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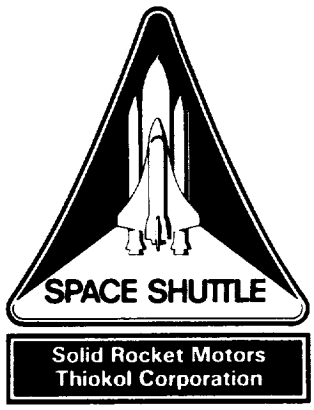

TWR-60832

NYLON AND TEFLON SCRIBE EFFECT ON NBR TO CHEMLOK 233 AND NBR TO NBR BOND INTERFACES

FINAL REPORT

June 1990

Prepared for:

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GEORGE C. MARSHALL SPACE FLIGHT CENTER
MARSHALL SPACE FLIGHT CENTER, ALABAMA 35812

Contract No. NAS8-30490

DR. No. 3-5

WBS.No. 4B 201

Thiokol CORPORATION
SPACE OPERATIONS

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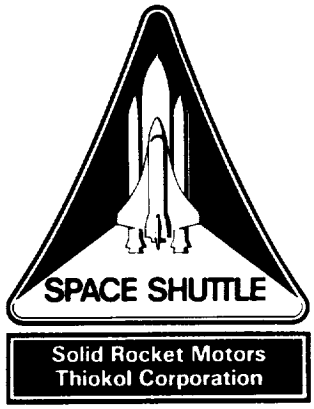

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FINAL REPORT

JUNE 1990

MATERIALS AND PROCESSES INVESTIGATION NO. 010

Prepared by:

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P C Tydeck 7-19-90
Release - Data Management
ECS No. SS 4153

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TABLES

FIGURES

ATTACHMENT

References: LWR No. 594849
LWR No. 594848

1.0 INTRODUCTION

A study was requested by Manufacturing Engineering to determine what effects marking with nylon (6/6) and Teflon scribes may have on subsequent bonding. Witness panel bond specimens were fabricated by the Development Lab to test both NBR to Chemlok and NBR to NBR after controlled exposure. The nylon rod used as a scribe tool demonstrates virtually no bond deterioration when used to scribe lines on either the Chemlok to NBR surfaces or the NBR to NBR interface.

2.0 OBJECTIVE

To determine what effects marking with nylon and Teflon scribes may have on subsequent bonding.

3.0 SUMMARY

Lab test results indicate that the nylon rod-exposed samples produce tensile and peel values very similar to the control samples and the Teflon exposed samples produce tensile and peel values much lower than the control samples.

Visual observation of the failure surfaces of the tested samples shows that Teflon scribing produces an obvious contamination to the surface and the nylon produces no effect. Photographs of test samples are provided as Figures 1 thru 4. It is concluded that Teflon stock used as a scribe tool on a Chemlok 233 to NBR surface or an NBR to NBR surface has a detrimental effect on the bond integrity on either of these bond interfaces. Therefore, it is recommended that the nylon rod continue to be used where a scribe line is required in the RSRM segment insulation layup operations. The use of Teflon scribes should not be considered.

4.0 CONCLUSIONS

1. Rubbing of the nylon rod on a Chemlok 233 surface or a raw NBR surface before subsequent raw NBR insulation layup has no detrimental effect on the resulting cured insulation interface strength.

2. Rubbing of either of the Teflon stocks on a Chemlok 233 surface or a raw NBR surface before subsequent raw NBR insulation layup does have a detrimental effect on the resulting cured insulation interface strength.

5.0 RECOMMENDATIONS

It is recommended that:

1. Nylon (6/6) rod stock be specified in the 4U134085 tool drawing and any similar applications in the Space Operations.

2. Teflon stocks not be used in this or similar applications anywhere in the Space Operations.

6.0 DISCUSSION

A nylon rod mounted in the 4U134085 tool is currently used to mark required location of specific patterns during the RSRM rubber layup operations. The objective of this investigation was to identify the contamination effect of the current nylon and alternate Teflon type materials that might be considered for this use.

There are numerous types of Teflon stocks. Teflon stock is typically soft, rubs off easily, and has weak adhesive strength. It was very unlikely that it would be a good candidate for this application. However, two of these materials were obtained from the Strategic Operations Plastic shop to verify Teflon stocks effect and determine if they should be designated as alternates.

Samples were built by technicians in the M-86 Development Lab on witness panel plates, duplicating normal witness panel procedures as closely as possible through the Chemlok 233 application. The scribe operation was conducted on the Chemlok or NBR surfaces per the test matrix provided as Table I. The (approximate) 1/2-in. distance for contamination (Figure 6) was chosen to ensure that the variables were represented within each test specimen. The excessive exposure samples (Figure 5) were built to ensure that any contamination effect would be obviously demonstrated in the test results.

Photographs of the typically exposed painted (Chemlok 233) panels are provided as Figures 5 and 6. The NBR surfaces requiring exposure were contaminated in the same manner. The witness panels were vacuum bagged and cured in the M-86 autoclave to a typical RSRM segment insulation cure (Figure 7). After cure the peel specimens were cut into 1-in. strips. The tensile buttons were tested at a pull rate of 2-in. per minute and the peel strips were pulled at 20-in. per minute (the same rates as used on production witness panels).

Test results (peel and tensile values) demonstrate that the nylon rod had no effect on bond strength. Both Teflon materials tested produced substantially lower tensile values. Individual data points, average values, and coefficient of variations are provided in Tables II and III. Tables IV and V provide graphic comparisons of the average test values. These individual test results were analyzed by D. S. Brown (Space Statistics). His observations and conclusions are reported in Memo 8863-FY90-M123 (Attachment I).

Visual observation of the tested specimens demonstrated very obvious failures where the surface (Chemlok 233 or NBR) was rubbed by the Teflon stocks. Photographs (Figures 2, 3, and 4) are provided to illustrate these typical failures. The nylon exposed specimens did not demonstrate any visual indication of contaminated surfaces (Figure 1).

