

UNCLASSIFIED

AD NUMBER
AD846281
NEW LIMITATION CHANGE
TO Approved for public release, distribution unlimited
FROM Distribution authorized to U.S. Gov't. agencies and their contractors; Administrative/Operational Use; 06 AUG 1986. Other requests shall be referred to Naval Air Systems Command, Washington, DC.
AUTHORITY
USNADC ltr, 5 Oct 1971

THIS PAGE IS UNCLASSIFIED

UNCLASSIFIED

Security Classification

AD-846 281

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) AERO-ELECTRONIC TECHNOLOGY DEPARTMENT NAVAL AIR DEVELOPMENT CENTER, JOHNSVILLE WARMINSTER, PENNSYLVANIA		2a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	
3. REPORT TITLE ASW TEST TARGET CAN		2b. GROUP	
4. DESCRIPTIVE NOTES (Type of report and inclusive dates) FINAL REPORT - INDEPENDENT EXPLORATORY DEVELOPMENT REPORT			
5. AUTHOR(S) (First name, middle initial, last name) F. E. BUCK			
6. REPORT DATE 6 AUGUST 1968	7a. TOTAL NO. OF PAGES 55	7b. NO. OF REFS 2 (FOOTNOTES)	
8a. CONTRACT OR GRANT NO.		8b. ORIGINATOR'S REPORT NUMBER(S) NADC-AE-6823	
b. PROJECT NO. IED TASK NO. ZF001-98-01 c. WORK UNIT NO. AE-5		9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)	
10. DISTRIBUTION STATEMENT THIS DOCUMENT IS SUBJECT TO SPECIAL EXPORT CONTROLS AND EACH TRANSMITTAL TO FOREIGN GOVERNMENTS OR FOREIGN NATIONALS MAY BE MADE ONLY WITH PRIOR APPROVAL OF COMMANDER, NAVAL AIR DEVELOPMENT CENTER.			
11. SUPPLEMENTARY NOTES		12. SPONSORING MILITARY ACTIVITY NAVAL AIR SYSTEMS COMMAND DEPARTMENT OF THE NAVY	
13. ABSTRACT The feasibility of an air launchable, acoustic target for underwater echo ranging purposes was investigated. Air drops of inert stores demonstrated excellent aerodynamic stability; reliability of depth selection devices; and structural integrity of the store. Echo ranging tests were conducted with live stores launched from a boat. Feasibility for further development was established.			

UNCLASSIFIED

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
ANTI-SUBMARINE WARFARE TEST TARGET SUBMARINE SIMULATOR						



DEPARTMENT OF THE NAVY
U. S. NAVAL AIR DEVELOPMENT CENTER
JOHNSVILLE
WARMINGTOWN, PA. 18974

Aero-Electronic Technology Department

REPORT NO. NADC-AE-6823

6 August 1968

ASW TEST TARGET CAN

FINAL REPORT
INDEPENDENT EXPLORATORY
DEVELOPMENT REPORT
TASK NO. ZF001-98-01
Work Unit No. AE-5

The feasibility of an air launchable, acoustic target for under-water echo ranging purposes was investigated. Air drops of inert stores demonstrated excellent aerodynamic stability; reliability of depth selection devices; and structural integrity of the store. Echo ranging tests were conducted with live stores launched from a boat. Feasibility for further development was established.

Reported by:

F. E. Buck

F. E. Buck
Development Support Division

Approved by:

E. R. Mullen

E. R. Mullen, Superintendent
Development Support Division

D. W. Mackiernan

D. W. Mackiernan
Technical Director

This document is subject to special export controls and each transmittal to foreign governments or foreign nationals may be made only with prior approval of Commander, Naval Air Development Center.

S U M M A R Y

INTRODUCTION

The ASW test target can may be used as a target in place of an actual submarine during test and evaluation of sonar equipment. Large quantities may also be used by the fleet during ASW practice.

Reports from field exercises indicate that the Navy False Target Can (FTC) MK2, MOD 1, designed to be ejected from a submarine has been used successfully as a target when submarine time is not available for equipment evaluation.

The FTC is a hermetically sealed metal can containing 18 lithium hydride pellets. Field operation by NAVAIRDEVCON personnel has required the use of a support boat to place the contents of the FTC remote from the sonar operation. The pellets have been placed on the water surface or in a wire basket and suspended from the surface on a 50-ft line. Hydrogen gas is produced by the reaction of the lithium hydride with water. The hydrogen gas forms an acoustic discontinuity and may be used as a target, in place of a submarine, since it will return an echo when subjected to an incident sound.

The NAVAIRDEVCON developed ASW test target cans each contain 15 lithium hydride pellets that are ejected at predetermined water depths and generate a bubble cloud of hydrogen gas.

SUMMARY OF RESULTS

Three different ASW test target cans, all essentially the same except for variations in the depth selection devices, were developed at the NAVAIRDEVCON. The depth selection devices are set to eject the 15 lithium hydride pellets at predetermined water depths of 50, 750, or 1500 ft. Each ASW test target can consists of an airtight outer container and an enclosed, expendable air launchable store. Each "A" size store (4-7/8 in. diameter x 36 in. long) is capable of being launched from the sonobuoy launchers of the Navy type P2 or P3 patrol planes when the launching aircraft is flying at low altitude (500 ft) and low speed (160 kn TAS).

CONCLUSIONS

The feasibility for further development of an air launchable, acoustic target for underwater echo ranging purposes has been established.

RECOMMENDATIONS

1. The fifteen ASW test target cans currently being obtained should be evaluated as acoustic targets.

2. Advanced development of the target should be initiated with attention given to the following items:

- a. Elimination of multiple echoes,
- b. development of chemical pellets capable of generating more hydrogen gas for a longer time,
- c. determination of pellet ejection depth for maximum target effectiveness, and
- d. air launch capability for the store at speeds and altitudes consistent with its operational requirements.

TABLE OF CONTENTS

	Page
SUMMARY	iii
Introduction	iii
Summary of Results	iii
Conclusions	iii
Recommendations	iii
LIST OF FIGURES	vi
LIST OF SYMBOLS	vii
DESCRIPTION OF ASW TEST TARGET CANS	1
Outer Container	1
ASW Test Target	3
Assembly and Inspection	11
Mounting in Aircraft	11
Operation of ASW Test Target Cans	11
Stowage	17
Safety Precautions	17
THEORETICAL ANALYSES	18
Aerodynamic Analysis	18
Hydrodynamic Analysis	22
TEST RESULTS	28
Outer Container	28
Hydrostatic Pressure Tests	32
Chemical Pellet Test	32
Air Drops - Inert Stores	32
Echo Ranging Tests	42
TABLES	
I Store Angle at Water Impact (θ), Degrees, as a Function of Aircraft Velocity and Altitude-Computer Results	23
II Store Horizontal Travel, Ft, as a Function of Air- craft Velocity and Altitude-Computer Results	24
III List of Air Dropped Inert Stores	35
IV Test No. 1 - Echo Ranging Data From the AN/SSQ-41 Sonobuoy	44
V Test No. 1 - Echo Ranging Data From the AN/SSQ-23 Sonobuoy	44
APPENDIX	
A Specification for ASW Test Target Can	A-1

LIST OF FIGURES

Figure	Title	Page
1	ASW Test Target Can	2
2	ASW Test Target Can and Tear Strip Key	2
3	ASW Test Target.	4
4	ASW Test Target - End View	4
5	Nose Components - 1500 Ft Depth.	5
5A	Push Pin	7
6	Chemical Pellet.	9
7	Spring Assembly.	10
8	Storage Rack	12
9	ASW Test Target Can Mounted in Storage Rack.	13
10	Adapter.	14
11	Operating Details - ASW Test Target Can - 50 Ft Depth Model	15
12	Store Impact Velocity Versus Aircraft Altitude at Various Aircraft Speeds - Computer Results.	19
13	Store Impact Velocity Versus Aircraft Altitude at Various Aircraft Speeds - Computer Results.	20
14	Store Angle at Water Impact (θ) Versus Aircraft Altitude When Launched at 150 Kn TAS-Computer Results.	21
15	ASW Test Target Disassembled	33
16	LiH Reacting With Water.	34
17	Inert Pellet	36
18	Nose With Nose Cap Removed	37
19	Store No. 12 After Air Launch.	38
20	Store No. 5 After Air Launch	40
21	Store No. 8 After Air Launch	41
22	Block Diagram - Test Equipment	43

