

DTIC FILE COPY

(12)

APPROVED FOR PUBLIC RELEASE  
DISTRIBUTION UNLIMITED

REPORT NO: 87-R-04  
AFPEA PROJECT NO: 85-P-132

AD-A181 942

CAREY SCOTT GRAVENSTINE

Materials Engineer  
Materials Engineering Branch  
HQ AFIC/DSTZT

AUTOVON 787-7445  
COMMERCIAL (513) 257-7445

DTIC  
ELECTE  
JUL 02 1987  
S  
D

EVALUATION OF DOW PELESPAN  
MOLD-A-PAC LOOSE-FILL CUSHIONING MATERIAL

HQ AFIC/DSTZ  
AIR FORCE PACKAGING EVALUATION AGENCY  
WRIGHT-PATTERSON AFB, OHIO 45433-5999

MAY 1987

20030127059

87

NOTICE

When government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related government procurement operation, the United States Government thereby incurs no responsibility whatsoever; and the fact that the government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto. This report is not to be used in whole or in part for advertising or sales purposes.

AFPEA PROJECT NO: 85-P-132

TITLE: Evaluation of Pelespan Mold-A-Pac Loose-Fill Cushioning Material

ABSTRACT

↙

The AMC Packaging, Storage, and Containerization Center requested this agency to evaluate the new Pelespan Mold-A-Pac (MPS), loose-fill cushioning material produced by Dow Chemical Company. The addition of a latex bonding agent to the "Pelespan", loose-fill bulk material provided a possible solution to typical sifting and settling characteristics of loose-fill material. The cushioning performance of both MPS and Foam-In-Place (FIP) materials were evaluated using the free-fall drop test of FTMS 101C, Method 5007.1. The Pelespan Mold-A-Pac was found to be a more effective cushioning material than Foam-In-Place for items with relatively low static bearing stresses, i.e., .35 psi and .42 psi for two inch and four inch thicknesses, respectively. However, for items with greater static bearing stresses FIP was found to be superior over MPS in its ability to retain material integrity and cushioning performance reliability after a series of free-fall impacts. Exposure to high humidity conditions caused the MPS material to perform less effective due to the failure of the latex bonding mechanism.

↑

PREPARED BY:

*Carey S. Graebstine*  
CAREY S. GRAEBSTINE  
Materials Engineer  
Materials Engineering Branch

PUBLICATION DATE:

27 MAY 1987

REVIEWED BY:

*Matthew A. Venetos*  
MATTHEW A. VENETOS  
Chief, Materials Engineering Branch  
AF Packaging Evaluation Agency

APPROVED BY:

*Jack E. Thompson*  
JACK E. THOMPSON  
Chief, AF Packaging  
Evaluation Agency

## TABLE OF CONTENTS

	PAGE
ABSTRACT.....	1
TABLE OF CONTENTS.....	ii
BACKGROUND.....	1
PURPOSE.....	1
DESCRIPTION OF TEST CONTAINERS.....	1
TEST EQUIPMENT AND INSTRUMENTATION.....	2
TEST PROCEDURE.....	2
RESULTS.....	2
CONCLUSION.....	3
GRAPH 1--MIL-F-83671, DYNAMIC CUSHIONING CURVE FOAM-IN-PLACE (1.0 PCF), Class 2, Grade B.....	5
GRAPH 2--FOAM-IN-PLACE VERSUS PELESPAN MOLD-A-PAC 2" THICKNESS.....	6
GRAPH 3--FOAM-IN-PLACE VERSUS PELESPAN MOLD-A-PAC 4" THICKNESS.....	7
GRAPH 4--PELESPAN MOLD-A-PAC AT 90 PERCENT RH 2" AND 4" THICKNESSES.....	8
FIGURE 1--INSTRUMENTATION AND CONTAINERS FOR THE 5" X 5" X 6" SIMULATED LOAD.....	9
FIGURE 2--INSTRUMENTATION AND CONTAINERS FOR THE 6" X 6" X 6" SIMULATED LOAD.....	10
FIGURE 3--INSTRUMENTATION AND CONTAINERS FOR THE 7" X 7" X 10" SIMULATED LOAD.....	11
FIGURE 4--GAYNES DROP TESTER, MODEL 125 DTP.....	12
DISTRIBUTION LIST.....	13
REPORT DOCUMENTATION PAGE (DD FORM 1473).....	15

## BACKGROUND

The AMC Packaging, Storage, and Containerization Center (AMCPSCC) requested the Air Force Packaging Evaluation Agency (AFPEA) to evaluate the new Pelespan Mold-A-Pac (MPS), cushioning material produced by Dow Chemical Company. The evaluation was conducted in accordance with AFPEA lead service responsibilities. This new concept in loose-fill cushioning/dunnage is primarily based on one of Dow's older products called Pelespan loose-fill cushioning material. The addition of a latex bonding agent to this material has provided a possible solution to the sifting and settling problems typically exhibited by loose-fill materials.

## PURPOSE

The purpose of this project was to identify performance characteristics of MPS. Due to interest expressed by several Air Logistics Centers and AMCPSCC in finding a possible alternative to polyurethane foam-in-place (FIP) cushioning, MPS performance was compared against that of similar packs incorporating FIP cushioning.

## DESCRIPTION OF TEST PACKS

Three simulated test loads, 5" x 5" x 6", 6" x 6" x 6" and 7" x 7" x 10" (Figures 1-3) consisting of a central wood block and interchangeable wood, aluminum, and steel plates were used to vary the load weight to attain the desired static stress points. Each "dummy" load was instrumented with three crystal accelerometers triaxially mounted in the central wood block. The exterior container was an RSC corrugated container fabricated from PPP-F-320, Class V3c, fiberboard. Two sizes of containers were used for each "dummy" load size to provide two and four inch cushioning protection. The interior cushioning consisted of polyurethane foam-in-place (1.0 PCF) or Pelespan Mold-A-Pac. Preparation of the FIP packs was accomplished at AFPEA using FIP material meeting MIL-F-83671, Class 2, Grade B, requirements. The dynamic cushioning quality conformance curves for the Grade B material are presented in Graph 1. The Pelespan Mold-A-Pacs were prepared by Dow Chemical USA at their Granville, Ohio facility.

