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1. COMPONENT/PART NAME PER GENERIC CODE: General Technical Data	2. PROGRAM OR WEAPON SYSTEM: Weteye	3. DATE OF:	DAY	MO.	YR.
4. ORIGINATOR'S SPECIFICATION TITLE: Shipping And Storage Container Mark 398 Mod 0 Development, Test and Evaluation	5. ORIGINATOR'S SPEC. NO.: OD 28970	ISSUE	1	10	64
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OD 28970

Code Ident
10001

SHIPPING AND STORAGE CONTAINER MARK 398 MOD 0

(FOR BOMB, CHEMICAL, MARK 116 MOD 0)

DEVELOPMENT, TEST, AND EVALUATION

Approved: _____
By direction

PUBLISHED BY DIRECTION OF
THE CHIEF OF THE BUREAU OF NAVAL WEAPONS

3

FOREWORD

Development of the Weteye weapon container was assigned to the Naval Ordnance Test Station, China Lake, California, by the Bureau of Naval Weapons as a part of the Weteye Weapon System to provide packaging for one Bomb, Chemical, Mark 116 Mod 0, that will afford adequate protection from mechanical damage during shipment, handling, and storage.

This report was prepared in compliance with WepTask Assignment, RM-3793 001/216 1/F008-22-01, problem assignment number 7, dated 8 August 1962, to supply the Bureau (RSWI-6) with analytical and test data for the determination of a container design.

The development and design of the Shipping and Storage Container, Mark 398 Mod 0, for one Bomb, Chemical, Mk 116 Mod 0, are described and test and evaluation data presented. This report is for informational purposes only.

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1. INTRODUCTION.

1.1 Scope. This ordnance data describes the development and evaluation test program of the Shipping and Storage Container, Mark 398 Mod 0, for the Weteye Weapon.

The development, design, fabrication of prototypes, tests and evaluation were conducted in accordance with the requirements of: the Bureau of Naval Weapons (BuWeps), MIL-W-21927 (NOrd), Weapons Requirements-11 (WR-11), and the safety requirements of the Naval Weapons Laboratory, Dahlgren, Virginia, correspondence 8072/S.

1.2 Information is based upon tests conducted at U. S. NOTS, China Lake, California.

2. APPLICABLE DOCUMENTS.

2.1 The following documents are referenced within this document.

SPECIFICATIONS

Military

MIL-W-21927	Weapons, Handling and Preparation for Delivery of: General Requirement for

WEAPONS REQUIREMENTS

Bureau of Naval Weapons
(Code Ident 10001)

WR-11	Design and Test of Packaging, Packing, Shipping and Handling Equipment for Weapon System Components

DRAWINGS

Bureau of Naval Weapons
(Code Ident 10001)

DL 1516671	Shipping and Storage Container, Mark 398 Mod 0 (for one Bomb, Chemical, Mk 116 Mod 0), General Arrangement
DL 1516672	Shipping and Storage Container, Mark 398 Mod 0 (for one Bomb, Chemical, Mk 116 Mod 0), Packing and Marking

LETTERS

Naval Weapons Laboratory
(Dahlgren, Virginia)

WWB:BER:cmf 8072/S Dated March 12, 1964	Proposed Safety Design Objectives for the WETEYE Weapon System, Final recommendation for

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3. DESCRIPTION OF CONTAINER, CONTENTS, AND TEST INSTRUMENTATION.

3.1 Description of container. Shipping and Storage Container, Mark 398 Mod 0, DL 1516771, shown in Figure 1, is a reuseable container designed to contain one agent-filled, Chemical Bomb, Mark 116 Mod 0 (less bursters and nose fuze assembly.

3.1.1 The container is a lightweight steel container which serves as a sealed, gastight vessel for the bomb. The container also functions as an overpack to insure protective covering against possible mechanical damage to the bomb in the event of rough handling during shipping and storage.

3.1.2 Basically, the container is a top opening, gasket-sealed clamshell type with the upper shell secured to the lower shell by captive latches. Two readily accessible sampling ports are located in the upper shell (one at each end of container) providing access for chemical-agent detector probes. Saddle supports with straps, each secured with two T bolts and two detent pins, restrain the bomb. Saddle supports and straps are lined with a coarse-weave cotton webbing. A resilent type cushion is placed at each end inside the container as additional protection to the bomb in the event of an excessive end drop.

3.1.3 The container is 102-11/16 inches long, 20 inches wide, 22 inches high, and is constructed of 16 gage (0.059) sheet steel. It consists of a Shell, Lower Assembly (BuWeps Dwg 1516694), Shell, Upper Assembly, (BuWeps Dwg 1516693), Cushion, Forward Assembly, (BuWeps Dwg 1331096), Filler (BuWeps Dwg 1331098), and Cushion, Aft Assembly (BuWeps Dwg 1331099). Two chemical-agent probe ports located at each end of the upper shell are designed to accept the air sampling probes of the Mark 15 and Mark 18 Chemical-Agent Detector Kits. Two bars encircle the container to facilitate stacking. Skid assemblies, openings for forklift trucks, and lifting eyes are integral features of the lower shell of the container. Weight of the empty container without cushions is approximately 312 pounds.

3.2 Description of contents. The WETEYE, Chemical Bomb, Mark 116 Mod 0 is essentially a cylindrical vessel 90 inches long and 14 inches in diameter. The weight of the bomb (less bursters and nose fuze assembly) is 525.5 pounds.

