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105-C OVERBORE 40 TUBE TEST PROCESS TUBE ASSEMBLY
FLOW AND PRESSURE DROP CALIBRATION TEST

BY

E. L. Etheridge
REACTOR MODIFICATION DESIGN

JUL 6 1961

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I. TITLE: 105-C Overbore 40 Tube Test Process Tube Assembly Flow and Pressure Drop Calibration Test

II. OBJECT OF TEST

The object of this test is to determine the hydraulic characteristics of the proposed overbore process tube assembly designs which are to be installed on 105-C Reactor for the 40 tube overbore fuel element test.

III. BACKGROUND AND JUSTIFICATION

For safe reactor operation, pressure drop-flow relations for each process tube assembly and fuel charge must be accurately known prior to installation. These data are used for setting panellit trip limitations for each process tube so as to not exceed the outlet water temperature limit set for that process tube. While pressure drop-flow data are calculated during design of the tube assembly components these data must be corroborated by test of the tube assembly in a hydraulic laboratory prior to installation.

Two process tube hardware designs (inlet and outlet nozzles) will be evaluated on pile during the 40 tube overbore fuel element test. These designs are shown on:

Design I Drawing SK-1-4774 - Inlet Clamp Nozzle Arrangement
SK-1-4781 - Outlet Nozzle Arrangement

Design II Drawing SK-1-4806 - Inlet Flapper Valve Nozzle Arrangement
SK-1-4767 - Outlet Bellows Nozzle Arrangement

It is planned to accomplish the 40 tube installation in two reactor outages. Twenty process tube assemblies of the first design (SK-1-4774 and 4781) will be installed during the first outage scheduled for August 15. The remainder of the tube installations consisting of tube assemblies of the second design is scheduled for September 15. In addition, single tubes with the appropriate hardware designs will be installed on the reactor one reactor operating period preceeding the scheduled installation outage for that particular hardware design. The single tube installation and operation will be observed to correct any unusual problems which may have been overlooked during design of the hardware components.

In view of the above on-pile installation schedule flow-pressure drop data must be available for the hardware of the first design by July 10 and for the second design by August 10.

IV. PROPOSED METHOD AND DATA REQUIRED

The initial flow tests will consist of calibrating the process tube assembly to be installed on the first single tube on-pile test. A 105-C overbore aluminum process tube assembly as shown on Work Sheet 1 and 2 will be mocked up on the test stand in 189-D Hydraulic Laboratory. An aluminum smooth bore process tube will be used in place of a zircaloy-2 process tube because no zircaloy-2 tubes are available. However, the hydraulic data should be valid for either tube since the inside diameter specification of both

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tubes is identical. It is requested, though, that the inside diameter of the tube be measured at several locations to determine the average diameter prior to testing since the overbore aluminum tubes presently installed in C Reactor are averaging 3 gpm additional flow per tube above the overbore zircaloy-2 tubes in the pile.

Prior to charging the tube with the proposed 40 tube fuel element test fuel charge it is suggested that the flow monitoring device (pinna meter) be calibrated measuring header to pinna meter differential pressure at flows of 10 to 80 gpm. The pinna meter (panellit) pressure should be within 240-260 psig at 400 psig front header pressure and tube flow of 54 gpm. If the pressure is below the range the pinna plug will be removed and the diameter machined down for the desired pressure range. If pressure is above the desired range the calibration will be continued and a new size, predicted from the obtained data, will be made and retested if the pressure above the range is considered significant. Upon determining the exact pinna plug diameter required for the panellit pressure range critical flow of the assembly shall be determined.

Following calibration of the pinna meter the tube will be charged with the following fuel loading and downstream perf pattern:

- 18 Self-supported 8" I&E overbore fuel elements
- 15 Self-supported 8" perfs
- 4 Solid aluminum pieces 2" O.D.
- 4 Self-supported 8" perfs

The tube assembly shall be calibrated between 250 and 450 psig front header pressure at ambient and 50 C water temperatures. The following pressure and flow data shall be measured:

Front Header	PSIG
Pinna Meter (panellit) Pressure	"
Front Nozzle Pressure	"
End of Active Section Pressure	"
Rear Nozzle Pressure	"
Rear Header Pressure	"
Tube Flow	GPM

Upon completion of the flow tests with 18 fuel element charge, the tests shall be repeated with full fuel charge (32 slugs) and downstream perf pattern (16 Self-supported 8" perfs). After completion of the flow tests it is expected that the pinna meter assemblies for the 40 tube test will be on site. Five assemblies will be selected from the lot and checked for the range of pressure readings between assemblies.

The tube mockup assembly will then be modified for the second design hardware. The rear nozzle tube collar will be cut off and the tube shortened 1 13/32 inches. A new tube collar will be welded on the tube. The rear nozzle assembly will then be rotated 180° from the first design and a different connector will be installed. The front nozzle assembly (flapper valve nozzle) will be installed as shown on Work Sheet 3. It is suggested that the gunbarrel

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flange to be used with the second design hardware be placed on the gunbarrel before assembling the tube mockup for the first design. If the flange is left off then the front tube collar will have to be cut off and another collar welded on after installing the flange. This will shorten the tube assembly and cause difficulties installing the connectors. The flange will be positioned against the weld bead on the gunbarrel and tack welded to prevent rotation. Caution must be used during welding so as to not melt the aluminum process tube. Maintaining water flow in the tube during welding of the flange should provide adequate cooling for the aluminum tube.

The second design tube hardware which has a header mounted venturi will then be calibrated and flow tested in the similar manner as the first hardware design. Five production venturi assemblies will also be checked for their range of pressure readings.

