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VOLUME ____ OF ____

TITLE Evaluation of 3M's Y-9050 Tape For Sealing Openings at the Intertank - to - Y - Ring Joint

MODEL NO. Sat V/S-IC CONTRACT NO. NAS8-5608

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PREPARED BY	R. O. Koch	5-7996	12-1-67
SUPERVISED BY	E. L. Clark	5-7996	2-29-68
APPROVED BY	W. W. Davis	5-7900	3-1-68
APPROVED BY			
APPROVED BY			
APPROVED BY			

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ABSTRACT

Tests were conducted to determine the suitability of 3M's Y-9050 Tape for sealing openings at the Intertank-to-Y-Ring joint. Peel tests were conducted over a temperature range of 75° to -250°F. Also the leading edges of the tape were subjected to a blast of air (@ ~ 75°F) to simulate the air flow encounted in flight. The performance of the tape was considered sufficient to meet Design Engineering requirements.

Key Words

Intertank-to-Y-Ring Joint

Y-9050 Tape or 60B32045 Type 14 Tape

'hesion Test

Air cream Test

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

1.0 OBJECT

To determine the suitability of MSFC-SPEC-60B32045 type 14 tape (3M's Y-9050) to seal openings at the intertank-to-Y-ring joints.

2.0 BACKGROUND

The above mentioned openings require sealing to prevent the entrance of air, thus preventing excess frost build-up, by freezing of condensate, during "lox fill".

To determine the suitability of the tape for this purpose the peel adhesion was determined over the expected temperature service range (ambient to -250°F, nominal). In addition, the tape was subjected to an air stream velocity of 30 psia to indicate whether or not it would blow off during flight.

3.0 CONCLUSIONS

The peel adhesion of Y-9050 tape over the expected temperature exposure range and the ability of the tape to resist the expected air stream velocity was considered sufficient to meet design requirements.

4.0 TEST PROCEDURES

4.1 PEEL TEST PROCEDURE

4.1.1 Backing Plates

7075-T6 aluminum plates (Figures 1 & 2), were used as the adherends from which the Y-9050 tape was peeled. The initial surface preparation of the plates consisted of: iriditing per BAC 5726 then overcoating with MIL-P-8585 zinc chromate primer applied by aerosol spray application per BAC 5776. Because a limited number of these plates were available each was subjected to repeated use. Some of the tests resulted in detachment of the zinc chromate primer; in such cases it was removed with a ketone solvent and reapplied, either by brushing or spraying as noted in the attached table, and given an accelerated cure per BAC 5776.

4.1.2 Application of Tape to Plates

Three inch wide strips of tape were applied to the plates by two different methods:with a roller per ASTM D1000, except the roller weight was only 8 pounds per 3 inches of width; and with hand pressure. To minimize procedure variations all specimens were prepared by the same technician.

4.1.3 Test Temperature

The various test temperatures, noted in Table I, were attained by adding the appropriate coolant, below, to the test fixture, [1], shown in Figure 3. The temperature was monitored with a thermocouple attached to the backing plate as shown in Figure 3.

Coolants Used to Obtain Low Temperature

Nominal Stabilization Temp.	Cooltant
-100°F	Methanol + Dry Ice
-200°F	Ethanol + LN_2
-320°F	Liquid Nitrogen

[1] Test Fixture: Made from ½ inch thick 321 stainless steel. Dimensions: 14 (height) x 12 x 6 inches.

Low temperatures were attained with the coolant which stabilized on the low side, at a temperature nearest the desired test temperature. Tests conducted at low temperatures above the stabilization temperature were performed as the temperature dropped. This resulted in a temperature range as shown in Table I.

Ambient tests were performed by filling the reservoir with ambient air.

4.1.4 Testing

The specimen was set up as shown in Figure 3. After reaching the desired temperature the tape was peeled from the backing plate at 180° at a rate of 12 inches per minute (ref. ASTM D1000). The tensile test machine used was "Baldwin 20K NASA #045482".

4.2 AIR STREAM TEST PROCEDURE

4.2.1 General

The following general procedure was used to determine the ability of Y-9050 tape to withstand the maximum expected air stream velocity that it will encounter during flight. The various air pressures referred to in the procedure were as specified by the organization that requested this test [2].

[2] Coordination Sheet No. I&HSG-M-87, from P. E. Oster to A. Paxhia, dated 2-7-66, Subject: Request for Test Support.

4.2.2 Application of Air Stream

Openings or gaps, approximately four square inches in area, in a test fixture configurated to simulate the propellant tank to Y-ring junction (figure 4), were sealed with strips of Y-9050 tape as shown in Figure 5. An air stream (30 psia) was applied perpendicular to the leading edge of the tape strips for a maximum period of 150 seconds. Four tests were conducted, two in each direction (up & down), to simulate the junction at each of the propellant tanks (lox and fuel).