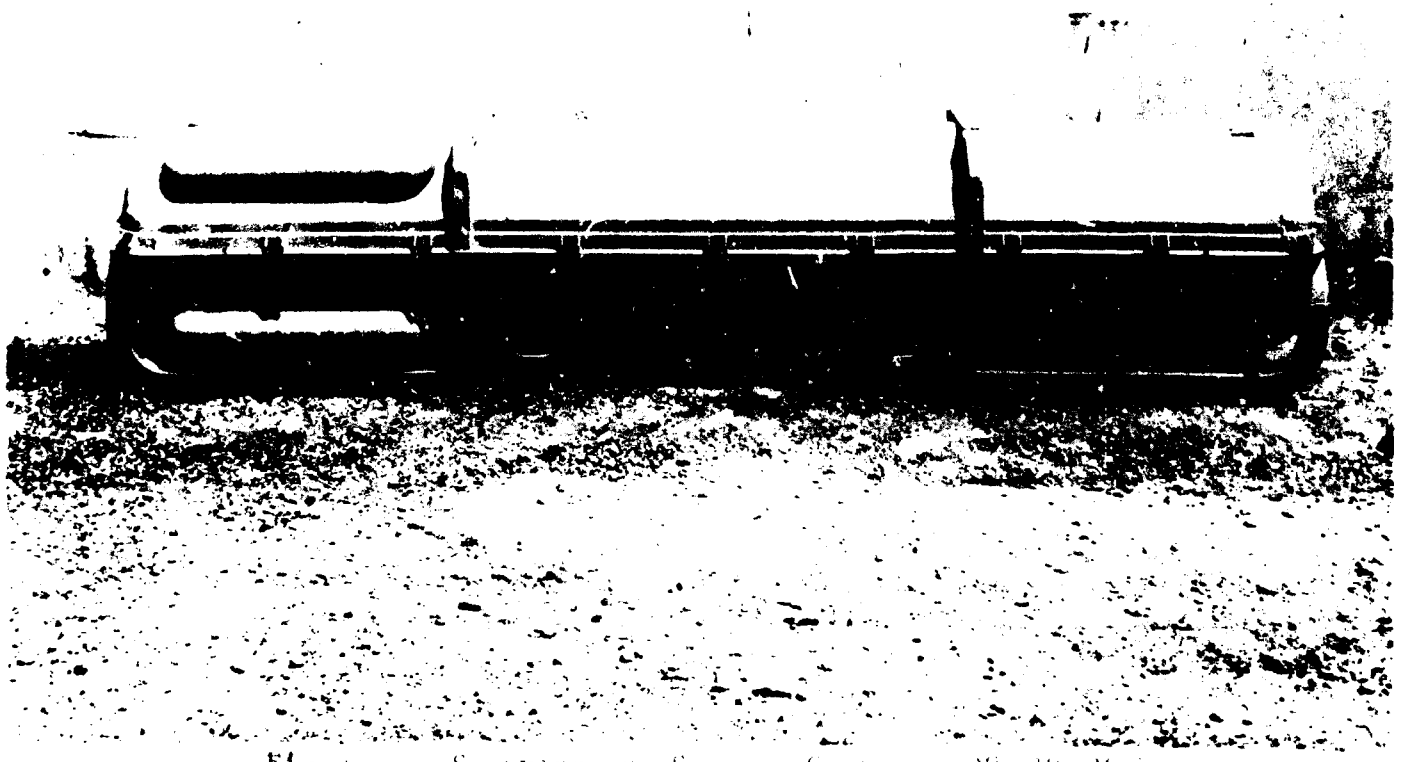

Figure [illegible] Shipping and Storage Container Mk 398 Mod [illegible]

3.3 Description of test instrumentation. The instruments used to record the results of the tests were as follows:

Pace Accelerometers, Model A12 (Self-recording)
Heise Precision Pressure Gauge
CEC Helium Detector
Weighing Scale, 1000 pound capacity

4. DESIGN DEVELOPMENT HISTORY.

4.1 WEPTASK problem assignment. The WETEYE bomb shipping and storage container development and design program was initiated in August 1962, to determine the feasibility of a container that would function as a sealed, gastight vessel and also provide an overpack, protective covering against mechanical damage during shipment, handling, and storage. In addition to meeting the requirements and specifications of the Weptask assignment, the Naval Weapons Laboratory, Dahlgren, Virginia, recommended three safety design objectives for excessive rough handling. These are:

A. The combined bomb and container should be disposable at sea. Attaching weights was considered an acceptable method of satisfying this requirement.

B. Forty-foot drop-test with combined unit. This test consists of three 40-foot drops of the bomb in its container at ambient temperature onto a flat steel plate embedded in reinforced concrete. Drops shall be made in three mutually orthogonal attitudes, (see Figures 2 and 3), nose down, nose up and horizontal. Criteria for passing this test are that the combined unit shall have a leak ratio no greater than the equivalent of 1×10^{-4} cc of STP Helium per second and shall be safe for handling incident to disposal.

C. The bomb will be safe to handle, safe to use operationally or safe to dispose after 5 years storage. Because the bomb is to remain in the container for the storage duration, the container must serve as a gastight vessel and shall incorporate a simple monitoring system for the detection of free CW agents within the package. This detection device must be accessible when the munitions are stacked in a magazine.

4.2 Experimental phase of development. With the assignment of the Weptask Problem, a search was started to locate and determine extent of station test facilities. Using the Area-R 80-foot drop tower and other available test equipment, a series of drop-tests were made using salvaged missile and torpedo containers.

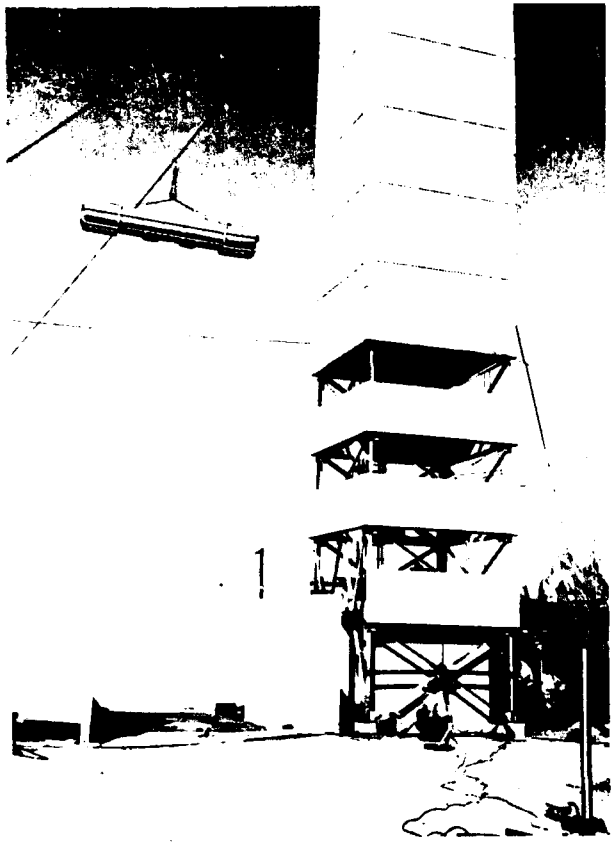

Figure 2. Container in position for 40-foot bottom drop-test.

Figure 3. Container in position for 40-foot end drop-test.

Drop-tests were started on November 1962, and extended through February 1963. The purpose of these tests was to determine the shock loads that could be expected in handling of this severity, and to establish a testing program.

Since salvaged containers were available in limited quantity and a bomb could not be obtained, the initial drops were made with empty containers. Shock levels obtained were consistently near 800 gravity units (g). Impact information obtained from these drops indicated design features which were adapted in subsequent design.

A 40-foot bottom drop used an empty salvaged container that had been subjected to drops of previous test. The container experienced acceleration of 800 g both in the base and the cover.

Other drop-tests using salvaged containers and simulated stores with restraining dunnage were evaluated. The simulated store was an aluminum tube 14 inches in diameter, closed at the ends and water filled. The dunnage used was expanded bead polystyrene, placed around the tube to form a tight pack. Self-recording accelerometers were attached to each end of the tube and one to the cover of the container. The drops produced acceleration of 600 to 750 g to the container and 300 to 400 g to the simulated stores.

Conclusion of this series of drops presented sufficient information for an experimental design, and a contract was let to a commercial firm to produce 9 containers for future testing.

Before receiving the 9 experimental containers, a review of test reports indicated that the 40-foot end-drop requirement was not feasible using resilient material. Consideration was then directed toward the use of saddles with restraining straps. To insure that a two-place hard-point restraint would not be detrimental to the midsection of the bomb, a 40-foot bottom drop-test was conducted with a surplus missile container loaded with an instrumented water filled tube. The shock levels to the tube were approximately 500 g and the container shock was 850 g. The impact caused a deformation of the tube wall at the supports and a weld fracture in the tube end closure. Since the construction of the tube was not comparable to that of the bomb, saddle and strap restraining was considered an effective concept to pursue. Damage to the container and tube is shown in Figures 4 and 5.

Figure 4. Surplus missile container after 40-foot bottom drop-test.

Figure 5. Damaged aluminum tube used to simulate bomb during 40-foot bottom drop.

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4.3 Development phase and evaluation. Receipt of the 9 experimental containers and the procuring of a rejected bomb afforded the opportunity to resume testing on March 1, 1963. The experimental containers used were identified as NOTS Model 17. Ten tests were conducted on the basic model, each test progressively contributing toward the eventual ability of the container to meet the requirements of the Weptask problem.

The first drop performed in this series was a 40-foot drop in the horizontal position. The container was loaded with a rejected bomb, serial number 7, which was wrapped in sufficient expanded bead polystyrene to form a tight pack. (See Figure 6.) The bomb was water filled and self-recording accelerometers attached. Weight of the loaded container was 830 pounds. Shock loads recorded at impact were: bomb, 520 g, and the container, 600 g. Only minor damage was caused to the bomb, 3 fins were sprung free from the retaining ring and the fourth was forced against the container, the bomb did not leak and was "safe-to-dispose". The container damage consisted of a broken swing bolt, the gasket flange was distorted and some tearing of the packing. (See Figure 7.)