LIST OF SYMBOLS

- A = Area (square feet)
- C_D = Drag coefficient based on projected frontal area
- d = Diameter (inches)
- d_a = Average bubble diameter (inches)
- p = Absolute pressure (pounds per square inch)
- R_d = Reynolds number based on diameter
- S_a = Displacement of an average diameter bubble (pounds)
- V = Velocity (feet per second)
- v = Volume (cubic inches)
- W_{sa} = Weight of store in air (pounds)
- W_{sw} = Weight of store in water (pounds)
- ν = Kinematic viscosity = 1.31×10^{-5} square foot per second for sea water at 69° F
- ρ = Mass density = 1.99 slugs per cubic foot for sea water at 69° F
- \approx = Approximately equal to

BLANK PAGE

DESCRIPTION OF
ASW TEST TARGET CANS

There are three different ASW test target cans, all essentially the same except for variations in the depth selection devices. The depth selection devices are set for pellet ejection at 50, 750, or 1500 ft. An ASW test target can is shown in figures 1 and 2. The unit is 4-31/32 in. in diameter by 36-13/16 in. long and weighs 35.7 lb. The ASW test target can consists of:

1. An outer airtight container
2. An ASW test target (an expendable, air launchable store)

OUTER CONTAINER

The outer container is the same for all three type stores. It consists of the following:

Lower can weld assembly
Top cup weld assembly
Spring plate
Can spring
Tear strip
Tear strip key

Lower Can Weld Assembly - This assembly (figures 1 and 2) is a 4-31/32 in. OD by 35 in. long tin plated, steel cylinder with one end closed. The tube is made of No. 20 gauge (0.0359 in.) cold-rolled low-carbon steel and the end plate is made of No. 13 gauge (0.0897 in.) cold-rolled low-carbon steel. The welded assembly is tin plated to a 0.0003 in. minimum thickness in accordance with MIL-T-10729.

Top Cup Weld Assembly - This assembly is a 4-31/32 in. OD by 13/16 in. long tin plated steel cylinder with one end closed. The tube is made of No. 20 gauge (0.0359 in.) cold-rolled, low-carbon steel and the end plate is made of No. 13 gauge (0.0897 in.) cold-rolled, low-carbon steel. See figures 1 and 2.

Spring Plate - The 0.032 in. thick by 4-27/32 in. diameter aluminum alloy spring plate has three small tabs located 120-deg from each other, and they are bent 90 deg to the plate. The spring plate is located inside the outer container and is used to position the can spring.

Can Spring - The can spring is positioned inside the outer container and is used as a shock absorber to protect the enclosed ASW test target. The spring has the following characteristics:

Mean diameter - 3 in.	Wire diameter - 0.125 in.
Free length - 1-1/2 in.	Material - music wire

NADC-AE-6823



FIGURE 1 - ASW Test Target Can

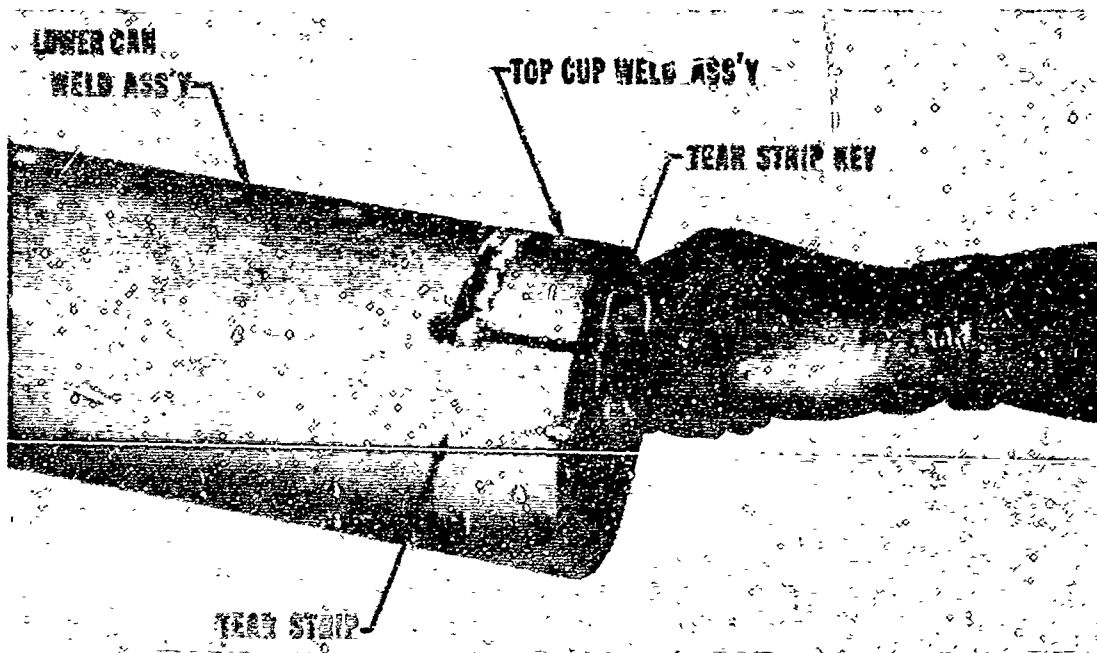


FIGURE 2 - ASW Test Target Can and Tear Strip Key

Tear Strip - The tear strip is a 0.010 in. thick by 5/8 in. by 16-1/2 in. tin plated steel strip that is used to fasten the lower can weld assembly to the top cup weld assembly. The tear strip is soldered to the parts to form a strong, air-tight joint. See figure 2. The tear strip material is commercial quality, dead-soft temper, cold-rolled, carbon-steel strip.

Tear Strip Key - The key used to remove the tear strip from the container is shown in figure 2. The key is made from 1/8 in. diameter carbon steel and is 3-5/16 in. long with a 2-in. wide handle.

ASW TEST TARGET

1500 Foot Depth

The ASW test target designed for pellet ejection at a water depth of 1500 ft is shown in figures 3 and 4. The unit is 4-13/16 in. in diameter by 36 in. long and weighs 28.5 lb. It is designed to be air launched from the standard navy "A" size sonobuoy launchers in use on navy type P2 and P3 aircraft. The center of gravity is 10.8 in. from the nose. The unit consists of the nose, afterbody, chemical pellets, pellet spacers, and spring assembly.

Nose

The nose (figure 3) consists of the following items some of which are shown in figure 5.

Nose Cap - This is a high-strength corrosion-resistant steel cap that absorbs the first shock when the ASW test target strikes the water after air launch. The cap is 4-13/16 in. in diameter by 1-9/32 in. deep with a flat front surface of 1/8 in. thick material. For assembly the cap is screwed on the nose body and locked in place with a 3/32 in. diameter roll pin.

Nose Body - This is a heavy brass part that is 4-13/16 in. in diameter by 3-1/8 in. long. It is the housing for the pressure release mechanism components.

Piston Spring - The Piston Spring has the following characteristics:

- Free length - 2 in.
- Mean diameter - 5/8
- Wire diameter - 3/32 in.
- Active coils - 7 1/2
- Spring material - corrosion resistant steel

Piston - The corrosion resistant steel piston has a 1/2 in. diameter plunger at one end and a 2.240-in. diameter by 1/2 in. thick section at the other end. A 25/32 in. diameter by 3/8 in. deep hole, used to position the piston spring, is located in line with the plunger. A small "O" ring (MS9021-012) is located in a groove on the plunger.

