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CROSSTIE FLOW TEST AND FLUSHING CALIBRATION

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CROSSTIE FLOW TEST AND FLUSHING CALIBRATION

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January 23, 1964

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

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RESULTS OF PRODUCTION TEST IP-628-I
CROSSTIE FLOW TEST AND FLUSHING CALIBRATION

INTRODUCTION

On February 16, 1963, Production Test IP-573-I¹ was conducted at the K reactors to provide data to reevaluate the adequacy of the last-ditch crosstie system. This test was run subsequent to rigorous mechanical cleaning of the crosstie system piping (January 9, 1963); therefore, the resulting data reflects essentially clean line conditions.

On November 1, 1963, approximately 8-1/2 months after the above-mentioned tests, a series of steady-state tests were conducted under authorization of Production Test IP-628-I.² These tests were designed to accomplish four³ major objectives:

1. To evaluate the change in flow capability of the crosstie system since the last test series.
2. To test the "worst case" crosstie flow capability. (This was not run in February.)
3. To obtain hydraulic data pertinent to a proposed Modified Secondary System.⁴
4. To obtain pressure drop and flow data on the crosstie system during flushing in order to reevaluate the system adequacy, i.e., capacity, at a later date by comparing flushing data.

This report contains the numerical results of the pressure and flow data obtained during these tests.

TEST SUMMARY AND CONCLUSIONS

A comparison of test data from the February series with data taken during the November test series indicates a flow loss of approximately six per cent. However, if the variance in diesel pump speeds and the difference in coolant temperature is taken into account, this flow loss figure changes to approximately 7.5 per cent. The latter figure represents the best estimate of hydraulic change

¹Lesser, L.C., 100-K Flow Tests, Production Test IP-573-I, HW-76483, February 8, 1963, Unclassified.

²Radtke, W.H., PT IP-628-I, Crosstie Flow Test and Flushing Calibration, HW-73910, Unclassified.

³PT IP-628-I indicates three major objectives. Item 3 above was added after the production test was in process of being issued.

⁴Design Change #772, Coolant Backup Control Circuit Modification, P.E. Lindstrom, to be issued.

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due to corrosion product buildup over the 8.5 month interval.

The "worst case" emergency conditions are defined here as:

1. Loss of primary and secondary pumping at KE reactor.
2. Loss of primary pumping and one low-lift pump or the steam turbine pump from the secondary system at KW reactor.
3. One of the three diesel pumps fails to start.

For these conditions, test A-2 shows a crosstie flow to the stricken reactor (KE) of 27,100 gpm.

In calibrating the crosstie flush flow and pressures, all data were obtained at given diesel pump speeds of 600 rpm at KE and 650 rpm at KW. To be able to duplicate flow condition at some future time, the V-71 valve was opened fully, thereby eliminating the inherent inaccuracy present with a partially throttled valve. On December 23, 1963, during a routine monthly crosstie flush, a calibration of the diesel pumps (Nos. 1 and 2) was performed and the data plotted as shown in Figure 2. This data in conjunction with the flush data obtained from tests B-1 and B-2 during the performance of PT-628 were used to construct current⁵ characteristic curves of the KE and KW segments of the crosstie line as shown in Figure 1. These curves may be used to compare with flush data obtained at some future time to indicate the relative change in crosstie flow capability. Certainly these data are not so precise as to allow major decisions to be based upon them alone, but will tend to give a good relative picture of the crosstie piping condition. Future data points compared to the curves on Figure 1 should not be considered as indicative of a hydraulic change unless a variance of greater than 2.5 per cent is observed.

TEST CONDITIONS

The testing program was conducted in two main phases. These were the through-reactor steady-state test phase (A series) and a flushing calibration phase (B series). Before and after the steady-state phase, a third, or "C," series of plugging test were run.

The steady-state tests consisted of:

A-1

This test was designed to exactly duplicate test B-1 of the February test series. In it, Nos. 3 and 4 low lifts plus the steam turbine pump are running at KW, diesel pumps Nos. 1 and 2 supply crosstie flow, mainly to KE.

A-2

This test was designed to depict the previously defined "worst case" flow

⁵Current normalized to December 23, 1963, condition, i.e., coolant temperature of 7.5 C.

