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Research Report No. 61/9-97

EXPANSION JOINT TESTS

FOR

GENERAL ELECTRIC COMPANY

By

Claud C. Lomax
Associate Hydraulic Engineer
Washington State University

Classification Cancelled and Changed To

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By Authority of DS Lewis

CG-PR-2, 4-21-94

By DK Hanson, 5-9-94

Verified By JE Savely 5-13-94

June 20, 1961

Project No. 609

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AT(45-1)-1350

Claud C. Lomax

Claud C. Lomax

E. Roy Tinney

E. Roy Tinney, Head
The R. L. Albrook Hydraulic
Laboratory

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DIVISION OF INDUSTRIAL RESEARCH

INSTITUTE OF TECHNOLOGY

Washington State University

Pullman, Washington

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EXPANSION JOINT TESTS

Introduction

The tests reported herein are part of the work accomplished under Design, Development and Research Contract DDR-111 between General Electric Company, Hanford Atomic Products Operation and Washington State University. The equipment and instrumentation used for the K-Downcomer tests were arranged to permit installation and testing of the expansion joints.

Discussion

Drawing 609-C-1, 609-C-8, and 609-B-7 and 9 show the test arrangements.

Pressure gages were used to control the back pressure and to measure pressure losses across the expansion joint. Strain gages were installed on the outer folds of the expansion bellows to measure the vibration component of the strains. In addition, visual observations were made of vibrations; and small vibrations were detected by placing a hand on the expansion joint. A sounding bar, consisting of a large screwdriver, was used to listen for cavitation noises.

Although most of the noise came from pumps, steam, and throttled control valves, some separation and cavitation was believed to exist in the original expansion joint. Similar noises were not detected in the revised bellows. The cavitation noise was not audible without the sounding probe.

Noticeably more vibrations were felt in the original bellows than the revised unit. These were relatively small. There are some inconsistencies in the pressure data which are believed to be due to the flanges and the gasket at the gage taps.

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Pressures lower than actual, and flow rates in excess of the required were used to determine if large vibrations could be stimulated but none were observed.

Table 1 summarizes these data.

Figures 1 and 2 are typical taped records. Figure 1 shows the effect of striking the bellows with the palm of one's hand. The relatively greater amplitude of the strain cycle is due to vibrations generated by cavitation at the downstream control valve. Figure 2 shows some raggedness to the signals which is believed partly due to slippage on the movement limiting rods. It was noted that in the compressed and offset position the harness clamps were tight against the movement limiting rods.

TABLE 1 - DATA FROM EXPANSION JOINT TESTS

Strain Gage Number	Strain Cycle in microinches per inch					
	Original	Revised	Original	Revised	Original	Revised
1	20	5	0	10	20	10
2	--	5	--	20	--	20
3	60	--	60	--	40	--
4	40	20	20	10	20	30
5	30	0	20	20	20	20
6	--	10	--	20	--	30
Pressure drop across expansion joint psi	2.0	2.0	1.5	1.5	1.5	0.25
Temperature	72°F.	66°F.	210°F.	210°F.	214°F.	214°F.
Flow Rate gpm	2,290	2,290	1,860	1,860	1,800	1,800
Back Pressure:						
Gage #2	0	- 2	2.0	1.5	9	10
Gage #3	0	0	0	0	10	14

All of the tests reported herein were made with the bellows compressed 0.6125 inch and with the downstream end offset 0.3060 inch from the axial centerline.

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Conclusions

The sounds which were detected with a sounding bar are believed to be due to separation and cavitation in the original expansion joint. The noise increased with flow rate and/or reduced back pressure. Higher temperatures tended to soften the noise. Noise from the revised design was less and could not be identified as separation and/or cavitation.

Vibrations were not visible. However, vibrations could be felt and those on the original expansion joint were greater than those on the revised expansion joint. The strain gage data indicates greater amplitude of vibrations for the original expansion bellow than the revised design. The revised design has a greater number of folds.

