**Cover Sheet for a Hanford
Historical Document
Released for Public Availability**

Released 1994

**Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830**

**Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
by Battelle Memorial Institute**

DISCLAIMER

This is a historical document that is being released for public availability. This was made from the best available copy. Neither the United States Government nor any agency thereof, nor Battelle Memorial Institute, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DECLASSIFIED

HW-76421

February 14, 1963

This document classified by

J. R. Spink

This document consists of
9 pages.

TEST RESULTS FOR UNRESTRAINED REACTOR

GUNBARREL-NOZZLE ASSEMBLIES

By

J. M. Goff, Jr.

Distribution

1. R. C. Breisch
2. M. A. Clinton
3. J. M. Goff, Jr.
4. P. J. Hollifield
5. D. L. Hovorka
6. L. C. Lessor
7. G. J. Rogers
8. J. R. Spink
9. F. W. Van Wormer
10. P. J. Zimmerman
11. 300 File
12. Record Center
- 13.-15. Extra

Classification Cancelled and Changed To

DECLASSIFIED

By Authority of CC-PR-2
RPI Dtn, 3-17-94.

By Jerry Malin, 3-30-94
Verified By RK Hanson, 4-4-94

MASTER 87B

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DECLASSIFIED

-2-

HW-76421

TEST RESULTS FOR UNRESTRAINED REACTOR

GUNBARREL-NOZZLE ASSEMBLIES

INTRODUCTION

These tests were performed in accordance with a letter from R. C. Breisch to J. R. Spink, May 7, 1962. An unrestrained gunbarrel condition was simulated for each of the standard process tube inlet assemblies for B, C, and K type reactors.

Primary objects of the testing were to obtain data on movement, pigtail damage, and effect on flow to the process tube in case of a Van Stone flange failure without key restraint of the gunbarrel.

All test conditions were relative to actual conditions, but these conditions were not necessarily typical or maximum. The gunbarrels were not loaded with do-muts or thermal shield pieces.

SUMMARY

All of the assemblies moved instantly and rapidly when released under pressure. The B and K braided type pigtails crimped just upstream of the ferrule on the nozzle connection. The helical tube C-type pigtail stretched about six inches, but did not travel far enough to cause flow restriction. Tube flow for the B case was 54 per cent of that prior to Van Stone flange failure. For the K test, the flow was reduced to 69 per cent of that prior to Van Stone flange failure.

TEST SETUP

The 189-D Building flow mock-ups were used to approximate reactor flow and pressure conditions. For the B and K tests, standard inlet and outlet hardware was used. The B setup was used for the C test, except that a C inlet nozzle, orifice, and pigtail were used. Standard central zone venturis were used.

Pressures were measured on the front and rear crossheaders as well as the nozzle barrels and venturi throats. Heise gages were used for pressure indication. Reading accuracy was within plus or minus 2 psi.

For each reactor simulation reference pressure and flow conditions were established before sawing the Van Stone flange off at its base. The separated flange was positioned on the end of the tube and the nozzle re-installed. Before pressurizing, the gunbarrel assembly was restrained so that the restraint could be removed at the pressurized condition.

Tube loads were all dummies. The K test was made with solid I&E and perforated dummies equal in numbers and length to the standard condition. For the B test, 20 solids (not I&E) and 17 perfs were used. For C,

DECLASSIFIED

HW-76421

Figure 1.
B-D-F Inlet Connectors -- Conditions Before and After Test

The bend with
some flattening.

Figure 2.
C Inlet Connector -- Condition After Test

DECLASSIFIED

-4-

HW-76421

three solids and 17 perfs were used. Solid I&E dummies in the B and C sizes were not readily available, therefore it was expedient to approximate the standard loadings in terms of flow. In all cases, representative tube pressures in the high ends of the ranges were sought ahead of average or maximum tube flow conditions.

