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PERFORMANCE EVALUATION OF A HIGH DENSITY POLYURETHANE SHIPPING --ETC(U)
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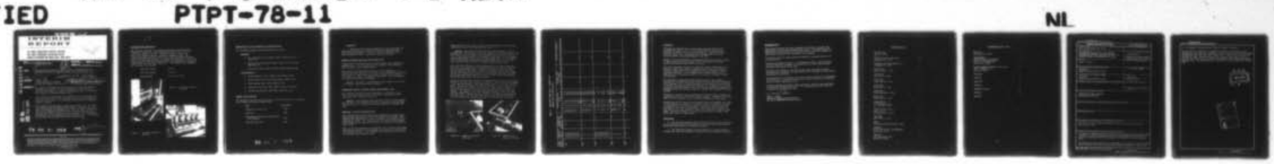

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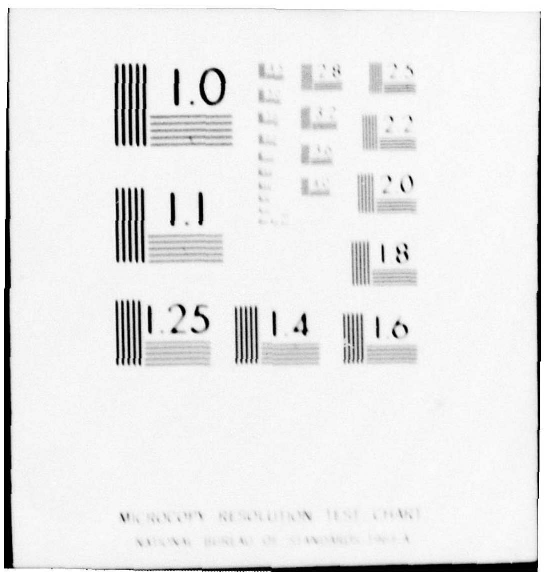
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INTERIM REPORT

AIR FORCE ACQUISITION LOGISTICS DIVISION
AIR FORCE PACKAGING EVALUATION AGENCY
WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433

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AFALD/PTPT **REPORT NO.** 78-11

PROJECT NO. 77-P7-55

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TITLE: PERFORMANCE EVALUATION OF A HIGH DENSITY POLYURETHANE SHIPPING CONTAINER FOR THE F-16 EMERGENCY POWER UNIT HYDRAZINE FUEL TANK.

(9) Interim rept., (14) PTPT-78-11 (12) 12p.

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ABSTRACT: In support of ASD/AEGT this Agency subjected a candidate prototype polyurethane container for the F-16 Emergency Power Unit (EPU) Hydrazine Fuel Tank, to a series of performance tests in accordance with Federal Test Method Standard 101 B.

The objective of these tests was to determine if the prototype container would protect the EPU fuel tank from mechanical damage and maintain a vapor seal, i.e. a minimum 1.0 psig pressure during all phases of testing.

The container was subjected to compression loading, free fall drop tests (ambient and low temperature), pneumatic pressure, and leak tests in accordance with Methods 5016, 5007, and 5009, respectively. These tests indicated the EPU fuel tank container will maintain a positive seal under 1.0 psig pressure and remain intact throughout environmental and transportation rough handling tests. The container did not meet the 25 G shock protection requirement.

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APPROVAL: Jack C. Thompson

Evaluation Agency

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CONTAINER/ITEM DESCRIPTION

The prototype container is a molded polyurethane reinforced with fiberglass (Figure 1). The dimensions are 48.5"x 13.5" x 13.75" with a tare weight of 58 lbs. A T-bolt design is utilized to secure the container halves to maintain a pneumatic seal. The container provides protection for a fuel tank containing H-70 hydrazine. The fuel tank is nested in a saddle constructed of (2 lb./cu.ft) polyethylene with end pads protecting the quick-disconnect fittings on either end of the fuel tank (Figure 2). The weight of the container and contents is as follows:

Container (empty)	58 lbs.
Fuel tank (empty)	39.5 lbs.
H-70 Hydrazine	55 lbs. (6.6 gal)