Accession For	NTIS <input checked="" type="checkbox"/> CR&I <input type="checkbox"/> DTIC <input type="checkbox"/> TAB <input type="checkbox"/> Unannounced <input type="checkbox"/> Justification
By	
Distribution/	
Availability Codes	
Dist	A-1

## TEST EQUIPMENT AND INSTRUMENTATION

A "Gaynes" drop tester, Model 125 DTP (Figure 4), was used in performing the completed pack drop tests to determine the dynamic cushioning properties. Instrumentation used to measure these properties consisted of the following:

- a. Endevco crystal accelerometers, Model 2233E, three each.
- b. Endevco charge amplifiers, Model 2614C, three each.
- c. Endevco power supply, Model 2622C.
- d. A Tektronix four trace Storage Oscilloscope, Model 5115.

## TEST PROCEDURES

The free-fall drop testing was conducted in accordance with Federal Test Method Standard 101C, Method 5007.1, Free-Fall Drop Test. The containers were dropped from a 30 inch height. The drop test procedure consisted of ten drops alternated between opposite end faces so that no face received two successive impacts. The resultants of the drops were averaged to give the peak acceleration for each static bearing stress point. Containers with MPS were also tested to determine the effects of high humidity on cushioning performance. After conditioning these containers for five days at 80 degrees F and 90 percent RH, drop tests were performed.

## RESULTS

The results are presented in the attached Peak Acceleration-Static Stress curves, Graphs 2-4. The results are plotted in terms of peak Gs versus static stress (psi). Data developed for both materials of two inch thickness is presented in Graph 2. At static bearing stresses below approximately 0.35 psi, MPS was a more effective cushioning material than FIP. However, above this point FIP provided better protection. For example, at the lowest point of the static stress range (0.1 psi) the shock protection provided by MPS was 50 Gs as compared to 80 Gs for FIP. For the portion of the static stress range above .35 psi, FIP material provides approximately 15-20 percent better protection than MPS. Inspection of the containers after 10 drops indicated no rotation or degradation of the FIP material. Loads with bearing stresses exceeding .80 psi, did however, cause the FIP to take a compression set. The MPS showed signs of sifting and settling as indicated by rotation of the load.

Comparison of the performance of the materials of four inch thickness is presented in Graph 3. At static bearing stresses below approximately 0.40 psi, MPS was a more effective cushioning material than FIP. Above .40 psi, the FIP material provides a moderate 10-15 percent improvement in protection over MPS. Inspection of the FIP containers after the drops, again indicated no rotation of the simulated loads or degradation of the cushioning material. The MPS material, however, was fractured with the simulated load rotating and migrating through the material.

Since there was a possibility of disturbing the integrity of the MPS material during testing, the containers were not opened to determine at what point in the drop test cycle the material began to fracture. For this reason several additional uninstrumented containers were evaluated to specifically determine when material fracture occurred. It was determined that material fracture occurred after 6-8 drops for the two and four inch material thicknesses at static bearing stresses of 0.35 and 0.42 psi, respectively.

Graph 4 presents the data collected on MPS subjected to 90 percent relative humidity (RH). A total of eight containers were evaluated; four each of two inch and four inch MPS material. Both thicknesses of MPS provided an average of 10-15 percent lesser protection than the containers evaluated at normal room conditions (70 degrees F, 50% RH). The loss in performance was attributed to the solubility of the latex adhesive material with water. At the higher humidity levels the bonding system broke down causing the simulated load to settle, rotate, and sift through the MPS material.

#### CONCLUSION

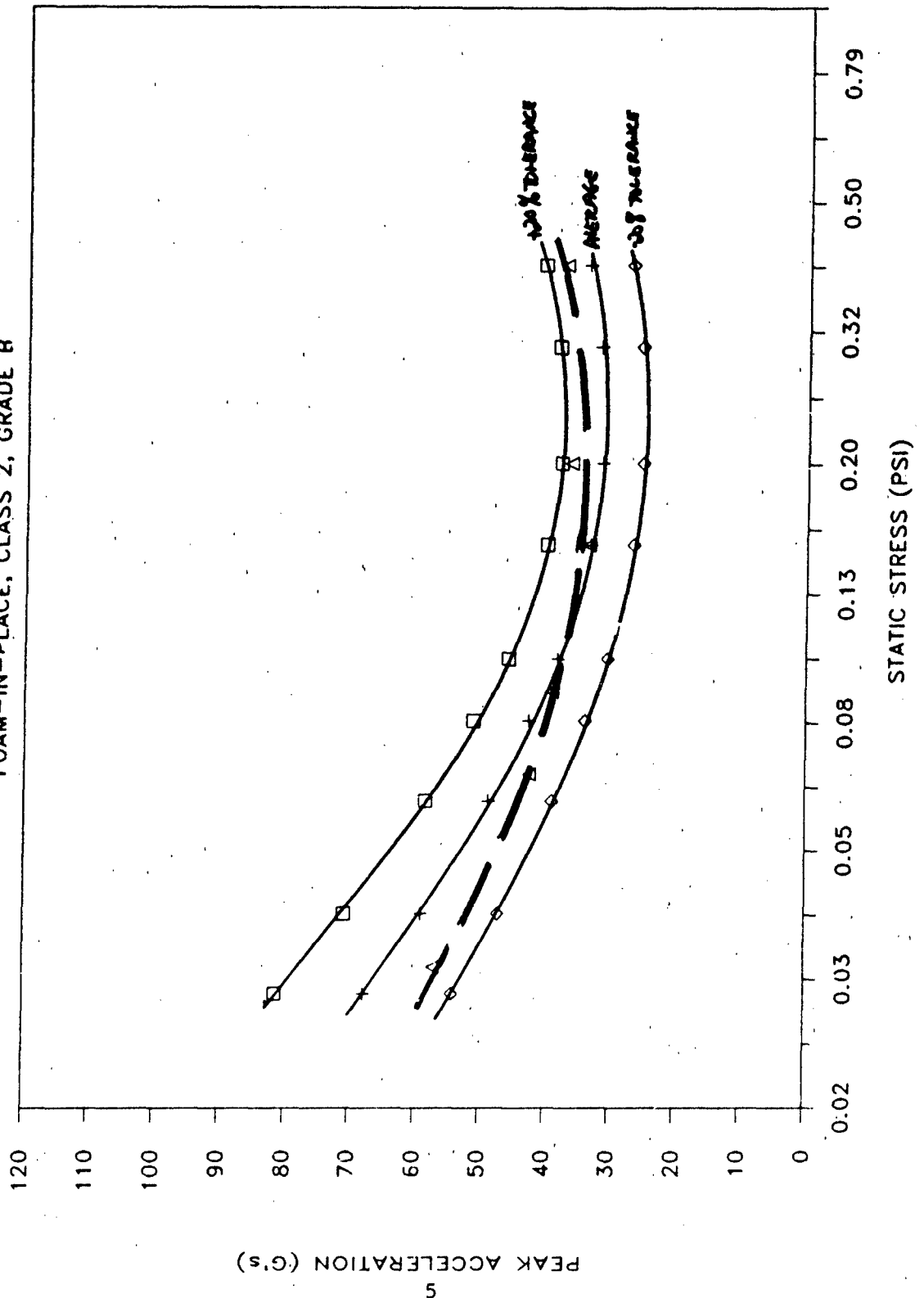
Pelespan Mold-A-Pac is a more effective cushioning material than polyurethane foam-in-place for items with relatively low static bearing stresses, i.e., static bearing stresses less than .35 psi and .42 psi for two inch and four inch thicknesses, respectively. These static stress points were determined to be fracture points for MPS. Static bearing stresses above these respective points caused the material to lose its adhesive bound integrity, particularly during multiple impacting. When this occurs the material then begins to perform as a typical loose-fill cushioning material.