NADC-AE-6823

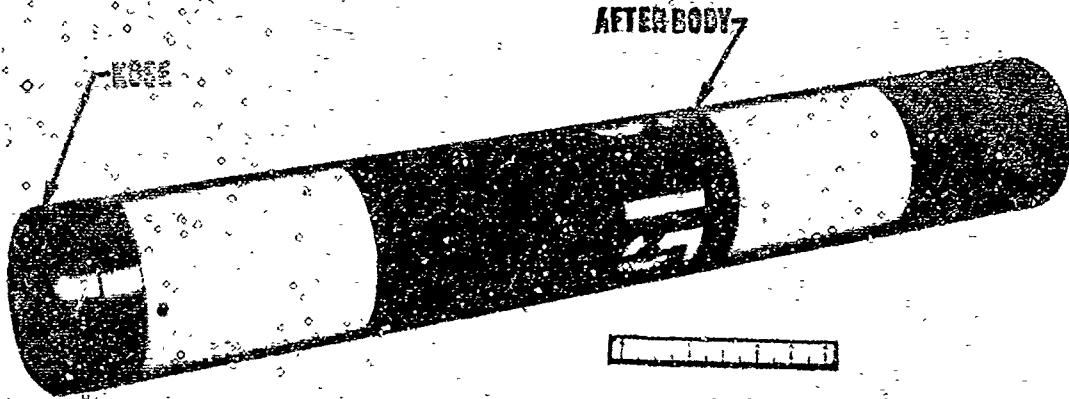


FIGURE 3 - ASW Test Target



FIGURE 4 - ASW Test Target - End View

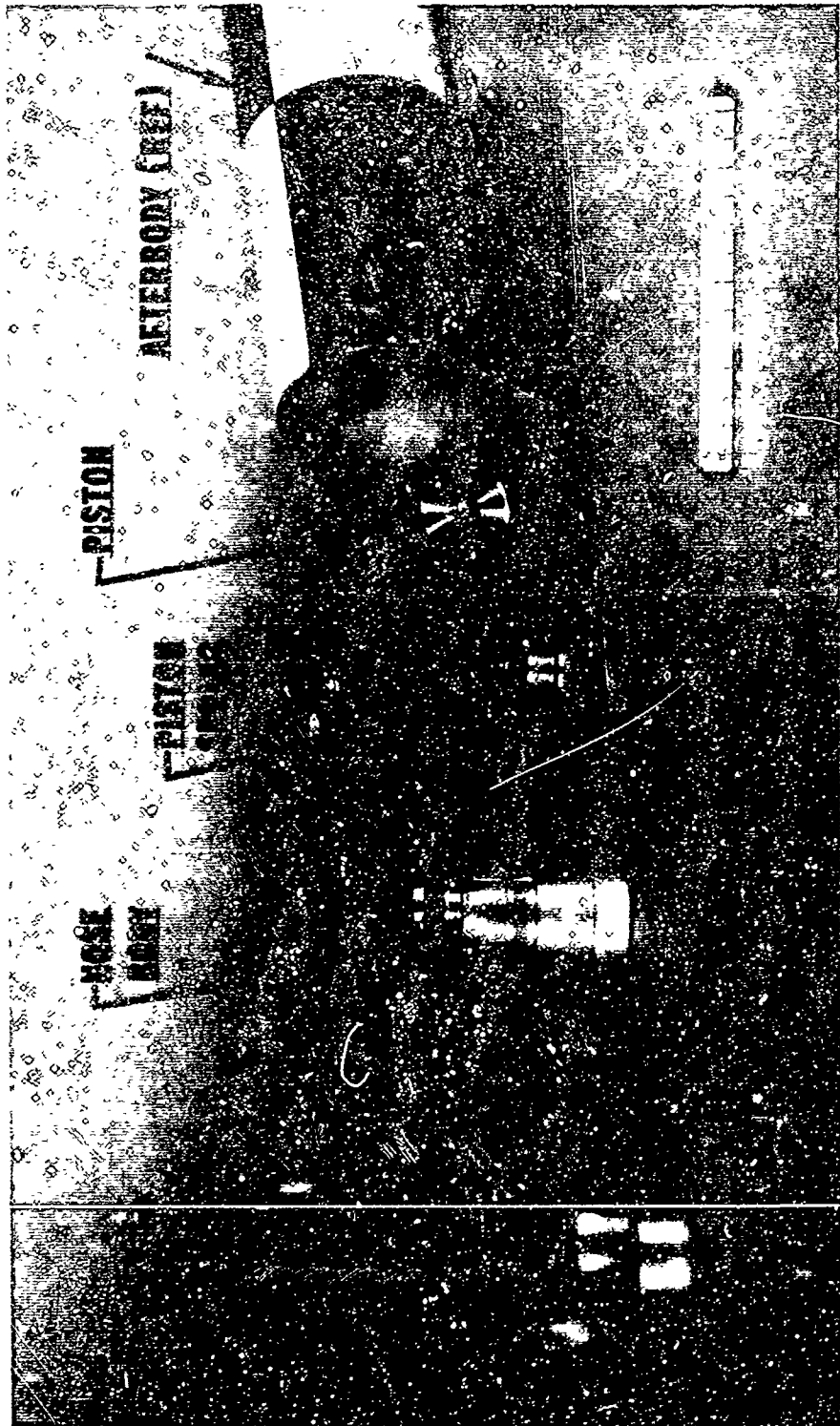


FIGURE 5 - Nose Components - 1500 Ft Depth

Guide - This is a $21/32$ in. thick brass part with a $2-7/8$ in. diameter by $1/8$ in. flange. The part fits into the end of the nose body. The guide has a $1/2$ in. diameter hole in the center which fits around the piston. The guide keeps the piston in line and in conjunction with two "O" rings it seals the front end of the nose from water entry.

Push Pin - There are two corrosion resistant steel push pins located inside the nose body. They are located $1-3/4$ in. apart, and they are symmetrical about the axial center line of the nose. Each pin is $1-1/4$ in. long (see figure 5A). The $1/4$ in. diameter pin has a groove for an MS9021-006 "O" ring located near its center. One end of the pin has a cone point while the other end of the pin has a 0.166 in. diameter for a distance of $3/8$ in. The "O" rings around the pins are used to seal the aft end of the nose from water entry.

Release Pin - There are two corrosion resistant steel release pins located inside the nose body. The end of one pin is shown in figure 5. Each pin is 1.86 in. long. The $3/8$ in. diameter pin is recessed at one end to receive the release pin spring and the other end of the pin has a 0.281 in. diameter for a length of $3/32$ in. The pin has a 70 -deg cone shaped recess perpendicular to its axis located $1/2$ in. from the spring end.

Release Pin Spring - There are two release pin springs, each one with the following characteristics:

- Free length - 0.860 in.
- Mean diameter - 0.218 in.
- Wire diameter - 0.032 in.
- Active coils - $7\ 1/2$
- Spring material - Corrosion resistant steel

Washer - There are two brass washers, each is $1/32$ -in. thick by $15/32$ -in. in diameter with a 0.180 -in. diameter hole in the center. Each washer fits around a push pin and is staked to the nose body. The washer is used to securely position the push pin.

Afterbody

The afterbody (figure 3) consists of a number of aluminum alloy parts riveted together to form a rigid assembly. The unit is basically a right circular cylinder open at one end and partially closed at the other. The assembly has a $4-13/16$ in. OD and a $33-7/32$ in. length. The unit consists of the following.

Shell Half - There are two shell halves which together make up the outer shell of the unit. Each shell half is made of 0.100 in. thick metal formed to a semi-circular cross section with a 2.306 -in. radius. Each part is $33-5/32$ in. long. There are 20 holes drilled through each shell half, each hole $3/8$ in. in diameter located near the aft end.