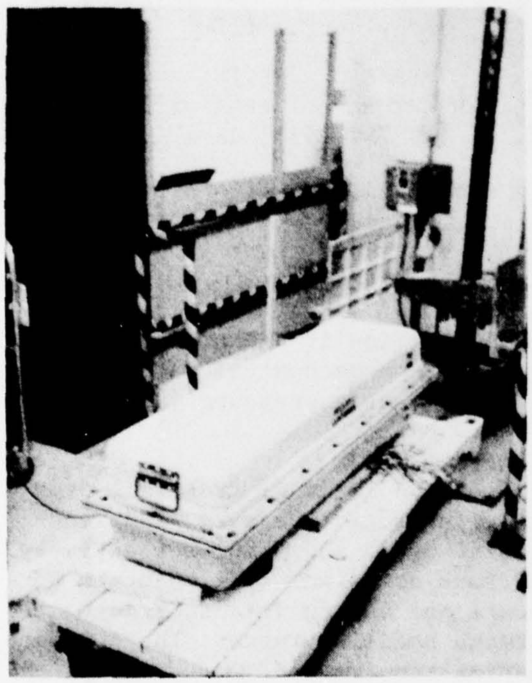

Figure 1. Prototype Container - Exterior

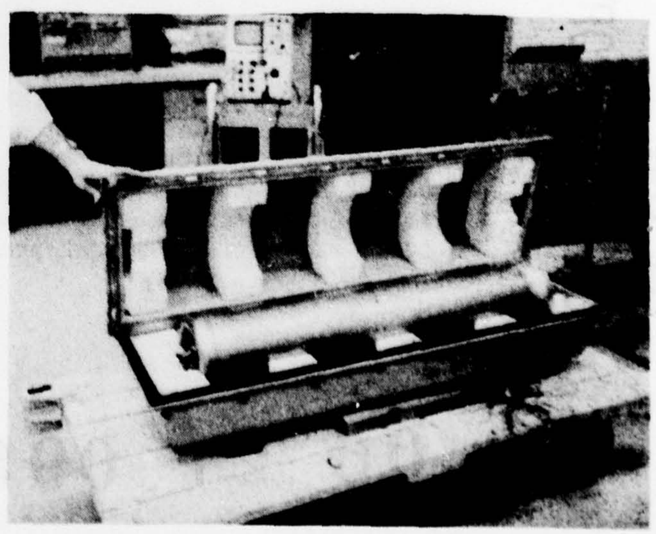

Figure 2. Prototype Container - Interior

DESCRIPTION OF TEST EQUIPMENT AND INSTRUMENTATION

The following equipment and instrumentation was used:

Equipment

a. Low temperature test chamber, Tenny Engineering, Inc., Union, N.Y.

b. High Capacity Compression Tester, Model 17-24, Testing Machines, Inc.

c. Gaynes Drop Tester, Model 125 DTP, Gaynes Engineering.

Instrumentation

a. Accelerometers (3 ea.), Model 2233E, Endevco Corp.

b. Charge amplifiers (3 ea.) Model 2614C, Endevco Corp.

c. Power supply, Model 2622C, Endevco Corp.

d. Manometer, Well Type, Model 30EB25, Meriam Instrument

e. Storage Oscilloscope, Type 564B, Tektronic, Inc.

GENERAL TEST PROCEDURE

The prototype container was subjected to the following tests in accordance with Federal Test Method Standard 101B:

TEST	TEST METHOD
Pneumatic Pressure Test	5009
Leak Test	5009
Superimposed-load Test (Stackability, with dunnage)	5016
Free Fall Drop Test	5007

Inspection

During initial prototype inspection it was noted that the prototype container was intact and no external damage had been incurred during shipment. Container inspection was made prior to and following each test to ascertain container integrity.

PNEUMATIC PRESSURE AND LEAK TEST (METHOD 5009)

A leak test was conducted prior to and following each shipping and handling test. A 1.0 psig pressure was applied to the container thru a fitting in the container wall.

This pressure was monitored by means of a water manometer. A positive seal was indicated if the water in the manometer dial did not fall below 27.5 inches when the external pressure was terminated. To identify the points of leakage, a soap bubble test was conducted, if a positive seal was not obtained.

Results: The water in the manometer held constant for a period of 1.5 hours, indicating a sealed container.

COMPRESSION LOADING--CONSTANT LOADING MODE (METHOD 5016)

The container was placed on the high capacity compression tester and a constant uniform pressure of 3940 lbs. was applied to the top surface for a period of one hour.

Results: The container deflection was 1/2 inch in the vertical and 1/2 inch in the horizontal direction, relative to the container. A positive seal of 1.0 psig pressure was maintained throughout the test.

