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PERFORMANCE ORIENTED PACKAGING TESTING
OF
POLYSTYRENE FOAM CONTAINER
FOR
MK 25 MARINE LOCATION MARKER

BY:

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Naval Weapons Support Center Crane
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19. ABSTRACT (Continue on reverse if necessary and identify by block number) Qualification tests were performed to determine whether the polystyrene foam container, for MK 25 Marine Location Markers meets the Performance Oriented Packaging (POP) requirements specified by the United Nations Recommendations on the Transportation of Dangerous Goods. The container loaded to a gross weight of 35 pounds successfully met the requirements and retained its contents throughout the test.					
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INTRODUCTION

The polystyrene foam container designed for shipping and storage of eight MK 25 Marine Location Markers, see Figure 1, was tested to ascertain whether this container would meet the requirements of Performance Oriented Packaging (POP) as specified by the United Nations (UN) Recommendation on the Transportation of Dangerous Goods, Document ST/SG/AC.10/1, Revision 6, Chapters 4 and 9. A Base Level Vibration Test was also conducted in accordance with the rulings specified in the Department of Transportation's (DOT) Performance Oriented Packaging Standards Federal Register/Vol. 55, No. 246/Friday, December 21, 1990. The objectives were to evaluate the adequacy of the container in protecting the MK 25 Marine Location Marker, as well as to evaluate the containers ability to protect personnel involved with handling and shipping the container.

TESTS PERFORMED

1. Stacking Test

This test was performed in accordance with ST/SG/AC.10/1, Chapter 9, Paragraph 9.7.6. Four different containers were used, and subjected to a stack weight of 1,200 pounds on each container. To ensure the container, rather than the Marine Location Marker would sustain the load, empty containers were used for the test. An initial test was performed on two of the empty containers for a period of 24 hours. The container was measured and examined before and after the test and found capable of supporting the simulated load of like containers stacked 16 feet high. There was no deformation or compression of the containers. A second series of tests was then performed on two additional empty containers for a period of 96 hours. After the allowed time, the weight was removed and the containers examined. Any deterioration, or distortion which could adversely affect transport, reduce strength or cause instability in stacks of packages was considered cause for rejection.

2. Drop Test

This test was performed in accordance with ST/SG/AC.10/1, Chapter 9, Paragraph 9.7.3. Each container was used for the four flat drops and one corner drop instead of the required five containers (one for each drop). The drops were performed from a height of 4 feet in the following sequence:

- a. Flat Bottom
- b. Flat Top
- c. Flat on Long Side
- d. Flat on Short Side
- e. One Corner

FIGURE - 1 INERT MK 25 MOD 4 MARINE
LOCATION MARKER INSIDE POLYSTYRENE
FOAM CONTAINER



This test was performed at ambient, $+70 \pm 20^{\circ}\text{F}$ temperature. The contents of the container should be retained within its packaging and exhibit no damage liable to affect safety during transport.

3. Base Level Vibration Test

This test was performed in accordance with Appendix C of Part 173 of Federal Register/Vol. 55, No. 246/Friday, December 21, 1990/Final Rule. Three sample containers were loaded with eight inert MK 25 Marine Location Markers to a gross weight of 35 pounds and closed for shipment. The three containers were placed on a vibrating platform that had a vertical amplitude (peak-to-peak displacement) of one inch. The containers were not restrained during vibration except by a fence attached to the test surface to prevent them from falling off the table. The containers were tested for 60 minutes in their normal shipping position. The vibratory input to the container was at a frequency that caused the container to be raised from the vibrating platform to such a degree that a piece of material approximately $1/16"$ (1.6mm) thickness could be passed between the bottom of the container and the platform. A similar test was conducted during the development and evaluation of this container for a period of 120 minutes with satisfactory results. This test along with other evaluation tests were reported in NWSC/CR/RDTN-185 dated 15 January 1985.

PASS/FAIL (UN CRITERIA)

The criteria for passing the stacking test is outlined in Paragraph 9.7.6.3 of ST/SG/AC.10/1 and states the following: "No test sample should show any deterioration which could adversely affect transport safety or any distortion liable to reduce its strength or cause instability in stacks of packages".

The criteria for passing the drop test is outlined in Paragraph 9.7.3.5 of ST/SG/AC.10/1 and states the following: "Where a packaging for solids undergoes a drop test and its upper face strikes the target, the test sample passes the test if the entire contents are retained by an inner packaging or inner receptacle (e.g., a plastic bag), even if the closure is no longer sift-proof".