4.2.3 Internal Pressure

To further simulate flight conditions a slight positive pressure differential was applied, simultaneously with the air stream test, to the inboard side of the fixture. This was accomplished by fabricating a balloon type seal, out of polyethylene, over an area to include the taped openings. Air pressure was applied, in the balloon seal, in an attempt to obtain a pressure differential of 1.5 psi; but due to uncontrollable leaks a maximum of only 0.4 psi was attained as indicated by a water filled manometer. Due to a tight schedule and to Design's opinion that attaining the 1.5 psi differential did not warrent the extra time and effort necessary to prepare a leak proof seal the test was conducted at the 0.4 psi (max.) differential.

5.0 RESULTS

5.1 PRESENTATION OF DATA

Individual peel test values along with averages for specimens prepared and tested under similar conditions are presented in Table I, attached. Figure 6 shows a plot of the average values at various temperatures [3].

The following discussion considers general peel test results based on Figure 6 ; but details the air stream test results.

5.2 PEEL TEST RESULTS

From Figure 6 it is apparent that the adhesion of Y-9050 tape increased from a nominal 5#/3 inch of width at ambient room temperature to a corresponding high of 20#/3 inches in the proximity of -100°F, then dropped rapidly to a nominal low of 2#/3 inches around -250°F.

[3] Although symbols on Figure 6 distinguishes between the various types of specimen preparation procedures, the average curve was drawn without consideration of this variable. This was done due to limited data for each type of preparation. However, the curve is considered valid because of the closeness of results of specimens tested at comparable temperatures.

5.2 PEEL TEST RESULTS (Continued)

The type of specimen preparation, that is, how the primer and tape were applied made no real significant difference as indicated by peel results compared at a common test temperature.

At temperatures above -200°F the plane of failure was at the tape adhesive/zinc chromate primer interface. Below -200°F failure occurred at different planes; but mostly at the same plane mentioned above.