DROP TEST - Free Fall (Method 5007)

The container with loaded fuel tank was dropped once on each of its eight corners and six faces from a drop height of 18 inches. This procedure was followed for a series of drops at both ambient and low temperature (-40^{o}F). The container and fuel tank was also dropped from a height of 48 inches for a series of two drops on each end face (nos. 5 & 6).

Prior to the low temperature drop sequence, the container with loaded fuel tank was placed in a cold chamber for a period of four hours at -40 degrees below zero. The container was then dropped once on each of its eight corners and six faces.

During the drop tests, when a loaded fuel tank was required, water was substituted for the H-70 hydrazine fuel (s.g. = 1).

Results: The results of the drop tests are presented in Table I. Although the average peak acceleration results for the 18-inch corner and flat drops are in the range of the required shock protection level of 25 G's, the values measured for individual corner and flat face impacts varied significantly above and below the average value. It is believed that the large peak acceleration readings obtained on corners 2-3-5, 1-4-5, and 3-4-5 may be due to the small end pad bearing areas.

Also, the wide variation in the individual drop test results may have been due to the difficulty in obtaining true corner impacts because of the 1½ inch protruding flange around the perimeter of the container. In some instances the angle of contact, at impact, between this flange and the floor caused the container to rotate producing higher acceleration inputs than would normally occur as a result of the translational motion associated with true corner drops.

During the 48-inch drop test the fuel tank made contact with the interior surface of the container (Figures 3a and 3b). This contact caused damage to the quick-disconnect fitting and allowed water to leak from the check valve. The arrows (Figure 3a) indicate the impact points between the fuel tank with the container interior wall. The container damage consisted of the peeling or tearing of the polyurethane at the points of contact. The damage to the quick-disconnect fitting (Figure 3b) which resulted from the impact, was the tearing of the plastic cap protecting the check valve. As the protecting cap tore, material was introduced into the check valve, allowing the water to leak from the fuel tank.

