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ASSEMBLY AND TESTING OF 1/4 INCH MR54040 TF04 RESISTOFLEX DYNATUBE FITTINGS

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16. ABSTRACT

Installation of Resistoflex dynatube fittings on ¼ in. tubing is sensitive to workmanship and to the state of repair of the installation tooling. Tooling with very slight out-of-specification imperfections will produce less than optimum swaged fittings. This investigation included fabrication of a significant quantity of samples, X-rays to determine the depth of swage and static and dynamic testing to determine joint performance.

17. KEY WORDS
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TECHNICAL MEMORANDUM

ASSEMBLY AND PERFORMANCE OF 1/4 INCH MR54040 TF04 RESISTOFLEX DYNATUBE FITTINGS

1. INTRODUCTION AND BACKGROUND

Dynatube is a trade name for a titanium (6Al-4V) threaded fitting used to join metal tubing (Figs. 1 and 2). These fitting are manufactured by the Resistoflex Corporation of Roseland, N.J. The outside surface of the metal tube is mechanically swaged into grooves in the inside surface of the fitting. Swaging is performed either by manual or power rotation of an expanding mandrel type tool (Figs. 3 and 4). These fittings have a long history of successful use in commercial and military aircraft and aerospace systems with minimum weight and critical leak rate requirements.

During build-up of hardware for the Space Shuttle Thrust Vector Control (TVC) system, some tube assemblies using Dynatube fittings were fabricated that did not pass the prescribed leak test of 1×10^{-5} standard cubic centimeters per second of helium at 400 psig. Leakage was detected between the fitting and the outside diameter of the tube. These tests were conducted using a helium sniffer and also by using "Leak Tek" solution and noting bubbles of escaping helium gas. It was determined that these same tube assemblies had previously passed the leak test requirements. Fittings are tested repeatedly as build-up of the assembly progresses to the next higher level. Sectioning of the leaking joint revealed a very light swage of less than 0.002 in. radial deformation of the tube into the fitting grooves which are 0.007 in. deep. Further investigation revealed that some lightly swaged fittings had passed all hydrostatic leak testing but could be made to leak if they were rotated on the tube during installation (Figs. 5 and 6).

Further investigation determined that Dynatube fitting assemblies had been made using swage tooling that was worn and/or misassembled. The worn tooling swaged light, as little as 0.002 in. deep in the four 0.007 in. deep fitting joints. The misassembled swage tool swaged short, i.e. good swages in the first three grooves but little or no swage in the farthest groove (4th groove) from the point of entry of the mandrel into the tube to be swaged. Refurbishment of the tooling by replacing the worn rollers on the expanding mandrel and by correcting the out of place spacer washers in the misassembled tool corrected the problem of swaging good joints. Correctly assembled and refurbished tooling can consistently swage grooves 0.005 in. deep or more when used by a trained operator. However, x-ray of inplace tubing assemblies revealed that some joints had been manufactured and installed that were lightly swaged and that had successfully passed the helium leak tests. A program was developed to determine the performance of lightly swaged joints and to duplicate and test joints equal to or worse than those known to be installed on the flight TVC hardware. This program was comprised of the following:

1) To be statistically meaningful, 100 each ¼ in. fittings were procured and fabricated into 50 each tube assemblies with one fitting at each end (Fig. 1).

2) All swage tooling was refurbished by the Resistoflex Corporation to the correct company specifications.

3) A tolerance study was made on the tubing, the tooling, and the fitting to determine the worst case swage that could be made (Appendix). Swages were made at minimum possible, medium range, and full depth. Additionally, samples were prepared that were fully swaged, but swaged short. Swage tool settings to accomplish these conditions were 0.219, 0.221, 0.223, 0.225, and 0.228 in. The 0.228 in. setting is the normal setting recommended by Resistoflex Corporation for these fittings. All samples were measured (I.D.) x-rayed to determine amount of swage, proof pressure tested at 7000 psi, mass spectrometer leak tested (sniffer method) at 400 psi with helium, rotated 15° in the fitting to simulate a careless fit-up, re-leak checked, and pressure tested. After rotation, approximately 25 percent of the samples did not pass the helium leak. These were assembled into a closed loop arrangement and pressurized at 400 psi with water. The pressure was maintained for two weeks. None of the swaged fittings that leaked helium, leaked water during the two weeks under pressure.

After static testing, the tubes were vibration tested to Shuttle flight level in the radial, tangential, and longitudinal axis (Table 1). While being vibrated, all tubes were pressurized at 400 psi with water containing red dye to enhance visibility in case of a leak. Sixty each fittings, including all the shallow swages and all the short swages, were tested. None leaked water at 400 psi during the vibration tests which simulated flight conditions.

2. FINDINGS

1) Resistoflex Dynatube swage tooling in the proper state of repair and used properly will consistently yield adequate swages. (0.005 or more in the first three grooves.)

2) The light and short swage conditions found were caused by worn and improperly assembled tooling respectively.

3) The inhouse MSFC test program demonstrated that a MR54040 TF04 swage joint with at least 0.0015 in. radial tube deformation, while not desirable, will pass the required leak rate of not more than 1×10^{-5} scc's helium at 400 psig. Additionally this joint will not leak water when pressurized to 400 psi and vibrated to 28.2 grms composite in the radial and tangential axis and 27.0 grms composite in the longitudinal axis.