It is to be concluded that the revised design does show improved performance in these tests but neither design shows any serious vibrations or cavitation originating within the bellows.

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OFF

Gage 2

N

Gage 1

W

Gage 4

A

Gage 5

U

Gage 6

Q

Tape Speed 1 mm per second

20 microinches per inch per small division

CONFIDENTIAL

ALABAMA HYDRAULIC LABORATORY			
UNIVERSITY OF ALABAMA			
REVISED DESIGN			
Q = 650 gpm		T = 70°F	
BACK PRESSURE = 35 psi			
DATE	TESTED	BY	APP'D
11-1-68	11-1-68	11-1-68	11-1-68
11-1-68	11-1-68	11-1-68	11-1-68
11-1-68	11-1-68	11-1-68	11-1-68

Backpressure Reduced to 10 psi

OFF

Gage 1

N

OFF

W

Gage 3

D

STUCK
NO
RECORD

Gage 4

S

Tape Speed 1mm per second

Gage 5

Q

CONFIDENTIAL

20 microns per inch per sec

2

2

3

3

4

4

5

ALBROOK HYDRAULIC LABORATORY		
WASHINGTON STATE UNIVERSITY		
ORIGINAL DESIGN		
Q = 1800 gpm T = 210°F		
BACK PRESSURE = 30 PSI		
DR. BY: E	DATE: 2-6-61	DWG. NO:
TR. BY:	CHKD:	609-B-
SCALE:	APPR:	15

6

6

2.7

FRONT ELEVATION
SCALE: 2" = 1'-0"

PLAN
SCALE: 2" = 1'-0"

FOLD —

Pc. No.	DESCRIPTION	MAT.	No. REQ	SOURCE
1	ALUMINUM SHEET - 3' x 2'	1/8" AL.	1	O.H.
2	TERMINAL BLOCK		10	"
3	5/16" - 18 NC BOLT, 1" LONG	STL.	2	"
4	5/16" - 18 NC HEX. NUT	"	2	"
5				
6

SECTION A-A
SCALE: 3" = 1'-0"

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WASHINGTON STATE UNIVERSITY INSTITUTE OF TECHNOLOGY DIVISION OF INDUSTRIAL RESEARCH THE R. L. ALBROOK HYDRAULIC LABORATORY		
PANEL FOR STRAIN GAGE TERMINAL BLOCKS		
DR. BY <u>D.B.</u>	TR. BY _____	DATE <u>3-3-61</u>
CHKD. BY _____	SCALE _____	DWG. <u>609-R-7</u>

FOR DETAILS OF MOUNTING BOARD
FOR LEAD WIRES SEE DWG. 609-B-7

EAST ELEVATION

PLAN

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- NOTES: 1. FOR DETAILS OF TESTS & PIPING, SEE DWG. 609-C-8
2. FOLLOW MANUFACTURES INSTRUCTIONS FOR INSTALLING STRAIN GAGES
ALSO a. AFTER HEATING, WATERPROOF WITH SILICONE VARNISH.
b. LEADS TO BE NO. 27 WIRE.
c. + INDICATES POSITION OF STRAIN GAGE
3. VERTICALLY OFFSET DOWNSTREAM END FROM AXIAL CENTERLINE 0.8060"
4. COMPRESS BELLOWS TO OVERALL LENGTH OF 36.000" MINUS 0.6125"

-B-7

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WASHINGTON STATE UNIVERSITY INSTITUTE OF TECHNOLOGY DIVISION OF INDUSTRIAL RESEARCH THE R. L. ALBROOK HYDRAULIC LABORATORY		
STRAIN GAGE INSTRUCTIONS		
DR. BY <u>D.B.</u>	TR. BY <u>---</u>	DATE <u>4-8-61</u>
CHKD. BY <u>---</u>	SCALE <u>3/4"=1'-0"</u>	DWG. <u>609-B-9</u>

