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GENERAL ELECTRIC

HW-65569

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June 8, 1960

HANFORD ATOMIC PRODUCTS OPERATION - RICHLAND, WASHINGTON

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HW-65569

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28 pages.

VIBRATION STUDIES:
REACTOR REAR FACE PIPING 105-F & H

By

P. H. Hutton
Reactor, Plant Engineering
FACILITIES ENGINEERING SECTION

June 8, 1960

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VIBRATION STUDIES
REACTOR REAR FACE PIPING

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INTRODUCTION

Failure of reactor rear face connectors has become a problem to varying degrees at B, D, DR, F, and H Reactors. A study of reactor rear face piping vibration has been conducted to provide data in support of development work on a permanent replacement for these connectors.

The study was conducted at H and F Reactors. Vibration information was obtained from rear nozzles, connectors and crossheaders within the process tube pattern.

SUMMARY

Vibration data were obtained from rear face piping for the following operating conditions:

- A. With full cold water flow prior to reactor startup.
- B. With the reactor at normal operating power level.
- C. During the transition from shutdown to normal operating power level.

The patterns of vibration indicated at 105-F and 105-H were similar with variation in magnitude. Generally, the indicated pattern consists of the following under current operating conditions:

A. Crossheaders

- 1. A three-to-six cycle per second vibration with maximum indicated amplitudes up to about ± 0.4 inches.
- 2. Transient, shock-type impulses.
- 3. Vibrations in the range of 300 to 1000 cps with maximum amplitudes up to about ± 0.002 inches.
- 4. Vibrations in the range of 3000 to 6000 cps with maximum indicated amplitudes less than ± 0.001 inches.
- 5. Vibration levels are quite low with full cold water flow prior to reactor startup. The levels increase to those indicated above as reactor power is increased to operating levels.

B. Nozzles

- 1. The nozzles showed no vibration of significance.

C. Connectors

1. The vibration of the connector varies with location on the connector relative to the nozzle and crossheader.
2. A vibration pattern similar to that of the crossheader is evidenced plus a moderate response at the resonant frequency of the connector.

A detailed compilation of data and typical oscillograph traces are contained in the Appendix of this report.

DISCUSSION

This study was conducted for the purpose of describing the conditions of vibration and relative movement under which the current rear connectors are operating. The information supports development work on a replacement connector in two ways. It is an aid in deciding on a basic approach and it provides a basis for vibration testing candidate replacement connectors.

It was decided to conduct the study at F and H Reactors for the following reasons:

1. The connector problem at H has been more severe than at any other area.
2. H Reactor has a unique connector to crossheader fitting. The Parker fitting attaches to the side of the thermocouple well which in turn attaches to the crossheader with a 90° elbow. In all the other areas, the Parker fitting attaches directly to the crossheader.
3. F Reactor power and flow levels tended to be somewhat higher than those at B, D, and DR.
4. The connector failure rate at F Reactor appeared to be representative of that at B, D, and DR, and F was more convenient geographically.
5. Due to the time consuming nature of a study of several rear face points and the time required to interpret oscillograph traces, it was decided to limit the study, for the present, to two apparently representative reactors.

The instrumentation used in making these measurements was as follows:

Crystal accelerometers with 75-foot coaxial leads fed into cathode followers. The output of the cathode followers went to linear/integrate amplifiers which in turn fed to a multichannel oscillograph. Usually, three points were monitored simultaneously. Although considerable care was exercised in an effort to get accurate data, the reader is cautioned against taking the numbers presented too literally. Due to the effects of temperature, radiation, long leads, instrument error, human error in interpretation, etc., the frequency may be off by an estimated ± 5 percent and the magnitude by ± 20 percent.