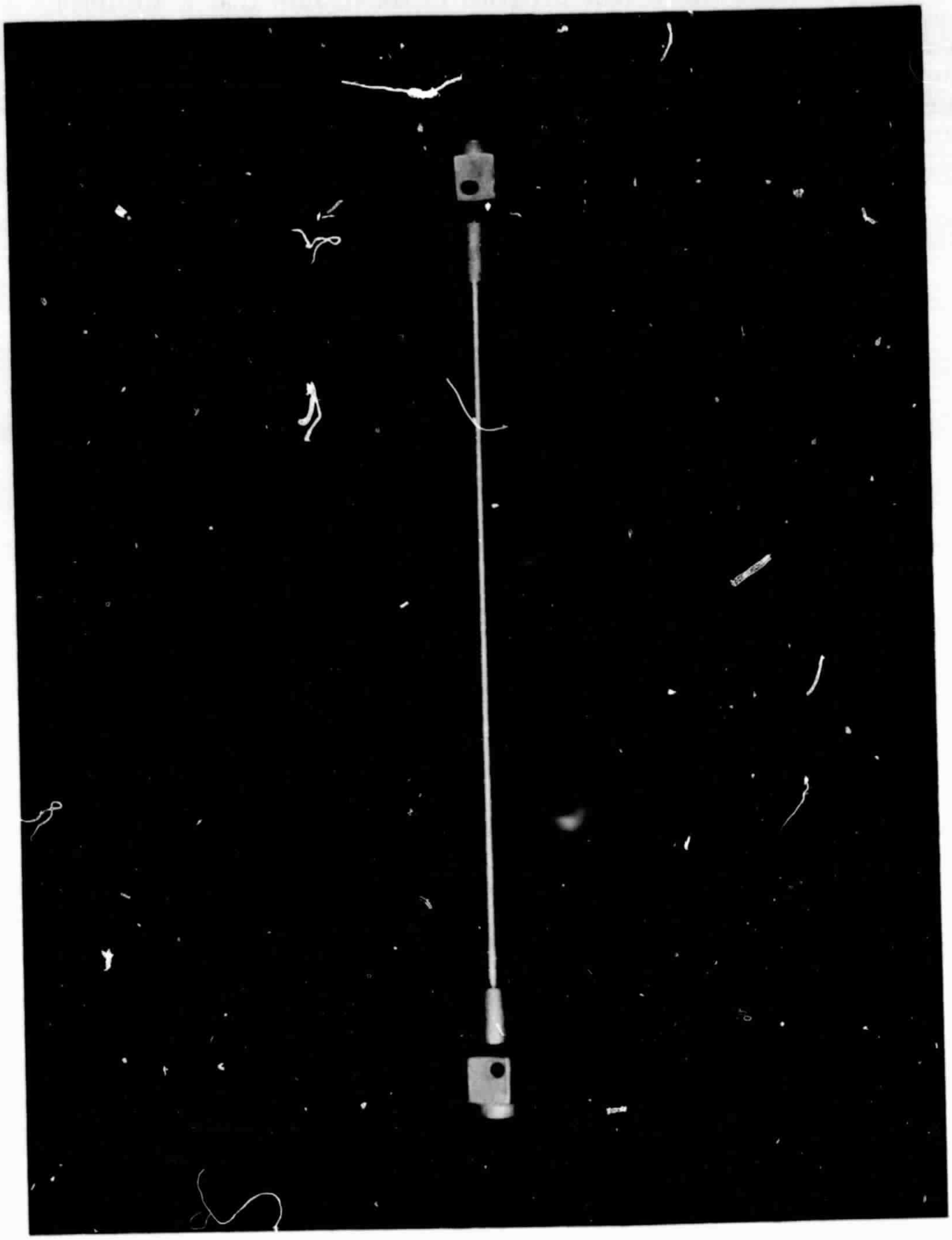


Figure 1. ¼ inch 304L stainless steel tube with MR54050 TF04 fitting each end.

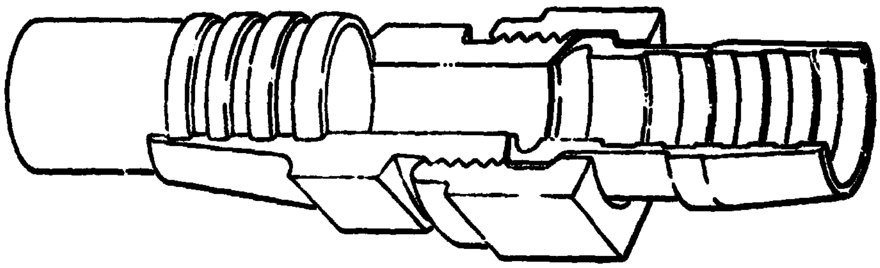


Figure 2. MR 54040 TF04 dynatube fitting.