It is concluded that the currently used nylon scribe rod has no detrimental effect on bond strength and that both of the Teflon stocks do have a detrimental effect. Therefore, it is recommended that nylon rod stock be specified in the tool drawing and that Teflon stocks not be used in this application or similar applications in the Space Operations.

TABLE I. Test Matrix

	Controls		NBR/NBR				233/NBR						NBR/NBR	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Surface Type														
1) NBR to NBR	x		x	x	x	x							x	x
2) Chemlok 233 to NBR		x					x	x	x	x	x	x		
Surface Contaminant														
1) None	x	x												
2) Nylon Rod			x	x			x	x						
3) Teflon Rod - I					x	x			x	x				
4) Teflon Rod - II											x	x	x	x
Exposure Amount														
1) None	x	x												
2) .5 inch apart			x		x		x		x		x		x	
3) Excessive rubbing on entire interface				x		x		x		x		x		x

TABLE II
TENSILE STRENGTH (MAX STRESS)

Variables		1	2	3	4	5	6	7
Surface Type		(Control) NBR to NBR	(Control) 233 to NBR	NBR to NBR	NBR to NBR	NBR to NBR	NBR to NBR	233 to NBR
Surface Contaminant		none	none	nylon rod	nylon rod	Teflon Rod-I	Teflon Rod-I	Nylon Rod
Exposure Amount		none	none	each .5 inch	excessive	each .5 inch	excessive	each .5 inch
		752	806	681	812	531	330	897
		772	796	786	740	432	314	878
		812	846	816	794	511	336	854
		778	816	679	794	468	330	870
		780	874	812	836	432	298	880
		768	814	828	766	557	352	884
		842	842	844	796	376	308	888
		776	852	673	782	458	344	860
	Ave.	785	831	778	790	471	327	876
	C.V.	3.6	3.2	8.9	3.6	12.7	5.6	1.7
		8	9	10	11	12	13	14
Surface Type		233 to NBR	233 to NBR	233 to NBR	233 to NBR	233 to NBR	NBR to NBR	NBR to NBR
Surface Contaminant		Nylon Rod	Teflon Rod I	Teflon Rod I	Teflon Rod II	Teflon Rod II	Teflon Rod II	Teflon Rod II
Exposure Amount		excessive	each .5 inch	excessive	each .5 inch	excessive	each .5 inch	excessive
		842	497	462	401	627	429	300
		872	651	643	439	794	329	291
		895	452	677	434	796	420	310
		812	603	754	484	794	448	476
		842	456	756	541	424	477	337
		850	497	525	436	770	589	232
		828	491	665	458	557	502	325
		842	481	766	414	662	556	610
	Ave.	848	516	656	451	678	469	350
	C.V.	3.0	13.9	17.0	9.8	20.2	17.5	34.0

TABLE III
PEEL STRENGTH (AVE. STRESS)

Variables		1	2	3	4	5	6	7
Surface Type		(Control) NBR to NBR	(Control) 233 to NBR	NBR to NBR	NBR to NBR	NBR to NBR	NBR to NBR	233 to NBR
Surface Contaminant		none	none	nylon rod	nylon rod	Teflon Rod-I	Teflon Rod-I	Nylon Rod
Exposure Amount		none	none	each .5 inch	excessive	each .5 inch	excessive	each .5 inch
		186.2	177.4	183.7	191.9	172.0	143.5	164.0
		178.5	175.8	179.0	181.5	172.2	155.5	166.0
		180.8	178.8	191.4	182.2	172.5	130.7	170.2
		184.8	174.9	178.7	185.3	172.2	124.3	167.7
		191.1	168.1	182.2	182.1	168.4	138.7	164.5
	Ave.	184.3	175.0	183.0	184.6	171.5	138.5	166.5
	C.V.	2.65	2.37	2.81	2.36	1.0	8.67	1.52

		8	9	10	11	12	13	14
Surface Type		233 to NBR	233 to NBR	233 to NBR	233 to NBR	233 to NBR	NBR to NBR	NBR to NBR
Surface Contaminant		Nylon Rod	Teflon Rod I	Teflon Rod I	Teflon Rod II	Teflon Rod II	Teflon Rod II	Teflon Rod II
Exposure Amount		excessive	each .5 inch	excessive	each .5 inch	excessive	each .5 inch	excessive
		165.3	137.6	119.9	122.0	156.2	88.6	182.8
		166.1	145.9	112.7	138.2	158.3	78.6	178.3
		166.2	148.6	122.4	138.1	154.5	99.8	114.7
		164.2	153.8	113.5	143.3	147.1	107.7	114.9
		160.7	147.0	107.2	151.4	152.7	110.8	99.6
	Ave.	164.5	146.6	115.1	138.6	153.8	97.1	138
	C.V.	1.38	3.99	5.25	7.75	2.76	13.85	28.48