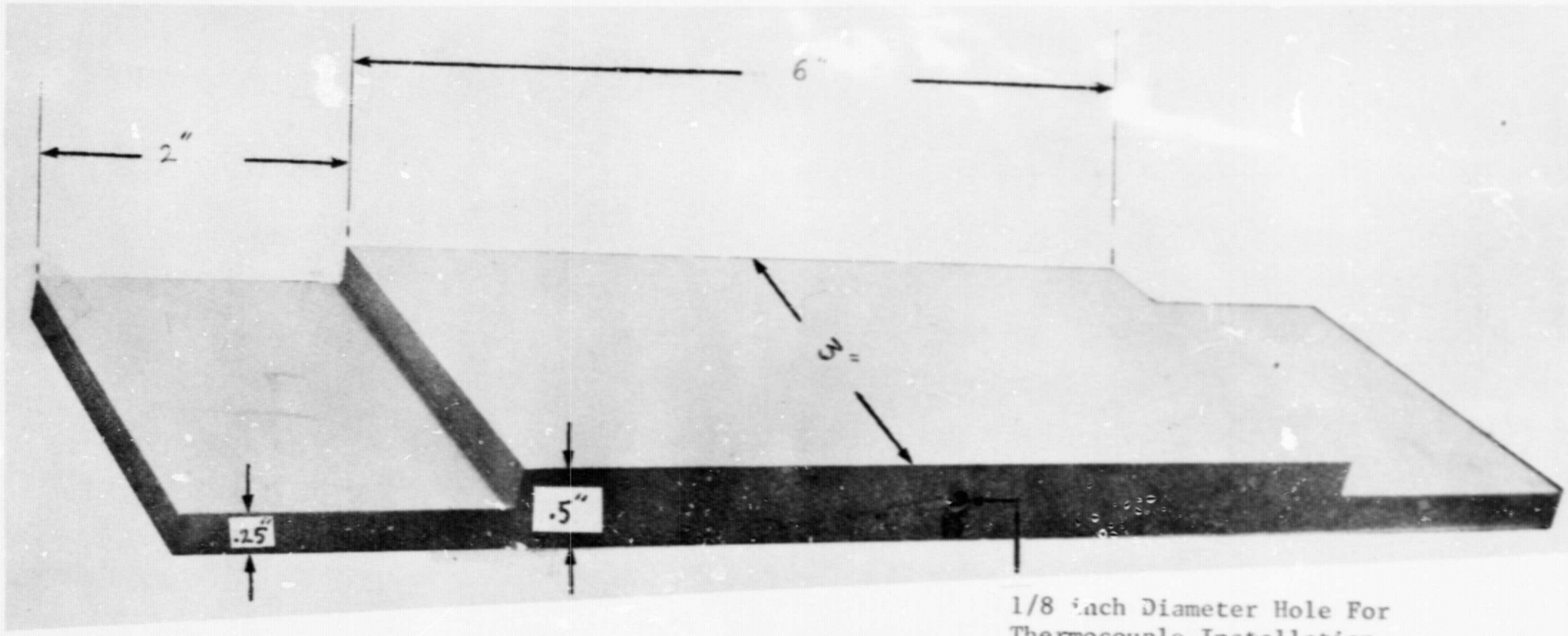
5.3 AIR STREAM TEST

Out of three of the four tests conducted, the leading edge of the tape began to peel back after withstanding the 30 psia air blast for a minimum of 110 seconds. During the remainder of the 150 second test period, peel in two of the tests progressed to the extent that the sealed opening was exposed. This occurred at a valley opening (See Figure 4) in both cases; also it occurred when the air stream was applied from either direction.

Although peel took place as mentioned above, in no case was the tape blown completely off.

5.4 SUMMARY

The performance of the tape was considered sufficient to meet design requirements since: (1) some degree of adhesion was retained at the temperature extreme of -250°F, and (2) it did not blow off during 150 second flight simulated air flow test.