As cited in the Summary, movement was immediate and relatively fast. The calculated maximum hydraulic forces acting on the assemblies were as follows:

B -- 1115 pounds

C -- 685 pounds

K -- 980 pounds

(Based on the nominal inside diameters of the gunbarrels and the tube pressures after cutting the Van Stone flange off.)

For comparative purposes, in reading the discussion and analyzing the data, the following may be helpful:

	Central Zone Tube ⁽¹⁾	Pressures ⁽²⁾	
	Flow Range gpm	Max. Crossheader	Typical Tube (central zone)
B	45 - 48	480	470
C	50 - 52	430	300
K	66 - 70	465	395

(1) Supplied by P. A. Carlson, Engineer, Reactor Engineering.

(2) Taken from R.O.L. (IBM runs) supplied by G. A. Sparks.

Movement and extent of damage to the pigtails are as follows:

B Type

The gunbarrel-nozzle assembly moved 8-1/16 inches and crimped the braided part of the pigtail adjacent to the ferrule at the nozzle connection. Although the outer layer of braid was deformed on the short radius, there was no break or leakage either at the crimped position or the normal position. The assembly rotated about 90 degrees counterclockwise. Tube flow was reduced to 54 per cent of the reference 45 gpm prior to Van Stone flange failure. Before and after pigtail configurations are shown in Figure 1, page 3.

C Type

The assembly moved 6-7/8 inches without significant damage to the helical pigtail. Other than leakage through the gunbarrel tube annulus, there was no flow reduction from the reference 47.3. However, the point of

DECLASSIFIED

-5-

HW-76421

Figure 3.
K Inlet Connector -- Normal Installation

Figure 4.
K Inlet Connector -- After Test

Figure 5.
K Inlet Connector -- After Test (Alt. View)

DECLASSIFIED

HW-76421

potential flow restriction appears to be the compound bend adjoining the final bend on the nozzle end. The compound bend was drawn down and probably slightly flattened during manufacture. This flattened zone after test measured less than 0.53-inch compared to the nominal 5/8-inch outside diameter of the pigtail. At the end of the test the wall of the pigtail contacted the edge of an adapter nut and the side of a pressure fitting protruding from this nut (venturi throat pressure tap). There is a mark 4-3/8 inches long ending at the edge of the nut, indicating that the pigtail contacted for more than half of the travel of the assembly. Another source of restraint at the end of travel of the assembly was the 1/4-inch copper gage line connected to the above mentioned pressure fitting. At the end of the test this gage line was kinked at the 90-degree bends at the fitting and at the tie strap. The full effect of this gage line restraint was not determined so that the test for the helical pigtail must be considered no more than typical. The gunbarrel-nozzle assembly did not rotate. The stretched pigtail is shown in Figure 2, page 3.

K Type

The result was similar to the B-D-F case, but not so severe in terms of flow reduction. Tube flow was reduced to 69 per cent of the 65.1 gpm prior to Van Stone failure. The crimping occurred at the nozzle connection. The permanent crease made a diagonal rather than a right angle to the longitudinal axis of the braided section. Rotation of the assembly was about 100 degrees counterclockwise. As in the B case, the pigtail did not leak even when returned to the normal position and near normal pressures. Before and after conditions of the pigtail are shown in Figures 3-5, page 5.

General

In both the B and K cases, the braid was deformed only on the inside of the crimped zones. Also, there was no evidence of damage to adjacent hardware, particularly the venturi assemblies which sustained the full shock to arrest the moving assemblies.

It is important to remember that the gunbarrels used for the test were exceptionally free of restraint. Prior to the tests they were exercised to assure free movement, and there were no shielding do-nuts or corrosion product formations to impede motion.

The C case is the least conservative due to the possible restraining effect of the short gage line. Interference with the nut and pressure fitting on the venturi housing is a typical condition.