At static stresses above .35 psi-.42 psi, FIP is a more effective cushioning material than MPS and exhibits a better ability to retain material integrity and reliability after repeated free-fall impacts.

Exposure to high humidity conditions (90 percent RH) will cause MPS to be 10-15 percent less effective as compared to performance at normal room conditions (50 percent RH). This was attributed to the failure of the latex bonding mechanism.

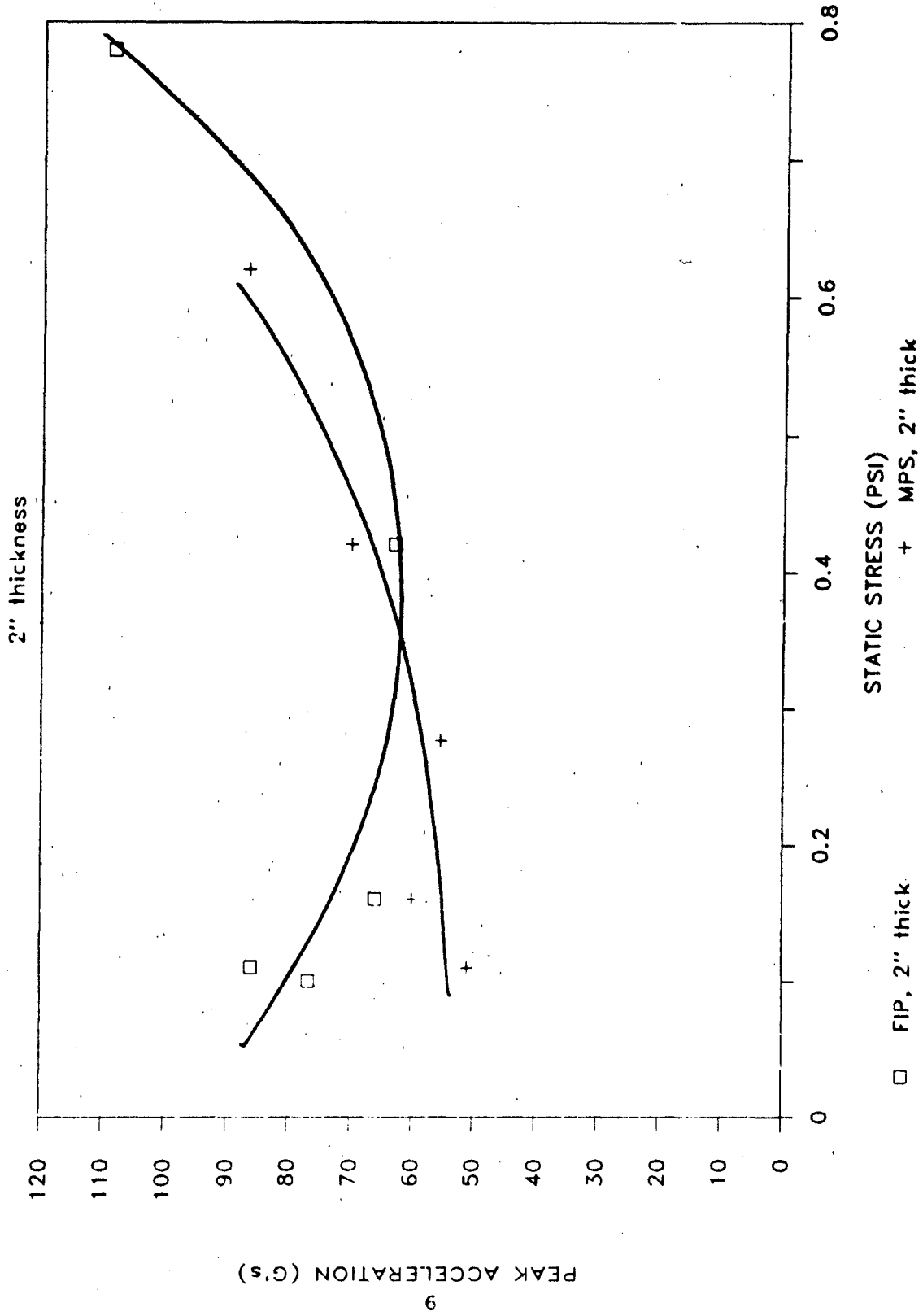
# GRAPH 1, PEAK G - STATIC STRESS CURVE

FOAM-IN-PLACE, CLASS 2, GRADE B

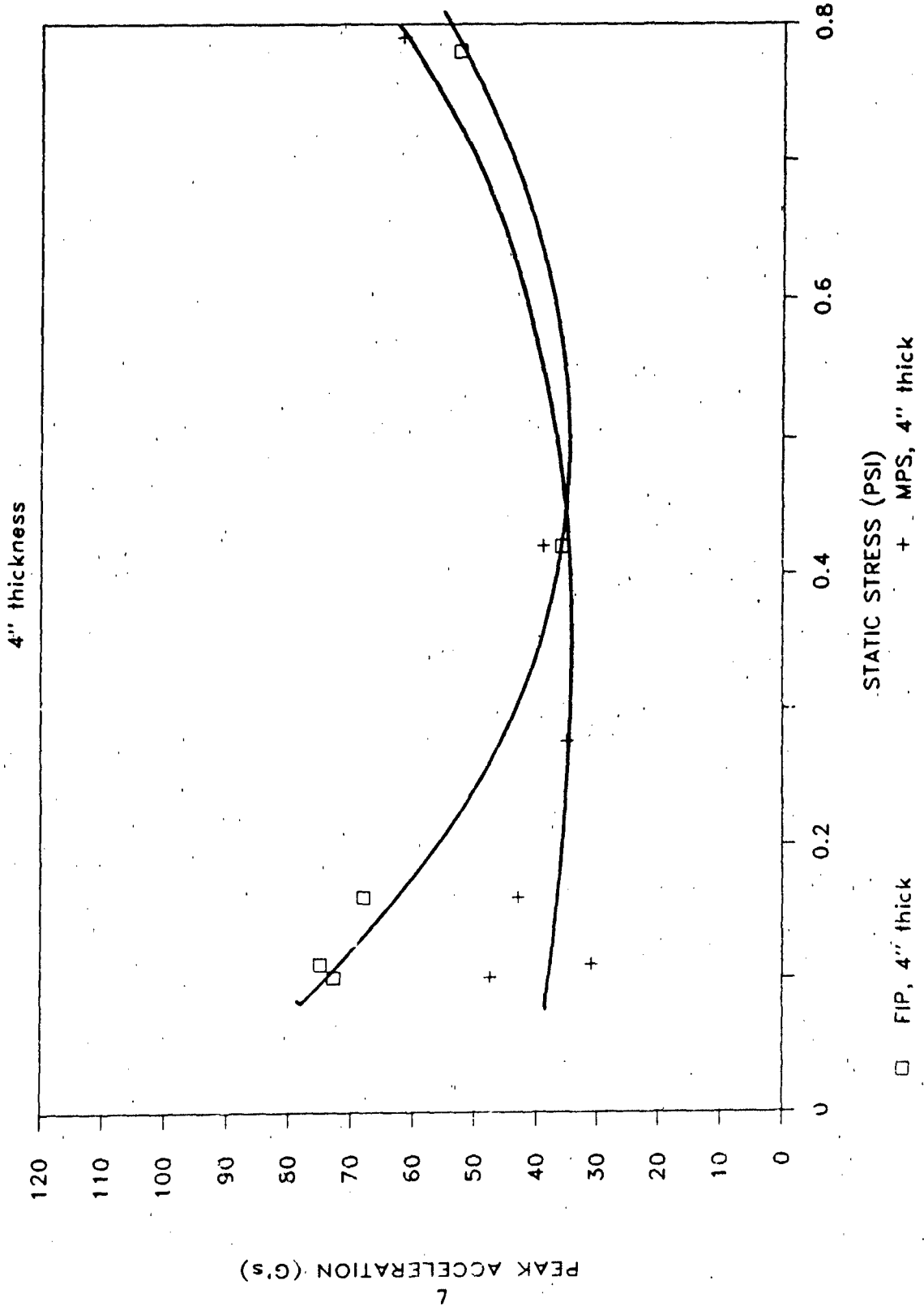