TABLE IV. Average Tensile Strength, Graph

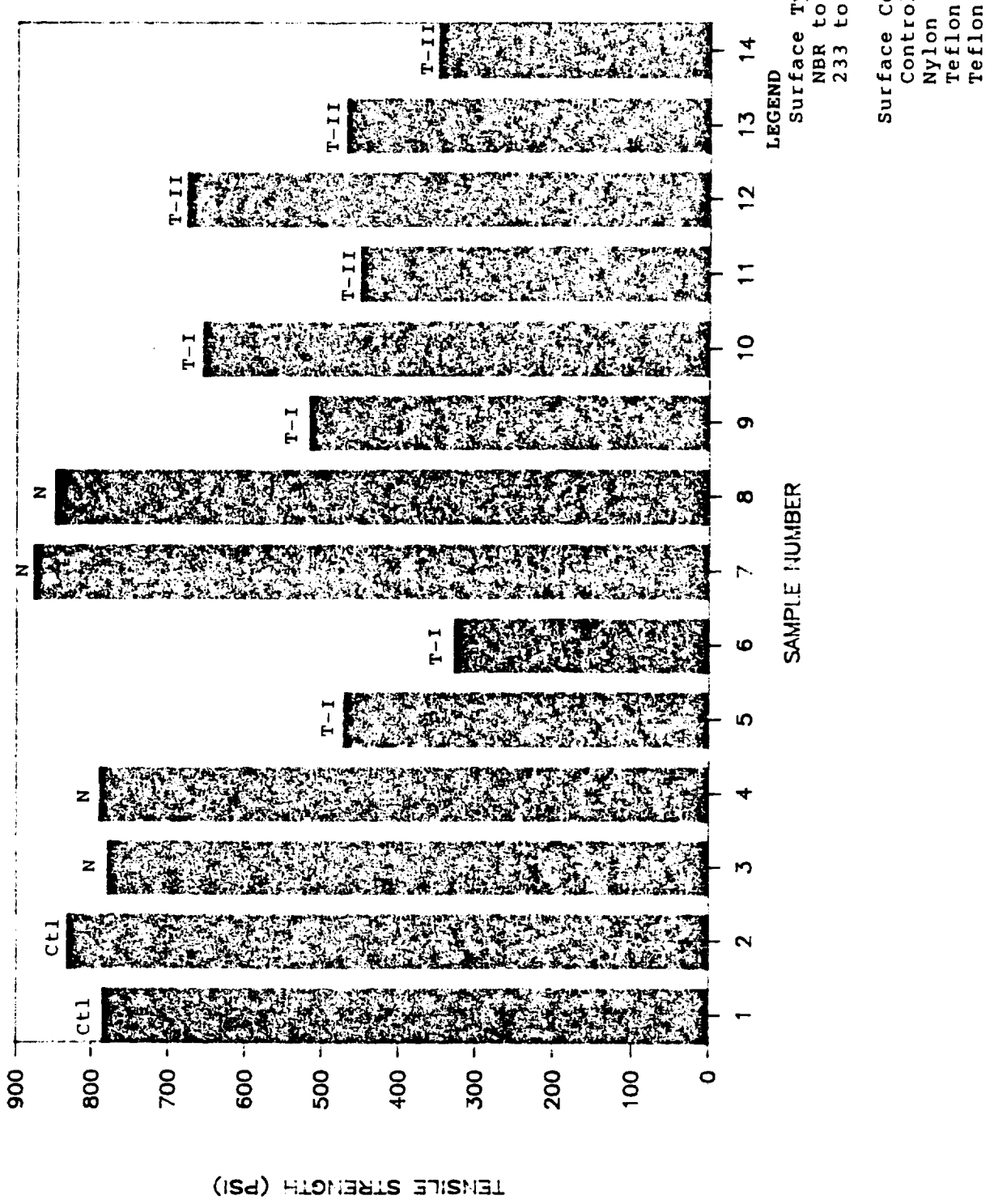
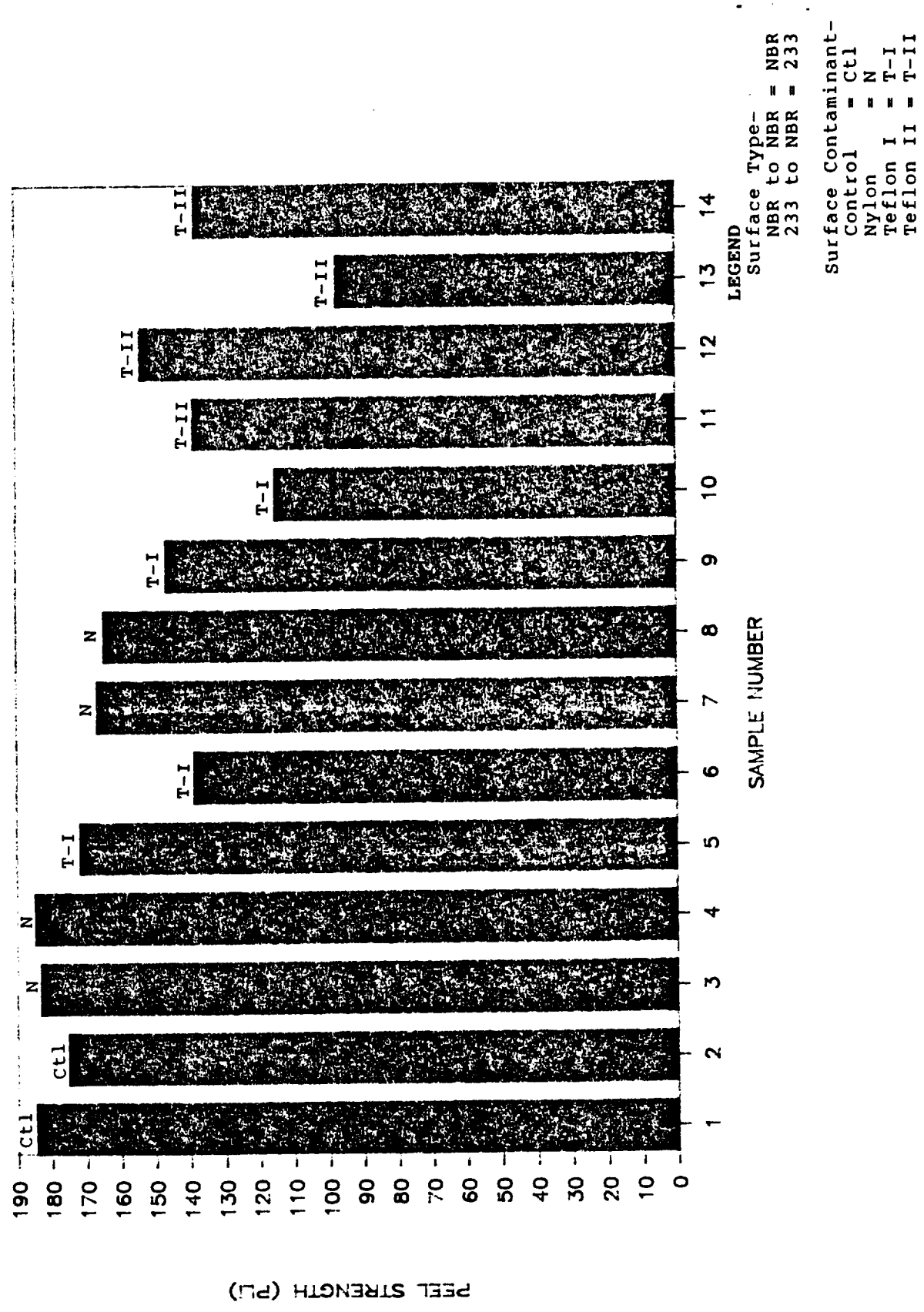