For all cases there was no leakage through the nozzle-to-gunbarrel joint. Leakage through the annulus between the gunbarrel and the outside of the tube is in the range of that calculated for the B-D-F situation in Secret Document HW-73596, "Flow Effects Following the Failure of a Front Van Stone Flange", reference page 6. The K leakages are low in comparison

DECLASSIFIED

-7-

HW-76421

to the B data, considering that the nominal area of the annulus is slightly greater due to the greater dimensions of the two basic diameters. This is easily explainable for this test. The K tube was bulged in the Van Stoning operation. The Van Stone flange was sawed off upstream of the start of the bulge so that a significant flow restriction existed. Though not pertinent to this test, the observed effect of the bulge may be of value for evaluation of the Van Stone flanges formed by one-shot machines because some degree of bulging seems to be inherent in the machine-forming methods.

The fairly rapid and forceful motion of the nozzles at failure warrants mention as a safety hazard to personnel comparable to the recoil of a gun.

Engineer
Equipment Laboratory and Testing
Facilities Engineering Operation
Irradiation Processing Department

JM Goff, Jr.:bt

DECLASSIFIED

-8-

HW-76421

DATA -- UNRESTRAINED GUNBARREL TEST

Reactor Type and Condition	Pressures (psi)				Inches Nozz. Fl. to Tie Strap	Flows-gpm		Remarks
	Cross Head.	Vent Throat	Nozz. Bar.	Rear Head.		Calc.	Meas.	
						Tube	Leak.	
Normal <u>B</u>	546	280	481	0	12-7/16	45.0	--	Venturi - 0.310" @ K = 2.76(5).
Flange cut off.	543	239	468	0	12-3/8	48.1	--	20 solid Al dummies
Assy. released.	559	458	160	0	21-5/16	27.8	--	plus 17 8" perfs.
Head. adj. norm.	546	454	136	0	21-5/16	26.5	--	
Ann. leaks for	(--	--	136	0	--	--	2.1	
indicated tube	(440	438	160	160	--	--	2.2	
pressures	(459	456	469	469	--	--	3.6	
Normal <u>C</u>	450	218	314	33	12-5/8	47.3	--	Venturi - 0.385" @ K = 3.10(5).
Flange cut off.	424	184	286	32	12-5/8	48.0	--	3 solid Al dummies
Assy. released.	426	184	284	32	19-1/2	48.3	--	plus 17 perfs.
Ann. leakage.	--	--	285	285	--	--	3.1	
Normal <u>K</u>	462	295	404	52	12-1/8	65.1	--	Venturi - 0.418" @ K = 5.04(5).
Flange cut off.	444	270	377	50	12	66.5	--	38 Al I&E dummies
Assy. released.	506	403	221	22.5	27-3/16	51.1	--	plus 14 perfs.
Head. adj. norm.	462	377	204	20	27-3/16	46.4	--	
Ann. leaks for	(219	218	218	278	--	--	1.2	
indicated tube	(379	378	378	378	--	--	1.9	
pressures	(							

- (1) Distance was measured from the face of the nozzle. The distance for the condition "flange cut off" was measured before pressure was applied to the tube.
- (2) Leakages through the annuli were measured with a stop watch and graduated container.
- (3) All B and C pressures were read on the same gage.
- (4) Sample flow calculation (for B "normal" condition): $\text{Flow (gpm)} = K\sqrt{\Delta P} = 2.76\sqrt{546 - 280} = 2.76\sqrt{266} = 45 \text{ gpm.}$

(continued on Page 9)

DECLASSIFIED

-9-

HW-76421

Data -- Unrestrained Gunbarrel Test (continued)

(5) K values were obtained from the D, C, and K Process Engineers.

Please note also that for K reactor the nominal venturi throat is 0.419-inch rather than 0.418-inch for the test unit. Flow data for the K test may be in error to the extent of the 0.001-inch variance since the official K value for a 0.419-inch venturi is used here.

**DATE
FILMED**

6/2/94

END