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situation. At KW, low lifts Nos. 4 and 6 were running. Two diesel pumps contributed primarily to KE via crosstie system. The reason that Nos. 4 and 6 low lifts were used instead of the usual Nos. 3 and 4 was to gain additional information concerning the proposed modified secondary system. (In this case, the modified secondary having lost one segment of its pumping capacity; that is, having lost one boiler or one emergency generator which is fed from the boiler not supplying the steam turbine pump, either pumps Nos. 1 and 3 or 4 and 6 would still be operating.)

A-3

Test A-3 was designed to reasonably duplicate test B-14' of the February testing. Instead of low-lift pumps Nos. 3 and 4, it called for the use of Nos. 4 and 6, primarily to obtain more useful information concerning the modified secondary system. This test depicted the loss of one segment of the proposed secondary which would not invalidate the use of the steam turbine.

A-3'

This test was run because of an erroneous KW riser pressure reading during test A-3. The technical consultant of the test noted what was thought to be a significant error in reading riser pressures. To clarify the situation, the pump status at 165-KE was changed to low lifts Nos. 3 and 4 rather than Nos. 4 and 6, in addition to the steam turbine. Data was obtained for this setup and the earlier discrepancy was not noted. Since this test duplicates the February B-14' test exactly, its data are used for comparison, although either A-3 or A-3' data would suffice.

A-4

This test was necessary to demonstrate the diesel flow to one K reactor while the other had a full, proposed modified secondary system in operation. Low lifts Nos. 1, 3, 4, and 6 were running at KE reactor, while two diesel pumps supplied mainly KW via the crosstie.

B-1

Test B-1 involved the flush of two diesel pumps' flow through the fully open V-71 valve at KE reactor. V-72 valves at both reactors were closed to assure that no reactor flow would be initiated. Data were taken when the two diesels were brought up to the highest acceptable speed.

B-2

This test was identical to B-1 except that the V-71 valve at KW reactor was used for the flush.

C-1 and C-2

These tests were designed to divert three low-lift pumps' flow through the

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A-B risers at each reactor. By comparing crossheader pressure data before and after the steady-state tests, plugging of the A-B crossheader screens could be detected. This technique proved to be reasonably efficient, although the front-header pressure taps were in poor shape. The Panellit pressures for all tubes on 90 column were used as a substitute.

TABLE I

PUMP AND VALVE STATUS

	Operating	Steam	FB-5	V-72	182 Diesel	Operating	Steam	FB-5	V-72
<u>Test</u>	<u>Low Lifts</u>	<u>Turbine</u>	<u>Valve</u>	<u>Valve</u>	<u>Pumps On</u>	<u>Low Lifts</u>	<u>Turbine</u>	<u>Valve</u>	<u>Valve</u>
C-1	1, 2,3	Off	Closed	Closed	Off	1,2,3	Off	Closed	Closed
A-1	Off	Off	Open	Open	1-2	3,4	On	Open	Open
A-2	Off	Off	Open	Open	1-2	4,6	Off	Open	Open
A-3	4,6	On	Open	Open	1-2	Off	Off	Open	Open
A-3'	3,4	On	Open	Open	1-2	Off	Off	Open	Open
A-4	1,3,4,6	Off	Open	Open	1-2	Off	Off	Open	Open
C-2	1,2,3	Off	Closed	Closed	Off	1,2,3	Off	Closed	Closed
			<u>V-71</u>	<u>V-72</u>	<u>Diesel</u>			<u>V-71</u>	<u>V-72</u>
			<u>Valve</u>	<u>Valve</u>	<u>Pumps On</u>			<u>Valve</u>	<u>Valve</u>
B-1	--	--	Open	Closed	1-2	--	--	Closed	Closed
B-2	--	--	Closed	Closed	1-2	--	--	Open	Closed

NOTE: During all tests, three service water pumps were on at each reactor. SC-1 valves were open, SE-1 and SE-2 valves were closed.

All diesel flow was taken from the KW clearwell.