PASS/FAIL (49 CFR CRITERIA)

The criteria for passing the Base Level Vibration Test is outlined in Appendix C of Part 173 Performance Oriented Packaging Standards, Federal Register/Vol. 55, No. 246/Friday, December 21, 1990/Final Rule and states the following: "Immediately following the period of vibration, each package shall be removed from the platform, turned on its side and observed for any evidence of leakage. Rupture or leakage from any of the packages constitutes failure of the test".

TEST RESULTS

1. Stacking Test

Satisfactory.

2. Drop Test

Satisfactory.

3. Base Level Vibration Test

Satisfactory with no leakage.

DISCUSSION

1. Stacking Test

Four different containers were used, and subjected to a stack weight of 1,200 pounds on each container. To ensure the container, rather than the Marine Location Marker would sustain the load, empty containers were used for the test. An initial test was performed on two of the empty containers for a period of 24 hours. The container was measured and examined before and after the test and found capable of supporting the simulated load of like containers stacked 16 feet high. There was no deformation or compression of the container. A second series of tests was then performed on two additional empty containers for a period of 96 hours. After the allowed time, the weight was removed and the containers examined. There was no leakage, distortion, crushing, or deterioration to any of the containers as a result of this test. In September 1964 a stacking test was also conducted on various other polystyrene foam containers developed by NWSC Crane. Each container was loaded to the equivalent concentrated load simulating a stack 15 feet high varying from 2.0 pounds/square inch (psi) to 3.5 psi. Additional information on this study can be obtained from an earlier POP Test Report on the MK 58 Marine Location Marker Container, DODPOPHM/USA/DOD/NADTR91105, dated March 1991.

2. Drop Test

Container number 1 was subjected to a flat drop on the bottom and inspected for any damage which would be a cause for rejection. Since there was no evidence of damage, the same container was subjected to three additional flat drops on the top, long side and the short side without damage. The container was then subjected to a corner drop from a height of four feet. The container was not damaged in any way by the test, as shown in Figure 2. The other four containers were then loaded and subjected to the same five drops from a height of four feet without damaging the container or the contents. There was some evidence of compression on the impacted corners as shown in Figure 3, but there was no cracking or failure of the container.

