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**FINAL REPORT ON
PRODUCTION TEST IP-289-I, SUPPLEMENT I
H REACTOR EXPORT FLOW TEST**

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IRRADIATION PROCESSING DEPARTMENT

July 10, 1961

FINAL REPORT ON

PRODUCTION TEST IP-289-I, SUPPLEMENT I
H REACTOR EXPORT FLOW TEST

INTRODUCTION

The raw water export system forms the last ditch water supply system to the "O" and "C" type reactors. In the event of electrical and steam power failure, at one of the several reactors, the export system is designed to supply an adequate amount of raw water coolant to the stricken reactor. A restrictive orifice plate, located in the export pipe immediately upstream of the Groves valve in the 105 building, limits the export flow to each reactor.

Following Project CG-558, reactor modifications at H reactor, the original 4.875-inch export orifice was to have been replaced with a less restrictive 5.110-inch orifice plate. In late 1959, Production Test IP-289-I authorized testing the export system at H reactor to assess the improvement in export flow to the reactor. The results of the 1959 test, unfortunately, did not confirm export flow improvement expectations. Instead of increasing flow, the 5.110-inch orifice actually seemed to reduce it.

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Subsequent examination of the export system showed that the original 4.875-inch orifice had never been removed before installing the 5.110-inch orifice. Further, the 5.110-inch orifice was installed in an unsatisfactory location downstream of the export Groves valve. Production Test IP-289-I, appended with Supplement I, authorized correction of the unsatisfactory double orifice arrangement and provided for the re-testing of the export system. The test was re-run with the proper pipe and orifice geometry on September 8, 1960.

SUMMARY

Operating at the normal system pressure of 220 psig, the export system will supply approximately 5500 gpm of raw water coolant to the reactor. Without increasing the size of the orifice still further, additional increases in export flow are likely only through a major reduction of the reactor hydraulic resistance.

PROCEDURE

The export flow test was run in conjunction with a high tank drawdown test. Following reactor shutdown, instrumentation for the drawdown test was installed. In addition, calibrated Heise gauges were installed in the control room to read the top-of-riser pressure (TORP).

After the reactor had been shutdown for 20 hours and while still loaded¹ and valved normally, the high tank drawdown test was run. Following the drawdown test (after the tanks were re-filled to Process Standard's requirements), the export test was run. After completing the preliminary safety checks, the test sequence was as follows:

1. Export raw water was supplied as follows:
 - 182-F - One steam pump at full flow.
 - 182-H - One steam pump on standby with Copes control set at 175 psig raw water line pressure.
 - 182-D - One steam pump at full flow.
 - 182-B - One steam pump at full flow plus two additional electric pumps to support system pressure between 210 and 230 psig as measured at 182-H.
2. The high tank discharge pipes were valved out of the flow system.
3. The raw water guard valve downstream of the Groves valve was closed.
4. The raw water Groves valve was tripped open.
5. The raw water guard valve downstream of the Groves valve was slowly opened.
6. After the raw water guard valve was fully opened, the process pumps were shut off and their discharge lines valved closed.

1. Refer to HW-66488, "Reactor Operating Limits (ROL)," 9/16/60 for complete loading pattern, in addition to flow distribution data.

7. After equilibrium was established, pressure data was taken.
8. The planned system pressure reduction phase of the test had to be aborted because of operational difficulties. Process flow was re-established using steam turbine pumps, and the system was restored to its pre-test condition.

DISCUSSION

In normal practice the measurement of a liquid flow rate in the multi-thousand gpm range is best accomplished using an orifice plate or flow nozzle. Unfortunately, when the flow restricting orifice was built into the export piping, no attention was given to the installation of flange taps, pipe taps, vera-contracta taps, or any other recognized pressure tap installation. As a result, the orifice plate in the export pipe functions only as a flow restricting device rather than a flow metering device.

Since a direct measurement of export flow was impossible, it was necessary to evaluate the flow by indirect means. Using the results of the high tank drawdown test² to establish the significant part of the reactor flow demand curve³, it was possible to evaluate the flow corresponding to any TORP. Thus, after reaching equilibrium, the export flow TORP was measured, and the corresponding flow was computed from the flow demand curve.

Because of the export flow measurement was by indirect means, the precision associated with the measurement can be no better than the precision associated with the least precise step in the overall procedure. Since the least count of the Heise gauges used was one psig, the precision of the gauges was plus or minus 0.5 psig. However, since the Heise gauges were actually used twice - once to determine the reactor demand curve and again to measure the export flow TORP - the overall precision of the method was no better than plus or minus one psig. As can be seen from the reactor demand curve⁴, errors of one psig of TORP can result in flow errors as great as 500 gpm. Because of the possible error due to measurement alone, the best estimate of the available export flow is 5500 gpm $\pm$ 500 gpm.

The production test authorizing the export flow test (IP-289-I) provided for the gradual reduction in export system pressure from 220 psig to 180 psig. This step was to provide data for a system analysis of the entire export complex. Because of operational difficulties at the time the test was run, the system pressure reduction phase of the test had to be aborted.

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2. HW-65715, "PT IP-326-I, Low Flow Calibration Tests at the Old Reactors," JL Benson
3. HW-66989, Pg. 15, "Numerical Results of Production Test IP-326-I, Low Flow Tests at B, D, F, and H Reactors," JL Benson. An abstract of this curve is included in the appendix for convenience.
4. ibid

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APPENDIX

DATA

Elevation of TORP Heise gauges = 38.0 inches.

Elevation of actual top of riser = 446.0 inches.

Pressure correction = 14.73 psi.

TORP as read on Heise gauges = 25.5 psig.

TORP corrected for elevation = 10.8 psig.

Export pressure at 182-H = 222 psig.

Export pressure at 182-B = 216 psig.

Export flow = 5500 gpm (from TORP vs. flow)
(curve pg. 15, HW-66989)

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Figure - 2

Reactor Hydraulic Demand at 20 °C

⊙ Circled Points Represent
Experimental Test Data

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