The low frequency (3-6 cps) high amplitude vibration appears to be the most significant from the standpoint of connector integrity. This may be a resonant response of the crossheader. The crossheaders are supported at about 10-foot intervals. This span should not resonate at that low a frequency; however, if the span were to increase to about 30 feet due to loose supports and/or bowing of the crossheader due to thermal expansion, the resonant frequency would be lowered to the region of three to six cycles per second. Recent studies by D. W. McLenegan, C. W. Harrison and V. R. Hill of Construction Engineering and Utilities Operation indicate that the source of excitation for this vibration may be the flow conditions at the riser to crossover line tee and at the approach section to the downcomer.

It is felt that the higher frequency (1000 cps and up) low amplitude vibration arises from turbulence and cavitation in the flow stream. This vibration, as such, does not appear to be of great significance to connector integrity. No attempt is made in this report to evaluate the general significance of the sources of this vibration, i.e., cavitation and turbulence in the flow stream.

The transient, shock type of impulses require further study to determine their true significance. They are discussed further below.

FURTHER STUDIES EVOLVING FROM THIS WORK

The data obtained in this study point out some regions which need further study in their own right. Foremost among these is the transient shock impulse. First, the authenticity of these indications must be verified. Preliminary work has started to devise a means of monitoring for this phenomena with a different basic measurement system. If this gives an indication similar to that already seen, authenticity will be reasonably well established. Assuming the above check to be positive, a study should then be made of the origin of these pulses and their mechanical effect on equipment. Another important phase of this study will be to carefully explore for possible effects that both the transient shock and steady cyclic disturbance may be having on the reactor safety circuit via the pressure monitor system.

Preliminary work has also been started to determine in considerable detail the movement of the rear risers as effluent temperatures change from shutdown to normal operating conditions.

ACKNOWLEDGMENTS

The writer wishes to acknowledge the fine cooperation of F and H Reactor Operation personnel and the R&E Process Engineers in these areas during the conduct of this study.

A P P E N D I XCOMPILATION OF VIBRATION DATA AND TYPICAL
OSCILLOGRAPH TRACES

The vibration data tabulated on Pages 6 through 16 shows the average of values taken from several feet of oscillograph chart in each case. For each set of data recorded in the field, each accelerometer output was monitored on each of three oscillograph channels used. This provided a check on the integrity of the "read out" instrumentation.

Figures 1, 2 and 3 show typical oscillograph charts of vibration measured on the rear face of 105-H during reactor operation. Since the channels of instrumentation were not standardized, the amplitude of the traces on a given chart should not be compared too literally. The charts do, however, show actual wave form. Location of the points is shown on Data Sheet 1H. Similarly, Figures 4 and 5 show typical oscillograph charts of vibration measured on the rear face of 105-F during reactor operation. Data Sheet 1F - Part A.

The charts shown in Figures 6, 7 and 8 illustrate the increase in low frequency vibration which occurred as the reactor power at 105-H was brought up to operating level. In this case, a given point appearing in the same channel from chart to chart can legitimately be compared in both amplitude and frequency directly from the chart. For example, the output from the accelerometer at Point D was measured with the same amplifier, etc and the same gain settings for all five conditions. Therefore, "D" on the five charts gives a visual comparison of relative vibration magnitude at Point D for the five operating conditions. Location of the points is shown on Data Sheet 4H - Part A. Figures 9 and 10 show a similar comparison for 105-F. Location of the points is indicated on Data Sheet 2F. The unlabeled traces on these charts should be ignored for the purposes of this report.

Figure 11 shows examples of the transient pulses which have shown up at both 105-H and F.

Figure 12 illustrates the amplitude modulation frequently observed in the medium frequencies.