TABLE V. Average Peel Strength, Graph



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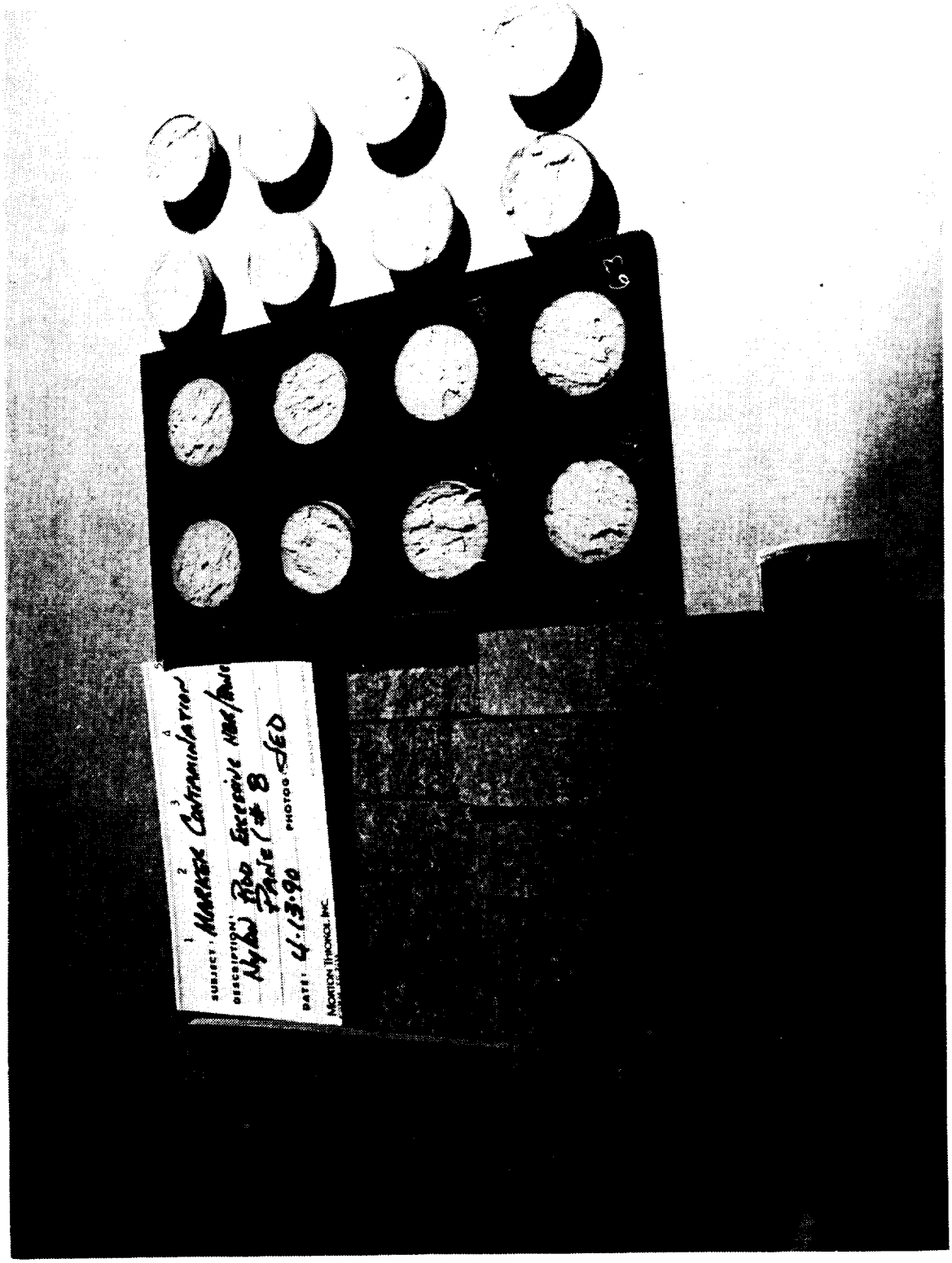

Figure 1. Photograph, Tested Sample, Excessive Nylon Contamination, ChemLok To NBR (No. 117074-7)