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TEST RESULTSSTEADY-STATE TEST DATA

Inlet Temperature 14 C

Test Number		A-1	A-2	A-3	A-3'	A-4
1. KE Riser Pressures BORP (0'0") 465" Elev.	A	40.5	38.7	70.7	72.0	74.7
	B	40.5	38.7	71.0	72.2	75.0
	C			73.2	72.2	75.0
	D			71.5	71.7	74.2
2. KW Riser Pressure BORP (0'0") 465' Elev.	A	70.8	62.1	41.7	43.9	45.0
	B	70.9	61.7	41.3	43.4	44.5
	C	70.7	65.7			
	D	70.4	62.6			
3. 182-K Diesel Pump Discharge Pressure 477.3' Elev.	#1	74	68	74	76	78
	#2	73	67	73	74	77
	#3					
4. 182-K Header Pressure 467.6" Elev.		73.5	67.0	73.5	75.2	77.3
5. Intermediate Pressure 457.7' Elev.		81.5	69.5	77.5	77.5	80.5
6. 105-KE Valve Pit Pressure 457.1' Elev.		52.8	49.3	74.8	75.8	77.8
7. 105-KW Valve Pit Pressure 457.1' Elev.		72.8	64.8	49.8	50.8	52.8
8. 105-KE Reactor Flow (GPM)						
a. Steam Turbine				18,000	18,500	
b. Low Lifts				28,200	28,200	51,000
c. Diesels		28,900	27,100	7,960	7,800	6,650
TOTAL		28,900	27,100	54,160	54,500	57,650
9. 105-KW Reactor Flow (GPM)						
a. Steam Turbine		18,000				
b. Low Lifts		30,300	39,200			
c. Diesels		8,600	12,600	29,800	29,900	30,300
TOTAL		56,900	51,800	29,800	29,900	30,300
10. 182-K Diesel Pump Speed (Strobotac)	#1	725(720)	725(720)	725(720)	725(720)	725(720)
	#2	715(720)	715(715)	715(720)	715(720)	715(720)
	#3					
11. 182-K Pump Well Level		30.8	30.3	31.0	31.5	31.3

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CROSSTIE FLUSHING CALIBRATION TEST DATA

<u>Test Number</u>		<u>B-1</u>	<u>B-2</u>
1. Diesel Pump Speed (RPM) (Strobotac)	#1 #2	600(604)	650(655)
2. 182-K Diesel Pump Discharge Pressure 477.3' Elev.	#1 #2	50.8 49.8	57.1 56.2
3. 182-K Header Pressure 467.6' Elev.		51.1	53.9
4. Intermediate Pressure 457.7' Elev.		53.5	59.5
5. 105-KE Flow (Direct Reading)		31,200	
6. 105-KW Flow (From Fig. 2)			34,000
7. 182-Pump Well Level (Feet)		32	31.5

DISCUSSION OF RESULTS

The presentation of the data is self-explanatory and will not be further discussed. Table II, below, shows the comparison of tests A-1 and A-3' with February tests B-1 and B-14', respectively. The flow differences noted approximate a change of six per cent. However, the coolant temperature of 14 C for the PT-628 series versus 5 C for the PT-573 series represents an additional significant loss (approximately two per cent).

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TABLE II

		<u>KE Stricken Reactor</u>		<u>KW Stricken Reactor</u>	
		<u>2/16/63</u>	<u>11/1/63</u>	<u>2/16/63</u>	<u>11/1/63</u>
<u>Test</u>		<u>B-1</u>	<u>A-1</u>	<u>B-14'</u>	<u>A-3'</u>
1. KE Riser Pressures	A	43.2	40.5	73.6	72.0
BORP (0'0")	B	43.2	40.5	73.8	72.2
465' Elev.	C			73.8	72.2
	D			73.2	71.7
2. KW Riser Pressures	A	71.5	70.8	46.7	43.9
BORP (0'0")	B	71.8	70.9	46.4	43.4
465' Elev.	C	71.5	70.7		
	D	71.5	70.4		
3. 182-K Diesel Pump	#1	74	74		76
Discharge Pressure	#2		73	76	74
477.3' Elev.	#3	74		74	
4. 182-K Header Pressure		74.2	73.5	75.2	75.2
467.6'					
5. Intermediate Pressure		77.5	81.5	79.5	77.5
457.7' Elev.					
6. 105-KE Valve Pit Pressure		54.7	52.8	76.2	75.8
457.1' Elev.					
7. 105-KW Valve Pit Pressure		74.0	72.8	54.0	50.8
457.1' Elev.					
8. 105-KE Reactor Flow					
a. Steam Turbine				20,000	18,500
b. Low Lifts				27,700	28,200
c. Diesels		<u>30,900</u>	<u>28,900</u>	<u>8,600</u>	<u>7,800</u>
TOTAL		30,900	28,900	56,300	54,500
9. 105-KW Reactor Flow					
a. Steam Turbine		18,000	18,000		
b. Low Lifts		28,500	30,300		
c. Diesels		<u>9,300</u>	<u>8,600</u>	<u>31,500</u>	<u>29,900</u>
TOTAL		55,800	56,900	31,500	29,900
10. 182-K Diesel Pump	#1	725	725(720)		725(720)
Speed (Strobotac)	#2		715(720)	721	715(720)
	#3	722		722	
11. 182-K Pump Well Level		27.25'	30.75'	27	31.5'
12. Coolant Temperature		5 C	14 C	5 C	14 C