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REACTOR: 105-H

TEST NO.: 1 H

DATE TAKEN: 10-5-59

BY: P. H. Hutton

TUBE FLOW: 50 gpm

HEADER FLOW: 3950 gpm

OPERATING LEVEL: Normal Operating Level

POINT NO.	FREQUENCY-CPS	ACCELERATION "G" PEAK	VELOCITY IN/SEC. PEAK	DISPLACEMENT IN. - PEAK TO PEAK
<u>101</u>	57 1250 3660 6000	0.25 3.0 - 6.5 6.0 - 13.0 3.0 - 7.8	0.29 0.15 - 0.36 0.12 - 0.28 0.03 - 0.09	0.0017 0.00004 - 0.00010 0.00001 - 0.00003 0.000002 - 0.000005
<u>D</u>	4 230 & 460 3700	0.2 - 0.3 15.0 - 24.0 4.5 - 30.0	2.5 - 5.0 2.0 - 3.5 0.08 - 0.55	0.20 - 0.40 0.001 - 0.002 0.00001 - 0.00005
<u>E</u>	4 625 3300 Note: The 3300 cps frequency modulates from maximum to minimum at about 180 to 210 cps.	0.2 - 0.75 3.7 - 7.4 5.3 - 25.6	2.9 - 11.6 0.38 - 0.76 0.11 - 0.50	0.22 - 0.90 0.0002 - 0.0004 0.00001 - 0.00005
<u>103</u>	4 240 2640 3960	0.11 - 0.23 3.0 - 6.5 3.5 - 35.0 10.9 - 30.0	1.85 - 3.7 0.8 - 1.8 0.09 - 0.85 0.18 - 0.50	0.15 - 0.30 0.001 - 0.0025 0.00001 - 0.0001 0.00002 - 0.00004
<u>104</u>	4-5 240 4800	0.2 - 1.1 4.0 - 6.0 18.5 - 46.0	2.85 - 14.3 1.10 - 1.65 0.25 - 0.65	0.18 - 0.90 0.0015 - 0.002 0.00002 - 0.000045

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REACTOR: 105-H

TEST NO.: 2 H

DATE TAKEN: 10-22-59

BY: P. H. Hutton

TUBE FLOW: 49.9 gpm

HEADER FLOW: 3952

OPERATING LEVEL: Normal Operating Level

POINT NO.	FREQUENCY-CPS	ACCELERATION "G" PEAK	VELOCITY IN/SEC. - PEAK	DISPLACEMENT IN. - PEAK TO PEAK
<u>E</u>	4-5 4500 - 5000	0.06 - 0.3 10.0 - 45.0	0.9 - 4.45 0.16 - 0.65	0.065 - 0.30 0.00001 - 0.000045
<u>103</u>	4-5 13 104 660 1500 6200	0.08 - 0.2 0.10 - 0.35 0.0 - 0.55 5.5 - 9.0 11.5 - 25.4 5.5 - 32.8	1.14 - 2.86 1.05 - 1.70 0.0 - 0.34 0.53 - 0.95 0.55 - 1.20 0.06 - 0.35	0.080 - 0.20 0.030 - 0.04 0.0 - 0.001 0.0003 - 0.0005 0.0001 - 0.00025 0.000003 - 0.00002
<u>104</u>	4-5 13 300 2000 5200	0.0 - 0.15 0.15 - 0.30 2.8 - 5.0 5.8 - 20.0 2.3 - 9.3	0.0 - 2.0 0.7 - 1.3 0.54 - 1.08 0.19 - 0.65 0.03 - 0.13	0.0 - 0.15 0.016 - 0.03 0.0006 - 0.001 0.00003 - 0.0001 0.000002 - 0.000007
<u>D-Transient Pulse, 3-1/3 cps wide.</u>		0.7	13.5	1.2
These appear Alternately	13 200 420 840 4000	0.09 - 0.3 2.0 - 4.0 8.0 - 14.0 5.5 - 15.0 3.0 - 22.5	0.42 - 1.7 0.63 - 1.27 1.17 - 2.04 0.4 - 1.10 0.05 - 0.38	0.01 - 0.04 0.001 - 0.002 0.0009 - 0.0017 0.00016 - 0.0004 0.000004 - 0.00003
<u>101-Transient Pulse, 2-3 cps wide</u>		0.2	5.0	0.65
These appear Alternately	12 420 780 1200 5000	0.08 - 1.0 1.8 - 3.7 1.0 - 9.0 6.9 - 19.6 3.5 - 13.9	0.45 - 1.55 0.27 - 0.54 0.09 - 0.76 0.4 - 1.10 0.045 - 0.20	0.012 - 0.15 0.0002 - 0.0004 0.00004 - 0.0003 0.0001 - 0.0003 0.000003 - 0.000012