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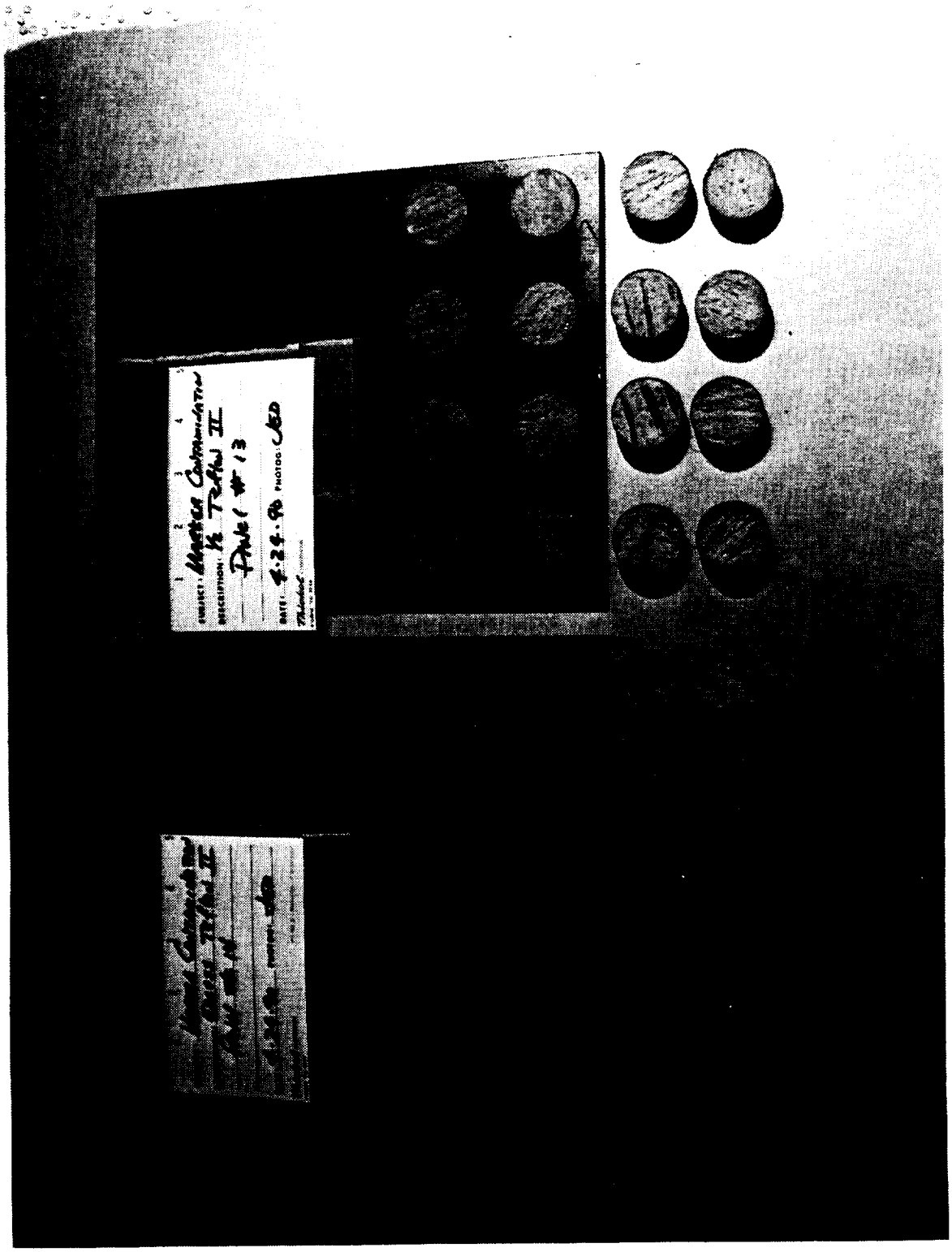

Figure 2. Photograph, Tested Sample, Excessive and 1/2-in. Teflon Contamination, NBR To NBR (No. 117342-4)

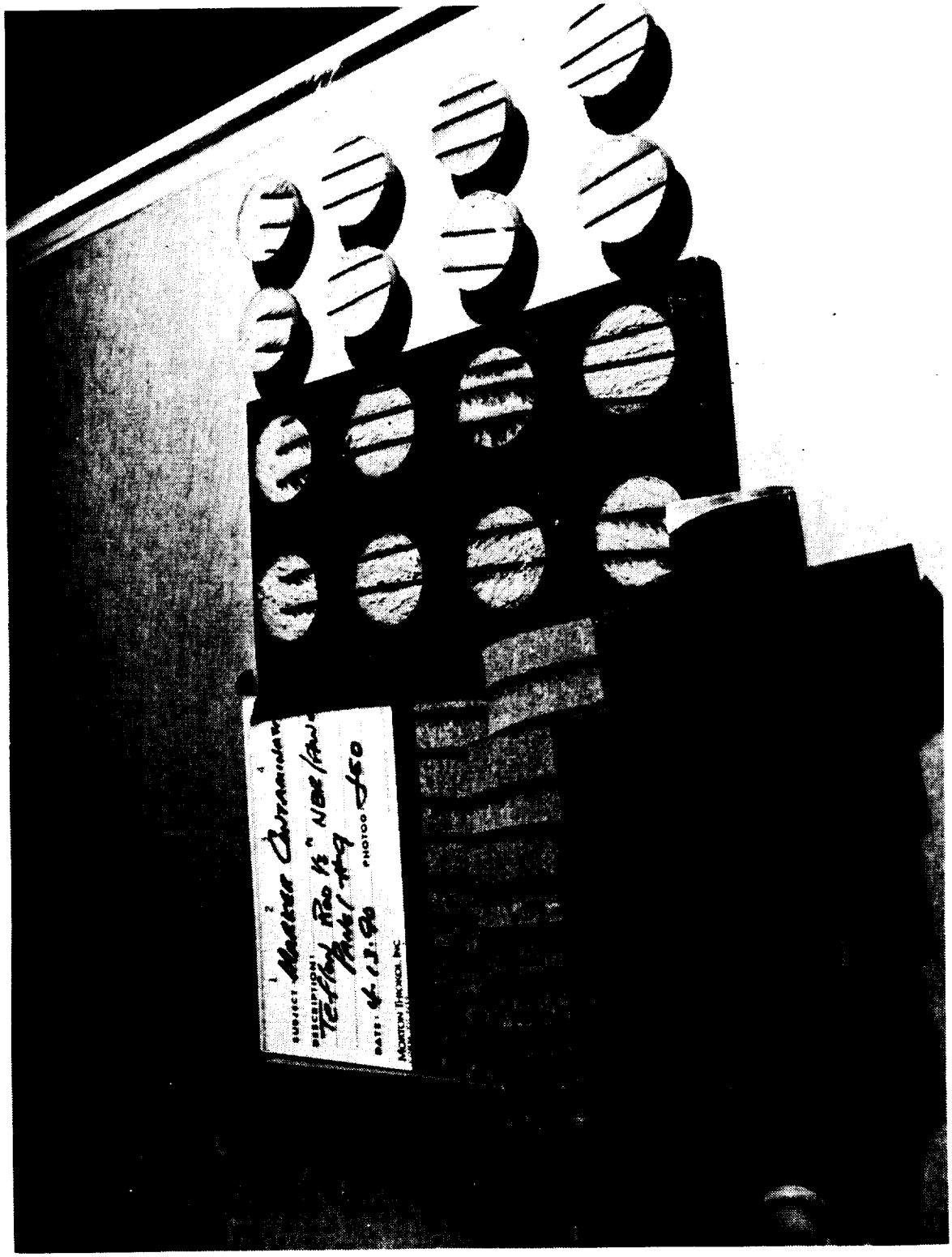

Figure 3. Photograph, Tested Sample, 1/2-in. Teflon Contamination, Chemlok To NBR (No. 117074-5)

