u>Average</u>
7 pump	73.6	29,300	26,575	27,937
6 pump	62.9	27,500	24,300	25,900
5 pump*	50.6	---	20,720	---

* High tank check valves opened.

Table III⁽²⁾

	<u>Pump #</u>	<u>Suction Pressure, psig</u>	<u>Discharge Pressure, psig</u>	<u>Speed r.p.m.</u>	<u>Flow g.p.m.</u>
7 pump	#3	17	132	2055	4100
	#4	17	140	2110	4100
	#5	17	128	2015	3875
	#6	17	126	1955	3400
	#7	18	132	2040	4000
	#8	18	135	2050	3800
	#9	18	125	1870	3300
6 pump	#4	16	138	2070	4200
	#5	16	120	2010	4100
	#6	16	118	1955	3600
	#7	17	124	2055	4050
	#8	17	125	2055	4050
	#3	16	120	2040	4200
5 pump	#3	16	107	2040	4475
	#4	16	115	2000	4150
	#5	16	110	1955	4125
	#6	16	108	1905	3700
	#7	17	103	1955	4270

2. Data shown in Table III were obtained by W. V. Thompson of Applied Reactor Engineering.

-5-

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B. High Tank Drawdown Test Data

Inlet water temperature - 19.0°C

High tube power tube outlet temperature 23 to 25°C

Time (Min.)	TORP (psig)	Crossheader ΔP (Inches of H ₂ O)			<u>Far High Tank</u>		<u>Near High Tank</u>		
					Man. Hg. Level (Inches)	Strainer Pressure P ₁ P ₂	Man. Hg. Level (Inches)	Strainer Pressure	
		42	44	46				P ₁	P ₂
Initial (1)					28.50		26.25		
0	16.85				25.10	38 35	22.30	40	36
1	16.80				24.75		22.00		
2	16.75				24.30	38 35	21.45	40	36
3	16.70				23.30		21.00		
4	16.65				22.80	38 35	20.50	40	36
5	16.60				22.40		20.10		
6	16.55	260	270	280	22.05	38 35	19.70	39	35
7	16.50				21.70		19.25		
8	16.45				21.30	38 35	18.85	39	35
9	16.39				20.90		18.50		
10	16.32				20.50	38 35	18.20	39	35
11 (2)	16.27				19.90		17.85		
12 (3)	16.17				19.50	38 35	17.50	39	35
13 (4)	14.55				19.20		17.20		
14	13.35	80	90	100	18.90	43 42	16.95	43	41
15	10.95				18.65		16.65		
16	9.50				18.30	49 48	16.40	53	53
17 (5)	8.55				18.20		16.25		
18	8.12	50	55	60	18.05	52 51	16.05	55	55
19	8.12				17.75		15.95		
20	8.12				17.50	52 51	15.80	55	55
21	8.12				17.40		15.65		
22	8.12	50	55	60	17.20	52 51	16.55	55	55
23	8.09				17.00		15.45		
24	8.09				16.90	52 51	15.30	55	55
25	8.09				16.70		15.15		
26 (6)	8.09	50	55	60	16.45	52 51	15.05	55	55

- (1) Full high tank level.
- (2) Started throttling high tank discharge line valves 20 turns.
- (3) Completed throttling 20 turns.
- (4) Completed throttling 30 turns.
- (5) Completed throttling for a total of 36 turns on each valve.
- (6) Requested electric-driven pumps be started.

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V. High Tank Flow Calculations

The flow from the high tanks was measured by a rate of level drop calculation. The high tank water level drop was determined from mercury manometer readings.

A high tank diameter of 41 feet was used. The following method of calculation was then used:

$$\text{Volume of water per foot of high tank} = \frac{\pi D^2}{4} \times 1 = \frac{\pi 41^2}{4} \times 1 = 1,320 \text{ ft}^3$$

$$\text{Gallons of water per foot of high tank} = 1,310 \text{ ft}^3 \times 7.481 \text{ gallons/ft}^3 = 9,876 \text{ gallons}$$

$$1 \text{ inch of mercury} = 1.13 \text{ feet of water}$$

$$\text{Then, 1 inch of mercury drop} = 9,876 \times 1.13 \text{ or } 11,160 \text{ gallons of water.}$$

The flow rate per tank was determined by measuring the manometer level drop over an interval of time, dividing the total level drop by the time interval, and multiplying this figure by 11,160.

L B Lessor

Process Engineering Unit
Process Technology
Research and Engineering Operation
IRRADIATION PROCESSING DEPARTMENT

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FIGURE-1

TOP OF RISER PRESSURE
VS.
HIGH TANK WATER LEVEL

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