In addition to the above testing, further testing is required to determine the hydraulic characteristics of some of the production models of the tube assembly components. To meet on-pile installation schedules all of the tube hardware for the single tube tests and flow testing were fabricated on site. Although efforts were made during fabrication to maintain the hydraulic paths through the components as close to the production models as possible it was necessary in some cases to improvise. Therefore as the production components are received on plant the hydraulic characteristics will be determined. It is also desired to observe the effect of turbulence upon the flapper valve in the nozzle during tube flow. A special nozzle end cap for observing the flapper valve will be provided. All of these special tests will be conducted after completion of the flow tests of the two hardware designs.

V. DIVISION OF RESPONSIBILITY

Thermal Hydraulics Operation will be responsible for mocking up the tube assembly and performing the tests as described above. Reactor Modification Design will be responsible for providing process tube, tube assembly components, fuel loading, and perms. Reactor Modification Design will also be responsible for interpreting the results of the tests.

VI. REPORT REQUIRED

Brief letter reports summarizing data after completion of tests for each hardware design is required. A final documented report shall be issued.

VII. SCHEDULE

Tests must be completed by:

Hardware Design I	July 10, 1961
Hardware Design II	August 10, 1961

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VIII. ESTIMATED COST

\$2,000

Prepared by: E. L. Etheridge
E. L. Etheridge
Reactor Modification Design

Approved by: J M Batch
J. M. Batch, Supervisor
Thermal Hydraulics

Approved by: C E Jones for
H. W. Heacock, Supervisor
Reactor Modification Design

QTY.	PT. NO.	DESCRIPTION
1	1	ARRANGEMENT
1	2	CLAMP NOZZLE SK-I-4783 PT-I
1	3	TEST GUNNBARREL & COLLAR SHOP SKETCH-1 & 2
1	4	NOZZLE CAP ASSEMBLY SK-I-4773 PT-I
1	5	SEAL SK-I-4775
1	6	RETAINING RING-WALDES TRUARC 5100-312 MF
1	7	DRILL ROD - 156 X $\frac{5}{8}$ LG.
1	8	ALUMINUM PROCESS TUBE COLLAR-SHOP SKETCH-3
1	9	SEAL SK-I-4756
1	10	NOZZLE CLAMP SK-I-4784
1	11	PINNA METER ASSEMBLY SK-I-4733 PT-I
1	12	O-RING - AN 6290 - 16
1	13	PROCESS TUBE - AL. 2.3170 D MAX. X 2.147 $\pm$.005 I.D. .075 MIN. WALL THK.
1	14	CONNECTOR ASSEMBLY SK-I-4782

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DATE 6/24/61				NONE		WORK SHEET		REV. NO. 1	
								PAGE 1

1 ARRANGEMENT

NO.		DESCRIPTION
		REVISIONS

QTY	PT NO	DESCRIPTION	QTY	PT NO	DESCRIPTION
1	16	K-SEAL #12100-CT-16	1	1	ARRANGEMENT
1	17	MALE BODY CONNECTOR PARKER #16FSX-SS	1	2	OUTLET NOZZLE SK-1-4475
1	18	CONNECTOR ASSY SK-1-4798 P-1	1	3	NOZZLE CAP ASSEMBLY SK-1-4473 PT-10
			1	4	GASKET - ALUMINUM - JOHNS-MANVILLE # 911
			1	5	SNAP RING - WALDES TRUARC # 5100 - 312 MF
			1	6	DRILL ROD .156 DIA. X $\frac{5}{8}$ LG 300 SST
			1	7	LUG RING SK-1-4773 - PT: 4
			1	8	GASKET - 3 $\frac{3}{16}$ O.D X 2 $\frac{1}{4}$ I.D. X $\frac{1}{16}$ THK. GARLOCK #7735
			4	9	BOLT $\frac{5}{8}$ -11UNC-2A X 3 $\frac{1}{2}$ LG.
			2	10	PROCESS TUBE COLLAR SHOP SKETCH 5
			1	11	FLOW TEST GUNBARREL FLANGE SHOP SKETCH 4
			1	12	FLOW TEST GUNBARREL-2 $\frac{1}{2}$ SCH 40 SHOP SKETCH 6 PIPE X 30" LG.
			1	13	PROCESS TUBE -AL.-2.317 O.D X 2.147 I.D. .005 MIN. WALL THK.
			1	14	CONNECTOR ASSEMBLY SK-1-4779
			1	15	MALE CONNECTOR BODY PARKER #16FTX-SS

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NOTES:

1. AFTER COMPLETION OF 1st SERIES OF TESTS CUT OFF 1 $\frac{1}{16}$ " OF TUBE AND WELD ON NEW COLLAR.
2. SLIDE TUBE ASSEMBLY TO REAR 1 $\frac{3}{16}$ INCHES
3. ROTATE NOZZLE 180° AND INSTALL PT 18.

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SCALE DRAWN <i>J.H. Widdling</i> DATE <i>5/5/61</i>		CHECKED <i>G. J. Schindler</i> DATE <i>6/20/61</i>		APPROVED FOR DESIGN BY <input type="text"/> FOR <input type="text"/> DATE <input type="text"/>		OUTLET NOZZLE ARRANGEMENT FLOW CALIBRATION TEST	
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2 SK-1-4767		OUTLET BELLWOS NOZZLE ARRGT.		2 SK-1-4781		OUTLET NOZZLE ARRANGEMENT FLOW CALIBRATION TEST	
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