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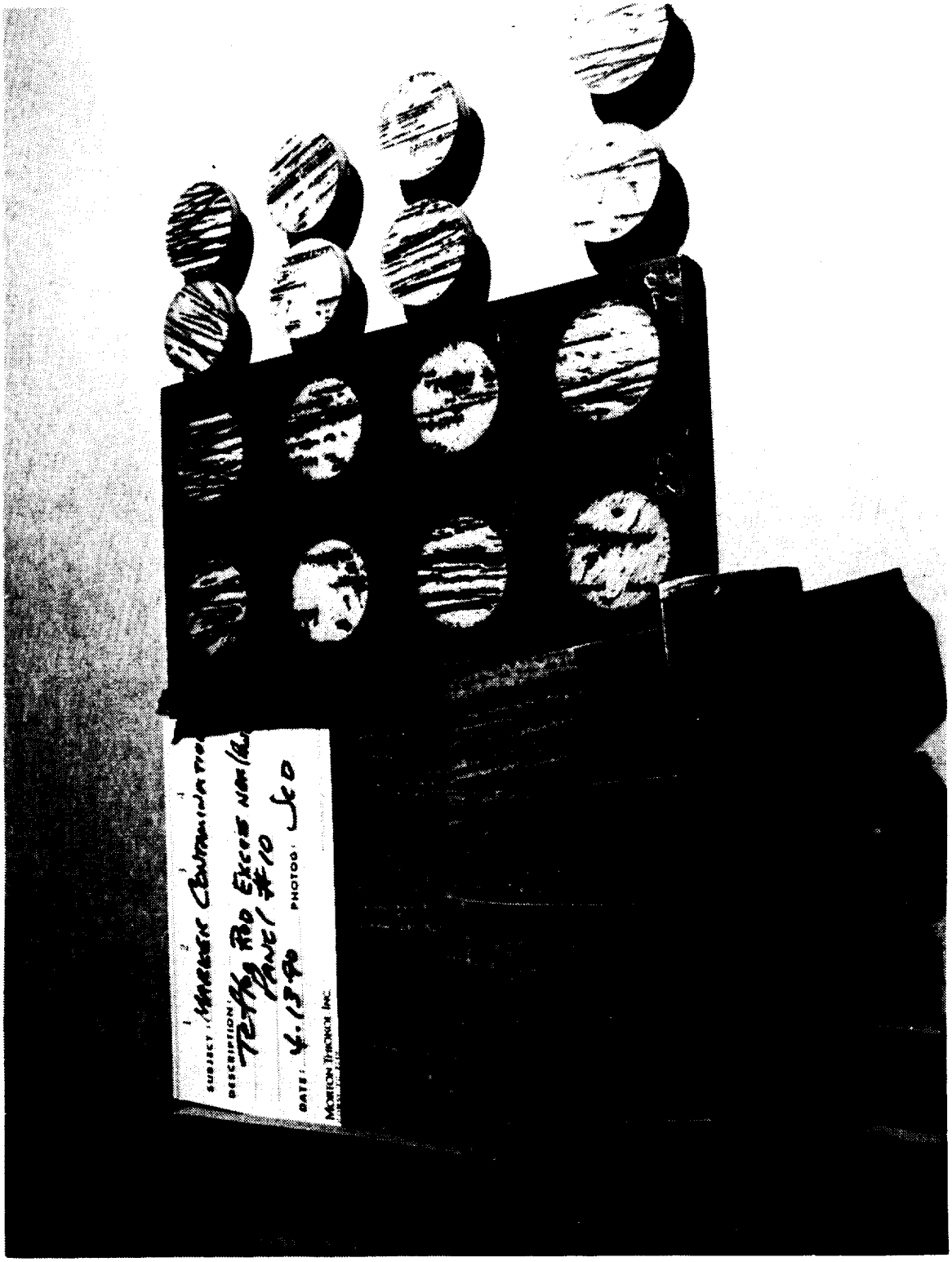

Figure 4. Photograph, Tested Sample, Excessive Teflon Contamination, Chemlok To NBR (No. 117074-4)