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FIGURE - 1
CROSSTIE FLUSHING CALIBRATION

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FIGURE -2
182 K DIESEL PUMP FLOW VS. DISCHARGE PRESSURE

Diesel Pumps Nos. 1 & 2 used
Average Well Level - 33 Ft.

INSTRUMENTATION1. Riser Pressure - 105-KE and KW

Rise pressure readings were obtained from a calibrated 0-100 psi Heise gauge installed in a test stand and located in each 105 control room. The readings are considered to be accurate to ± 0.2 psi. The data contained in this report are corrected for calibration and elevation difference to 0'0" (465' actual elevation).

2. 182-K Diesel Pump Discharge Pressures and 182-K Header Pressures

Diesel pump discharge pressures and header pressure readings were taken from a calibrated 0-300 psi Heise gauge. The data reported are corrected for calibration and to elevation of pipe centerlines as indicated. These data are considered to be accurate to ± 1 psi.

3. 182-K Intermediate Pressure

The pressure at the cross that connects the 36-inch line to the old 24-inch crosstie line was obtained using a 0-100 psi Master gauge (estimated accuracy ± 1 psi). The data shown has been corrected to elevation of the pipe centerline as indicated.

4. 105-KE and 105-KW Valve Pit Pressures

These pressures were measured using a 0-100 psi Master gauge installed between the V-72 and V-73 valves. Estimated accuracy is ± 1 psi. Corrections were made for the elevation difference to the centerline of the pipes.

5. 105-KE and 105-KW Reactor FlowA. Steam Turbine

The flow was read on the 165 control room flow gauge. Estimated accuracy is ± 500 gpm.

B. Electric Low Lifts

Flow from each pump was taken from individual pump Foxboro flow transmitters at the 165 buildings. Estimated accuracy is ± 100 gpm per transmitter.

C. Diesel

Crosstie flow to each reactor was measured by use of a Mercury manometer which indicated a delta P across a flow tube. The delta P readings were converted to flow readings by using a calibration curve. Accuracy is estimated to be ± 200 gpm.

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6. 182-K Diesel Pump Speed

Pump speeds were taken from individual tachometers installed on each diesel pump. These were supplemented with Strobotac readings.

7. 182-K Pump Well Level

Well levels were obtained from the project installed gauge in the 182-K building. Estimated accuracy is ± 3 inches.

CROSSHEADER SCREEN PLUGGING TEST

Before and after the steady-state tests each reactor was supplied solely by Nos. 1, 2, and 3 low-lift pumps. The flow balancing valve, FB-5, was closed as were the V-72 valves at both reactors which effectively shunted all flow through the A-B riser side crossheader screens. A comparison of header pressure (changed to venturi pressure on column 90 for expediency) showed that a total of six screens at KE and four screens at KW were partially plugged. This testing method seemed to give reliable results since after screen cleaning no operational difficulties were encountered. However, inspection of some of the screens that were deemed plugged showed no visible sign of foreign material. The plugging data would be more reliable in this respect if the front-header pressure taps were in better condition so as to allow data taking as originally intended.

W. A. Radtke

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