1/8 Inch Diameter Hole For
Thermocouple Installation

FIGURE 1

ALUMINUM BACKING PLATE FOR PEEL TEST

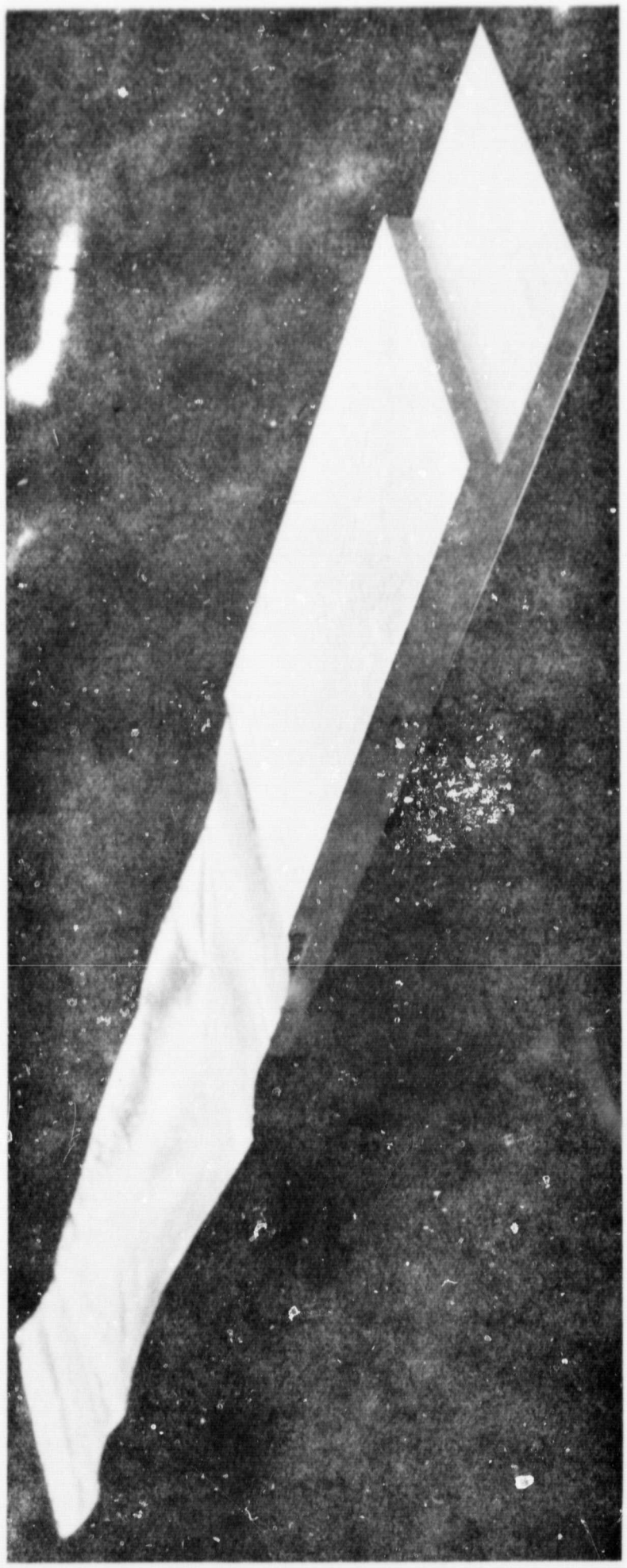


FIGURE 2 ALUMINUM BACKING PLATE WITH TAPE APPLIED

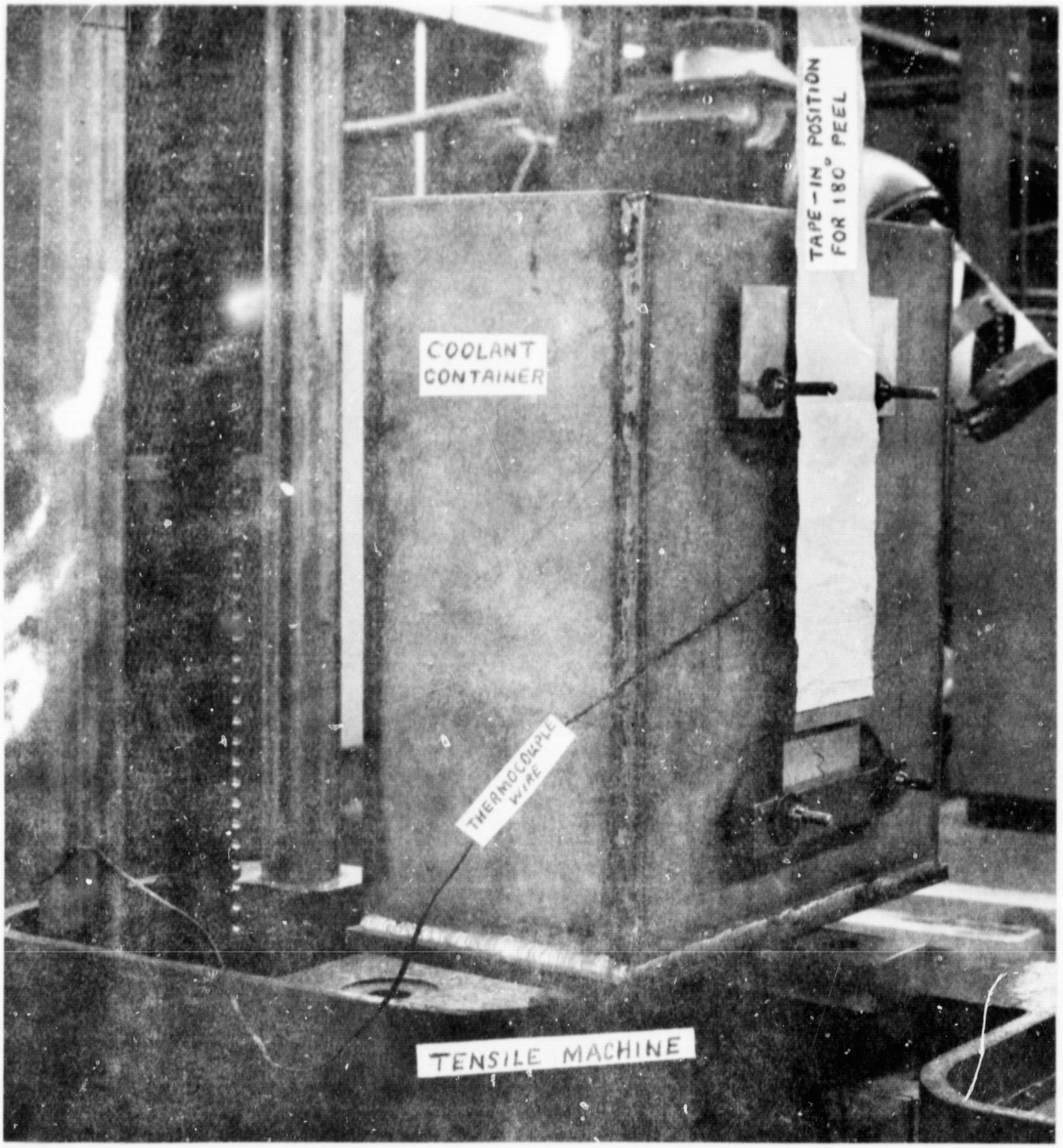


FIGURE 3