GRAPH 2, FIP vs. PELESPAN MOLD-A-PACK

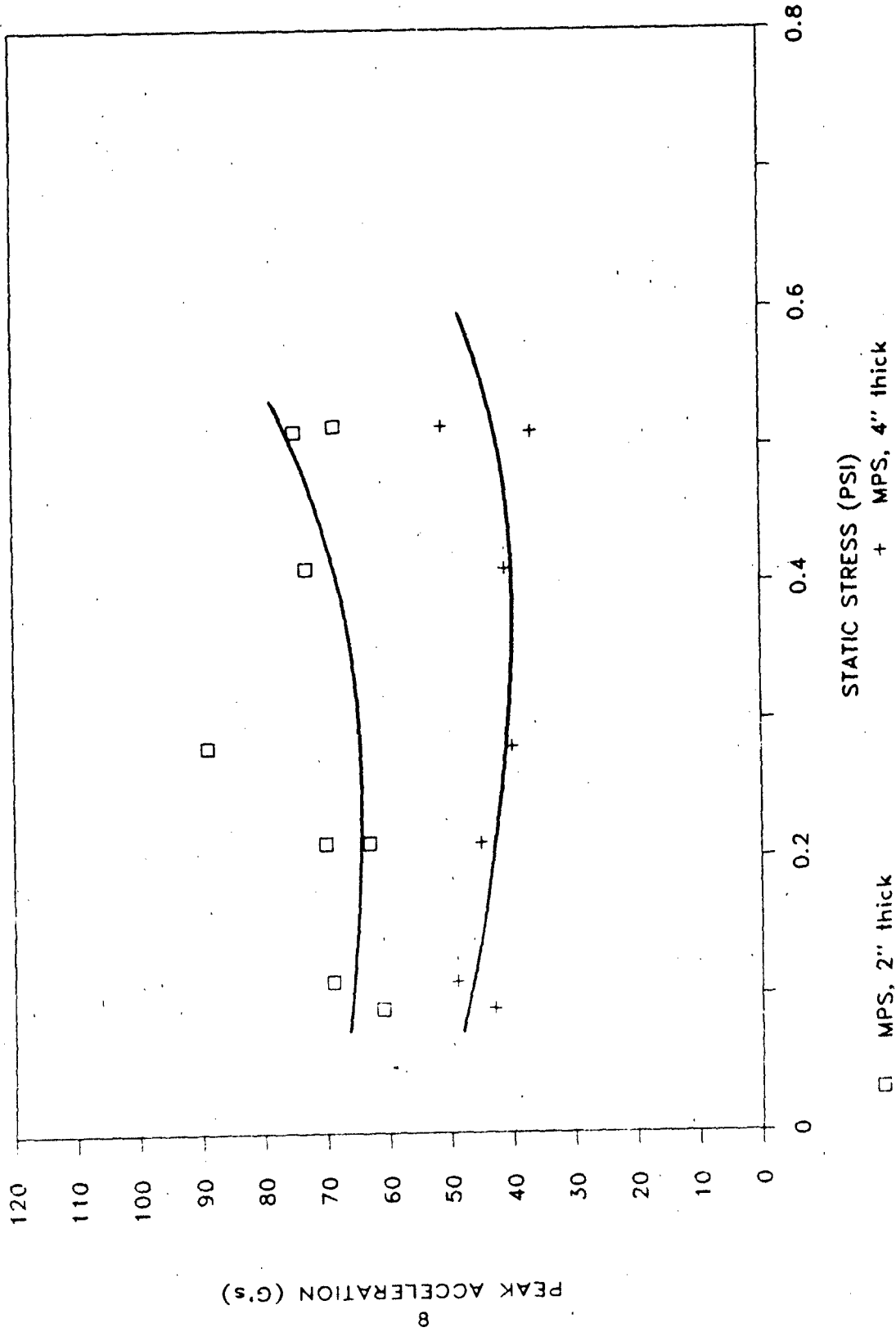


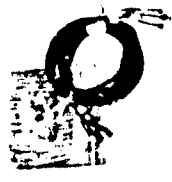
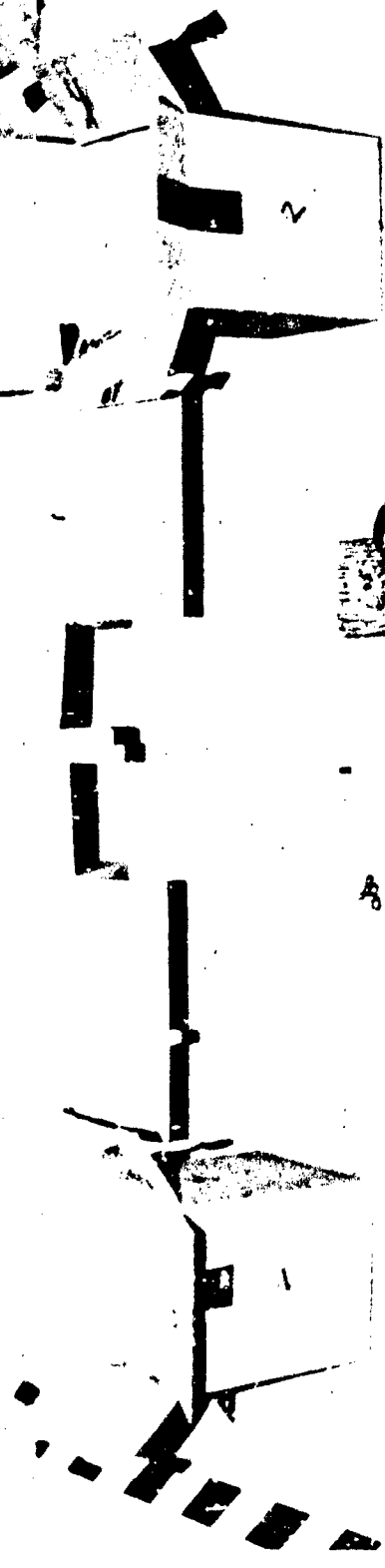
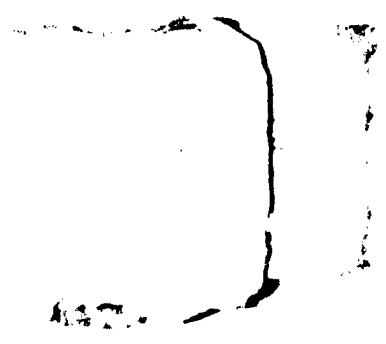
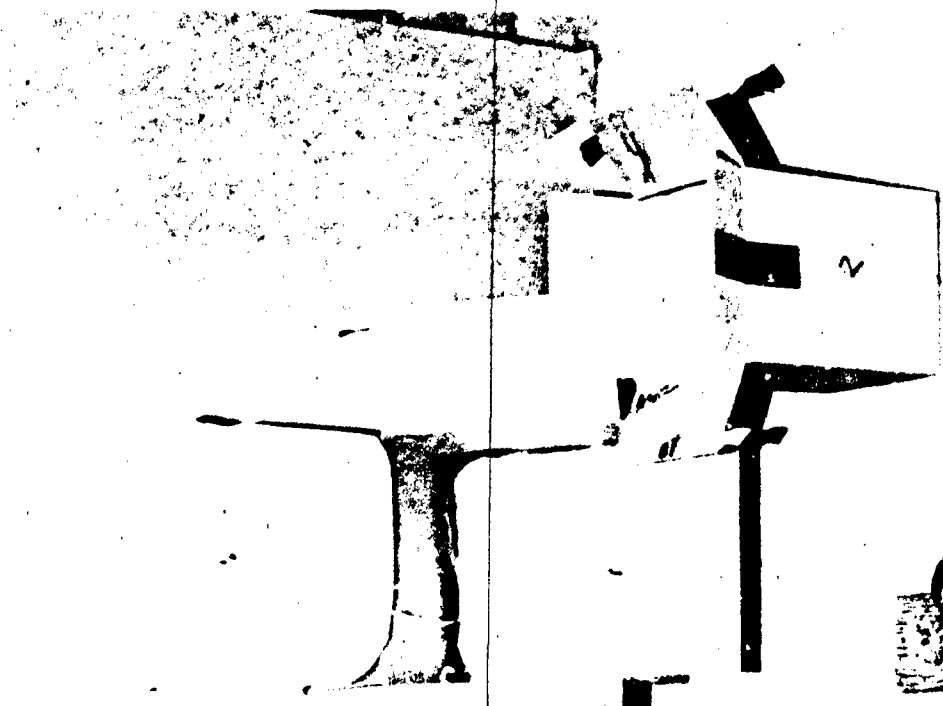
GRAPH 3, FIP vs. PELESPAN MOLD-A-PACK