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REACTOR: 105-H

TEST NO.: 3H

DATE TAKEN: 11-10-59

BY: P. H. Hutton

TUBE FLOW: 45.0 gpm

HEADER FLOW: 4015 gpm

OPERATING LEVEL: Normal Operating Level

POINT NO.	FREQUENCY-CPS	ACCELERATION "G" PEAK	VELOCITY IN/SEC. - PEAK	DISPLACEMENT IN. - PEAK TO PEAK
<u>D</u> - Transient Pulse 2 cps wide.		0.09 - 0.13	2.54 - 4.0	0.35 - 0.65
	3	0.04 - 0.10	0.67 - 2.0	0.06 - 0.19
	80	0.50 - 0.70	0.40 - 0.55	0.0016 - 0.0022
	1260	3.0 - 12.0	0.16 - 0.63	0.00004 - 0.00017
	4100	7.3 - 25.0	0.10 - 0.38	0.000009 - 0.00003
<u>103</u> - Transient Pulse 1-1/4 cps wide.		0.05	2.67	0.7
	4-5	0.02 - 0.10	0.33 - 1.67	0.03 - 0.13
	180	1.30 - 5.0	0.45 - 1.72	0.0008 - 0.003
	1000	2.5 - 15.0	0.17 - 0.9	0.00005 - 0.0003
	6700	2.7 - 13.6	0.03 - 0.15	0.000001 - 0.000007
<u>104</u> - Transient Pulse 2 cps wide.		0.15	4.67	0.7
	3-5	0.04 - 0.22	0.62 - 3.7	0.05 - 0.3
	366	2.0 - 8.5	0.36 - 1.6	0.0003 - 0.0015
	1250	3.5 - 20.0	0.2 - 1.14	0.00005 - 0.0003
<u>102</u>	3-5	0.02 - 0.11	0.3 - 2.3	0.02 - 0.25
	360	1.3 - 18.0	0.24 - 3.2	0.0002 - 0.003
	4100	2.2 - 16.1	0.035 - 0.25	0.000003 - 0.00002

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IN-65569

REACTOR: 105-H

TEST NO.: 3H

DATE TAKEN: 11-10-59

BY: P. H. Hutton

TUBE FLOW: 49.0 gpm

HEADER FLOW: 3880 gpm

OPERATING LEVEL: Normal Operating Level

POINT NO.	FREQUENCY-CPS	ACCELERATION "G" PEAK	VELOCITY IN/SEC. - PEAK	DISPLACEMENT IN. - PEAK TO PEAK
<u>E</u>	3-5	0.07 - 0.18	0.84 - 4.45	0.055 - 0.58
	1260	4.5 - 9.0	0.24 - 0.49	0.00006 - 0.00013
	6300	6.0 - 18.0	0.06 - 0.18	0.000003 - 0.000009
<hr/>				
<u>101</u> - Transient Pulse 2-1/2 - 3 cps wide.		0.17 - 0.48	3.66 - 10.0	0.38 - 1.0
	175	1.0 - 3.0	0.36 - 1.2	0.0007 - 0.0020
	810	1.3 - 9.0	0.11 - 0.76	0.00005 - 0.0003
	5000	2.3 - 11.5	0.03 - 0.17	0.000002 - 0.00001

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REACTOR: 105-H

TEST NO.: 4H, Part A

DATE TAKEN: 11-30-59

BY: P. H. Hutton

TUBE FLOW: No. 2692 - 39.2 gpm
No. 3386 - 43.09 gpm

HEADER FLOW:

OPERATING LEVEL: Full pre-startup cold flow.
Effectively zero power level.