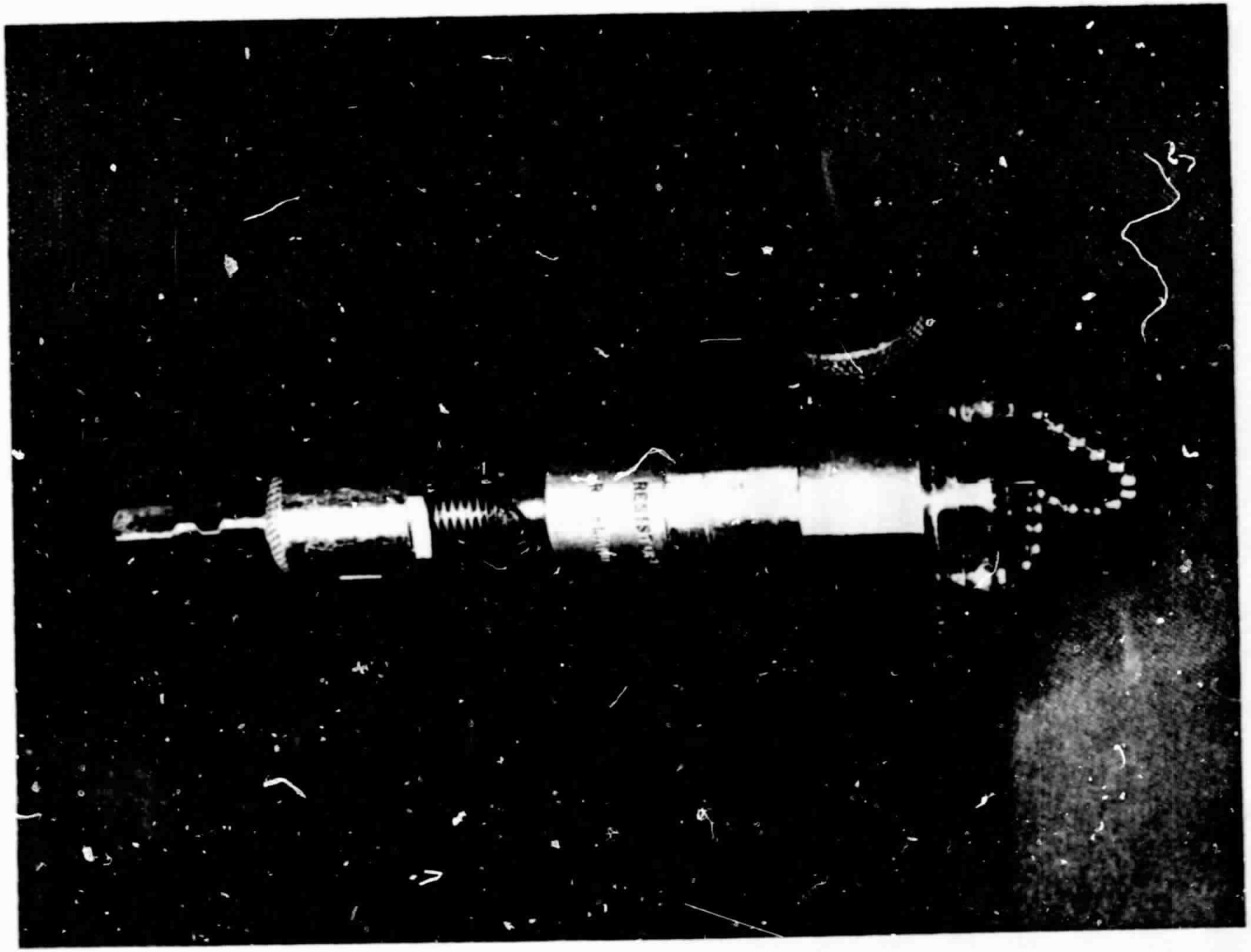


Figure 3. Swage tool (fully assembled).

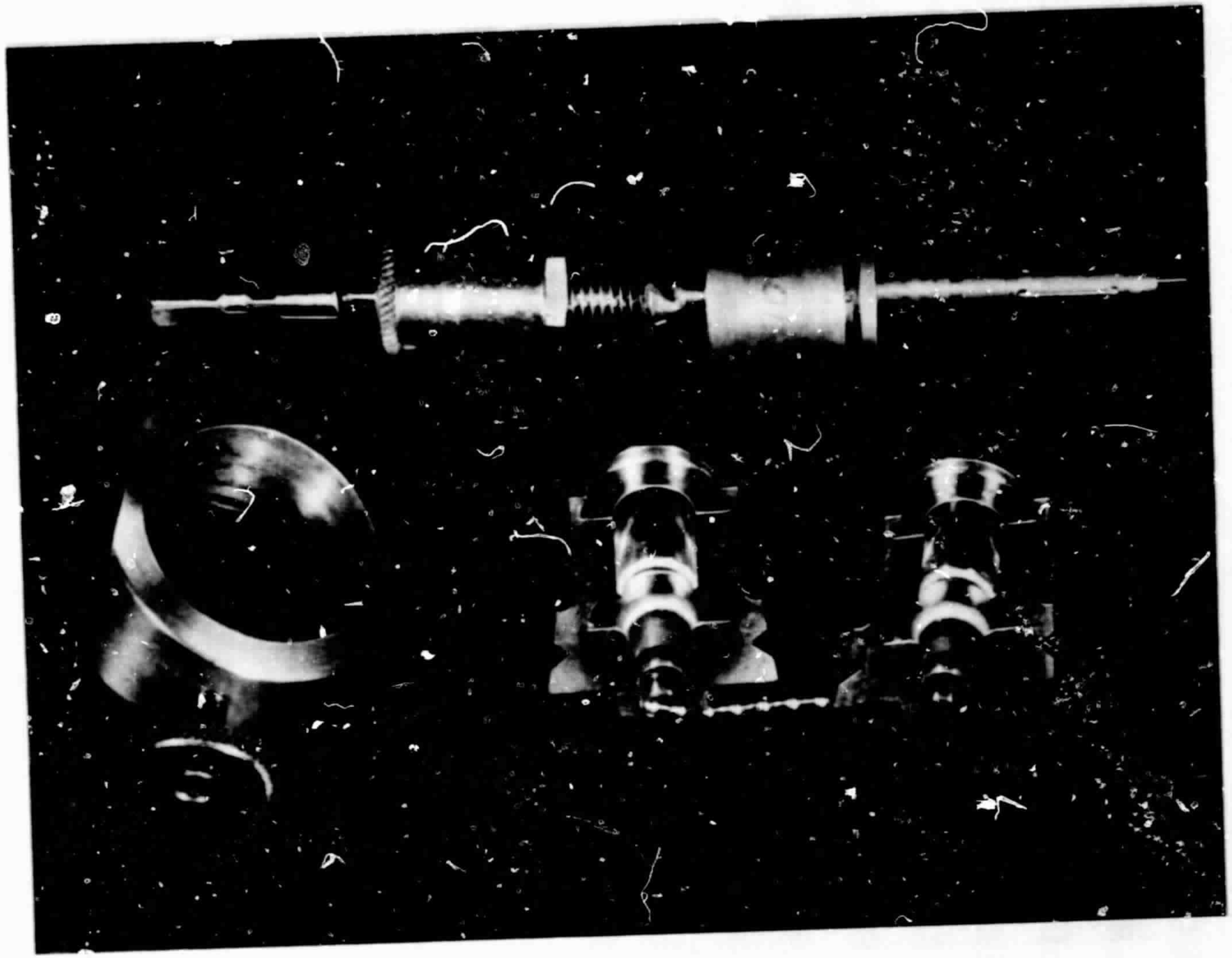


Figure 4. Swage tool (disassembled).