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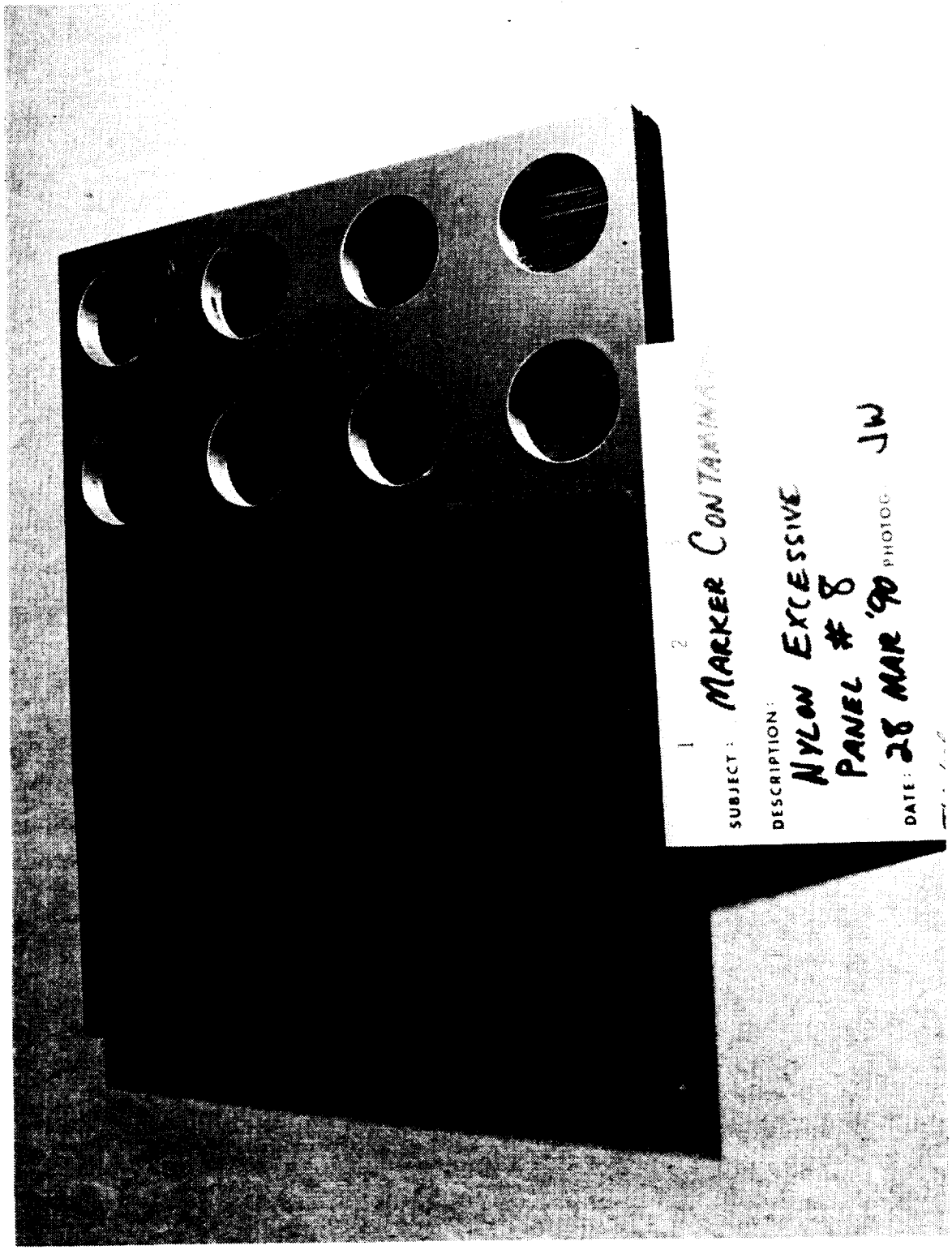

Figure 5. Photograph, Witness Panel Plate, Excessive Nylon Contamination, Chemlok 233 (No. 116835-1)

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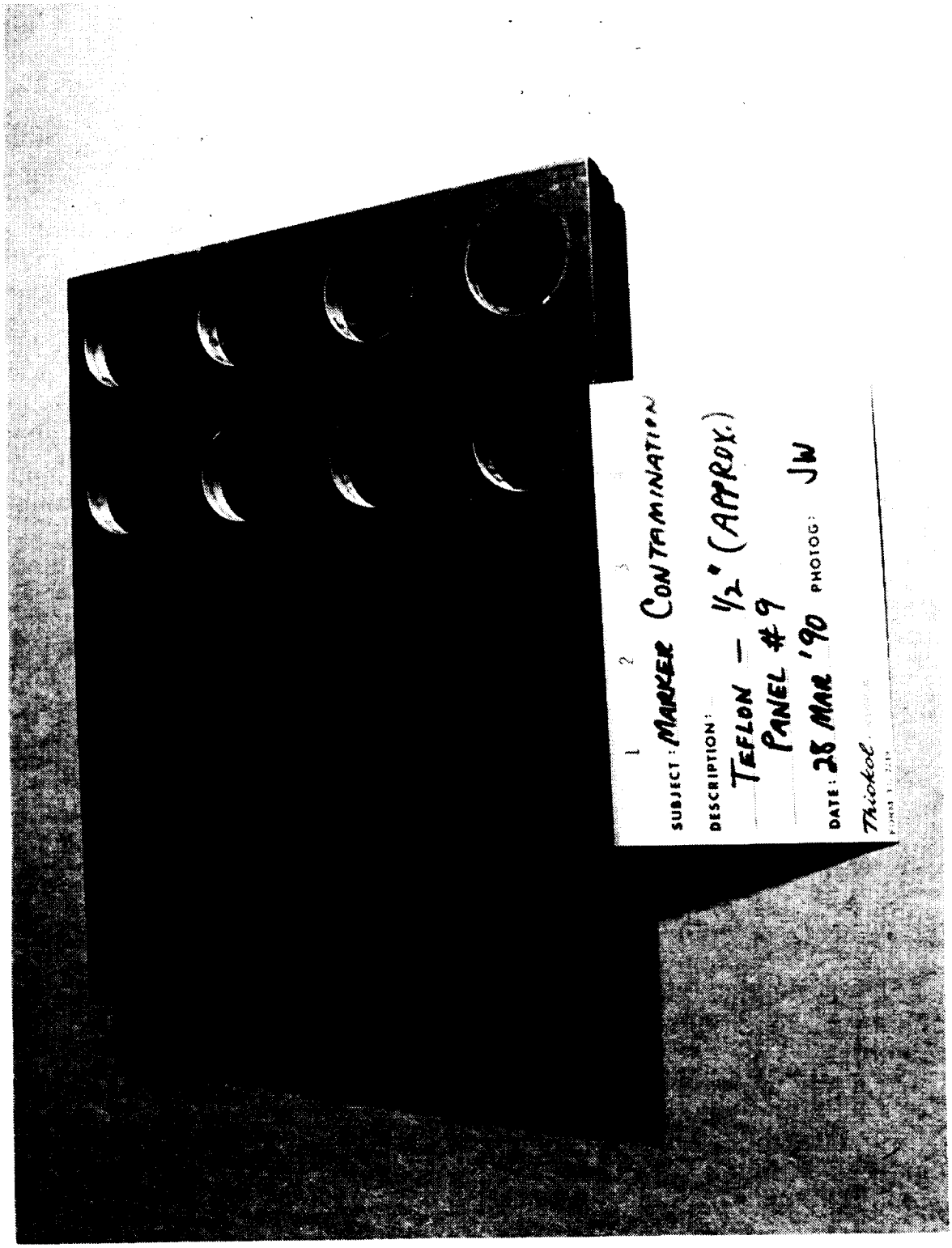