POINT NO.	FREQUENCY-CPS	ACCELERATION "G" PEAK	VELOCITY IN./SEC - PEAK	DISPLACEMENT IN. - PEAK TO PEAK
<u>E</u>	4-5	0.01 - 0.08	0.18 - 1.1	0.013 - 0.08
	300	0.55 - 1.7	0.12 - 0.35	0.00012 - 0.0004
	1350	2.0 - 5.5	0.10 - 0.27	0.000025 - 0.00006
	3600	4.5 - 12.0	0.08 - 0.23	0.000007 - 0.00002
	6950	3.25 - 9.7	0.03 - 0.1	0.000002 - 0.000005
<u>101</u>	165	0.5 - 1.3	0.22 - 0.57	0.00045 - 0.0012
	720	0.7 - 6.0	0.06 - 0.51	0.00003 - 0.0002
	1140	2.3 - 9.2	0.12 - 0.52	0.000035 - 0.00015
	4630	2.3 - 5.8	0.03 - 0.08	0.000003 - 0.000006
<u>D</u>	4	0.007 - 0.03	0.11 - 0.44	0.009 - 0.035
	1225	2.0 - 5.0	0.10 - 0.23	0.000025 - 0.00006
	2214	4.5 - 6.5	0.13 - 0.19	0.00002 - 0.00003
	5370	1.6 - 8.6	0.02 - 0.10	0.000001 - 0.000006
<u>103</u>	150	0.5 - 2.0	0.2 - 0.7	0.0004 - 0.0015
	850	1.1 - 10.0	0.08 - 0.7	0.000028 - 0.00025
	5640	2.7 - 10.9	0.04 - 0.12	0.000002 - 0.000007
<u>102</u>	4-5	0.02 - 0.1	0.31 - 1.5	0.023 - 0.1
	70	0.33 - 0.85	0.27 - 0.7	0.0013 - 0.0034
	720	2.0 - 10.0	0.17 - 0.8	0.000075 - 0.00036
	3600	4.1 - 38.0	0.08 - 0.7	0.000007 - 0.000065

Note: 3600 cps frequency modulates from maximum to minimum at about 300 cps.

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REACTOR: 105-H

TEST NO.: 4H Part B

DATE TAKEN: 11-30-59

BY: P. H. Hutton

TUBE FLOW:

HEADER FLOW:

OPERATING LEVEL: 850 MW

See 4H, Part A for location of points.

POINT NO.	FREQUENCY-CPS	ACCELERATION "G" PEAK	VELOCITY IN/SEC. - PEAK	DISPLACEMENT IN. - PEAK TO PEAK
<u>D</u>	4	0.013 - 0.17	0.2 - 2.5	0.017 - 0.20
<u>102</u>	3-1/2	0.06 - 0.19	1.14 - 3.43	0.10 - 0.30
<u>103</u>	4	0.018	0.28	0.022

Note: Only low frequencies (400 cps and below) were being monitored on this part of the test.

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HW-65569

REACTOR: 105-H

TEST NO.: 4H, Part C

DATE TAKEN: 12-1-59

BY: P. H. Hutton

TUBE FLOW: No. 2692 - 48.4 gpm
No. 3386 - 44.8 gpm

HEADER FLOW: No. 25-3928 gpm
No. 33-3986 gpm

OPERATING LEVEL: 1300 MW

See 4H, Part A for location of points.