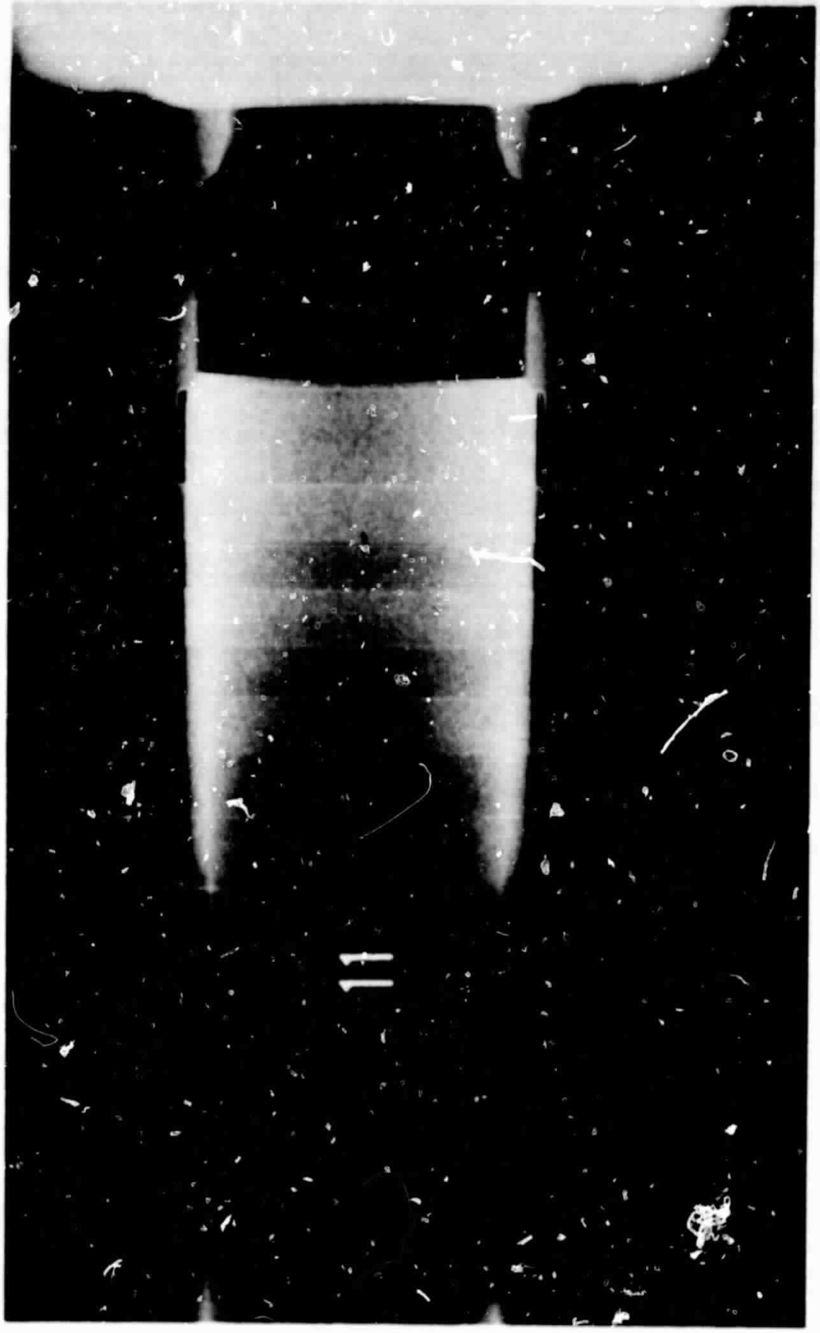
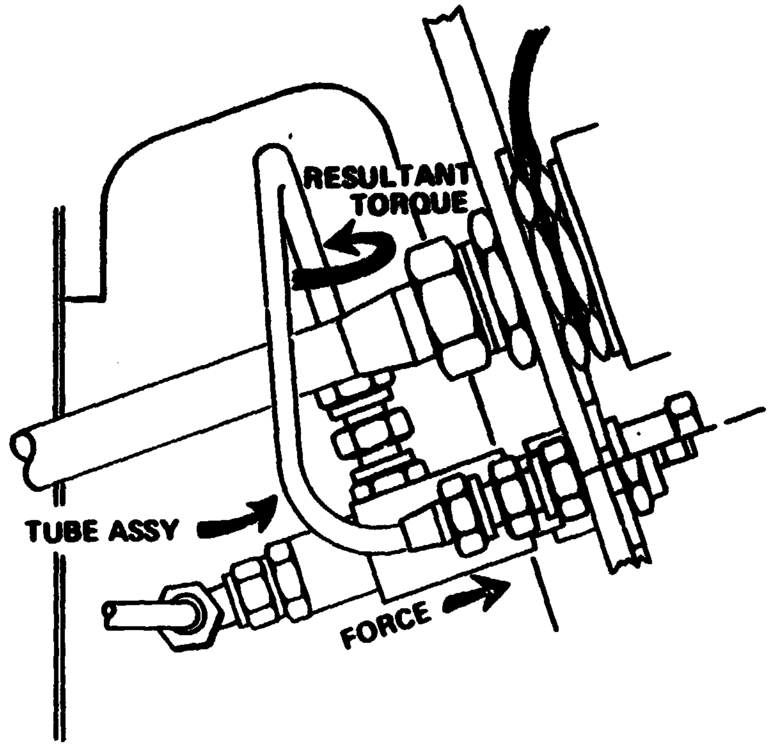


Figure 5. Enlarged x-ray of fitting and tube showing minimal swage of tube into fitting grooves.



ROTATING THE TUBE IN THE SWAGE FITTING COULD OCCUR DURING INSTALLATION WHEN ONE END OF THE ASSEMBLY HAS BEEN SECURED THEN THE OTHER END IS DRAWN AGAINST ITS MATING FITTING CAUSING A ROTATIONAL TORQUE ON THE OPPOSITE END.

Figure 6. Example of possible rotation.