Since the results of earlier drops were unfavorable towards the use of cushioning material, it was decided to pursue the use of two or more metal saddles with hinged hold down straps to secure the bomb. Efforts were directed to modifying a container for the next test.

During March 1963, five containers were sent to Rocky Mountain Arsenal. These containers used a resilient suspension pack since the saddle and strap configuration was not yet available. These containers were used to transport five loaded bombs overland to Dugway Proving Grounds. Packaging the store into the container was efficient and the store was received in good condition.

July 19, 1963, drop-test number 2: this was a 10-foot end drop. The container was equipped with three 3-inch-wide straps lined with coarse cotton webbing. (See Figure 8.) The bomb used was serial number 50 and was water filled to a total weight of 505 pounds. After installing the bomb in the saddles, the strap assembly T bolts were torqued 200 inch pounds. Self-recording accelerometers were installed. Impact was on the forward end, shock loads to the container were 790 g and 250 g to the bomb. Damage to the bomb was:

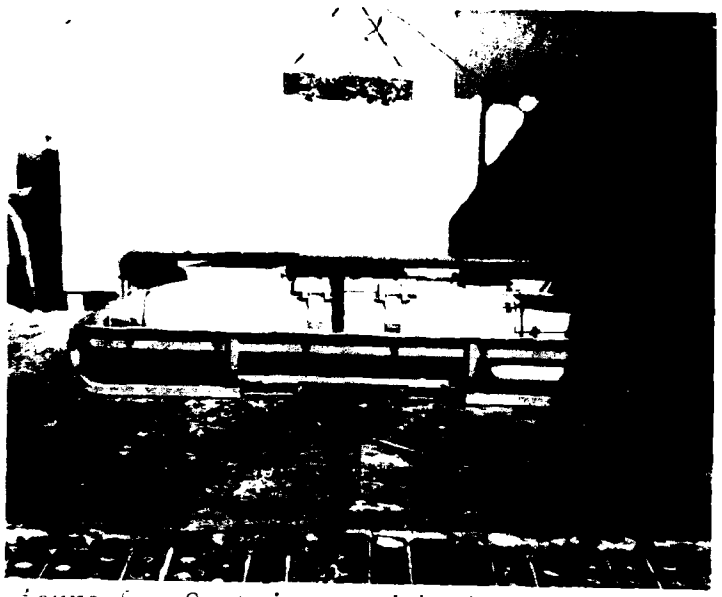


Figure 6. Container and bomb after drop-test number 1, resilient material used for restraint.

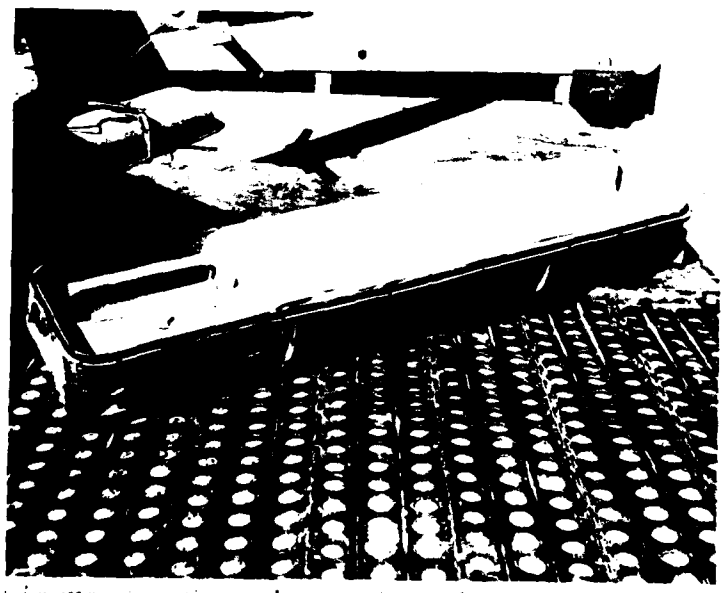


Figure [illegible]. Container after drop-test number [illegible].

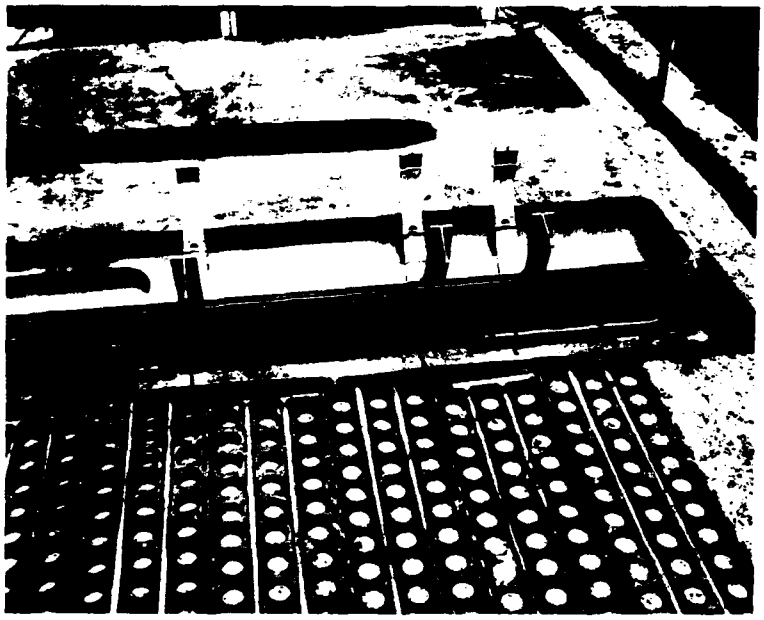


Figure 6. Lower shell of container in saddle and strap configuration.

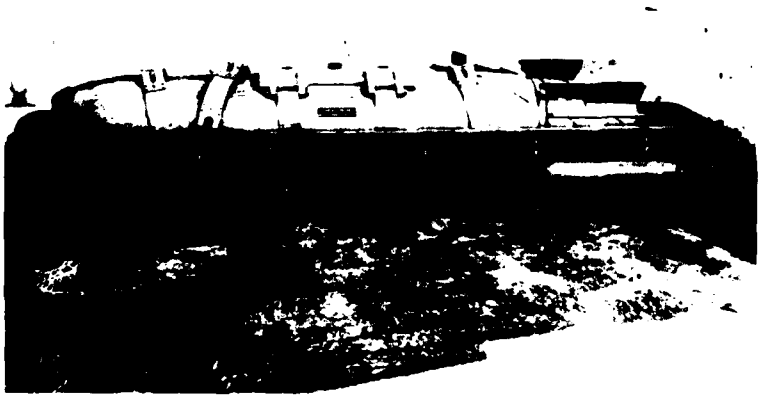


Figure 7. Saddle [illegible] Plumbore [illegible] op-[illegible]

abrasions on bomb surface caused by strap webbing, minor gouges caused by washers on straps, fins were released from the retainer ring, bomb saddle assembly was forced aft and tabs sheared from the lower saddle assembly. The total movement was 3 inches, the bomb did not leak and was "safe-to-dispose". Container damage (see Figure 9) was: left hand top blister was punctured, some distortion of saddles and straps and the middle strap was torn free at the hinge pins.

Drop number 3 was performed on July 19, 1963, and was intended to be a 40-foot horizontal drop. Due to a hesitation of the release mechanism, the container was oriented 45 degrees at impact. The container was equipped with two 3-inch-wide straps, the strap T bolts were torqued to 250 inch pounds. Bomb number 50 was water filled and used again in this test. Two accelerometers were installed. The shock level to the container was 730 g and to the bomb 400 g. The bomb was subjected to only incidental damage, no leakage was evident and the bomb was "safe-to-dispose". The container received extensive deformation (see Figures 10 and 11). Slippage of the bomb in the container was minimal and the capability of the container to protect the store from end shocks was evident.