TYPICAL TEST SET-UP FOR PEEL TEST

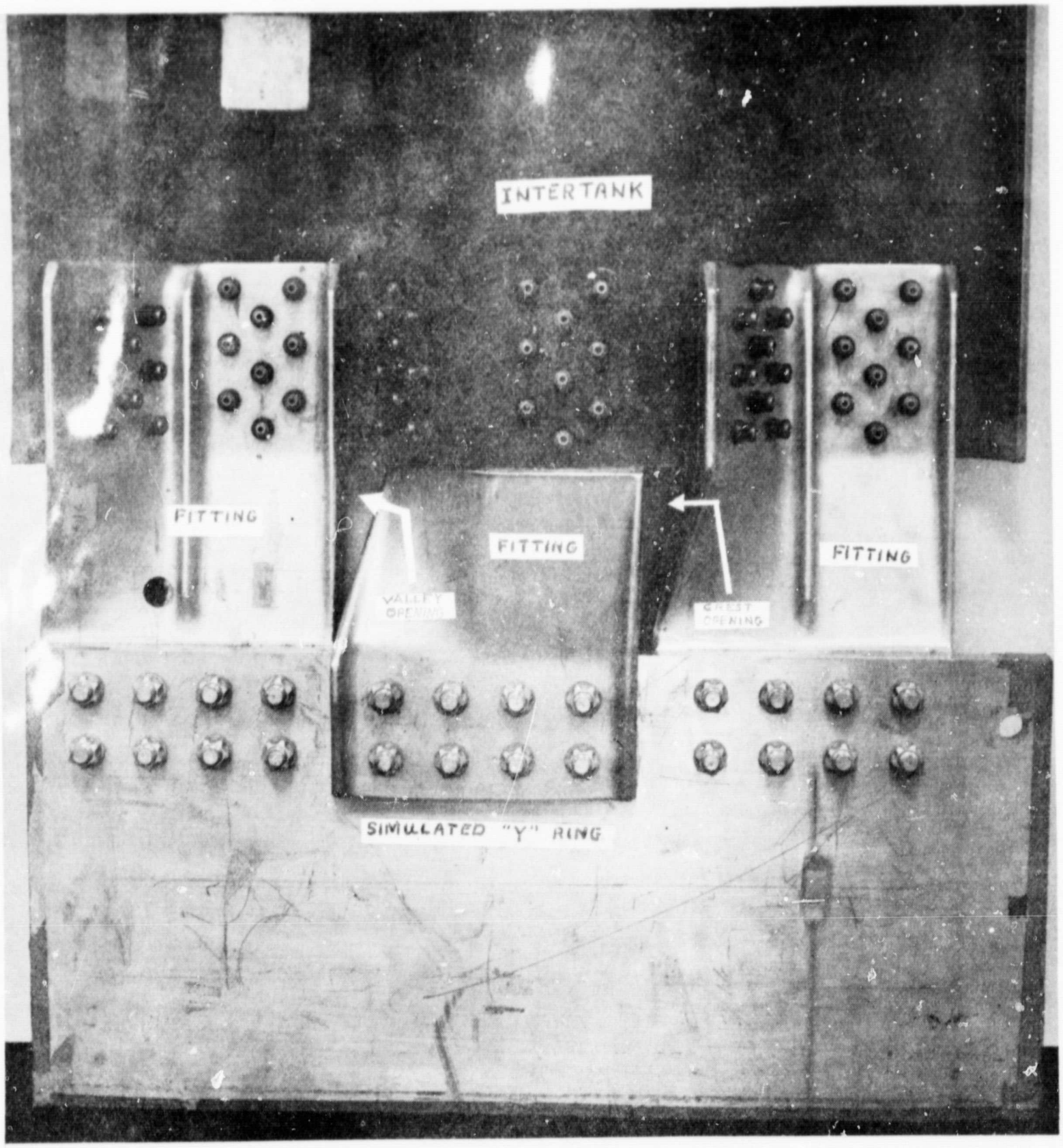


FIGURE 4

TEST FIXTURE FOR AIR STREAM TEST - BEFORE APPLICATION OF TAPE

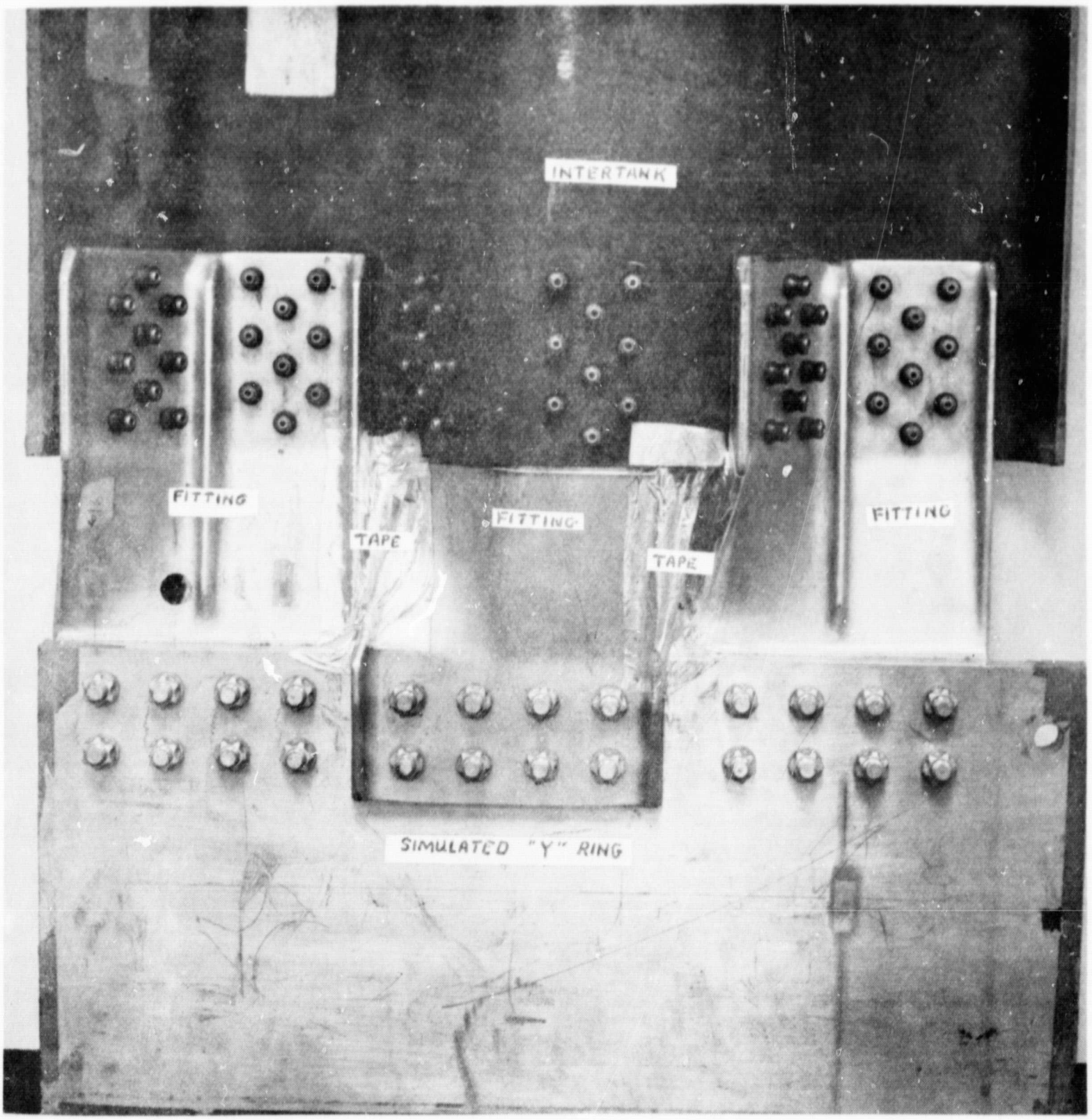


FIGURE 5

AIR STREAM TEST FIXTURE WITH TAPE APPLIED