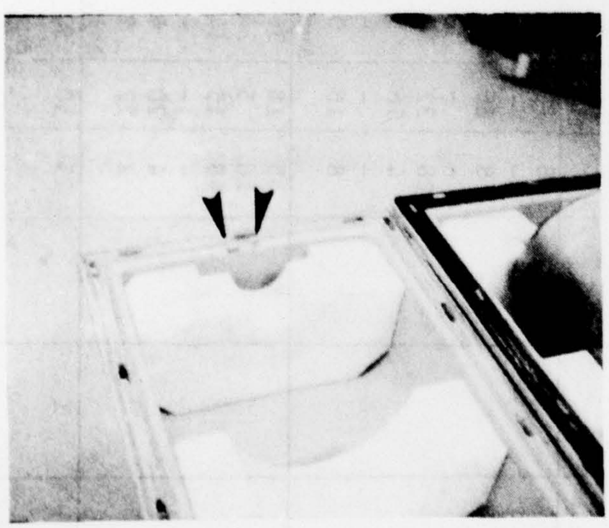

Figure 3a. Damage to Container Inner Wall

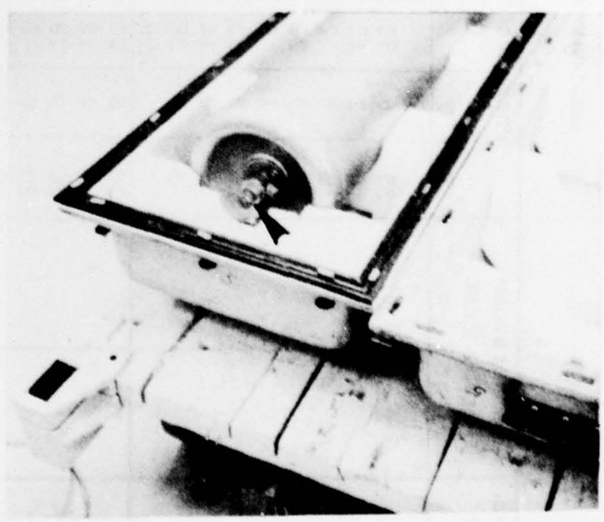

Figure 3b. Damaged Quick-Disconnect Fitting

TABLE I. DROP TEST (FREE FALL) - METHOD 5007

Ambient and Low Temperature

Drop Height (inches)	Impacted Face or Corner	Temperature During Test		Peak Acceleration (G's)				Pneumatic Seal (1.0 psig)		Container Integrity	
		Ambient	$-40^{o}F$	X	Y	Z	Resultant	Acceptable	Unacceptable	Satisfactory	Unsatisfactory
18"	2-3-5	X		35	6	32	47.8				
	1-4-6			10	2	12	15.7				
	2-3-6			12	8	2	14.6				
	1-4-5			32	5	22	39.2				
	1-2-6			15	7	8	16.6				
	3-4-5			24	0	30	38.4				
	3-4-6			5	0	14	14.9				
	1-2-5			5	0	28	28.4				
						Avg.	21.6	X		X	
18"	3	X		20	8	20	29.4				
	1			9	4	18	20.5				
	2			16	0	26	30.5				
	4			20	0	6	28.6				
	5			10	10	8	16.2				
	6			2	12	4	12.8				
						Avg.	23.0	X		X	
18"	2-3-5		X	8	19	2	20.7				
	1-4-6			-	-	-	-				
	2-3-6			8	26	20	33.8				
	1-4-5			-	-	-	-				
	1-2-6			28	32	16	45.4				
	3-4-5			4	16	9	18.8				
	3-4-6			-	-	-	-				
	1-2-5			8	16	0	17.9				
						Avg.	27.3	X		X	
18"	3		X	35	18	36	53.3				
	1			16	5	24	29.3				
	2			48	15	14	52.2				
	4			-	-	-	-				
	5			4	20	0	20.4				
	6			2	22	2	22.2				
						Avg.	28.2				
48"	5 & 6	X		25	50	50	75.0	X		X	

DISCUSSION

Although the required level of shock protection specified for the hydrazine fuel tank is 25 G, it is obvious from the test results presented in Table I that the actual fragility of the tank is well above the rated value. Resultant shock readings above 50 G were recorded without any apparent damage to the tank.

Damage to the quick-disconnect fitting during 48-inch drop test was due to high localized stresses acting on this fitting which protrudes beyond the protective end collar of the tank.

The T-bolt fasteners utilized for container closure contributed to an effective vapor seal; however, compared to other types of container fasteners, they result in an increase in the time required to open or close the container. It is estimated that a proper closure can be achieved in 8 to 10 minutes, while 3 to 5 minutes is required to open the container.

The fiberglass reinforced urethane material used in the container evaluated is not indicated on the current listing of materials compatible with hydrazine (H-70). The manufacturer has stated that this may be due to the fact that the material is relatively new. Compatibility test data provided by the manufacturer shows that when the material is immersed in hydrazine (H-70) for 24 hours, there is a slight (12%) decrease in tensile strength.

Although the container has no provision for fork lift entry, handles are provided on each end to facilitate manual handling. Handling of the fuel tank itself is difficult due to the lack of handles or carry straps.

Although the 48-inch drop test was not specified in the original test plan, it was conducted in response to a question raised by AFALD/PTE regarding the possibility of the container being accidentally dropped during the placement of the tank in the aircraft. Flat drops from 18 inches were also added to the test procedure because prior experience indicates this impact orientation commonly occurs and usually results in higher shock inputs than corner or edge impacts.

CONCLUSIONS

a. The prototype container will provide protection to the fuel tank at the prescribed standard drop height of 18 inches but cannot maintain protection from drops in the range of 48 inches.

b. The container's gasket seal will maintain a 1.0 psig pressure differential under environmental, transportation, and handling conditions.

RECOMMENDATIONS

Both end pad cushions should be increased in thickness to prevent the development of potentially damaging shock inputs. The diameter of the saddle should be decreased to 8 inches in order to provide a tighter fit and prevent rattling of the tank within the container.

The required level of shock protection should be increased from 25 G to a value of 55 G.

Consideration should be given to redesigning the tank. The end collar or recess should be designed so that none of the end fittings protrude beyond the end surface of the tank.

The addition of handles or carrying straps would also improve safety conditions while handling the tank outside of its shipping case and during installation in aircraft.

The compatibility of fiberglass reinforced urethane material with hydrazine (H-70) should be evaluated using the same criteria employed for establishing the current compatibility list.

Container opening and closure time requirements should be developed based on anticipated operational factors. It is believed that these criteria could best be established by TAC.

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In support of ASD/AEGT this Agency subjected a candidate prototype polyurethane container for the F-16 Emergency Power Unit (EPU) Hydrazine Fuel Tank to a series of performance tests in accordance with Federal Test Method Standard 101 B.

The objective of these tests was to determine if the prototype container would protect the EPU fuel tank from mechanical damage and maintain a vapor seal,

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