Drop number 4, September 27, 1963, was the first 40-foot end drop. The impact surface was the forward or nose end. The container used incorporated two 6-inch-wide straps, each having two T bolts and utilizing a bridge plate in an effort to increase the surface friction to the bomb. Bomb number 50, water filled to simulate actual weight, was used again. Self-recording accelerometers were positioned as in previous test. The bomb received a 550 g shock and the container shock was near 800 g. Damage to the bomb was minor (see Figures 12 and 13). The fins were sprung free of their retainers and the upper saddle assembly was forced aft slightly. Leakage was not evident and the bomb was "safe-to-dispose". The container was rendered unserviceable since the nose end was deformed approximately 3 inches. The straps afforded adequate restraint, one bridge plate was dislocated from the strap. The container required minimum effort to open and the store was easily removed.

Drop number 5, January 13, 1964, the container was equipped with two 5-inch-wide straps using a single T bolt. The drop was a 40-foot horizontal impact. Bomb number 51, filled with a salt water solution to simulate actual weight,

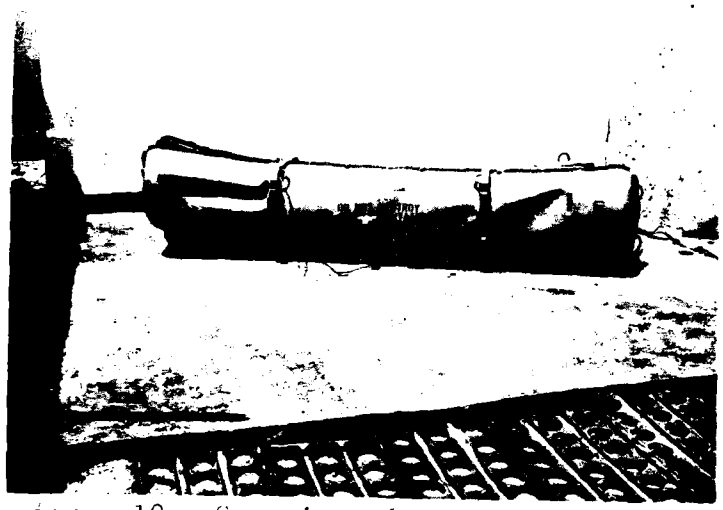


Figure 10. Container damage after 40-foot, forty-five degree drop-test.

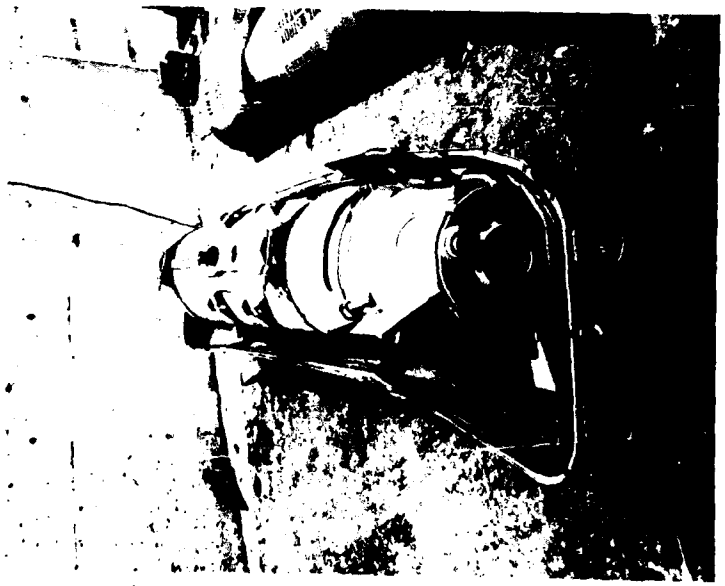


Figure 11. Container [illegible] damage caused [illegible] foot, [illegible] degree drop-test.

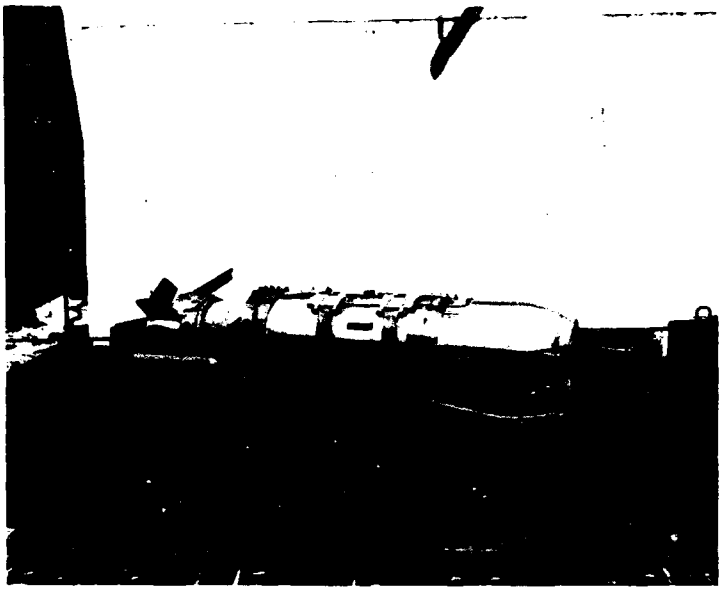


Figure 12. Container and bomb damage caused by 40-foot nose down end drop-test.

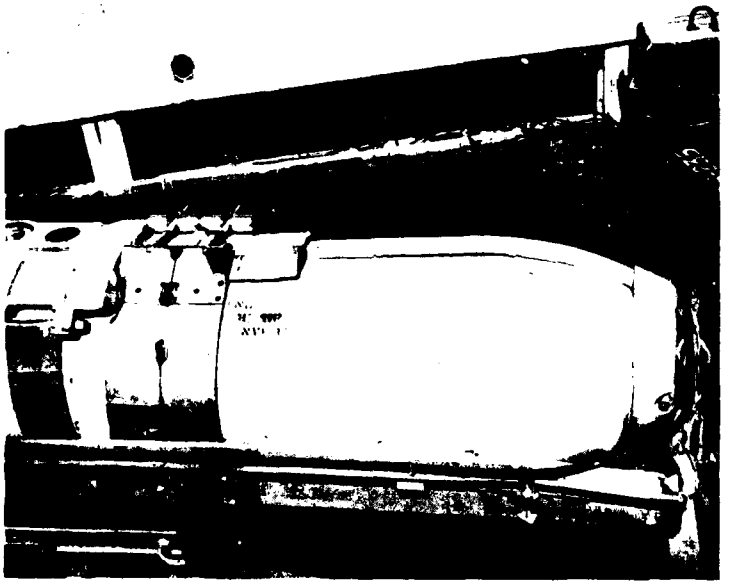


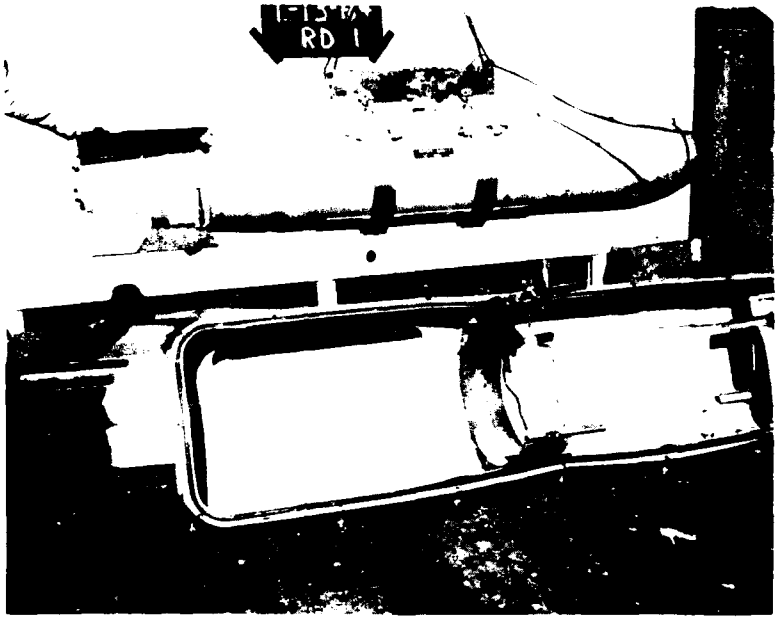
Figure 13. Container and bomb damage caused by 40-foot nose down end drop-test.