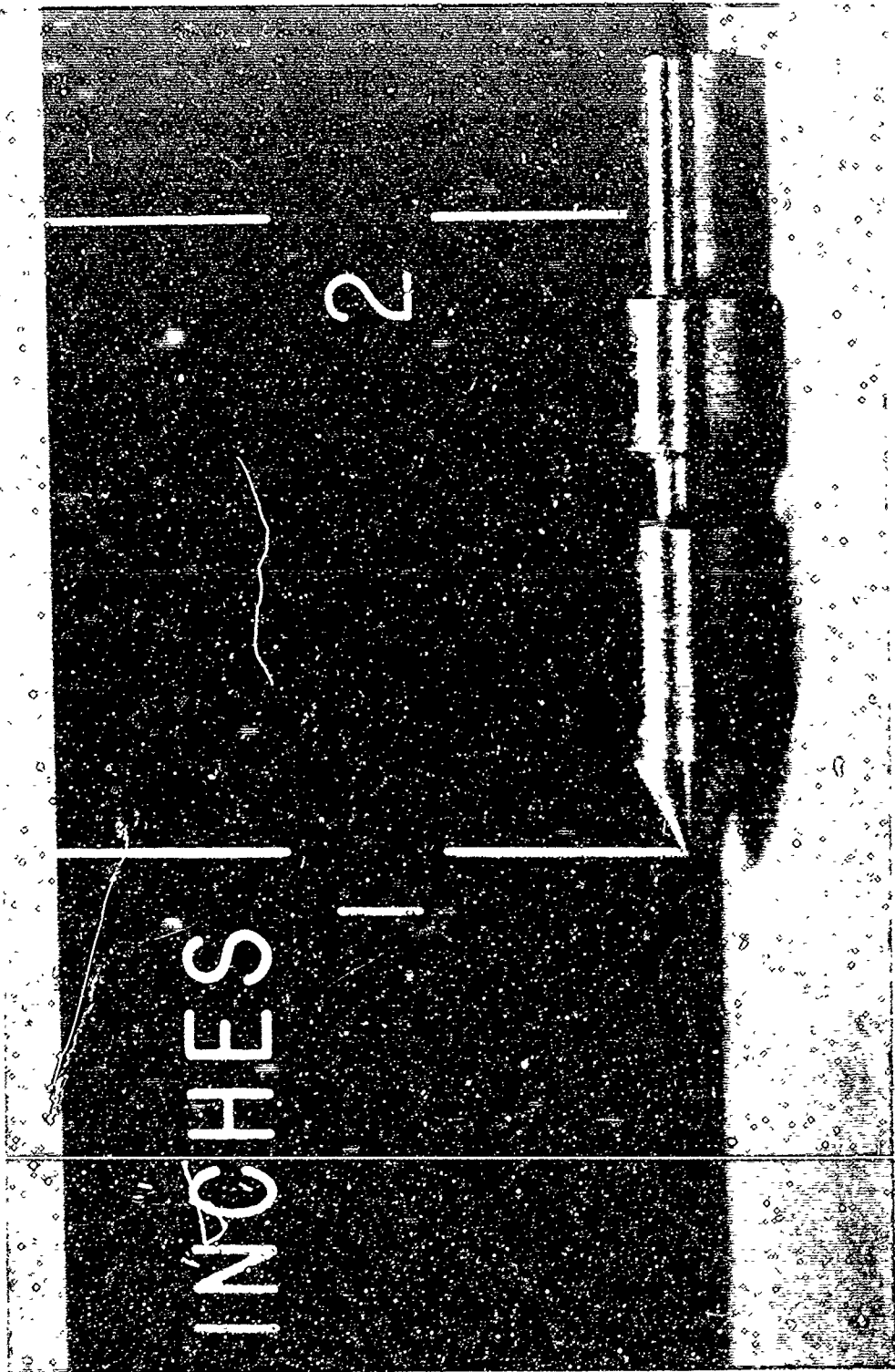


FIGURE 5A - Push Pin

Liner Half - There are two liner halves which together form an inner liner for the afterbody. Each liner half is made of 1/32 in. thick material and is 30-1/2 in. long.

Cap - The aft end of the outer shell is closed with a 3/8 in. thick cap. The cap has 10 holes, each 9/16 in. in diameter, located on a 3-5/8 in. diameter circle that is symmetrical about the axial center line. The cap is shown in figure 4.

Fin - Two separate internal fins are included as part of the aft end of the afterbody. They are used in conjunction with the holes in the outer shell and other parts of the after body to stabilize the store during air launch and during its descent through the water. Each fin is made of 1/32 in. thick material formed into a "U" shape. Each fin is 6 in. long.

Backing Plate - There are two 1/32 in. by 1-3/8 in. by 30-1/2 in. backing plates used to connect the shell halves together and to provide additional structural strength to the after body.

Chemical Pellets

The ASW test target contains fifteen chemical pellets. The pellet is shown in figure 6. Each pellet consists of the following:

Cup - The cup has a 2-3/4 in. diameter, it is 1-7/8 in. deep, and it is made of 0.015 in. tin-plated steel. The cup is made to Naval Ordnance Laboratory (NOL) Drawing No. 398088.

Lead Block - A lead block weighing 45 g is located in the bottom of the cup. The block measures approximately 1/8 in. by 1 in. by 2 in. and is made to NOL Drawing No. 398090.

Chemical Mixture - Each pellet consists of 116 ±2 g of the chemical mixture that is pressed into the cup under pressure with the lead weight centered in the bottom of the cup. The chemical mixture consists of the following:

Lithium hydride (LiH) - 79.2%
Isopropyl naphthalene sodium sulfonate (Aerosol OS) - 1.0%
Paraffin - 19.8%

The chemical mixture is specified on NOL Drawing No. 398089 and the details of manufacture are given in Military Specification No. MIL-C-18571 (NOrd), "Cans, False Target, MK 2 MODS 0 and 1." The pellets used in the ASW Test Targets were obtained from False Target Cans, MK 2, MOD 1, Federal Stock Number, FSN 1370-038-5007-L125 as manufactured by Federal Laboratories, Incorporated, Saltsburg, Pennsylvania.

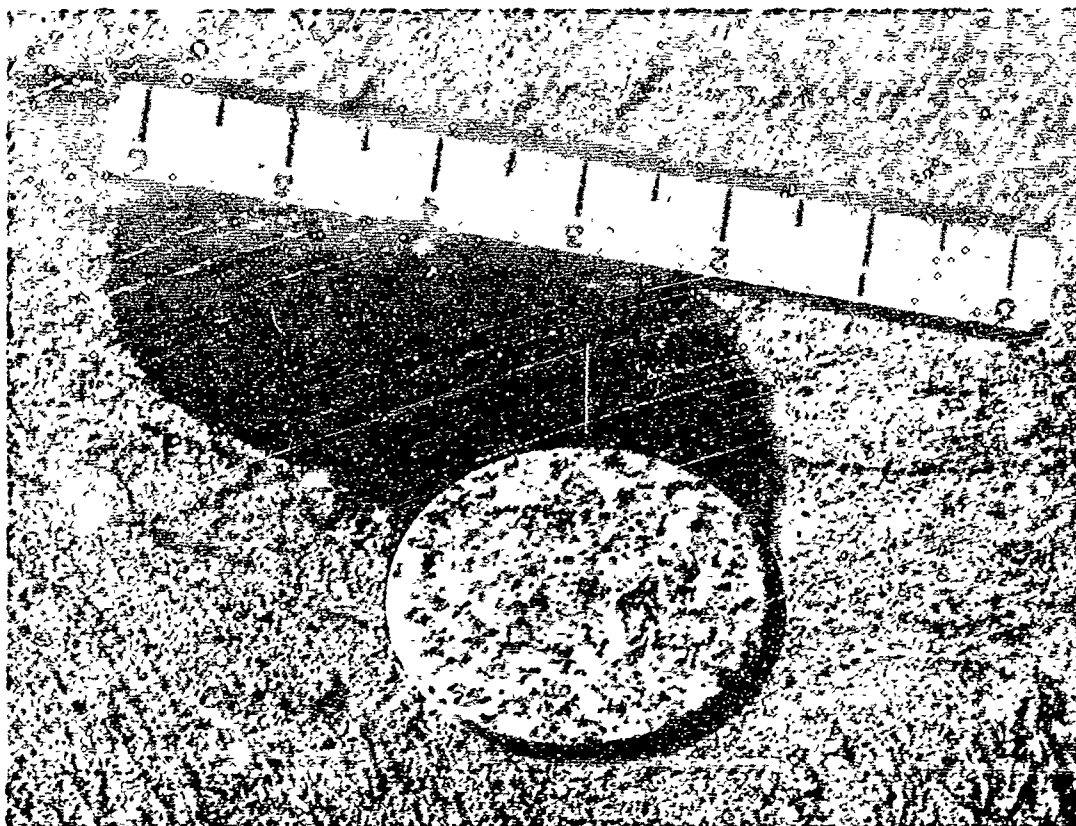


FIGURE 6 - Chemical Pellet

Pellet Spacers

There are fourteen spacers that are used to separate the fifteen chemical pellets. Each spacer is a 1/32 in. thick by 2-3/4 in. diameter aluminum alloy disk.