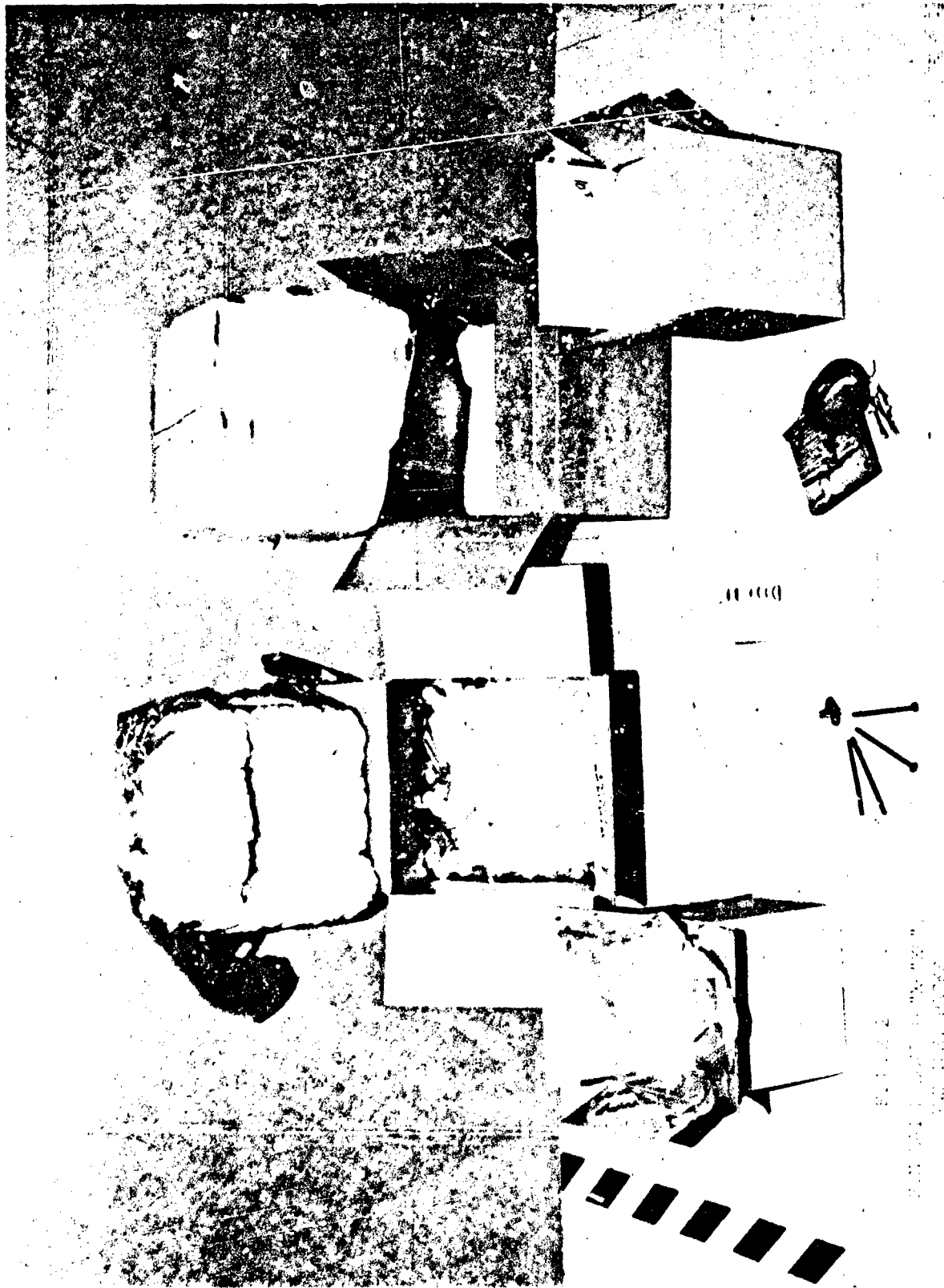


# GRAPH 4, PELESPAN MOLD-A-PACK at 90%RH

2" and 4" thickness