was used. Shock levels were not recorded on this test. Deformation of the gasket flanges was the major damage to the container. The bomb received abrasions on the nose and a small cut to bottom (see Figure 14). The cut was caused by impact with the flooding void and only a small seepage was apparent. Corrective action was to remove the flooding void from the lower shell of the container.

Drop number 6, a nose-down end drop, was performed the same day using bomb number 51 (see Figure 15). No shock levels were recorded. The container was the same configuration as used in drop 5 and was rendered unserviceable by the drop. The bomb was further damaged with a weld fracture at the aft end of the burster tube. Efforts were directed to determine the feasibility of end cushioning to absorb longitudinal movement of the bomb.

Drop number 7, February 26, 1964, was a 40-foot nose-down end drop. The container was equipped with two 5-inch-wide straps. The bomb, serial number 17, was filled with a solution of water and ethylene-glycol. Damage to the container was: approximately 3-inch deformation of the forward end and deformation to the gasket flange (see Figures 16 and 17). The forward strap assembly sheared its hinge pin and the bomb was shifted approximately 3 inches in the straps. A small weld fracture occurred in the burster tube and minute leakage was detected. Results of this test indicated a need for modification of the restraining strap assemblies and a more effective means of securing the container cover.

Drop number 8, February 28, 1964, using a container with two 5-inch strap assemblies as the means of support. The bomb, serial number 35, was filled to loaded bomb weight. This drop was a 40-foot end drop, impact was on the forward end of the container. Container damage consisted of extensive end deformation of the container and gasket flange (see Figure 18). Minimum effort was required to open the container and the bomb was easily removed. The bomb moved in the restraining straps causing the bomb's lower saddle assembly to be forced aft (see Figure 19). Minor abrasions caused by the strap assemblies was the extent of damage. The bomb received no punctures or cuts and remained "safe-to-dispose".

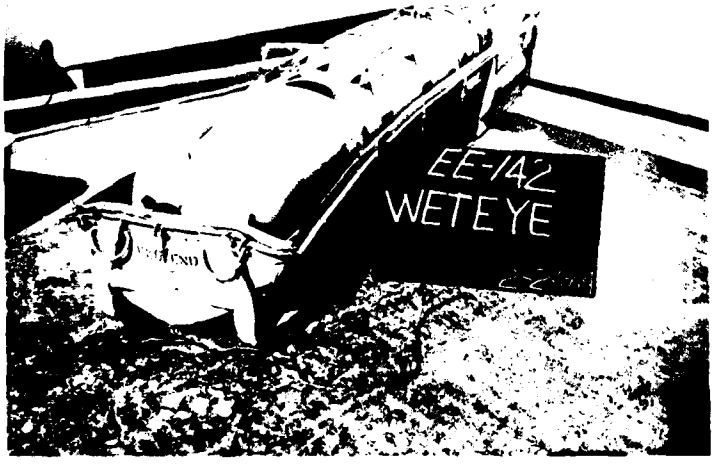


[illegible] Cabinet and [illegible] damage caused [illegible] from crop-test.

[illegible] Cabinet and [illegible] damage caused [illegible] from end crop-test.

op 28 ...

Figure 15. Container deformation after 40-foot nose down end drop-test.



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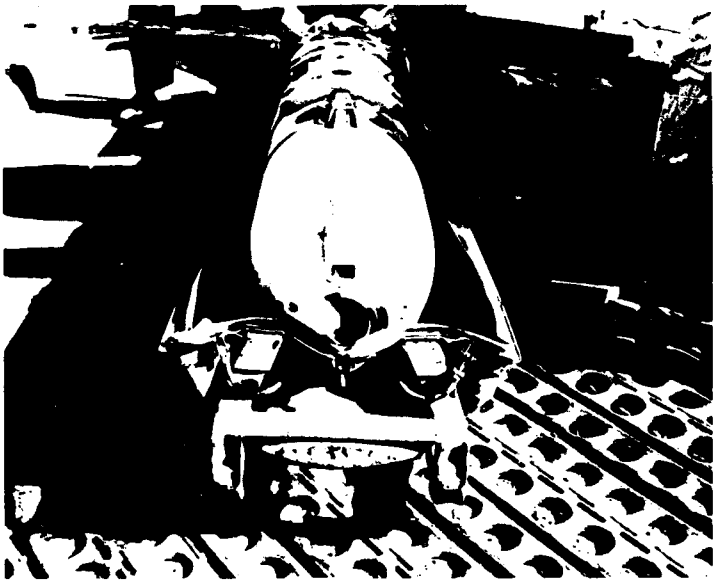

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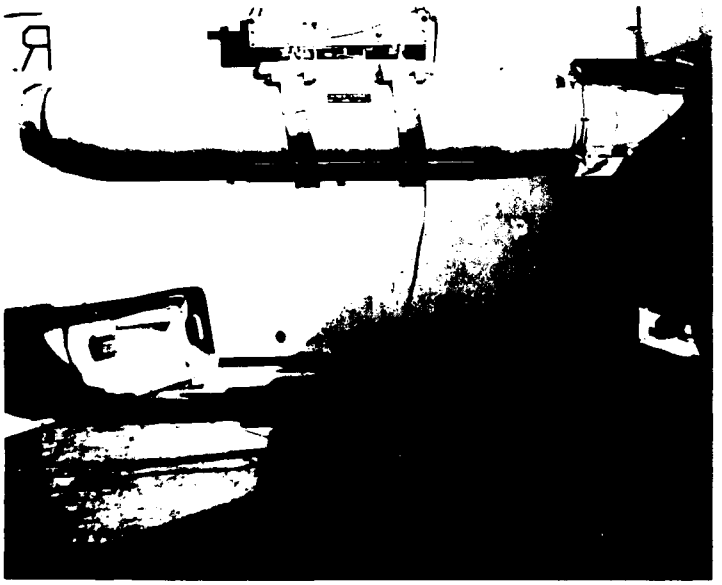

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p assem s.

Drop number 9, March 30, 1964, was a 40-foot nose-down end drop. A container with bomb, serial number 7, filled to weight as in previous test, was used. Two 5-inch straps with one T-bolt each were used. T bolt torque was 250 inch pounds each. To afford additional protection from end impact, an expanded bead polystyrene plywood backed end cushion was placed at each end of the bomb in the container (see Figure 20.) Impact on this container was square enough so that the container remained standing on its end. Damage to the container was: 3-inch deformation to end of container, forward end cushion destroyed, and T bolts and hinge pins in strap assemblies bent (see Figure 21). The bomb was moved forward 3-1/2 inches causing abrasions from strap webbing and denting the bomb nose cap 1-3/8 inches. After removing the bomb from the container, the bomb was subjected to 28 pounds per square inch gauge (psig) air pressure for a period of 24 hours. There was no discernible leakage or significant pressure change.