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CALC	CHECK	APR	APR

DATE	REVISED

PEEL STRENGTH VS. TEMPERATURE OF 3M'S Y-9050 TAPE

Figure 6

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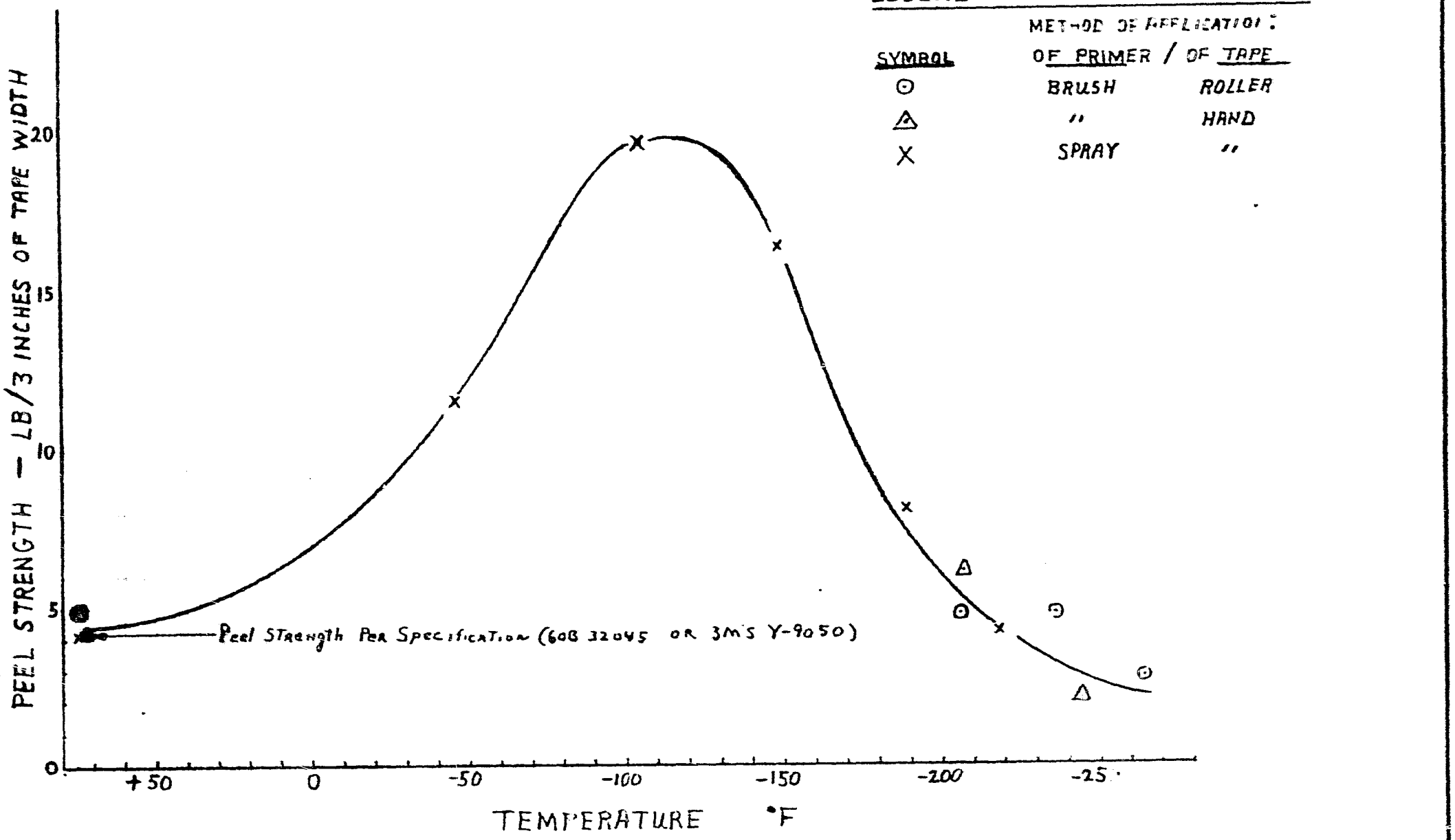
T5-6556-1