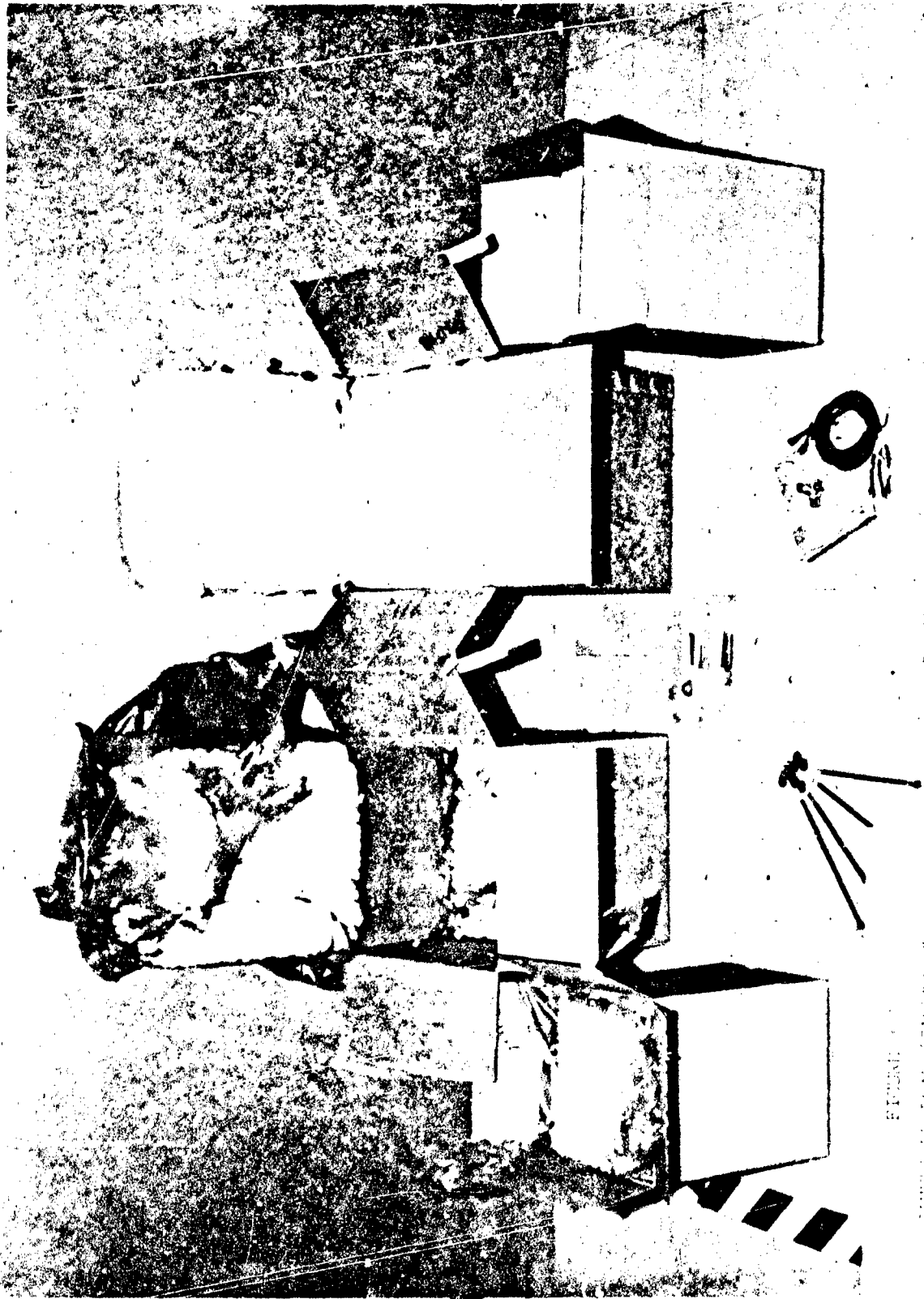
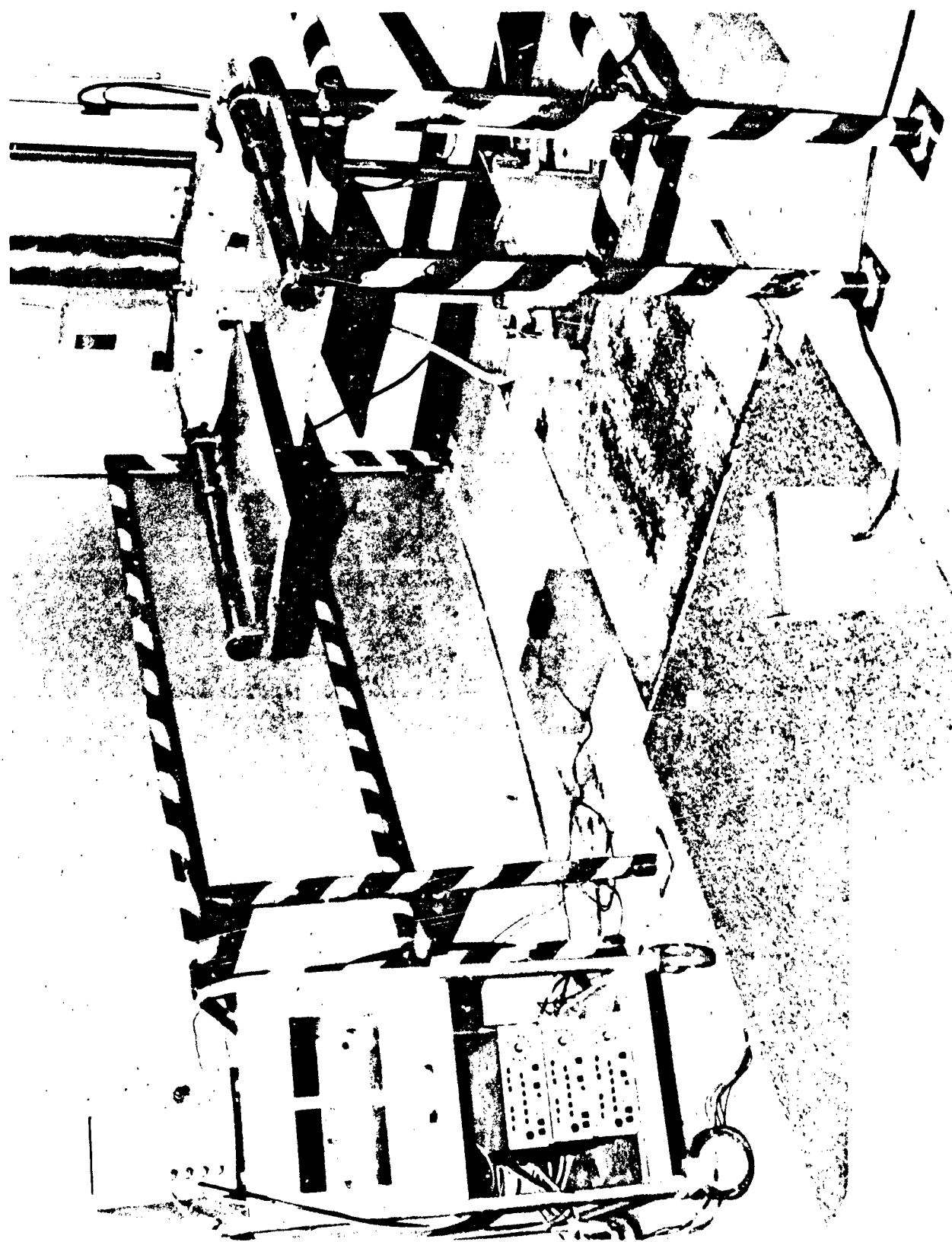