Spring Assembly

The Spring Assembly (figure 7) consists of the following:

Spring - The spring has the following characteristics:

- Free length - 30 in.
- Mean diameter - 2-1/2 in.
- Wire - 0.118 in.
- Active coils - 25
- Spring material - music wire

Spacer Weld Assembly - This consists of a 1/32 in. thick by 2-3/4 in. diameter base plate welded to a 3/4 in. OD by 3-19/32 in. long tube with a 0.035 in. wall thickness. The base plate has three small tabs that are bent around the spring coil at one end of the spring.

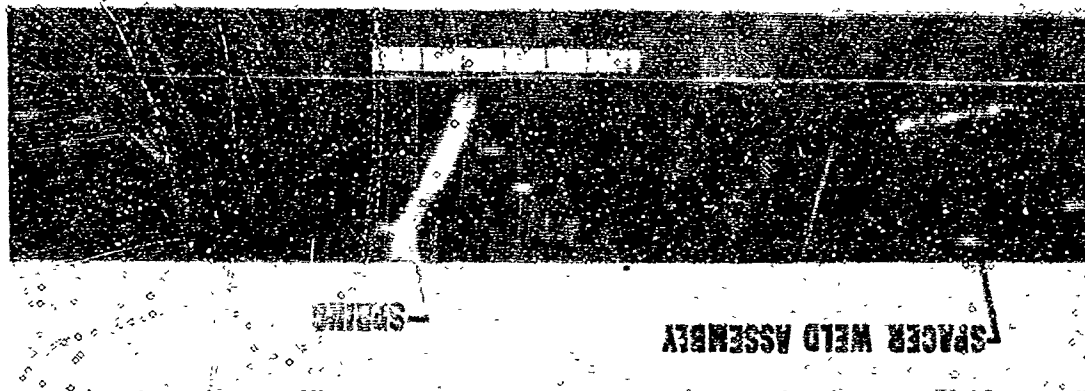


FIGURE 7 - Spring Assembly

750-Foot Depth

The ASW test target designed for pellet ejection at a water depth of 750 ft is the same as the ASW test target designed for pellet ejection at a water depth of 1500 ft, except that the piston spring (figure 5) is deleted in the 750-ft depth unit.

50-Foot Depth

The ASW test target designed for pellet ejection at a water depth of 50 ft is the same as the ASW test target designed for pellet ejection at a water depth of 1500 ft, except for differences in the nose assemblies. The 50-ft depth unit has a larger piston and a different piston spring than the 1500-ft depth unit. The parts used with the 50-ft unit are described below.

Piston - The corrosion resistant steel piston has a 2-1/4 in. diameter and is 1-9/32 in. long. A groove is cut in the piston for a MS9021-G34 "O" ring.

Piston Spring - The piston spring has the following characteristics:

NADC-AE-6823

Free length - 2 in.
Mean diameter - 0.546 in.
Wire diameter - 0.105 in.
Active coils - 3
Spring material - corrosion resistant steel

ASSEMBLY AND INSPECTION

The special assembly and inspection procedures used to obtain live stores, i.e., stores containing LiH pellets, for evaluation by the NAVAIR-DEVCEN are given in NAVAIRDEVCEEN Specification No. AEH-04 of 25 August 1967, Revision 1, "Specification for ASW Test Target Can." This specification is given in appendix A.

MOUNTING IN AIRCRAFT

The ASW test target cans are to be carried in U.S. Navy type P2 and P3 patrol planes. Prior to launching, the enclosed ASW test target, which is the same size as an "A" size sonobuoy, is removed from its outer container. This outer container is larger than the "A" size sonobuoy, therefore, it cannot be carried in the "A" size sonobuoy racks of the P3 aircraft unless some modifications are made.

As a temporary measure the ASW test target cans can be carried in the vertical sonobuoy racks of the P3 aircraft if a special adapter is used on one end of the can and the obstructing cross piece is removed from the rack. Photos taken on board U.S. Navy aircraft type P3-B, BuNo. 152744 at Key West, Florida, are shown in figures 8, 9, and 10. Seven cans can be carried in the vertical racks of the P3 aircraft by using this procedure.

Mounting of the ASW test target cans in the type P2 patrol plane has not been investigated.

OPERATION OF ASW TEST TARGET CANS

The operation of the three different ASW test target cans is the same except that the depth selection devices operate at different depths, i.e., 50, 750, and 1500 ft. The operating details are shown in figure 11.

The ASW test target can is carried in a U.S. Navy type P2 or P3 patrol plane that is fitted for launching the "A" size (4-7/8 in. diameter by 36 in. long) sonobuoy. The ASW test target is removed from the outer container by first removing the tear strip as shown in figure 2. The ASW test target is immediately loaded into an "A" size sonobuoy launcher and launched from the aircraft. Since LiH generates hydrogen gas when exposed to water (such as moisture in the air), it is necessary to immediately launch the ASW test target to prevent the possible dangerous accumulation of hydrogen gas. The store is launched when the launching aircraft is flying at low altitude (500 ft) and low speed (160 kn TRUE airspeed). The store must be launched tail first from the aircraft. When launched tail first the