PAGE 10



FOLDOUT FRAME 1

SPEC. NO.	TEST TEMP. RANGE °F	TEST TEMP. NOMINAL AVG	TEST VALUES - LB/3 INCHES OF WIDTH - READINGS TAKEN @ ½ INCH INTERVALS									
			1	2	3	4	5	6	7	8	9	10
1	75 ± 5°F		5.0	5.0	5.2	4.8	4.6	4.8	5.0	4.8	4.2	3.6
2			5.6	5.4	5.4	5.6	5.2	5.6	4.8	4.8	4.4	5.4
3			6.0	6.0	5.8	5.8	6.0	5.8	5.6	5.6	5.6	5.8
4			4.8	4.6	4.2	4.0	4.6	4.5	4.6	4.4	5.0	5.2
5			5.0	4.3	4.0	4.6	4.2	4.2	4.2	4.2	4.2	4.2
			(AVG. OF SPECIMENS 1-5)									
6			5.0	5.0	5.0	4.8	5.0	5.0	4.6	4.6	4.6	4.6
7			4.8	5.0	5.0	5.2	5.6	5.4	5.4	5.2	5.6	5.6
8			4.2	5.0	5.0	4.4	4.8	5.0	4.8	4.8	4.8	4.8
			(AVG. OF SPECIMENS 6-7)									
9			4.5	4.4	4.3	4.4	4.1	3.8	3.6	3.5	3.5	-
10			4.6	4.4	4.2	4.2	4.4	4.4	4.4	4.2	4.1	4.8
			(AVG. OF SPECIMENS 9 & 10)									
11	-100	-112 -106	19.0	17.0	20.8	20.0	19.0	18.6	17.0	15.2	15.4	-
12	-100	-120 -110	22.4	23.4	22.0	21.4	21.2	20.6	19.4	19.6	21.4	22.4
13	-100	-102 -101	22.0	21.4	20.8	20.8	21.6	19.8	17.0	17.2	17.6	17.2
(AVG. SPEC. 11 - 13)		-105										
14	-45	-50 -48	10.0	8.6	9.0	11.6	10.4	11.2	10.8	10.6	10.0	9.8
15	-42	-45 -44	13.0	12.8	13.0	13.5	13.8	12.4	12.8	11.8	11.0	10.8
(AVG. SPEC. 14 & 15)		-46										
16	-200	-210 -205	6.8	6.0	5.8	5.4	6.4	6.0	6.0	4.0	3.8	3.4
17	-205	-209 -207	3.6	4.0	4.2	5.0	6.0	5.2	3.6	3.2	3.8	4.2
(AVG. SPEC. 16 & 17)		-206										
18	-233	-238 -236	4.0	5.0	4.8	5.4	6.0	4.4	4.2	4.4	4.6	5.0

			REVISED	DATE	PEEL TEST DATA OF 3M'S Y-9050 TAPE	PAGE 1 of 2
Calc.						
Trac						TABLE I
Chk						
Appr.					THE BOEING COMPANY SEATTLE 24, WASHINGTON	
Appr.						