APPENDIX

TOLERANCE ANALYSIS

FITTING

Resistoflex MR54040

TUBE

MIL-T-6845C

Size Range Outside Diameter (Inch)	Tolerance
¼ thru ½ INCL	+.004 - .000
over ½ thru 1½	+.005 - .000
over 1½ thru 2¼	+.010 - .000
over 2¼ thru 3	+.010 - .010
over 3 thru 5	+.015 - .015

Tube OD: $.250 \begin{smallmatrix} +.004 \\ -.000 \end{smallmatrix}$

Tube Wall: .020 ± .002 = .040 ± .004 cumulative

$$
\begin{array}{rl}
 & .250 \begin{smallmatrix} +.004 \\ -.000 \end{smallmatrix} \\
 & \underline{-.040 \pm .004} \\
\text{Tube ID} = & .210 \begin{smallmatrix} +.008 \\ -.004 \end{smallmatrix}
\end{array}
$$

$$
\begin{array}{lr}
\text{Test Gage} & \\
\text{Diameter} & .224 \pm .002 \\
\text{Tube Wt.} & \underline{+.040} \pm .004 \\
 & \\
\text{Range} & .264 \pm .006 \\
\text{Fitting ID} & \underline{-.255 \pm .002} \\
 & \underline{\underline{.009 \pm .008}}
\end{array}
$$

This tolerance guarantees positive interference fit even if (in the unlikely event) the tube is the smallest possible, with the thinnest wall permissible, and the fitting is at the extreme upper limit. Factors such as spring back and wall thinning are handled by adding an additional .004 inch extra expansion to tool settings.

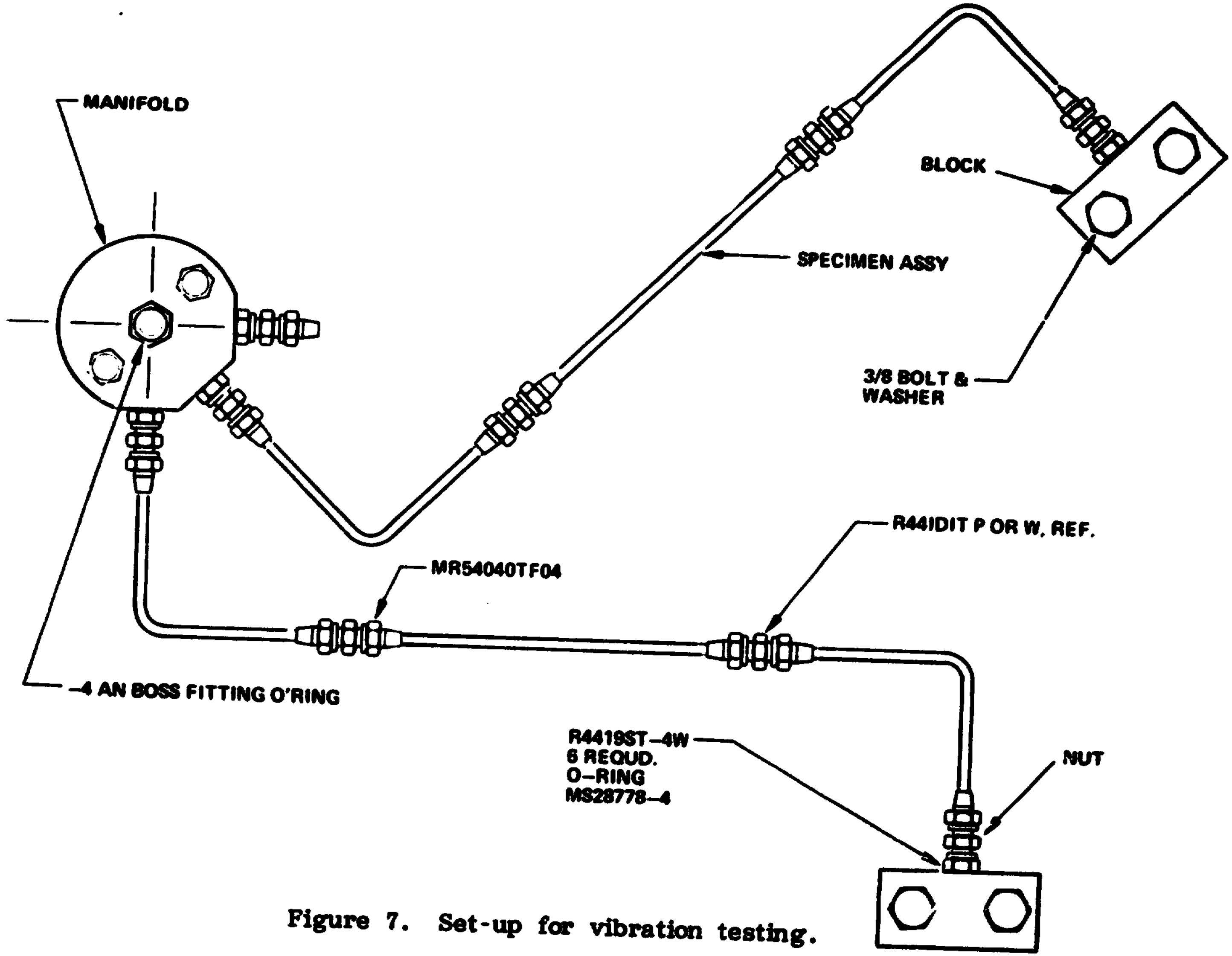


Figure 7. Set-up for vibration testing.

TABLE 1. VIBRATION INPUT TO SRB TVC TUBE (0.25" Dia.) ASSEMBLIES

Lift-off and Boost Random Vibration Criteria
(180 seconds in each axis)

RADIAL AXIS	LONGITUDINAL AXIS
20 Hz @ 0.1 g^2/Hz	20- 60 Hz @ 0.1 g^2/Hz
20- 60 Hz @ +7 dB/oct	60- 200 Hz @ +5.5 dB/oct
60- 150 Hz @ 1.2 g^2/Hz	200- 400 Hz @ 0.9 g^2/Hz
150-2000 Hz @ -2 dB/oct	400-2000 Hz @ -4 dB/oct
2000 Hz @ 0.2 g^2/Hz	2000 Hz @ 0.1 g^2/Hz
Composite = 28.2 grms	Composite = 27.0 grms

TANGENTIAL AXIS
20- 60 Hz @ 0.1 g^2/Hz
60- 100 Hz @ 13.5 dB/oct
100- 300 Hz @ 1.0 g^2/Hz
300-2000 Hz @ -3.5 dB/oct
2000 Hz @ 0.1 g^2/Hz
Composite = 28.6 grms