FIGURE 8 - Storage Rack



FIGURE 9 - ASW Test Target Can Mounted in Storage Rack

NADC-AE-6823

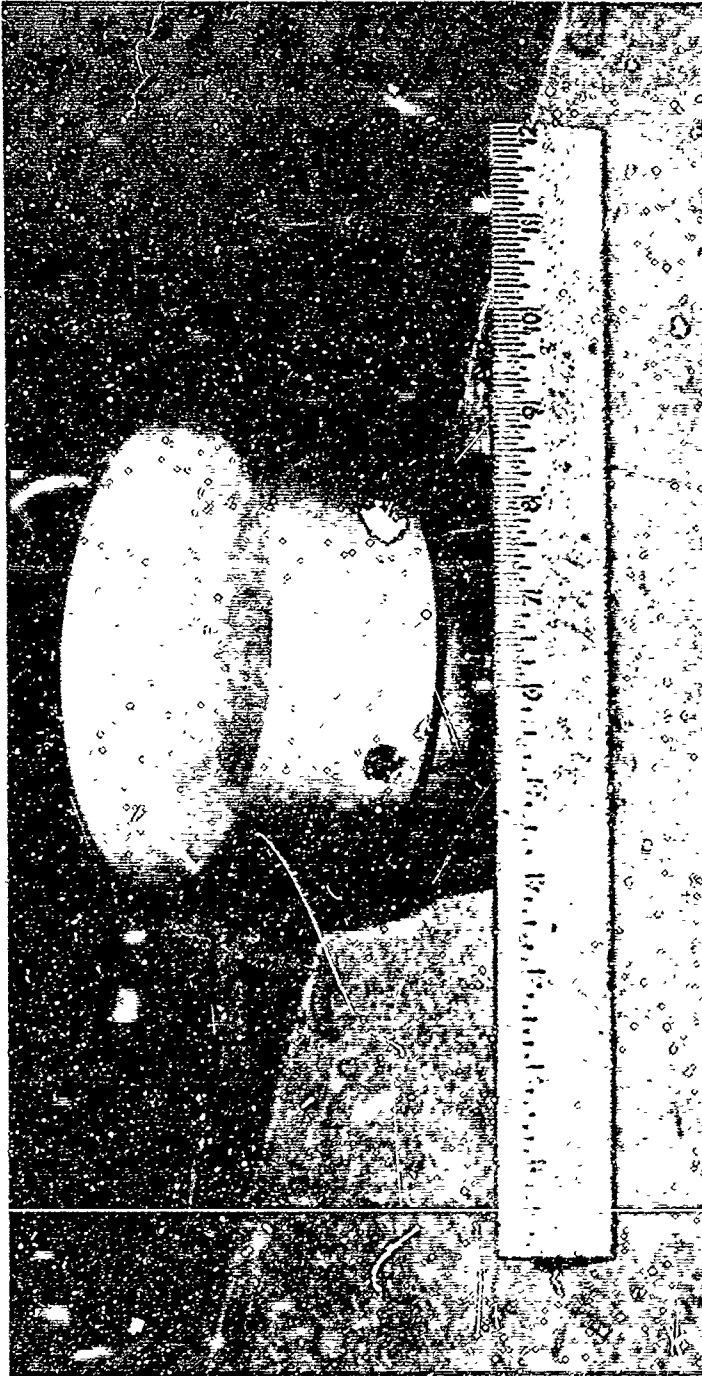


FIGURE 10 - Adapter

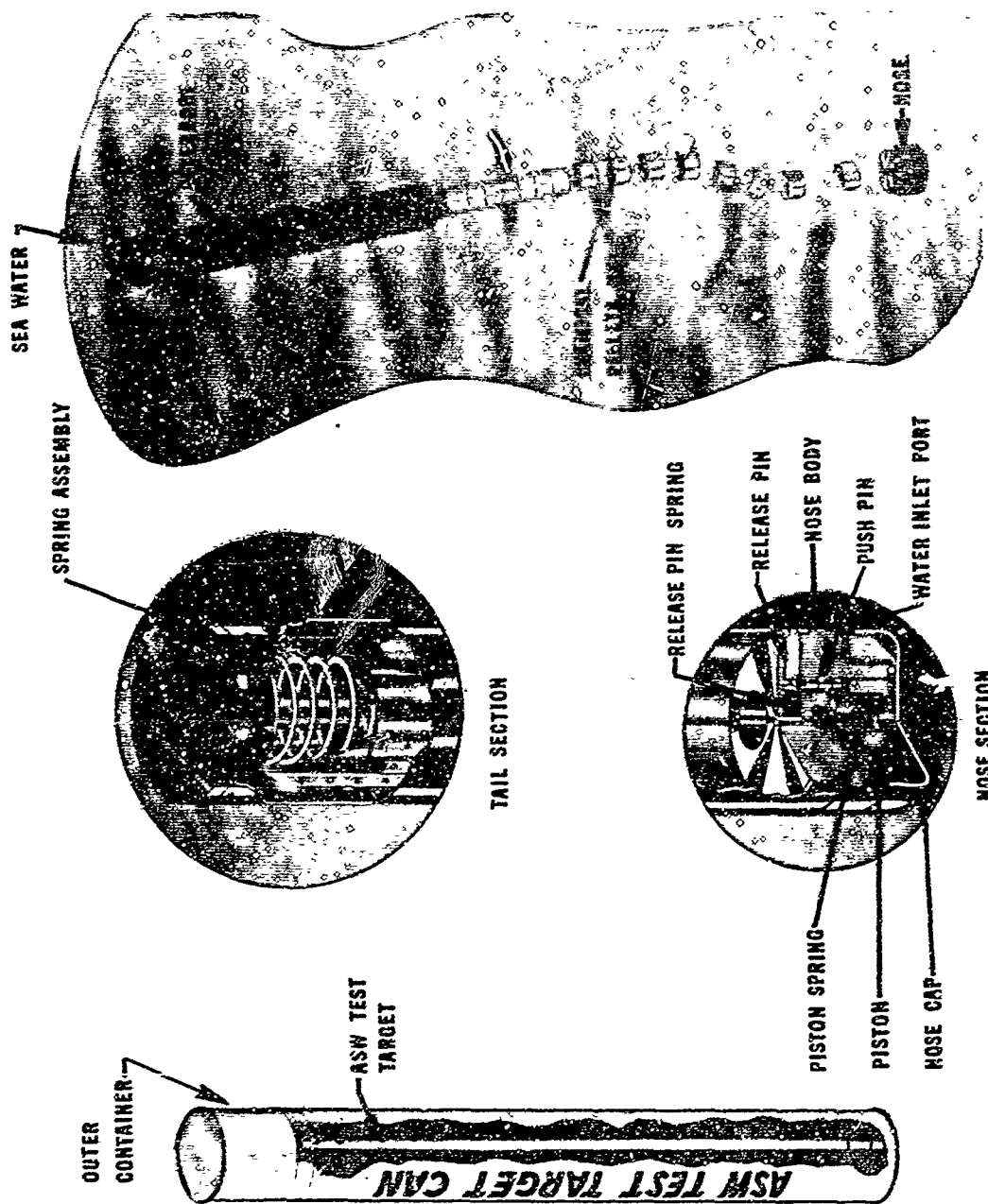


FIGURE 11 - Operating Details - ASW Test Target Can - 50 Ft Depth Model

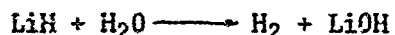
store will slowly tumble in the air, then stabilize in a nose down attitude and strike the water nose first. If the store is launched nose first, it will tumble end-over-end. It will not stabilize and may hit the water broadside and may damage the store. During the descent of the store from the launch aircraft to the water surface, the air passes through the forty holes (each 3/8 in. in diameter) on the aft part of the afterbody shell, into the aft end of the store, and it is deflected by the internal tail fins and associated structure and passes out the ten holes (each 9/16 in. in diameter) in the end cap. The passage of the air through this tail structure produces a fluid dynamic drag which stabilizes the store in a nose down attitude. A view of the tail structure is shown in figure 11.

When the nose of the store strikes the water surface, the initial shock is absorbed by the nose cap which protects the pressure actuated piston in the nose. After the initial shock, the free flooding store quickly attains a sinking rate of approximately 15.4 ft/sec. The time for the target to reach its assigned depth is:

<u>Depth (ft)</u>	<u>Time (sec)</u>
50	3
750	49
1150	98

While sinking through the water, the tail structure of the store functions to stabilize the unit in a nose down attitude. As the store sinks through the water, the water enters the four inlet ports in the nose and exerts a pressure on the piston which is directly proportional to the water depth. This water pressure exerts a force on the face of the piston which moves the piston against the two push pins. The push pins in turn move the two release pins which disengage the nose from the afterbody when the store is at its assigned depth. With the nose disengaged, the fifteen chemical pellets are ejected from the afterbody by the spring assembly, as shown in figure 11.

During the rapid descent of the free flooding store from the water surface to its assigned depth, the enclosed LiH is partially exposed to the seawater for a short period of time; but at the assigned depth, when the LiH pellets are ejected from the store, all fifteen pellets are fully exposed to the seawater. When exposed to water, the LiH generates a large quantity of hydrogen gas, as follows,



Each pellet, when submerged in water for a period of approximately 10 min, is capable of generating 226 liters of hydrogen at standard conditions of temperature and pressure. The fifteen pellets will generate 120 cu ft of hydrogen gas at standard conditions of temperature and pressure. As the finely divided hydrogen gas bubbles, which are relatively insoluble in

NADC-AE-6823

water, leave each pellet and travel upwards toward the water surface, they gradually expand in volume and displace a large volume of water, starting at the pellets and extending upwards toward the water surface. The bubble column forms an acoustic discontinuity and may be used as a target, in place of a submarine, since it will return an echo when subjected to an incident sound.

STOWAGE

The ASW test target cans should be separated from pyrotechnics and other ammunition components. Stowage should be as cool and as dry as conditions will permit.

Although the cans are watertight until the tear strip seal is broken, it should be noted that the LiH mixture in the cans reacts with water to release large quantities of hydrogen. It is undesirable to use water in combating fire in the immediate vicinity of the cans. If the LiH catches fire, carbon dioxide and carbon tetrachloride (usual fire fighting agents) should not be used because they react exothermally with the burning hydride. A LiH fire may be extinguished by using argon or nitrogen to exclude air by blanketing the burning material. A LiH fire may also be extinguished by using the dry powder, "LITH-X," which may be obtained from the Ansul Chemical Company, 24 State Road, Paoli, Pennsylvania. "LITH-X" is composed of a special graphite base with additives to render it free-flowing so that it can be discharged from an extinguisher. The material excludes air and conducts heat away from the burning mass which results in its extinguishment.

Any ASW test target can which has been partially or completely opened should not be returned to stowage in that condition. In this case the chemical pellets should be stowed in an airtight container until conditions permit their disposal, which should be as soon as possible.

SAFETY PRECAUTIONS

The LiH pellets within the ASW test target can release large quantities of hydrogen when brought into contact with water. The ASW test target can should not be opened until immediately prior to launching the enclosed ASW test target from the aircraft.

Since LiH dust, even in small quantities, is irritating to the skin and to the mucous membranes, protective clothing and gloves should be used when handling the opened ASW test target cans.