DATA S

US 4011 4000

FOLDOUT FRAME 2

- READINGS				PLAIN OF FAILURE			METHOD OF APPLYING ZINC CHROMATE PRIMER		METHOD OF APPLYING TAPE		NOTES:
8	9	10	AVG	1/N	2/N	3/N	BRUSH	SPRAY	8 LB ROLLER PRESSURE	HAND PRESSURE	
.8	4.2	3.6	4.7	1/100			X		X		
.8	4.4	5.4	5.2	1/100			X		X		
.6	5.6	5.8	5.8	1/100			X		X		
.4	5.0	5.2	4.6	1/100			X		X		
.2	4.2	4.2	4.4	1/100			X		X		
			4.9								
.6	4.6	4.6	4.8	1/100			X			X	
.2	5.6	5.6	5.3	1/100			X			X	
.8	4.8	4.8	4.8	1/100			X			X	
			5.0								
.5	3.5	-	4.0	1/100				X		X	
.2	4.1	4.8	4.4	1/100				X		X	
			4.2								
.2	15.4	-	18.0	1/100				X		X	
.6	21.4	22.4	21.4	1/100				X		X	
.2	17.6	17.2	19.5	1/100				X		X	
			19.6								
.6	10.0	9.8	10.2	1/100				X		X	
.8	11.0	10.8	12.9	1/100				X		X	
			11.5								
4.0	3.8	3.4	5.2	1/90		3/10	X		X		
3.2	3.8	4.2	4.3	1/90		3/10	X		X		
			4.8								
4.4	4.6	5.0	4.8	1/100			X		X		

DATA SHEET

FOLDOUT FRAME 3

YING

HAND-
OSURE

NOTES: 1 - Failed at interface of primer and tape adhesive

2 - Failed at interface of primer and iridite

3 - Failed at interface of tape adhesive and tape backing

N - Approximate % of a given mode of failure.

BOILOUT ARTICLE

SPEC. NO.	TEST TEMP. RANGE °F		NOMINAL AVG	TEST VALUES - LB/3 INCHES OF WIDTH - READINGS TA AT ½ INCH INTERVALS									
				1	2	3	4	5	6	7	8	9	10
19	-262	-266	-264	2.4	2.4	3.0	2.8	3.0	3.0	2.4	3.0	2.4	-
20	-147	-150	-149	13.2	15.1	10.2	12.6	12.2	15.8	15.8	20.2	22.8	25.0
21	-188	-190	-189	3.6	3.6	6.2	4.6	5.8	9.2	10.8	10.6	11.2	15.4
22	-215	-220	-208	4.8	5.0	4.2	5.2	3.6	3.6	3.5	3.0	-	-
23	-202	-212	-207	10.0	6.0	5.0	6.0	9.0	4.0	4.0	5.0	5.4	7.0
24	-239	-243	-241	2.8	3.0	3.6	3.2	3.4	3.8	2.2	2.2	2.2	2.4
25	-243	-246	-245	3.0	3.0	2.0	3.0	3.8	2.4	3.6	2.2	2.2	2.0
26	-240	-250	-245	2.4	2.4	1.8	2.0	2.8	2.8	3.4	2.0	3.0	3.6
(AVG. SPEC 24 - 26)			-244										

Calc.			REVISED	DATE
Trac				
Chk				
Appr.				
Appr.				

PEEL TEST DATA OF 3M'S Y-9050 TAPE

PAGE 2 of 2

TABLE I

THE BOEING COMPANY
SEATTLE 24, WASHINGTON

DATA

UB 4011 4000

FRAME 2

- READINGS TAKEN				PLAIN OF FAILURE [1 →		METHOD OF APPLYING ZINC CHROMATE PRIMER		METHOD OF APPLYING TAPE		
	9	10	AVG.	1/N	2/N	BRUSH	SPRAY	8 LB ROLLER PRESSURE	HAND PRESSURE	NOTES:
								PRESSURE	[1 →	1
0	2.4	-	2.7	1/80	2/10	X		X		2
										3
2	22.8	25.0	16.3	1/90			X		X	N
6	11.2	15.4	8.1	1/70	2/10		X		X	
0	-	-	4.2		2/80		X		X	
0	5.4	7.0	6.1	1/10	2/30	X			X	
2	2.2	2.4	2.9	1/50	2/30	X			X	
2	2.2	2.0	2.7	1/40	2/60	X			X	
0	3.0	3.6	2.6	1/90		X			X	
			2.1							

DATA SHEET

NOTES:

1 - Failed at interface of primer and tape adhesive

2 - Failed at interface of primer and iridite

3 - Failed at interface of tape adhesive and tape backing

N - Approximate % of a given mode of failure.