POINT NO.	FREQUENCY-CPS	ACCELERATION "G" PEAK	VELOCITY IN./SEC - PEAK	DISPLACEMENT IN. - PEAK TO PEAK
<u>E</u>	4	0.02 - 0.13	0.36 - 2.18	0.03 - 0.18
	7	0.03 - 0.25	0.22 - 2.2	0.01 - 0.10
	1250	2.2 - 5.7	0.11 - 0.3	0.00003 - 0.00008
	5950	5.7 - 32.4	0.06 - 0.35	0.000003 - 0.000019
<u>101</u>	2-1/2	0.006 - 0.09	0.17 - 2.3	0.02 - 0.3
	150	0.65 - 2.2	0.29 - 1.0	0.00065 - 0.0023
	750	1.8 - 4.2	0.15 - 0.38	0.000065 - 0.00017
	1000	1.8 - 8.5	0.11 - 0.53	0.000035 - 0.00018
<u>D</u>	4	0.03 - 0.25	0.42 - 4.0	0.035 - 0.32
	1250	4.0 - 10.0	0.22 - 0.54	0.00006 - 0.00015
	1760	7.0 - 15.0	0.27 - 0.54	0.00005 - 0.00010
	2520	8.0 - 17.0	0.22 - 0.43	0.00003 - 0.00006
	5490	6.0 - 33.0	0.07 - 0.4	0.000004 - 0.00002
<u>103</u>	4	0.02 - 0.07	0.29 - 1.14	0.018 - 0.09
	150	0.55 - 2.0	0.24 - 0.86	0.0006 - 0.002
	615	1.8 - 10.0	0.18 - 1.10	0.00009 - 0.0006
	750	1.9 - 7.0	0.17 - 0.63	0.00007 - 0.0003
	1260	2.8 - 18.0	0.15 - 0.91	0.00004 - 0.00025
	5850	2.2 - 12.2	0.025 - 0.15	0.000002 - 0.000008
<u>102</u>	4	0.06 - 0.5	1.0 - 8.0	0.08 - 0.65
	650	3.2 - 13.0	0.32 - 1.27	0.0002 - 0.00065
	3360	6.9 - 53.0	0.15 - 1.05	0.000015 - 0.0001

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HW-65569

REACTOR: 105-H

TEST NO.:

4H, Part D

DATE TAKEN: 12-14-59

BY:

P. H. Hutton

TUBE FLOW: No. 2692 - 48.4 gpm
No. 3386 - 45.6 gpm

HEADER FLOW: No. 25-3930 gpm
No. 33-3990 gpm

OPERATING LEVEL: 1550 MW

See 4H, Part A for location of points.

POINT NO.	FREQUENCY-CPS	ACCELERATION "C" PEAK	VELOCITY IN./SEC-PEAK	DISPLACEMENT IN. - PEAK TO PEAK
<u>101</u>	4 Transient pulse 4 cps wide	0.02 - 0.08 0.2	0.31 - 1.23 3.1	0.025 - 0.1 0.25
	150	1.0 - 3.5	0.45 - 1.63	0.001 - 0.0035
	1060	1.5 - 7.0	0.08 - 0.42	0.000025 - 0.00013
	4350	1.1 - 9.8	0.02 - 0.15	0.000001 - 0.00001
<u>102</u>	4-5 700 3350	0.07 - 0.5 5.0 - 21.0 5.6 - 53.3	1.0 - 7.0 0.48 - 2.0 0.11 - 1.0	0.07 - 0.55 0.0002 - 0.0009 0.00001 - 0.0001
<u>103</u>	4-5 150 600 1000 - 5760	0.02 - 0.09 1.2 - 4.0 5.5 - 16.4 2.2 - 17.0 2.7 - 21.8	0.3 - 1.3 0.54 - 1.9 0.6 - 1.7 0.15 - 1.1 0.02 - 0.26	0.02 - 0.09 0.0013 - 0.004 0.0003 - 0.0009 0.00005 - 0.00035 0.000002 - 0.000015
<u>D</u>	4-6 5460	0.06 - 0.23 4.3 - 26.8	0.89 - 3.78 0.05 - 0.3	0.07 - 0.30 0.000003 - 0.000018
<u>E</u>	5 3300 6400	0.035 - 0.3 5.0 - 30.0 5.7 - 20.0	0.44 - 3.6 0.1 - 0.57 0.055 - 0.2	0.03 - 0.23 0.000009 - 0.00005 0.000003 - 0.00001

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REACTOR: 105-F

TEST NO.: 1F, Part A

DATE TAKEN: 12-16-59

BY: P. H. Hutton

TUBE FLOW:

HEADER FLOW: See below.