EXPLANATION OF TABLE 2

The data contained in Table 2 denote the specimen number, the fitting on each end (No. 1 and No. 2) of the tube, the tube diameter in inches, and the swage tool setting in inches. The depth of swage per groove determination was made by evaluation of x-rays using an optical comparator. The No. 1 groove is the first groove from the sealing surface and the No. 4 groove is the last groove on the tube end of the fitting. The x-ray is a cross sectional view and the reading is left to right top and bottom. The determination was made by positioning the fine line of the optical comparator on the land of the groove and reading the amount of upset of the tube into the fitting groove. The tube internal diameter of swage was made using an internal micrometer with a stop to ensure that all tubes were measured at the same position. The column noting helium leakage determines if the fitting leaked in excess of 1×10^{-5} scc's of helium at 400 psig. Next, the fitting was rotated 15 degrees on the tube to simulate a careless assembly (Fig. 6). After rotation the fitting was rechecked with the mass spectrometer to determine leakage. The remaining data column denotes those fittings selected for vibration testing.

TABLE 2. RESISTOFLEX DYNATUBE MSFC TESTING

RESISTOFLEX DYNATUBE
MSFC TESTING

* SEALING SURFACE TO LEFT

TUBE #	FITTING #	FITTING I.D.	TUBE I.D.	TUBE O.D.	SWAGE TOOL SETTING	* DEPTH OF SWAGE PER GROOVE # TOP LEFT → RIGHT 1	2	3	4	BOTTOM LEFT → RIGHT 1	2	3	4	I.D. AFTER SWAGE	HE LEAK YES	HE LEAK NO	ROTATED YES	ROTATED NO	VIBRATION TESTED	COMMENTS
1	1	.253	.205	.250	.219	.005	.000	.000	.000	.005	.000	.000	.000	.2168		X		X	X	
	2	.253	.204	.250	.219	.002	.000	.000	.000	.002	.000	.000	.000	.2168	X			X	X	
2	1	.254	.203	.250	.219	.002	.000	.000	.000	.002	.000	.000	.000	.217		X		X	X	
	2	.255	.204	.250	.219	.002	.000	.000	.000	.002	.000	.000	.000	.2168		X		X	X	
3	1	.254	.204	.250	.219	.001	.000	.000	.000	.001	.000	.000	.000	.2167		X		X	X	
	2	.254	.204	.250	.219	.001	.001	.000	.000	.001	.000	.000	.000	.2167		X	X		X	
4	1	.254	.204	.250	.219	.001	.000	.000	.000	.001	.000	.000	.000	.2168		X	X		X	
	2	.253	.204	.250	.219	.001	.000	.000	.000	.001	.000	.000	.000	.217		X	X		X	
5	1	.254	.204	.250	.219	.001	.001	.000	.000	.001	.000	.000	.000	.2168		X		X	X	
	2	.254	.203	.250	.219	.001	.000	.000	.000	.001	.000	.000	.000	.2172		X	X		X	
6	1	.254	.207	.250	.219	.002	.001	.000	.000	.002	.001	.000	.000	.217		X	X		X	
	2	.254	.207	.250	.219	.001	.000	.000	.000	.002	.000	.000	.000	.217		X		X	X	
7	1	.253	.206	.250	.221	.0025	.001	.000	.000	.0025	.001	.000	.000	.219		X		X	X	
	2	.253	.206	.250	.221	.0025	.002	.002	.001	.0025	.002	.001	.000	.219		X		X	X	

*Sealing surface to left.

TABLE 2. (Continued)

TUBE #	FITTING #	FITTING I.D.	TUBE I.D.	TUBE O.D.	SWAGE TOOL SETTING	*DEPTH OF SWAGE PER GROOVE # TOP LEFT → RIGHT 1	2	3	4	BOTTOM LEFT → RIGHT 1	2	3	4	I.D. AFTER SWAGE	HE LEAK YES	HE LEAK NO	ROTATED LEAKED YES	ROTATED LEAKED NO	VIBRATION TESTED	COMMENTS
8	1	.253	.202	.250	.221	.003	.002	.001	.000	.003	.002	.001	.000	.2188		X	X		X	
	2	.253	.202	.250	.221	.003	.002	.001	.001	.003	.002	.001	.001	.2188		X		X	X	
9	1	.254	.202	.250	.221	.003	.002	.001	.000	.003	.002	.001	.000	.2186		X		X	X	
	2	.254	.201	.250	.221	.003	.002	.001	.000	.003	.002	.001	.000	.2192		X		X	X	
10	1	.254	.204	.250	.221	.003	.002	.001	.000	.003	.002	.001	.000	.2192		X		X	X	
	2	.254	.204	.250	.221	.003	.002	.001	.000	.003	.002	.001	.000	.2188		X	X		X	
11	1	.254	.207	.250	.219	.001	.000	.000	.000	.001	.000	.000	.000	.2165						FAILED PRESSURE TEST AT 6500PSI
	2	.255	.205	.250	.219	.001	.000	.000	.000	.001	.000	.000	.000	.2155						
12	1	.253	.207	.250	.221	.004	.003	.002	.001	.004	.003	.001	.000	.2193		X		X	X	
	2	.254	.206	.250	.221	.003	.002	.001	.000	.004	.002	.001	.000	.2185		X		X	X	
13	1	.253	.207	.250	.221	.003	.002	.001	.000	.003	.002	.001	.000	.2187		X		X	X	
	2	.254	.198	.250	.221	.003	.002	.001	.000	.003	.002	.001	.000	.2185		X		X	X	
14	1	.254	.208	.250	.221	.003	.002	.001	.001	.003	.002	.001	.001	.2186		X		X	X	
	2	.253	.208	.250	.221	.003	.002	.001	.000	.003	.002	.001	.000	.2185		X	X		X	

*Sealing surface to left.