9-C-5

VIEW OF PIPING

PLAN VIEW OF EXPANSION
SCALE: $1\frac{1}{2}" = 1'-0"$

ANSION JOINT

Pc. No.	DESCRIPTION	MAT.	No. REQ
1	EXPANSION JOINT.		1
2	8" GATE VALVE		2
3	8" PIPE	STEEL	45'
4	6" PIPE	"	26'
5	8" TEE	"	1
6	12" C 32.9	"	1
7	6" TEE	"	1
8	1/8" NEOPRENE GASKET	NEO.	4
9	MOUNTING BRACKET - 3/8" PLATE	STEEL PLATE	2
10	3/4"-10NC. HEX. NUT	STEEL	88
11	3 1/2" 3/4"-10NC BOLT	"	"
12	2" 5/8"-11NC BOLT	"	8
13	5/8"-11NC NUT	"	"
14	4 1/2" Pipe Flange	"	2
15	4 1/2" Pipe Gasket 1/8"	Neoprene	2
16	6" GATE VALVE	"	1
17	PRESSURE GAUGE		2
18	6" - 90° ELBOWS	STEEL	4
19	8" - 90° ELBOWS	"	2
20	8" Pipe Flange Std. B-1	steel	8
21	8" Pipe Gasket 1/8"	Neoprene	6
22	6" Pipe Flange std. B-1	steel	2
23	6" Pipe Gasket 1/8"	Neoprene	2
24	12" Pipe Flange std. B-1	steel	1
25	12" Pipe Gasket 1/8"	Neoprene	1
26	8" to 12" Pipe Reducer, 10-Gage	Steel	1

Pc. No.	DESCRIPTION	MAT.	No. Req.	SOURCE
1	EXPANSION JOINT		1	O.H.
2	8" GATE VALVE		2	O.H.
3	8" PIPE	STEEL	45'	O.H.
4	6" PIPE	"	26'	O.H.
5	8" TEE	"	1	O.H.
6	12" C 32.9	"	1	O.H.
7	6" TEE	"	1	O.H.
8	1/8" NEOPRENE GASKET	NEO.	4	O.H.
9	MOUNTING BRACKET - 3/8" PLATE	STEEL PLATE	2	O.H.
10	3/4"-10NC. Hex. NUT	STEEL	88	O.H.
11	3 1/2" 3/4"-10NC BOLT	"	"	O.H.
12	2" 5/8"-11NC BOLT	"	8	O.H.
13	5/8"-11NC NUT	"	"	O.H.
14	4 1/2" Pipe Flange	"	2	O.H.
15	4 1/2" Pipe Gasket 1/8"	Neoprene	2	O.H.
16	6" GATE VALVE	"	1	O.H.
17	PRESSURE GAUGE		2	O.H.
18	6" - 90° ELBOWS	STEEL	4	O.H.
19	8" - 90° ELBOWS	"	2	O.H.
20	8" Pipe Flange Std. B-1	steel	8	O.H.
21	8" Pipe Gasket 1/8"	Neoprene	6	O.H.
22	6" Pipe Flange std. B-1	steel	2	O.H.
23	6" Pipe Gasket 1/8"	Neoprene	2	O.H.
24	12" Pipe Flange std. B-1	Steel	1	O.H.
25	12" Pipe Gasket 1/8"	Neoprene	1	O.H.
26	8" to 12" Pipe Reducer 10-Gage	Steel	1	O.H.

JOINT

SECTION A-A
SCALE: $\frac{1}{2}" = 1'-0"$

(14) Use Existing Bolts
(15) Nuts & Gaskets

SIDE VIEW OF EXPAN

DETAIL - A
SCALE: $1\frac{1}{2}" = 1'-0"$

26	8 TO 16 PIPE NUTS, 100
27	3/4\"-10 NC x 1 3/4\" Bolts

OF EXPANSION JOINT

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DETAIL - A
SCALE: 1 1/2\" = 1'-0"

	Notes & Sect PC's. 14 & 15 Ch. Added.
Revision	Desc
WASHINGTON INSTITUTE OF DIVISION OF IND	
THE R. L. ALBROOK	
PIPING EXPANSION JO	
DR. BY D. B.	TR. BY
CHKD. BY	SCALE AS NC

26	Ø 10 1/2 PIPE REDUCER, 10 GAGE	STEEL	1	O.H.
27	3/4"-10 NC x 1 3/4" Bolts	steel	72	O.H.