Figure 6. Photograph, Witness Panel Plate, 1/2-in. Teflon Contamination, Chemlok 233 (No. 116835-3)

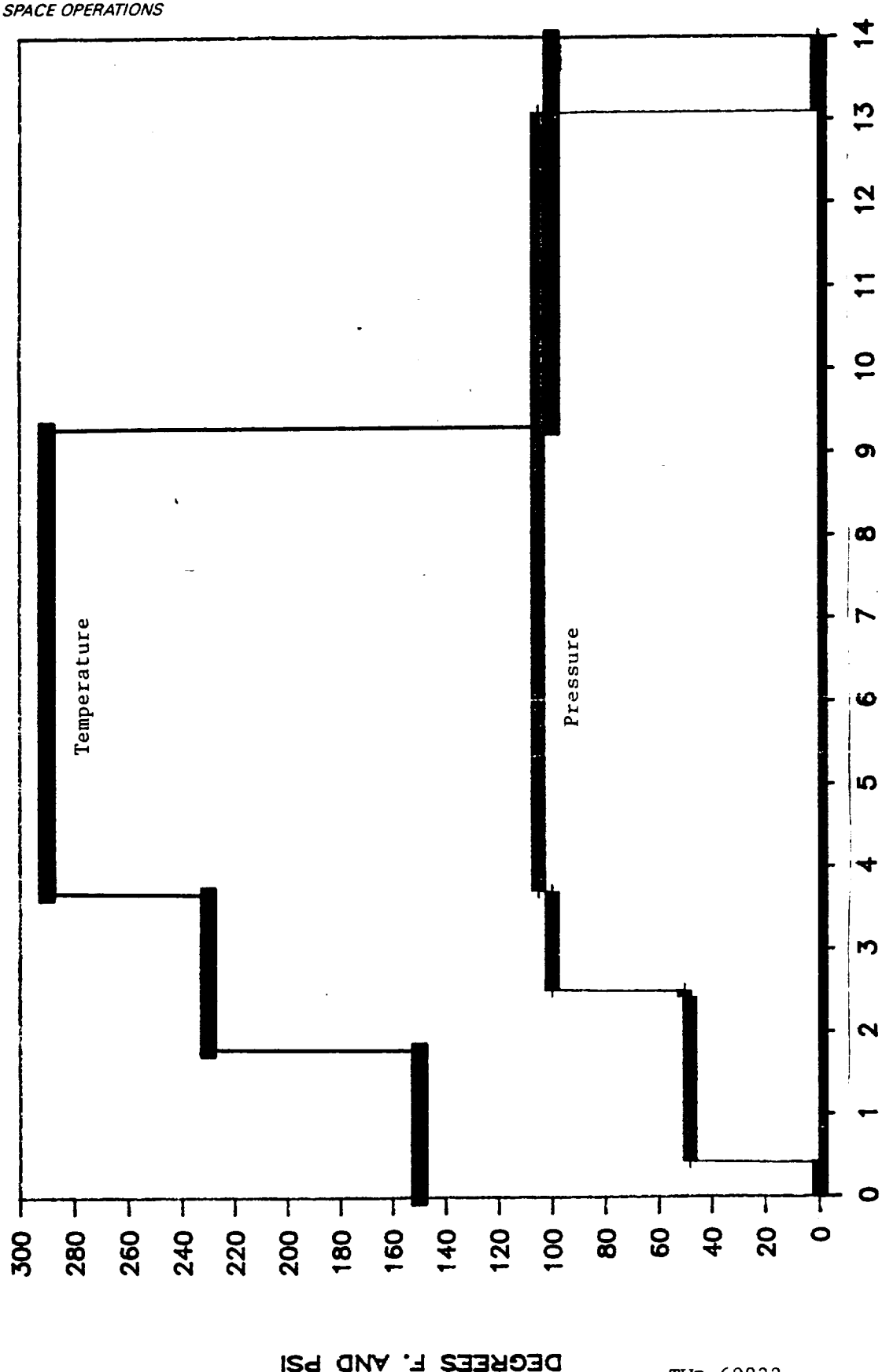

Figure 7. Autoclave Cure Cycle

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ATTACHMENT I. Memo No. 8863-FY90-M123

Thiokol CORPORATION
SPACE OPERATIONS

26 APR 1990
8863-FY90-M123

TO: S. K. Jensen

FROM: D. S. Brown
Extension 5813

SUBJECT: Nylon/Teflon Rod Surface Exposure Contamination Effect Evaluation

REVIEW

A test matrix of 14 different combinations was set up and eight tensile strength measurements and five peel strength measurements were taken at each combination (see Table 1). For tensile strength, the maximum stress values were analyzed, and for peel strength, the average stress values were analyzed. See Tables 2 & 3 for the data values.

CONCLUSIONS

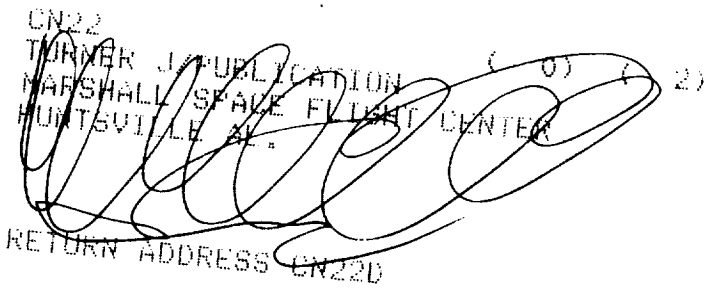
For both surface types, the statistical tests indicate that the "Teflon Rod - I" and "Teflon Rod - II" surface contaminant levels yield smaller values than the "None" level. Also for both surface types, the statistical tests indicate that the "Nylon Rod" level yields values that are similar to the "None" level. This is indicating that the teflon rods are causing contamination, while the nylon rod is not causing contamination.

It is not clear from the statistical tests whether the exposure levels are affecting the measurements or not.

The statistical tests were performed at a 95% confidence level.

Duane S. Brown

Duane S. Brown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