TABLE 2. (Continued)

TUBE #	FITTING #	FITTING I.D.	TUBE I.D.	TUBE O.D.	SWAGE TOOL SETTING	*DEPTH OF SWAGE PER GROOVE # TOP LEFT → RIGHT 1	2	3	4	BOTTOM LEFT → RIGHT 1	2	3	4	I.D. AFTER SWAGE	HE LEAK YES	HE LEAK NO	ROTATED YES	NO LEAKED	VIBRATION TESTED	COMMENTS
15	1	.253	.205	.250	.221	.003	.002	.001	.001	.003	.002	.001	.001	.2188		X		X	X	
	2	.254	.207	.250	.221	.003	.002	.001	.001	.003	.002	.001	.001	.019		X		X	X	
16	1	.253	.200	.250	.221	.003	.002	.001	.001	.003	.002	.001	.001	.2188		X		X	X	
	2	.253	.203	.250	.221	.003	.002	.001	.001	.004	.003	.002	.002	.2183		X		X	X	
17	1	.254	.202	.250	.221	.003	.002	.001	.001	.003	.002	.001	.001	.219		X	X		X	
	2	.255	.202	.250	.221	.003	.002	.001	.001	.003	.002	.001	.001	.219		X		X	X	
18	1	.253	.206	.250	.223	.005	.004	.004	.003	.005	.004	.004	.003	.2193		X		X		
	2	.252	.205	.250	.223	.005	.004	.004	.003	.005	.004	.004	.003	.2192		X	X			
19	1	.253	.207	.250	.223	.005	.004	.003	.003	.005	.004	.004	.003	.2198		X	X		X	
	2	.253	.205	.250	.223	.005	.004	.004	.003	.005	.004	.004	.003	.2196		X		X	X	
20	1	.254	.205	.250	.223	.005	.004	.004	.003	.005	.004	.004	.003	.220		X	X			
	2	.253	.208	.250	.223	.005	.004	.004	.003	.005	.004	.004	.003	.2204		X	X			
21	1	.254	.206	.250	.219	.001	.000	.000	.000	.001	.000	.000	.000	.2166		X		X	X	
	2	.254	.206	.250	.219	.001	.000	.000	.000	.001	.000	.000	.000	.2168		X	X		X	

*Sealing surface to left.

TABLE 2. (Continued)

RESISTOFLEX DYNATUBE
MSFC TESTING

* SEALING SURFACE TO LEFT

TUBE #	FITTING #	FITTING I.D.	TUBE I.D.	TUBE O.D.	SWAGE TOOL SETTING	*DEPTH OF SWAGE PER GROOVE # TOP LEFT → RIGHT				BOTTOM LEFT → RIGHT				I.D. AFTER SWAGE	HE LEAK		[illegible]		VIBRATION TESTED	COMMENTS
						1	2	3	4	1	2	3	4		YES	NO	YES	NO		
22	1	.254	.207	.250	.223	.005	.004	.004	.003	.005	.004	.004	.003	.2198		X		X	X	
	2	.255	.206	.250	.223	.005	.004	.004	.003	.003	.004	.004	.003	.2196		X		X	X	
23	1	.253	.208	.250	.223	.005	.003	.002	.001	.005	.003	.002	.001	.2198		X		X		
	2	.254	.205	.250	.223	.004	.003	.003	.003	.004	.003	.003	.003	.2197		X		X		
24	1	.254	.207	.250	.223	.004	.003	.003	.002	.004	.003	.003	.002	.2195		X	X			
	2	.254	.205	.250	.223	.004	.003	.003	.002	.004	.003	.003	.002	.2197		X		X		
25	1	.254	.206	.250	.223	.004	.003	.003	.003	.004	.003	.003	.003	.2197		X		X	X	
	2	.254	.206	.250	.223	.004	.003	.003	.002	.004	.003	.003	.002	.2197		X		X	X	
26	1	.253	.208	.250	.223	.005	.004	.004	.003	.005	.004	.004	.003	.2198		X		X		
	2	.253	.201	.250	.223	.005	.004	.004	.003	.005	.004	.004	.005	.2196		X		X		
27	1	.253	.207	.250	.223	.005	.004	.004	.003	.005	.004	.004	.003	.220		X	X			
	2	.254	.205	.250	.223	.004	.004	.003	.003	.004	.004	.003	.003	.2197		X		X		
28	1	.254	.208	.250	.223	.004	.002	.001	.001	.004	.002	.001	.001	.2196		X	X			
	2	.254	.205	.250	.223	.004	.002	.001	.001	.004	.002	.001	.001	.2195		X		X		

*Sealing surface to left.

TABLE 2. (Continued)

RESISTOFLEX DYNATUBE
MSFC TESTING

* SEALING SURFACE TO LEFT

TUBE #	FITTING #	FITTING I.D.	TUBE I.D.	TUBE O.D.	SWAGE TOOL SETTING	*DEPTH OF SWAGE PER GROOVE # TOP LEFT → RIGHT 1	2	3	4	BOTTOM LEFT → RIGHT 1	2	3	4	I.D. AFTER SWAGE	HE LEAK YES	HE LEAK NO	[illegible] I.D. [illegible] YES	[illegible] I.D. [illegible] NO	VIBRATION TESTED	COMMENTS
29	1	.254	.206	.250	.225	.005	.005	.004	.004	.005	.005	.004	.004	.2209		X	X			
	2	.253	.206	.250	.225	.005	.005	.004	.004	.005	.005	.004	.004	.2206		X		X		
30	1	.253	.208	.250	.225	.005	.005	.004	.004	.005	.005	.004	.004	.2212		X		X	X	
	2	.253	.208	.250	.225	.005	.005	.004	.004	.005	.005	.004	.004	.2211		X		X	X	
31	1	.253	.203	.250	.219	.001	.000	.000	.000	.001	.000	.000	.000	.216						
	2	.254	.207	.250	.219	.000	.000	.000	.000	GAP	GAP	GAP	GAP	.208						FAILED PRESSURE TEST– IMPROPER SWAGE – GAP
32	1	.254	.208	.250	.225	.005	.005	.004	.004	.005	.005	.004	.004	.2206		X			X	
	2	.254	.208	.250	.225	.005	.005	.004	.004	.005	.005	.004	.004	.2213		X		X	X	
33	1	.254	.204	.250	.225	.005	.005	.004	.004	.005	.005	.004	.004	.2206		X		X	X	
	2	.254	.207	.250	.225	.005	.005	.004	.004	.005	.005	.004	.004	.2206		X		X	X	
34	1	.254	.206	.250	.225	.005	.005	.004	.004	.005	.005	.004	.004	.2209		X		X		
	2	.253	.208	.250	.225	.005	[illegible]	.004	.004	.004	.003	.003	.003	.221		X		X		
35	1	.254	.208	.250	.275	.005	.005	.004	.004	.005	.005	.004	.004	.2208		X		X		
	2	.254	.206	.250	.225	.005	[illegible]	.004	.003	.005	.005	.004	.003	.2207		X		X		

*Sealing surface to left.