Drop number 10, July 10, 1964, was a 40-foot aft end drop. Information gained from earlier tests had revealed several problem areas in the previous container design. The container used in this test incorporated several modifications that will be part of the final container design. The strap assemblies used were 5 inches wide, each used two T bolts and the hinge pins were replaced with quick disconnect detent pins. The saddle and straps were lined with 1/8-inch-thick coarse weave cotton webbing held in place by adhesive. The previous cover swing bolts were replaced with an overcenter latch assembly which increased holding strength and facilitates faster closing and opening. Polyethylene end cushions faced with plywood were used (see Figure 22). Bomb number 108 was filled to weight with water and ethylene-glycol. Container damage was similar to that of previous drops, 3-inch end deformation and deformation of the gasket flange. Only minor distortion was apparent in the strap assemblies, the detent pins remained serviceable and proved to be an efficient means of releasing the bomb when removing it from the container. The cover latches were easily unlatched with common tools available at the test site, latches at and near the impact surface were crushed against the container but remained in the latched position (see Figure 23). Bomb movement was minimal, container deflection and bomb movement crushed the aft end cushion but no bomb damage resulted (see Figures 24 and 25). After the bomb was removed from the container, the bomb was pressurized with Helium to 1 atmosphere and monitored for 168 hours. No loss of pressure was observed.

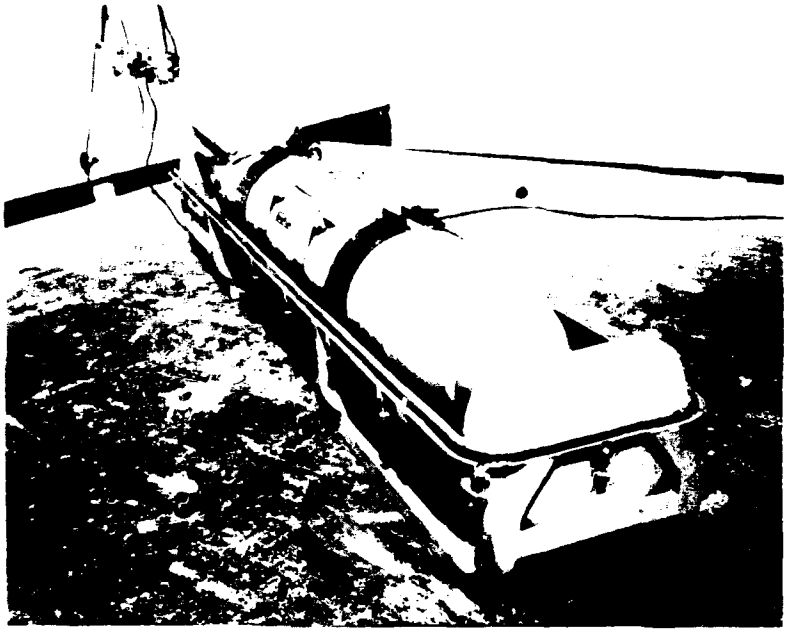

Figure 70. Container end cushion before a 40-foot end drop-test.

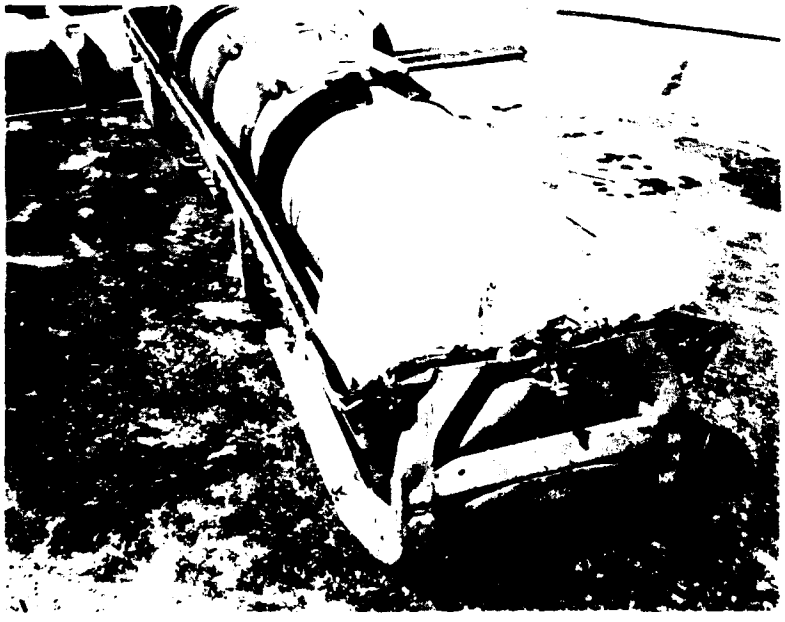

Figure 71. Container end cushion damage resulting from 40-foot end drop-test.

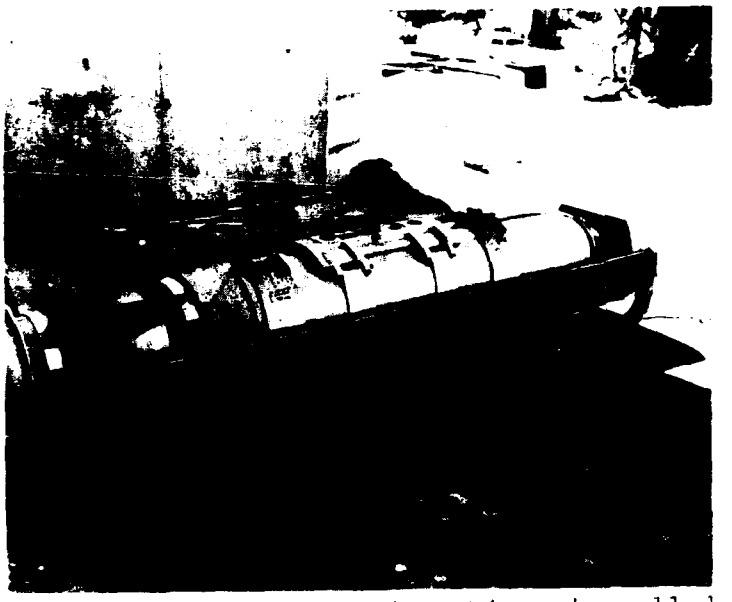

Figure 22. Bomb and end cushions installed in container before a 40-foot aft end drop-test.

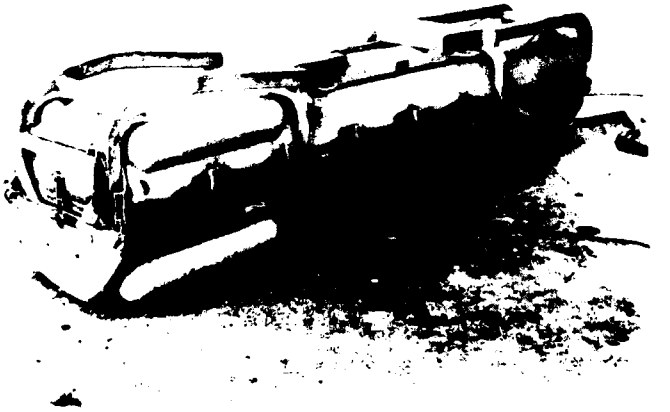

Figure 23. Container damage after a 40-foot drop-test.