In the event of an accidental release of the LiH pellets in the aircraft, the pellets should not be allowed to come into contact with water. The pellets should be kept dry and removed from the aircraft as soon as possible for immediate disposal.

The ASW test target cans should be carefully handled, in order to prevent the possibility of rupturing the tear strips prior to actual use.

THEORETICAL ANALYSES

AERODYNAMIC ANALYSIS

A theoretical analysis was made to determine the store velocity and attitude at water impact when the store is air launched from various altitudes and aircraft speeds. The horizontal distance that the store travels from air launch to water impact was also determined. A computer program was utilized to expedite the analysis. The following store parameters were used in the analysis,

$$W_{sa} = 28 \text{ lb}$$

$$C_D = 0.6$$

$$A = 0.136 \text{ sq ft}$$

The weight was a preliminary estimate and compares favorably with the final design value of $W_{sa} = 28.5 \text{ lb}$. The projected frontal area, A , was also a first estimate with the final design having a projected frontal area of 0.127 sq ft . The drag coefficient, C_D , is an estimated value. The following aircraft parameters were also used in the analysis,

Aircraft true airspeed: 150, 175, 200, 225, and 250 kn

Aircraft altitude: from 150 to 1000 ft in 50-ft increments; and from 1000 to 10,000 ft in 1000-ft increments.

The results of the computer analysis are representative approximations of the aerodynamic characteristics of the store.

The store impact velocity versus aircraft altitude at various aircraft speeds is given in figures 12 and 13. The general trend of the curves gives increased store impact velocity with an increase in aircraft altitude when the aircraft TAS is held constant; also, increased store impact velocity with increased aircraft speed when the aircraft altitude is held constant. At 150 kn aircraft TAS, the store impact velocity is 258 ft/sec when launched from 150 ft altitude. The impact velocity increases to 310 ft/sec when launched from an altitude of 1000 ft at an aircraft velocity of 150 kn TAS. The store impact velocity increases to 511 ft/sec when launched from an altitude of 10,000 ft at 150 kn TAS. With the aircraft traveling at a speed of 200 kn TAS, the corresponding impact velocities are 326 ft/sec from 150 ft altitude; 346 ft/sec from 1000 ft altitude; and 511 ft/sec from 10,000 ft.

The store angle with the vertical at water impact (θ) versus aircraft altitude when launched at 150 kn TAS is given in figure 14. The angle varies from 67.2 degrees at 150 ft altitude to 40.9 deg at 1000 ft altitude. The computer analysis also shows that the angle will reduce to

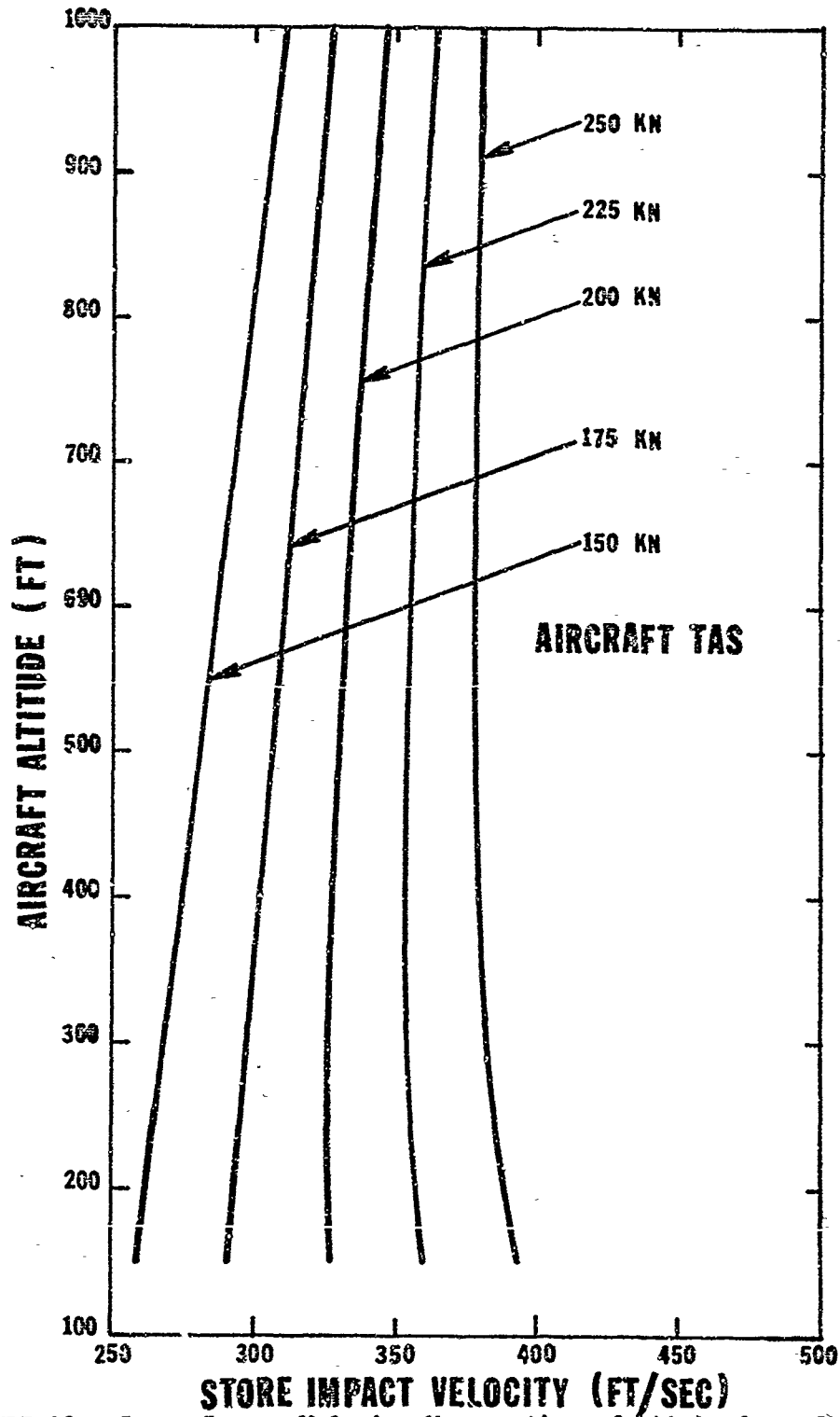


FIGURE 12 - Store Impact Velocity Versus Aircraft Altitude at Various Aircraft Speeds - Computer Results