FIGURE 1  
PHOTOGRAPH OF THE INTERIOR OF THE  
CANNON AT THE TIME OF THE  
EXPLOSION



DISTRIBUTION LIST

DTIC/FDAC Cameron Station Alexandria VA 22304-6145	12	Commander Naval Supply Systems Command ATTN: N. Karl (SUP 0611F) Washington DC 20376-5000	1
HQ AFLC/DSTZ Library Wright-Patterson AFB OH 45433-5999	20	Commander Naval Air Systems Command ATTN: E. Panigot (AIR 41212A) Washington DC 20361	1
HQ USAF/LETT Washington DC 20330	1	Commander Space and Naval Warfare Systems ATTN: C. Corbe (Code 8218) Washington DC 20360	1
HQ AFLC/DSTP Wright-Patterson AFB OH 45433-5999	1	Commander Naval Facilities Engineering Hoffman Bldg. #2, Room 12S21 ATTN: C. Manwarring (FAC 0644) Alexandria VA 22332	1
OO-ALC/DST Hill AFB UT 84406-5999	1	Commanding Officer Naval Construction Battalion ATTN: K. Pollock (Code 15611K) Port Hueneme CA 93043	1
OC-ALC/DST Tinker AFB OK 73145-5999	1	Commander Naval Sea Systems Command ATTN: G. Mustin (SEA 6G53) Washington DC 20362	1
SM-ALC/DST McClellan AFB CA 95652	1	Commander Naval Sea Systems Command ATTN: F. Basford (SEA 05M3) Washington DC 20362	1
SA-ALC/DST Kelly AFB TX 78241-5999	1	Commanding Officer Naval Aviation Supply Office 700 Robbins Avenue ATTN: J. Yannello (Code EPP-A) Philadelphia PA 19111-5098	1
WR-ALC/DST Robins AFB GA 31098-5999	1	Commanding Officer Navy Ships Parts Control Center PO Box 2020 ATTN: F. Sechrist (Code 0541) Mechanicsburg PA 17055-0788	1
ASD/AWL/ALXP Wright-Patterson AFB OH 45433-6503	3		
DLSIE/AMXMC-D USA Logistics Management Center Fort Lee VA 23801-6043	1		
US AMCPSCC/SDSTO-T Tobyhanna PA 18466	1		
US Army Natick Laboratory ATTN: STRNC-ES Natick MA 01760	1		
Commanding Officer Naval Air Engineering Center ATTN: F. Magnifico (SESD Code 9321) Lakehurst NJ 08733-5100	1		



DISTRIBUTION LIST (Con't)

AD/YNP Eglin AFB FL 32542	1	HQ DLA-OWO Cameron Station Alexandria VA 22304-6145	1
ASO/TEP-A 4030 700 Robbins Avenue Philadelphia PA 19111	1	US Army Armament Munitions and Chemical Command ATTN: SMCAR-AED Dover NJ 07801-5001	1
GSA, Office of Engineering Management Packaging Division Washington DC 20406	1	Commanding Officer Naval Weapon Station, Earle ATTN: NWHC 80A Coltsneck NJ 07722	1
HQ AFSC/LGT Andrews AFB DC 20334			

REPORT DOCUMENTATION PAGE				Form Approved OMB No. 0704-0188	
1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED		1b. RESTRICTIVE MARKINGS UNLIMITED DISTRIBUTION			
2a. SECURITY CLASSIFICATION AUTHORITY N/A		3. DISTRIBUTION / AVAILABILITY OF REPORT APPROVED FOR PUBLIC RELEASE			
2b. DECLASSIFICATION / DOWNGRADING SCHEDULE N/A		DISTRIBUTION UNLIMITED			
4. PERFORMING ORGANIZATION REPORT NUMBER(S)  DSTZT Report No: 87-R-04		5. MONITORING ORGANIZATION REPORT NUMBER(S)  DSTZT Report No: 87-R-04			
6a. NAME OF PERFORMING ORGANIZATION Air Force Packaging Evaluation Agency		6b. OFFICE SYMBOL (if applicable) HQ AFLC/DSTZT	7a. NAME OF MONITORING ORGANIZATION Air Force Packaging Evaluation Agency		
6c. ADDRESS (City, State, and Zip Code) HQ AFLC/DSTZT Wright-Patterson AFB OH 45433-5999		7b. ADDRESS (City, State, and ZIP Code) HQ AFLC/DSTZT Wright-Patterson AFB OH 45433-5999			
8a. NAME OF FUNDING / SPONSORING ORGANIZATION AFPEA/HQ AFLC		8b. OFFICE SYMBOL (if applicable) HQ AFLC/DSTZT	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER  N/A		
8c. ADDRESS (City, State, and ZIP Code) HQ AFLC/DSTZT Wright-Patterson AFB OH 45433-5999		10. SOURCE OF FUNDING NUMBERS	PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.
				85-P-132	WORK UNIT ACCESSION NO.
11. TITLE (Include Security Classification)  Evaluation of Dow Pelespan Mold-A-Pac Loose-Fill Cushioning Material					
12. PERSONAL AUTHOR(S) Gravenstone, Carey Scott					
13a. TYPE OF REPORT Technical		13b. TIME COVERED FROM Oct 85 TO Mar 87		14. DATE OF REPORT (Year, Month, Day) 1987 March	15. PAGE COUNT
16. SUPPLEMENTARY NOTATION					
17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)		
FIELD	GROUP	SUB-GROUP			
19. ABSTRACT (Continue on reverse if necessary and identify by block number) AMC Packaging, Storage, and Containerization Center requested this agency to evaluate the new Pelespan Mold-A-Pac (MPS), loose-fill cushioning material produced by Dow Chemical Co. The addition of a latex bonding agent to the "Pelespan", loose-fill bulk material provided a possible solution to typical sifting and settling characteristics of loose-fill material. The cushioning performance of both MPS and Foam-In-Place (FIP) materials were evaluated using the free-fall drop test of FTMS 101C, Method 5007.1. The pelespan Mold-A-Pac was found to be a more effective cushioning material than Foam-In-Place for items with relatively low static bearing stresses, i.e., .35 psi and .42 psi for two and four inch thicknesses, respectively. However, for items with greater static bearing stresses FIP was found to be superior over MPS in its ability to retain material integrity and cushioning performance reliability after a series of free-fall impacts. Exposure to high humidity conditions caused the MPS material to perform less effective due to the failure of the latex mechanism.					
20. DISTRIBUTION / AVAILABILITY OF ABSTRACT <input checked="" type="checkbox"/> UNCLASSIFIED/UNLIMITED <input type="checkbox"/> SAME AS RPT <input type="checkbox"/> DTIC USERS			21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED		
22a. NAME OF RESPONSIBLE INDIVIDUAL Carey Scott Gravenstone			22b. TELEPHONE (Include Area Code) (513) 257-7445	22c. OFFICE SYMBOL HQ AFLC/DSTZT	