JOINT

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ES

⚠	Notes & Sect's B-B & C-C Added Pc's. 14 & 15 Changed, Pc's. 20 & 27 Added.		1-13-61
Revision	Description	Date	
WASHINGTON STATE UNIVERSITY INSTITUTE OF TECHNOLOGY DIVISION OF INDUSTRIAL RESEARCH THE R. L. ALBROOK HYDRAULIC LABORATORY			
PIPING FOR EXPANSION JOINT TESTS			
DR. BY D.B.	TR. BY	DATE JAN-11-1961	
CHKD. BY E	SCALE AS NOTED	DWG. 609-C-1	

LES

-12-

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FIGURE 5

I. H
E
II. E
C

PLAN 1
SCALE: $\frac{3}{4}" = 1'-0"$

CAUTION

- I. INSTALLATION OF THESE STRAIN GAGES REQUIRES EXTREME CARE
- II. BELLAWS ASSEMBLY MUST BE HANDLED WITH GREAT CARE TO AVOID DAMAGE TO THE STRAIN GAGES.

DETAIL - I

SCALE: $\frac{1}{2}" = 1"$

SECTION

SCALE: $\frac{1}{2}" = 1"$

OVERALL HEIGHT VARIES WITH
THE SLOPE OF THE FLOOR

Pc.No.	DESCRIPTION	MAT.	No. Req	SOURCE
1	STRAIN GAGES ; BUDD-TATNALL TYPE C9-112		10	O. H.
2	1/4" F.P.T. PIPE CAP	STL.	4	O. H.
3	1/2" STEEL PLATE FILLER	STL.	1	O. H.
4	WEDGE	STL.	2	MFG.
5	8" PIPE GASKET 1/8"	NEOPRENE	1	O. H.
6	0.606" STEEL PLATE LIFT	STL.	1	MFG.
7	3" x 1'-0" x 1/4" PLATE	STL.	1	O. H.
8	1 1/4" x 1 1/4" x 1/8" ANGLE = 1'-3" LONG	STL.	2	O. H.
9	2" x 1'-6" x 1/4" PLATE	STL.	1	O. H.
10	WATERPROOFING BUDD GW-1	SILICONE		O. H.
11	SOLDER ; KESTER * 44	RESIN CORE		O. H.
12	LEAD WIRE * 27 SOLDEREZE			O. H.
13	CEMENT ; BUDD-GA-50			O. H.
14	SOLDERING IRON ; 37 1/2 PENCIL TYPE		1	O. H.
15	1/32" GASKET : I.D. = 6" ; O.D. = 7 1/2"	NEOPRENE	1	O. H.
16	PRESSURE GAGES		3	O. H.

ION A-A

1/2" = 1"

SEE DETAIL 2

EAST

SCALE: $\frac{3}{4}" = 1'$

RECORD OF ME

SIDE	DIST			
	WITH STOPS			
	1-4	2-3	1-2	3
A				
B				
C				
D				
E				
F				

* DISTANCE

EAST ELEVATION

SCALE: $\frac{3}{4}" = 1'-0"$

CORD OF MEASUREMENTS

DISTANCE			
WITH STOPS			* TEST
2-3	1-2	3-4	1-4

* DISTANCE WITH STOPS MINUS 0.6125"

DETAIL - 2

SCALE: $1\frac{1}{2}" = 1'-0"$

1. FOR TESTING USE $\frac{1}{2}"$ STEEL PLATE AND $\frac{1}{8}"$ COMPRESS EXPANSION JOINT 0.6125". ADD THICK FOR VERTICAL LIFT.

