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KE DOWNCOMER INCREASED FLOW TEST

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DEVELOPMENT TEST IP-778
KE DOWNCOMER INCREASED FLOW TEST

Stephen S. Jones

Research and Engineering Section
Irradiation Processing Department

May 20, 1965

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

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DEVELOPMENT TEST IP-778
KE DOWNCOMER INCREASED FLOW TEST

OBJECTIVE

To determine the present flow properties of the KE downcomer and the effect of small flow increases upon the downcomer pressure characteristics.

BASIS AND JUSTIFICATION

Reactor flow increases are being considered for all the Hanford production reactors. These plans focused attention on the reactor downcomers as a potential problem area, and a restriction on downcomer flows at current operating levels was imposed¹. This limitation was established pending the determination of the actual downcomer water levels and pressures.

A preliminary test² of the KE downcomer under current cold flow conditions showed several important conditions:

1. The downcomer is running nearly full of water.
2. The present downcomer instrumentation is inaccurate and inadequate.
3. The downcomer inlet elbow exhibits cavitation at low temperatures and probably vapor locks at high temperatures.

Therefore, it is important to obtain a clear picture of the present operation of the downcomer and the effect of one or more small flow increases. The need for such a program is emphasized by the current fuel development plans which could allow an increase in reactor flow this June or July.

INSTRUMENTATION

The K downcomer flow is complex, with varying parallel flow through nine to ten parallel channels. Therefore, considerable instrumentation is required to resolve the flow picture and the pressure characteristics of the system. The required instrumentation is presented in Table I, and its location is given in Figures 1 and 2.

1. R. W. Reid. Recommended Downcomer Flow Limits, RL-REA-97. November 6, 1964. (Secret)
2. Stephen S. Jones. KE Downcomer Flow Test and Preliminary Flow Analysis, RL-REA-871. March 22, 1965. (Secret)

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TABLE I
RECOMMENDED K DOWNCOMER INSTRUMENTATION

<u>No.</u>	<u>Location</u>		<u>Purpose</u>
	<u>General</u>	<u>Specific</u>	
0a	Approach box	✓ $6 \pm 0.1''$ in front of honeycomb $6 \pm 0.2''$ above floor (54.50')*	Water level in approach box
0b	"	$6 \pm 0.1''$ in front of honeycomb $18 \pm 0.2''$ above floor (56.00')*	"
0c	"	Present p-12 tap (61.0')*	Top of downcomer reference pressure
1a	Inlet elbow	✓ $2 \pm 0.1''$ inside channel #1 0.75" above floor of channel (53.1')*	Honeycomb entrance effect (cavitation and choking effects)
3a	"	"	"
3b	"	On 45° line from center of curvature 0.75" radially beyond floor of channel (54.2')*	Downcomer suction effects and potential for choking
3c	"	On 90° line from center of curvature at center of channel (52.1')*	"
1d	Downcomer orifice	✓ $1 \pm 0.02'$ above orifice plate in middle of channel** (4.5')*	Orifice flow**
3d	"	✓ " "	"**
5d	"	" "	"**

* Elevation, feet above 0'0".

** The flow should vary in each channel; therefore, many channels must be measured.

✓ Points required for initial testing.

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TABLE I (Cont'd)

No.	Location		Purpose
	General	Specific	
7d	"	"	"** Δ
9d	"	"	"**
10d	"	✓ "	"**
1e	Downcomer orifice (vena contracta)	✓ $1 \pm 0.2''$ below orifice plate (3.4')*	Orifice flow and choking
3e	"	✓ "	"
5e	"	"	" Δ
7e	"	"	" Δ
1f	Downcomer honeycomb exit	$6.5 \pm 0.2'$ below orifice plate (-4.0')*	Orifice pressure loss
3f	"	✓ "	"
e-a	Effluent line	✓ Top of effluent line 50' from ϕ of near riser (-8.2')*	Effluent line pressure drop

* Elevation, feet above 0'0".

** The flow should vary in each channel; therefore, many channels must be measured.

Δ Delay installing these taps until their need is indicated.

✓ Points required for initial testing.

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An examination of the pressure taps already installed on the KE downcomer indicated a considerable degree of burring on the inner edge of the hole. This casts doubt on these existing taps and new ones are to be carefully installed. This will be done both because of the burring problem and because of desired changes in the tap locations.

In addition to the pressure instrumentation, it will be important to monitor the rear riser temperatures. The vapor lock aspects of the downcomer elbow are very much a function of the effluent temperature. There is negligible mixing of the riser streams before they reach the downcomer elbow; therefore, riser temperature measurement serves as a good indication of this problem. Furthermore, it indicates the reactor side-to-side heat distortion and suggests when corrective action is desirable. Therefore, four temperature measuring elements are to be installed, two on each riser, as a part of this test. These are to be read on a recorder situated in the control room. The general arrangement of this equipment is shown in Figure 3.

PROCEDURE

A. Preliminary

1. All test instrumentation is to be calibrated and in good working order.
2. Phone communication should be established between the 38-foot level, the No. 1 electrical room, and the reactor control room.
3. Test manpower is to be provided at these sites, plus the 165 control room, by Process Engineering.

B. Shutdown Testing

As much as possible, this test is to be run in conjunction with the production test on using the crossunder bypass line to maintain a reactor flow above the downcomer limit. If this production test is approved, then these two tests will be run simultaneously using the procedure established in the production test. If not, the following testing procedure will be performed.