OPERATING LEVEL: 1650 MW

PT.	LOCATION	FLOW-GPM	TEMPERATURE-°C
A	22 Rear Header between column 91 and 92	1567	68
B	06 Rear Header between column 91 and 92	3503	78
C	02 Rear Header between column 91 and 92	2417	65
104	21 Rear Header between column 91 and 92	2406	97

Note: All headers equipped with Du Pont connectors.

POINT NO.	FREQUENCY-CPS	ACCELERATION "G" PEAK	VELOCITY IN./SEC - PEAK	DISPLACEMENT IN. - PEAK TO PEAK
<u>A</u>	2-4 1140 3225 4350	0.01 - 0.18 3.2 - 15.0 2.0 - 12.0 2.4 - 18.7	0.18 - 2.9 0.19 - 0.8 0.04 - 0.27 0.04 - 0.25	0.014 - 0.23 0.000055 - 0.00025 0.000004 - 0.000027 0.000003 - 0.000019
<u>B</u> Transient Pulse wide.	4-5 4-7 cps 1130 4370 7200	0.01 - 0.17 0.5 2.5 - 9.5 3.5 - 10.0 3.0 - 17.3	0.21 - 2.52 8.0 0.14 - 0.54 0.05 - 0.16 0.03 - 0.15	0.017 - 0.20 0.6 0.00004 - 0.00016 0.000004 - 0.00001 0.000001 - 0.000006
<u>C</u> Transient Pulse wide. Pulse decay	3-5 4 cps 100 1130 5150	0.03 - 0.22 0.6 0.29 - 0.05 0.27 - 0.6 1.5 - 6.5 4.0 - 30.0	0.44 - 3.56 9.25 4.63 - 0.84 0.18 - 0.38 0.08 - 0.36 0.05 - 0.38	0.035 - 0.28 0.75 0.35 - 0.07 0.0005 - 0.0012 0.000022 - 0.0001 0.000003 - 0.000023
<u>104</u>	3-4 1100 4350	0.02 - 0.17 2.3 - 23.1 1.15 - 6.9	0.33 - 2.67 0.13 - 1.50 0.02 - 0.10	0.028 - 0.21 0.000035 - 0.00042 0.000002 - 0.000008

DECLASSIFIED

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HW-65569

REACTOR: 105-F

TEST NO.: 1F, Part B

DATE TAKEN: 1-29-60

BY: P. H. Hutton

TUBE FLOW:

HEADER FLOW: See below

OPERATING LEVEL: About 1600 MW

PT.	LOCATION	FLOW-GPM	TEMPERATURE-°C
A	22 Rear Header between columns 91 and 92	1570	66
B	06 Rear Header between columns 91 and 92	3488	79
C	02 Rear Header between columns 91 and 92	2380	70
104	21 Rear Header between columns 91 and 92	2394	94

Note: Header No. 21 equipped with "J" connectors, all others with Du Pont connectors.

POINT NO.	FREQUENCY-CPS	ACCELERATION "G" PEAK	VELOCITY IN./SEC.- PEAK	DISPLACEMENT IN. - PEAK TO PEAK
<u>A</u>	4-5 980 1120 3190	0.02 - 0.14 1.7 - 9.0 3.6 - 14.0 2.1 - 27.0	0.36 - 2.2 0.11 - 0.61 0.20 - 0.80 0.04 - 0.52	0.03 - 0.18 0.00004 - 0.0002 0.00006 - 0.00023 0.000004 - 0.00005
<u>B</u> Transient Pulse 4 cps wide	4 980 1110 7300	0.03 - 0.28 0.48 2.3 - 6.5 2.8 - 8.0 2.1 - 23.6	0.42 - 4.20 7.6 0.16 - 0.44 0.16 - 0.49 0.02 - 0.2	0.035 - 0.33 0.6 0.00005 - 0.00015 0.00004 - 0.00014 0.000001 - 0.00001
<u>C</u> Transient Pulse 2-3 cps wide.	4-6 1110 1230 5580	0.035 - 0.3 0.2 1.2 - 4.5 2.9 - 7.5 1.6 - 23.5	0.44 - 3.6 5.8 0.08 - 0.27 0.16 - 0.40 0.02 - 0.30	0.03 - 0.22 0.8 0.00002 - 0.000075 0.00004 - 0.0001 0.000001 - 0.000017
<u>104</u>	3 1030 4710	0 - 0.06 3.33 - 8.9 1.1 - 8.9	0 - 1.14 0.20 - 0.50 0.02 - 0.13	0 - 0.12 0.00006 - 0.00016 0.000001 - 0.00001