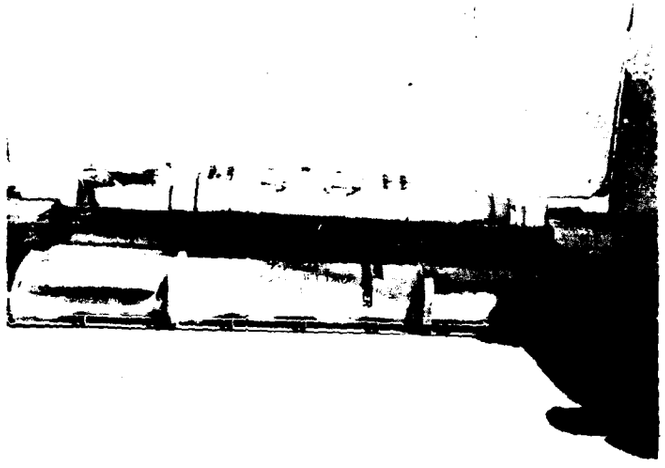

Figure 2[illegible]. Container and bomb condition after 40 foot aft end drop test.

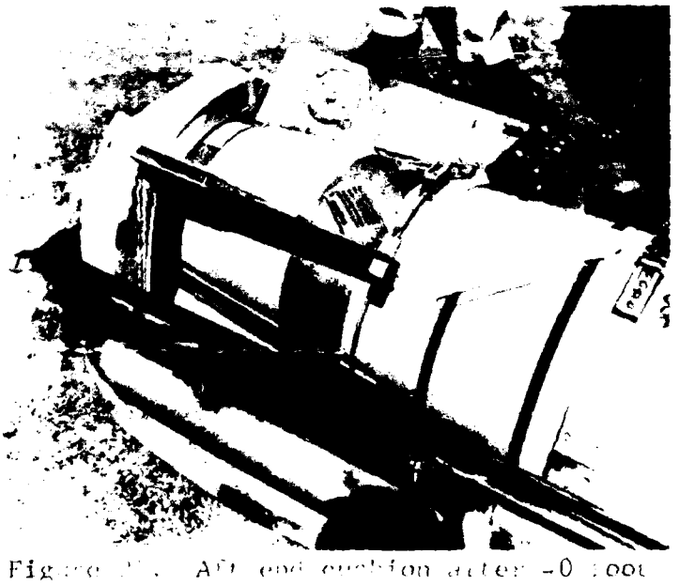

Figure 2[illegible]. Aft end cushion after 40 foot aft end drop test.

4.4 Disposal at sea and water tightness test. A disposal at sea procedure has been outlined in Naval Weapons Laboratory letter 8072/S, 12 March 1964, which requires that a specific gravity (SP GR) of 1.5 be obtained when the weapon in the container is disposed of at sea. Further, it is stated that: "Attaching weights to the unit is considered an acceptable method of satisfying this requirement".

A loaded container was subjected to a series of flotation and submergence tests. The tests and results consist of:

Test 1. A loaded container in an airtight condition will float on the surface. Specific gravity in fresh water is .81, and in sea water .79 calculated.

Test 2. A loaded container in an airtight condition to attain SP GR equal to 1.0 requires attached weight (see Figure 26) of 227 pounds in fresh water, and 306 pounds calculated in sea water.

Test 3. A loaded container in an airtight condition was lowered into the water. The two detection plugs were removed and the container allowed to flood. Time to obtain negative buoyancy required 87 minutes in still water.

Test 4. The cover was removed from the loaded container and with the bomb still strapped in position the unit was lowered into the water (see Figure 27). A negative buoyancy was obtained. SP GR in fresh water was: 1.59, and in sea water: 1.55 calculated.

4.4.1 Summary of disposal at sea and water tightness test. The test indicated three methods of meeting the dispose-at-sea requirements. These are:

1. Attaching weights to the container to obtain negative buoyancy.

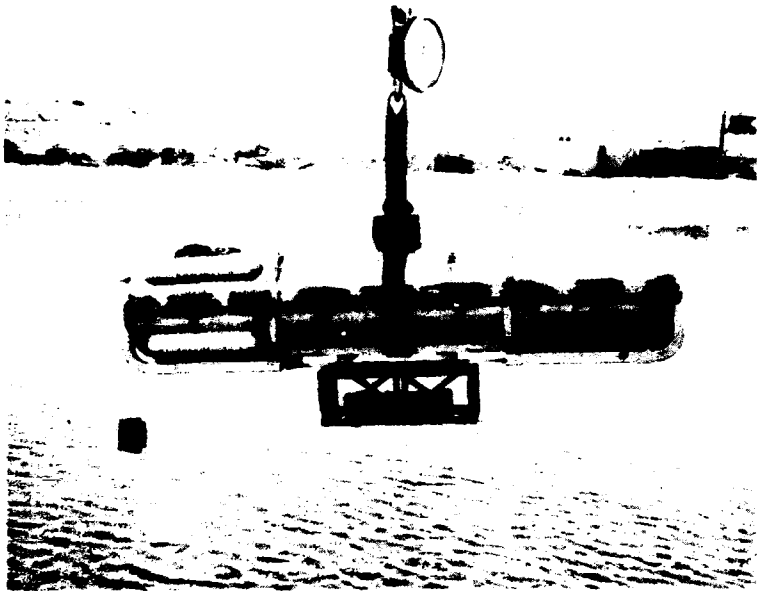

Figure 26. Container weighted for submergence test.

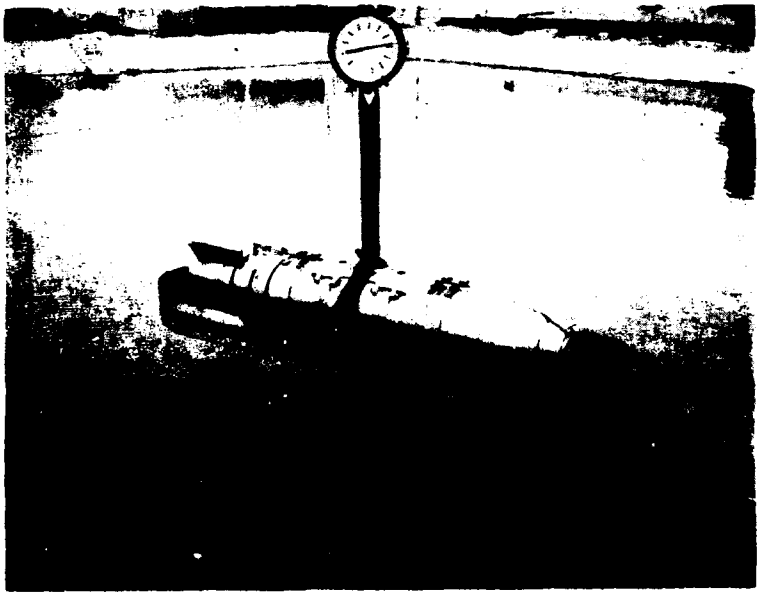

Figure 27. Open container in position for submergence test.

2. Destroying the airtight integrity of the loaded container by releasing 5 or more consecutive latches along the side of the container.

3. Removal of the detection ports to obtain negative buoyancy by flooding.

4.5 Conclusion of experimental and development phases. The information and engineering effort resulting from these test phases have enabled NOTS personnel to evolve a container design that is both practical to manufacture and capable of protecting its store from environmental and handling tests prescribed by the Naval Weapons Laboratory.

During the test phases described in this section and in Table I, the container has progressively displayed the ability to maintain its store in "safe-to-dispose" condition after extreme shock levels resulting from free fall drops of 40 feet.