1. With the reactor tubes closed, the crossheaders unthrottled, and the BORP at the normal shutdown value of 79 psig, obtain a set of test readings from all data stations.
2. Increase the reactor flow and the riser BORP according to the steps shown in Table II, taking test data from all stations at the completion of each flow step.

C. Testing During Reactor Operation

Again, if the crossunder bypass line production test is approved, this test will be run in conjunction with the PT. If there is no PT, the following testing procedure is required:

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TABLE II

KE DOWNCOMER TESTING

Reactor Conditions					Remarks
<u>Test No.</u>	<u>Operation</u>	<u>Riser Pressure BORP psig</u>	<u>% Full Flow*</u>	<u>% Bulk Temp. Limit</u>	
B-1	Shutdown	79	32	<15	Normal shutdown flow.
B-2	"	200	60	<15	
B-3	"	493	96	<15	Maximum shutdown flow.
B-4	"	450	92	<15	Normal startup flow.
C-1	Operating	440	98	70	Normal temperature map requirement.
C-2	"	440	100	90	
C-3	"	"	100	92	
C-4	"	"	100	94	
C-5	"	"	100	96	
C-6	"	"	100	98	
C-8	"	"	100	100	
D-1	Shutdown		100	<20	Maximum shutdown flow after arch rail charge.
D-2	"		96	<20	Normal startup flow after arch rail charge.
E-1	Operating	435	102	70	Normal temperature map requirement.
E-2	"	"	104	90	
E-3	"	"	"	92	
E-4	"	"	"	94	
E-5	"	"	"	96	
E-6	"	"	"	98	
E-7	"	"	"	100	
					Full level operation at increased flow.

* % of full operating flow as of May 1, 1965.

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1. Hold the reactor power level constant and obtain a complete set of test data at ~70 per cent of power at the time the required outlet temperature map is run.
- 2-8. As the reactor is being slowly raised from 90 to 100 per cent of level, obtain test data at every 2 per cent increase as shown in the table. The test coordinator should bear in mind that a relatively constant power level during the data collection period is more important than being exactly on the two per cent level increase value.
9. Once full power level is achieved, then a complete data set should be obtained at least once a day for a week.

These results will be reviewed and the decision made by Reactor Engineering whether to continue with parts C and D of this test before any downcomer modifications or the establishment of riser temperature control.

D. Further Shutdown Testing

If steps B and C warrant it, step D will proceed as follows:

1. After the completion of the arch-rail support charge, raise the reactor to maximum shutdown flow conditions and obtain test data.
2. Obtain a second set of test readings at normal startup flow conditions.

E. Further Operation Testing*

1. Obtain test data with the increased flows available from the arch-rail support charge according to the procedure of part C and according to the steps in Table II.

HAZARDS

There should be no additional hazards associated with this test. During the shutdown part of this test, the KE V-72 valve must be closed and the KE steam pump must be on automatic backup for the process electric pump (or pumps). There must be no critical electrical condition during the single pump operation of this test.

During the reactor operating parts of this test, there will be no hazardous conditions other than those pertaining to normal reactor operation.

* With the crossunder bypass production test in effect, this procedure will be changed to maintaining the present downcomer flow and then under PT conditions increase this flow by slowly closing (part or all of the way) the crossunder bypass valve until a limiting downcomer flow is reached.

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COSTS

It is expected that this test could lead to increased reactor flow. The instrumentation includes special test units and units that should be a part of a continued operation monitor of the effluent system. Therefore, the test costs are divided as follows:

Pressure Transients - PARDSS (\$1000)

Pressure Gage Installation and Observing - 25% Research and Engineering (\$500)
25% KE Processing (\$500)
25% KW Processing (\$500)
25% Plant Engineering Design (\$500)

Riser Temperature Installation - PARDSS (~\$1000)

TEST SCHEDULE

This test is to be conducted the earliest possible reactor startup following the completion of the instrument installation.

TEST DURATION

This test will terminate one year from date of issuance or as soon as the required data have been accumulated.

Reactor Engineering
Process and Reactor Development

Stephen S. Jones:nmd

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TEST RESPONSIBILITIES

Research and Engineering Section

Process Technology Subsection

Process Engineering Unit will be responsible for obtaining and reporting the test data and for test coordination with Operations.

WMS EST

Process and Reactor Development Subsection

Reactor Engineering Unit will be responsible for over-all test programming and for interpreting the test results.

PPE / SMS AM

Facilities Engineering Section

Design Engineering Subsection

Plant Design Unit will be responsible for coordinating these test results with the model studies at WSU and for providing any indicated downcomer design changes as a result of these tests.

DM Dieker

Equipment Development Subsection

Mechanical Development Unit will be responsible for the installation of the transient pressure transducers and recorders and for obtaining transient pressure data as required by the test. They will also be responsible for transcribing and reporting the results of their transducer measurements.

Port. D. L. Zimorka

Manufacturing Section

Manufacturing Engineering Subsection

Plant Engineering Unit will be responsible for the installation of the test equipment and for the calibration and proper operation of this equipment.

GL. Vance

KE-KW Reactor Subsection

KE Processing Unit will be responsible for scheduling the test equipment installation and performance. They will be responsible for providing the different test conditions, along with any necessary communications and coordination of test forces.

BB Cluff

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FIGURE 1 K DOWNCOMER PRESSURE TAPS (Top)

FIG. 2 KE-DOWNCOMER ORIFICE TAPS

* Placed diametrically opposite T_1 .

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FIG. 3: LOCATION OF RISER INSTR. AT KE
 (T) - Temperature, (P) - Pressure

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END