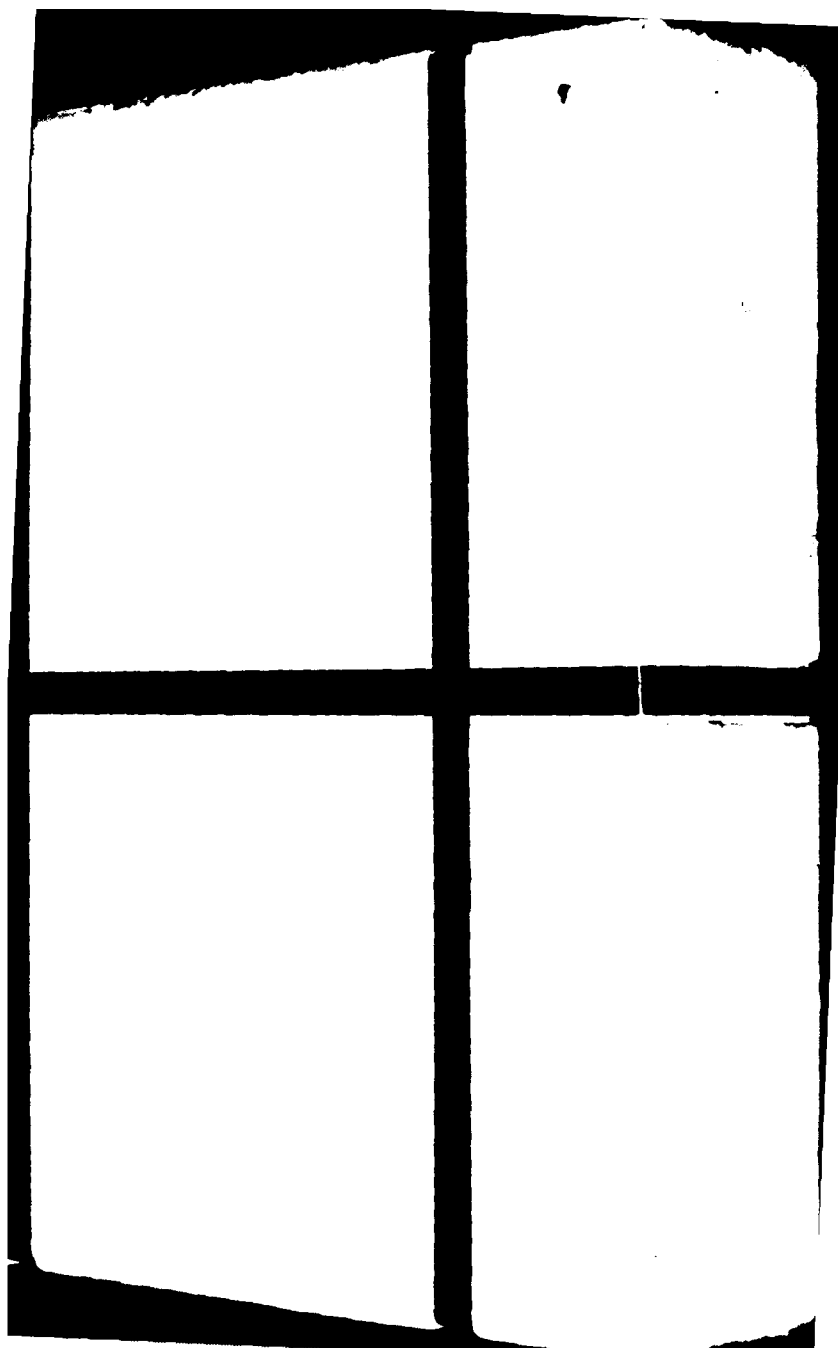
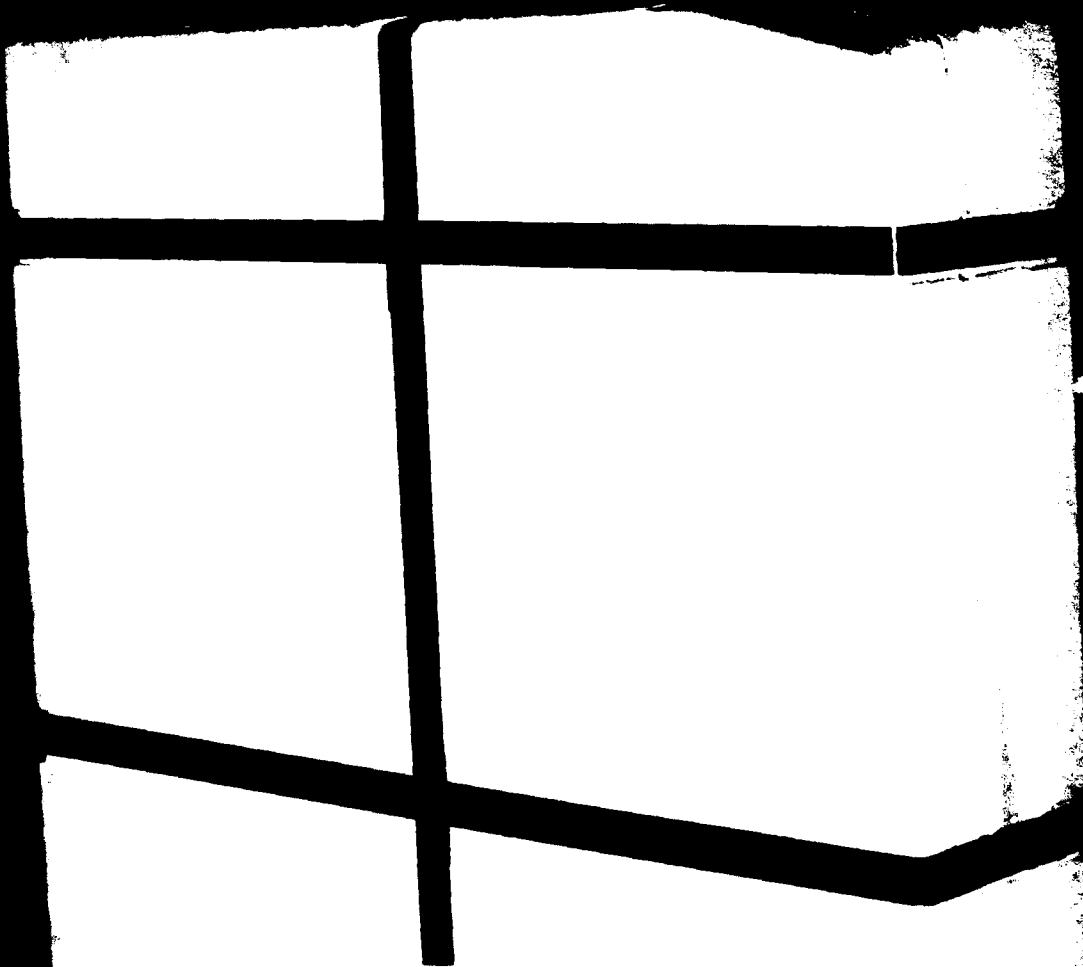


FIGURE 3 - Compressive set on impacted corner after drop from 4 feet.