TABLE 2. (Continued)

TUBE #	FITTING #	FITTING I	TUBE I.D.	TUBE O.D.	SWAGE TOOL SETTING	*DEPTH OF SWAGE PER GROOVE = TOP LEFT → RIGHT 1	2	3	4	BOTTOM LEFT → RIGHT 1	2	3	4	I.D. AFTER SWAGE	HE LEAK YES	HE LEAK NO	ROTATED LEAKED YES	ROTATED LEAKED NO	VIBRATION TESTED	COMMENTS
36	1	253	206	250	219	001	000	000	000	001	000	000	000	216		X		X	X	
	2	254	207	250	219	001	000	000	000	001	000	000	000	2165		X		X	X	
37	1	254	2075	250	225	005	005	004	004	004	004	003	003	2212		X		X		
	2	253	208	250	225	005	005	004	004	005	004	004	003	2211		X		X		
38	1	253	208	250	225	005	005	005	004	005	005	004	004	2214		X		X		
	2	254	207	250	225	005	005	004	004	005	004	004	003	2207		X	X			
39	1	253	2075	250	225	006	005	005	004	006	005	005	004	2209		X		X	X	
	2	253	207	250	225	006	005	005	004	006	005	005	004	2213		X	X		X	
40	1	252	208	250	225	006	005	005	004	006	005	005	004	2208		X	X		X	
	2	253	2075	250	225	005	005	004	003	005	005	004	003	221		X	X		X	
41	1	2535	206	250	228	007	007	007	000	007	007	007	000	2238		X		X		SWAGED SHOR (= 3 TOOL SET-UP)
	2	253	205	250	228	007	007	007	000	007	007	007	000	2235		X		X		SWAGED SHOR (= 3 TOOL SET-UP)
42	1	255	200	250	228	007	007	007	000	007	007	007	000	223		X		X	X	SWAGED SHOR (= 3 TOOL SET-UP)
	2	254	203	250	228	007	007	007	000	007	007	007	000	224		X		X	X	SWAGED SHOR (= 3 TOOL SET-UP)

*Sealing surface to left.

TABLE 2. (Continued)

TUBE #	FITTING #	FITTING I.D.	TUBE I.D.	TUBE O.D.	SWAGE TOOL SETTING	DEPTH OF SWAGE PER GROOVE #								I.D. AFTER SWAGE	HE LEAK		ROTATED LEAKED		VIBRATION TESTED	COMMENTS
						TOP LEFT → RIGHT				BOTTOM LEFT → RIGHT										
						1	2	3	4	1	2	3	4		YES	NO	YES	NO		
43	1	.253	.204	.250	.228	.007	.007	.007	.000	.007	.007	.007	.000	.2236		x		x	x	
	2	.255	.204	.250	.228	.007	.007	.007	.000	.007	.007	.007	.000	.2234		x		x	x	
44	1	.253	.204	.250	.228	.007	.007	.007	.000	.007	.007	.007	.000	.2237		x		x	x	
	2	.253	.204	.250	.228	.007	.007	.007	.000	.007	.007	.007	.000	.2236		x		x	x	
45	1	.253	.205	.250	.228	.007	.007	.007	.000	.007	.007	.007	.000	.2236		x		x	x	
	2	.254	.201	.250	.228	.007	.007	.007	.000	.007	.007	.007	.000	.224		x		x	x	
46	1	.2535	.208	.250	.228	.007	.007	.006	.006	.007	.007	.006	.006	.227		x		x		
	2	.254	.208	.250	.228	.007	.007	.006	.006	.007	.007	.005	.005	.223		x		x		
47	1	.254	.208	.250	.228	.007	.007	.006	.006	.007	.007	.006	.006	.2228		x		x		
	2	.207	.255	.250	.228	.007	.007	.006	.006	.007	.007	.006	.006	.2232		x		x		
48	1	.2535	.209	.250	.228	.007	.007	.006	.006	.007	.007	.006	.006	.224		x		x		
	2	.254	.2095	.250	.228	.007	.007	.005	.005	.007	.007	.005	.005	.2232		x		x		
49	1	.255	.208	.250	.228	.007	.007	.006	.006	.007	.007	.006	.006	.2228		x		x		
	2	.254	.2085	.250	.226	.007	.007	.006	.006	.007	.007	.006	.006	.2223		x		x		

*Sealing surface to left.

TABLE 2. (Concluded)

RESISTOFLEX DYNATUBE
MSFC TESTING

TUBE #	FITTING #	FITTING I.D.	TUBE I.D.	TUBE O.D.	SWAGE TOOL SETTING	DEPTH OF SWAGE PER GROOVE # TOP LEFT → RIGHT 1	2	3	4	BOTTOM LEFT → RIGHT 1	2	3	4	I.D. AFTER SWAGE	HE LEAK YES	HE LEAK NO	ROTATED LEAKED YES	ROTATED LEAKED NO	VIBRATION TESTED	COMMENTS
50	1	.254	.207	.250	.228	.007	.007	.006	.006	.007	.007	.006	.006	.2229		X		X		
	2	.254	.208	.250	.228	.007	.007	.005	.005	.007	.007	.005	.005	.2234		X		X		

APPROVAL

ASSEMBLY AND TESTING OF 1/4 INCH MR54040 TF04 RESISTOFLEX DYNATUBE FITTINGS

By J. H. Ehl

The information in this report has been reviewed for technical content. Review of any information concerning Department of Defense or nuclear energy activities or programs has been made by the MSFC Security Classification Officer. This report, in its entirety, has been determined to be unclassified.

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