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HW-65569

REACTOR: 105-F

TEST NO.: 2F

DATE TAKEN: 2-6,8,11-60

BY: P. H. Hutton

TUBE FLOW: _____

HEADER FLOW: _____

OPERATING LEVEL: See below

PT.

LOCATION

E No. 23 Rear Header between columns 65 and 66.
101 No. 23 Rear Header between columns 59 and 60.

POINT NO.	FREQUENCY-CPS	ACCELERATION "G" PEAK	VELOCITY IN./SEC. - PEAK	DISPLACEMENT IN. - PEAK TO PEAK
<u>Front Header Pressure = 415 psig, Bulk Outlet Temperature = About 10° C.</u>				
<u>E & 101</u>	Negligible Vibration			
<u>Front Header Pressure = 465 psig, Bulk Outlet Temperature = 50° C.</u>				
<u>E</u>	6	0.02 - 0.08	0.22 - 0.88	0.012 - 0.047
<u>101</u>	3-1/2	0.015 - 0.065	0.25 - 1.25	0.022 - 0.110
<u>Front Header Pressure = 487 psig, Bulk Outlet Temperature = 66° C.</u>				
<u>E</u>	4	0.028 - 0.055	0.44 - 0.89	0.035 - 0.070
<u>101</u>	4	0.031 - 0.13	0.5 - 2.0	0.04 - 0.17
<u>Front Header Pressure = 490 psig, Bulk Outlet Temperature = 86° C.</u>				
<u>E</u>	5	0.035 - 0.15	0.44 - 1.8	0.03 - 0.12
<u>101</u>	5	0.075 - 0.28	1.0 - 3.5	0.065 - 0.22

Note: Only low frequencies (400 cps and below) were monitored on this test.

UNCLASSIFIED

105-H
10-5-59

1 H

1"/SEC.

LOW FREQUENCIES

101

FIGURE 1

UNCLASSIFIED

105-H 1H 25"/sec

10-5-59

MEDIUM FREQUENCIES

101

D

E

FIGURE 2

UNCLASSIFIED

105-H 1 H
10-5-59
101 HIGH FREQUENCIES

1/20 sec.

103

104

FIGURE 3

UNCLASSIFIED

FIGURE 4

105-F 1F-Part A
 12-16-59
 HIGH FREQUENCIES

← 1/60 sec. →

FIGURE 5

10-1-77
10-1-77
LOW FREQUENCIES
COLD PLON PRIN TO START-UP
D
103
101

105-H
11-30-59

4H - Between
Part A & Part B

1 sec.

LOW FREQUENCIES

ABOUT HALF WAY TO TURN AROUND

D

103

101

FIGURE 6

105-H
11-30-59

4H-Part B

→ || ← 1 sec.

LOW FREQUENCIES
ABOUT 850 MW

P

103

101

DECLASSIFIED

FIGURE 7

DECLASSIFIED

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HW-65569

FIGURE 8

105-F

2-6-60

LOW FREQUENCIES

415 psig

10°C

5"/sec.

~~101~~

~~E~~

105-F 487 poly
2-8-60 66°C
LOW FREQUENCIES

101
1 sec

DECLASSIFIED

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HW-65569

105-F 490 psig
2-H-60 86 psig
LOW FREQUENCIES

1-1 sec-2

101

E

FIGURE 10

UNCLASSIFIED

FIGURE 11

UNCLASSIFIED

FIGURE 12

DATE

FILMED

8/2/94

END