2. SCRIBE REFERENCE MARKS FOR PRECISE MEASUREMENTS OF THE TWO FLANGES. REFERENCE MARKS SHOULD BE EXACTLY OPPOSITE THOSE

3. FOLLOW MANUFACTURER'S INSTRUCTIONS FOR INSULATION ALSO

a. AFTER HEATING, WATERPROOF WITH SILICONE VARNISH.
b. GAGE TO BE INSTALLED INSIDE OF COATING OF GACO NEOPRENE WITH THE SILICONE VARNISH.

c. LEADS TO BE #27 WIRE.
d. + INDICATES POSITION OF GAGE.

4. LEADS FROM THE INSIDE GAGE MUST BE CUSHIONED WHEN BROUGHT EXTERNAL.

5. PROCEDURE

a. LOCATE REFERENCE MARKS AND MEASUREMENTS ON THIS DRAWING.
b. INSTALL STRAIN GAGES ON SPARE BARS.
c. HEAT TREAT AND WATER PROOF.

OVERALL HEIGHT VARIES WITH
THE SLOPE OF THE FLOOR

LEAD W

DET.
SCALE: 3

2

5. CONT.

- d. ASSEMBLE BELLOWS, C
REDUCERS AS A UNIT V
EXTERNAL THROUGH G.
- e. INSTALL TERMINAL BLOCK
609-C-9.
- f. REMOVE STOPS BY CHIP
- g. OFFSET AND COMPRESS

STEEL PLATE AND $\frac{1}{8}$ " NEOPRENE GASKET.
JOINT 0.6125". ADD A PLATE 0.806"
-1FT.

MARKS FOR PRECISE MEASUREMENTS ON ALL 6
FLANGES. REFERENCE MARKS ON CENTERING
ACTUALLY OPPOSITE THOSE ON THE FLANGES.

5 INSTRUCTIONS FOR INSTALLING STRAIN GAGES.
PAINTING, WATERPROOF WITH SILICONE VARNISH.
INSTALLED INSIDE OF BELLOWS TO HAVE A
GACO NEOPRENE WATERPROOFING FOLLOWING
THE VARNISH.

USE #27 WIRE.
POSITION OF GAGE.

EACH GAGE MUST BE CUSHIONED BETWEEN TWO GASKETS
NAT.

REFERENCE MARKS AND MEASURE AND RECORD DISTANCE
DRAWING.

PAINT GAGES ON SPARE BELLOWS.
PAINT AND WATER PROOF.

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WASHINGTON INSTITUTE DIVISION C	
THE R. L. A	
NEW TEST INSTRUCTIONS	
DR. BY D.B.	TR.
CHKD. BY	SC

ITH
R

← LEAD WIRE

DETAIL - 3
SCALE: 3" = 1'-0"

5. CONT.
- d. ASSEMBLE BELLOWS, CHANNEL SUPPORT AND EXTEND REDUCERS AS A UNIT WITH LEADS FROM INTERNAL BROUGHT EXTERNAL THROUGH GASKETS AT BELL ENTRANCE.
 - e. INSTALL TERMINAL BLOCKS AND EXTEND LEADS FOR RECORDERS, 609-C-9.
 - f. REMOVE STOPS BY CHIPPING.
 - g. OFFSET AND COMPRESS BELLOWS REQUIRED AMOUNT.

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SKETS

STANCE

WASHINGTON STATE UNIVERSITY INSTITUTE OF TECHNOLOGY DIVISION OF INDUSTRIAL RESEARCH		
THE R. L. ALBROOK HYDRAULIC LABORATORY		
NEW EXPANSION JOINT TEST INSTRUCTIONS. TEST PREPARATIONS		
DR. BY <u>D.B.</u>	TR. BY _____	DATE <u>21 - FEB. - 61</u>
CHKD. BY _____	SCALE <u>As NOTED</u>	DWG. <u>609-C-8</u>

DATE

FILMED

8/17/94

END