3. Vibration Test

Immediately after the vibration test was completed, each container was removed from the platform, turned on its side and observed for any evidence of leakage. The tape remained intact, the seals were not broken, and there was no evidence of leakage or damage to the contents or the container.

4. General

Although many discussions have been held over the past 27 years concerning the use of polystyrene containers for ordnance and pyrotechnic packaging, there are no known records available indicating that the container has not done its job in protecting the item. The tensile test associated with the MK 25 Marine Location Marker design (see NWSC/CR/RDTN-185 in references) has forced the manufacturers to maintain quality in their molding procedure and the container itself has allowed the Navy to come as close to the ideal package as possible. That is, a container that weighs nothing, costs nothing and takes up no space. The price of the MK 25 Marine Location Marker container has risen from \$1.20 each in 1966 to approximately \$10.50 each in 1991, but it still represents less than two percent of the cost of the item. The .331 pounds it adds to the weight of the item is also less than eight percent of the overall weight. A comparison of the number of polystyrene foam containers (15), that are required to match the weight of one of the wood boxes used for eight markers prior to 1964, is shown in Figure 4. It does constitute 68 percent of the overall cube, but even this is less than most wood containers would require. Approximately 16 markers packaged in two polystyrene foam containers can be stored in the same area as eight markers packaged in one of the original wood boxes, see Figure 5.



FIGURE 4 - COMPARISON OF ALIEN'S ORIGINAL
FBI BOX WITH 15 IDENTIFICATION TAGS

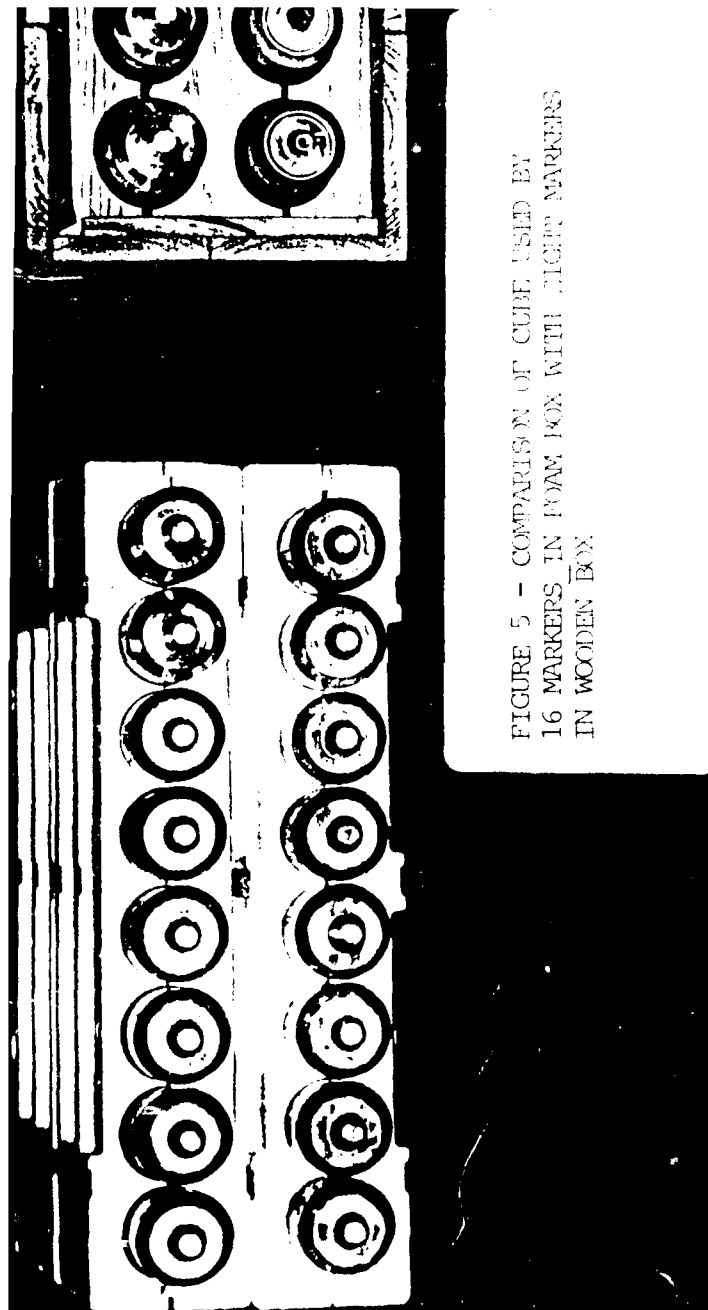


FIGURE 5 - COMPARISON OF CUBE USED BY
16 MARKERS IN FOAM BOX WITH EIGHT MARKERS
IN WOODEN BOX.