Table I. Drop Test Schedule

Test	Date	Height	Attitude	Description	Results
1	Mar. 1, 1963	40 ft	Horizontal	Bomb cushioned with polystyrene	Bomb did not leak. End drop not considered advisable with tight pack cushioning
2	July 19, 1963	10 ft	End	Bomb secured with metal straps. No end cushioning.	No damage to bomb. Structural damage used to absorb shock.
3	July 19,	40 ft	45° Drop	Bomb secured with 2 straps with bridge.	Bomb did not leak.
4	Sep. 27, 1963	40 ft	End (First)	Bomb secured with 2 straps - 6" wide straps with bridge. No end cushioning.	Bomb did not leak.
5	Jan. 13, 1964	40 ft	Horizontal	Bomb secured with 2 straps - 5" wide, one T bolt.	Flooding void cut bomb. Second drop possible.
6	Same	40 ft	End	Bomb secured with 2 straps - 5" wide, one T bolt. No end cushioning.	Bomb fractures at aft weld. Hinge failure.
7	Feb. 26, 1964	40 ft	End	Same	Fine-line fractures at aft bomb weldment. Pins sheared.
8	Feb. 28, 1964	40 ft	End	Same	Bomb did not leak.
9	Mar. 30, 1964	40 ft	End	Except end cushioning added.	Bomb did not leak.
10	July 17, 1964	40 ft	End (first tail-down)	Bomb secured with 2 straps - 5" wide, double T bolts. End cushioning added.	Bomb did not leak.

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5. ROUGH HANDLING TEST.

5.1 Description of test. These additional tests were selected from and conducted in accordance with WR-11. The tests selected were: vibration, free fall drop, rotational drop, and air tightness. These tests were considered best suited to further evaluate the container's ability to protect the bomb under shipping and handling conditions.

5.1.1 Vibration and air tightness test. These tests were performed with an ethylene-glycol filled bomb. The container was pressurized to 15 psig air pressure and placed on a vibration table. The loaded container weight was 865.5 pounds. The container was vibrated at 1 inch, double displacement starting at 2 cycles per second (cps), the amplitude was gradually increased until the container just began to leave the vibration table. This occurred at 4.5 cps. The container was then vibrated at this amplitude for 1 hour, during this period air pressure was monitored and no decrease in pressure was observed. After vibration, the leak test was observed for a period of 2 hours. No discernible air pressure drop was observed. Examination of the container and contents disclosed no damage.

5.1.2 Rotational drop test. The rotational drop tests were conducted with a pressurized container containing a ethylene-glycol filled bomb, the container was pressurized to 15 psig. The container was positioned with one corner suspended 18 inches above the impact surface (see Figure 28A). Each bottom corner was subjected to an impact, no damage was experienced by either the container or the bomb and no loss of air pressure occurred.

5.1.3 Free fall drop test. Eighteen-inch free fall drops were made from two positions: one drop in the horizontal position impacting on the bottom, and one drop in the vertical position impacting on the forward end (see Figures 28B and 28C). The container was loaded with an ethylene-glycol filled bomb for each of these tests, gross weight of the loaded container was 865.5 pounds. Neither of the drops produced damage to the bomb.

5.2 Rough handling test summary. Through each of the rough handling tests, the container displayed the ability to protect its contents from damage and to maintain its airtight integrity.

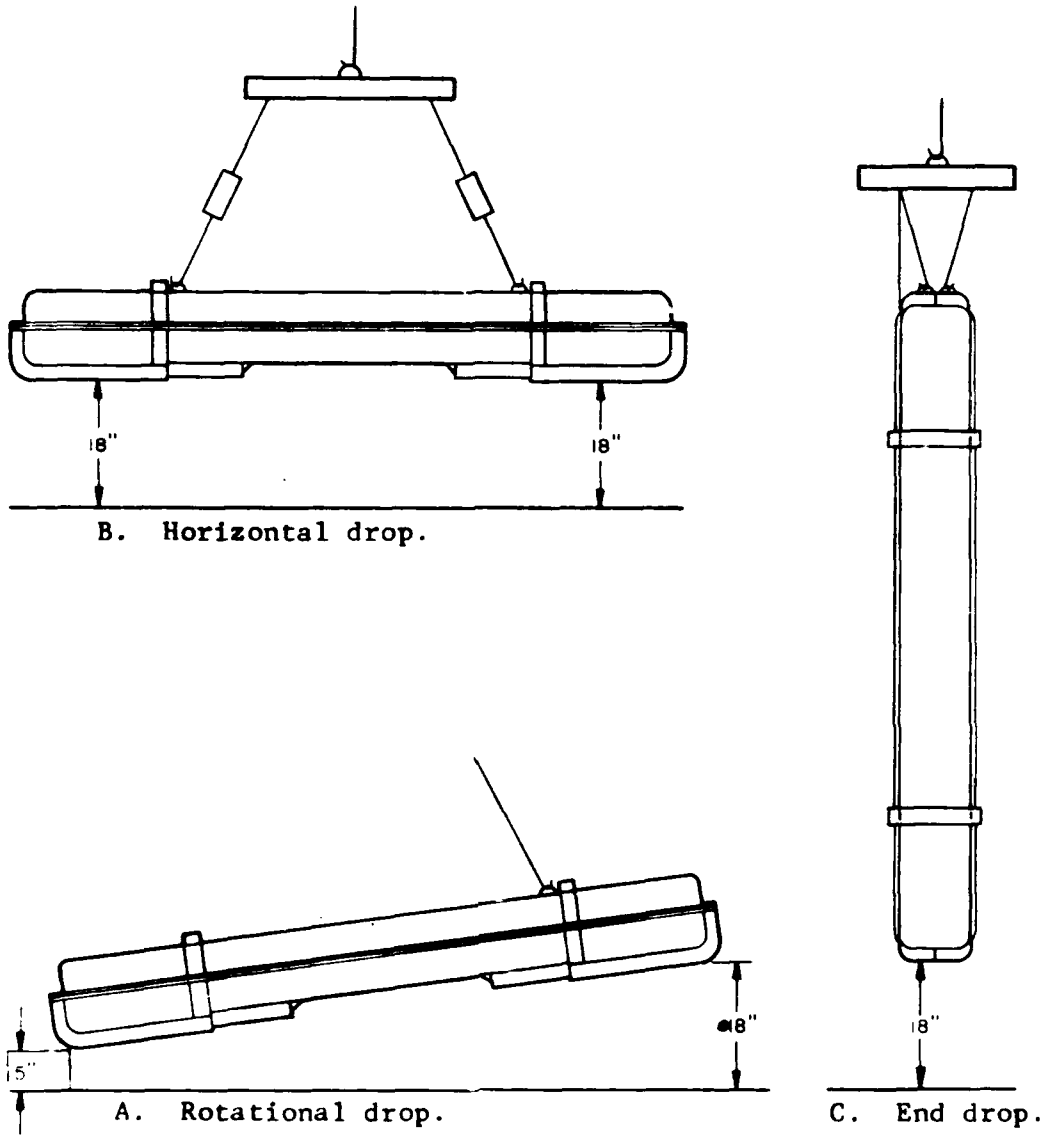

Figure 28. Container positions for WR-11 rough handling test.

6. CONCLUSION.

The Shipping and Storage Container, Mark 398 Mod 0, whose development and evaluation have been disclosed by this document, is considered by NOTS engineering personnel to have met the requirements set forth by the Weptask problem assignment.

Safety criteria established by the Naval Weapons Laboratory and WR-11 has been fulfilled. Research has been justified by the development of an effective gas detection monitoring system that is compatible with military training procedures, technical personnel, and sources of supply. Capability of the container to protect the bomb from free fall drops of 40 feet has been demonstrated. In all later tests using the restraining strap configuration and end cushions, the bomb has been "safe-to-dispose" without hazard to personnel. Requirements for rough handling selected from WR-11 have further demonstrated safety criteria by the ability of the container to remain gastight when subjected to prolonged vibration and normal handling shocks.

The container design is such that it requires no special manufacturing techniques or materials that would be uncommon to industry, therefore, allowing economical procurement. Consideration to using activities resulted in simplified attaching hardware and closing devices. Packaging and unpackaging the store is accomplished efficiently even after abusive handling.