REFERENCE MATERIAL

United Nations "Recommendation on the Transportation of Dangerous Goods", ST/SG/AC.10/1, Revision 6

49 CFR Part 107, et al. Performance Oriented Packaging Standards, Federal Register/Vol. 55, No. 246/Friday, December 21, 1990, Final Rule

Applied Science Department, Report NWSC/CR/RDTN-185, on Development and Evaluation of MK 25 MOD 4 Marine Location Marker Container, 15 January 1985, U. S. Naval Weapons Support Center, Crane, Indiana

DODPOPHM/USA/DOD/NADTR91105, Performance Oriented Packaging Testing of MK 58 Marine Location Marker Container

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DATA SHEET

CONTAINER: Polystyrene Foam Shipping and Storage Container For the MK 25 Marine Location Marker	
Type: 4H1	UN Code: 1.3G
Specification Number: MIL-P-19644	Material: Polystyrene Foam
Capacity: 16 kg (35 pounds)	Dimensions: .71 m (L) x .53 m (W) x .14 m(H) (27.75" L x 21.00" W x 5.44" H)
Closure (Method/type): Glass filament Reinforced Tape	Tare Weight: 14.67 kg (32.3 pounds)
Additional Description: SHIPPING AND STORAGE CONTAINER, consisting of identical container halves, drawing 1556AS501 or drawing 2141484.	
PRODUCTS: MK 25 MOD 2 Marine Location Marker, L554, 1370-00-804-3561 MK 25 MOD 3 Marine Location Marker, L554, 1370-00-690-1458 MK 25 MOD 4 Marine Location Marker, L553, 1370-01-194-4143	
Proper Shipping Name: MK 25 MOD 2 - Signals, Distress MK 25 MOD 3 - Signals, Distress MK 25 MOD 4 - Fireworks	
United Nations Number: MK 25 MOD 2 - 0195 MK 25 MOD 3 - 0195 MK 25 MOD 4 - 0335	
United Nations Packing Group: II	
Physical State: Solid	
Amount Per Container: Eight (8)	
Net Weight (MK 25 Marker): 1.75 kg (3.85 pounds)	
TEST PRODUCT: Name: Inert MK 25 MOD 4 Marine Location Markers Physical State: Solid	
Size : .08 m Dia x .48 m L (3.00" Dia x 19.07" L)	
Quantity : Eight (8)	
Dunnage: None	
Gross Weight: 16 kg (35 pounds)	

SUPPLEMENTARY

INFORMATION

ERRATA

2 December 1991

TEST DATA SHEET

Container: Polystyrene Foam Shipping and Storage Container For the MK 25 Marine Location Marker

Type: 4H1	UN Code: 1.3G
Specification Number: MIL-P-19644	Material: Polystyrene Foam
Gross Weight: 16 kg (35 pounds)	Dimensions: .71 m (L) x .53 m (W) x .14 m (H) (27.75" L x 21.00" W x 5.44" H)
Closure (Method/type): Glass filament Reinforced Tape	Tare Weight: 1.3 kg (2.8 pounds)

Additional Description: SHIPPING AND STORAGE CONTAINER, consisting of identical container halves, drawing 1556AS501 or drawing 2141484.

PRODUCTS:

MK 25 MOD 2, Marine Location Marker, L554, 1370-00-804-3561
MK 25 MOD 3, Marine Location Marker, L554, 1370-00-690-1458
MK 25 MOD 4, Marine Location Marker, L553, 1370-01-194-4143

Proper Shipping Name:

MK 25 MOD 2 - Signals, Distress
MK 25 MOD 3 - Signals, Distress
MK 25 MOD 4 - Fireworks

United Nations Number:

MK 25 MOD 2 - 0195
MK 25 MOD 3 - 0195
MK 25 MOD 4 - 0335

United Nations Packing Group: II

Physical State: Solid

Amount Per Container: Eight (8)

Net Weight (MK 25 Marker): 14 kg (30.8 pounds)

TEST PRODUCT:

Name: Inert MK 25 MOD 4 Marine Location Markers

Size: .08 m Dia x .48 m L (3.00" Dia x 19.07" L)

Physical State: Solid

Quantity: Eight (8)

Dunnage: None

Gross Weight: 16 kg (35 pounds)

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