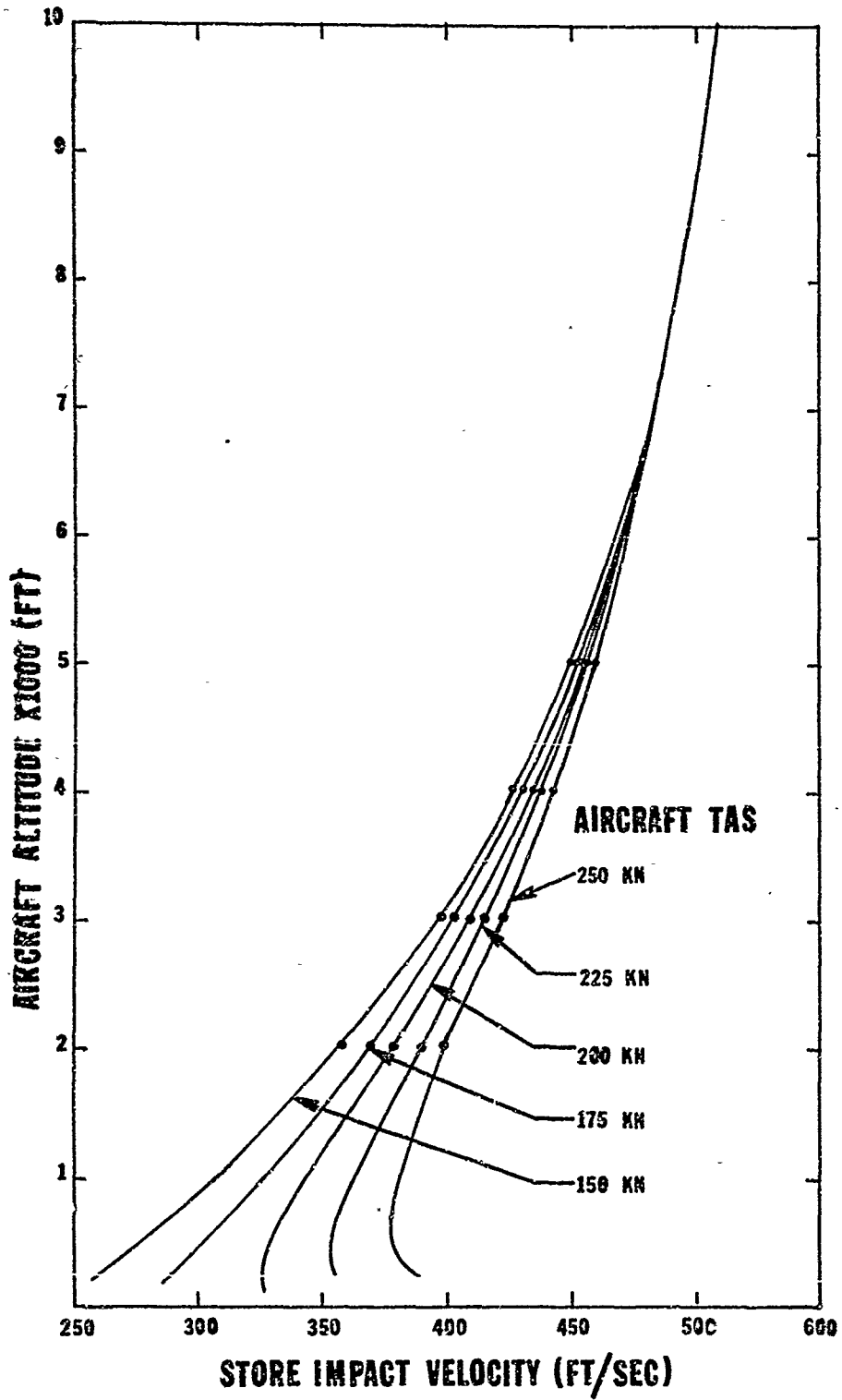


FIGURE 13 - Store Impact Velocity Versus Aircraft Altitude at Various Aircraft Speeds - Computer Results

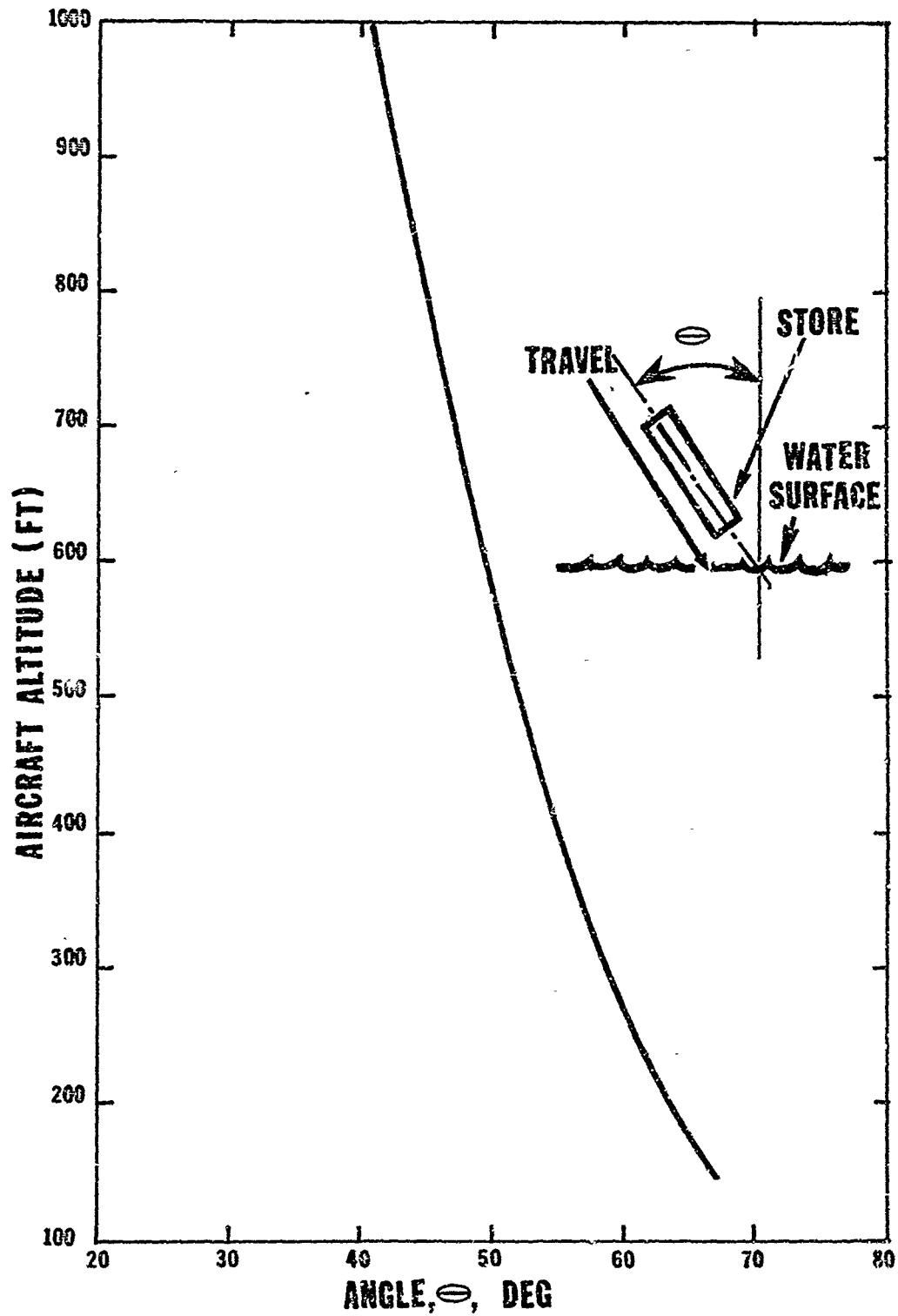


FIGURE 14 - Store Angle at Water Impact (θ) Versus Aircraft Altitude When Launched at 150 Kn TAS-Computer Results

8.2 deg when the store is launched from an altitude of 10,000 ft at an aircraft velocity of 150 kn TAS. A summary of the computer results for the store angle with the vertical (θ) is given in table I. Table I shows the following:

1. At any fixed aircraft velocity, the angle θ decreases with an increase in aircraft altitude.

2. At any fixed aircraft altitude, the angle θ increases with an increase in aircraft velocity.

A summary of the computer results for the horizontal travel of the store is given in table II. Table II shows the following:

1. At any fixed aircraft velocity, the horizontal travel of the store increases with an increase in aircraft altitude.

2. At any fixed aircraft altitude, the horizontal travel of the store increases with an increase in aircraft velocity.

HYDRODYNAMIC ANALYSIS

A theoretical analysis was made to determine the terminal velocity of the store in water and the time for it to reach its assigned depth. The terminal velocity of the store is determined by the following equation,

$$W_{sw} = (C_D) (1/2) \rho V^2 A$$

where,

W_{sw} = weight of the store in water = 18 lb

C_D = drag coefficient based on projected frontal area = 0.6

ρ = mass density = 1.99 slugs/cu ft for sea water at 69° F

V = velocity, ft/sec

A = area = 0.127 sq ft

Substituting these values in the above equation gives

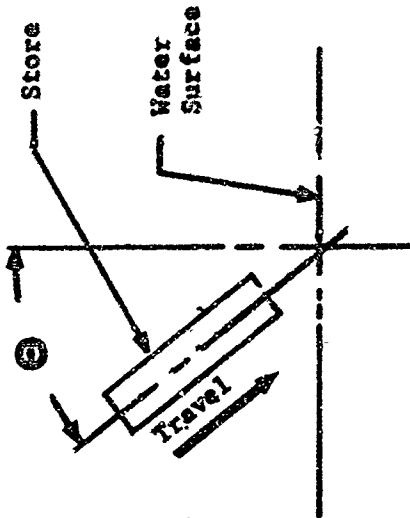
$$18 = (0.6) (1/2) (1.99) V^2 (0.127)$$

$$V^2 = \frac{18}{(0.6)(0.127)}$$

$$V = 15.4 \text{ ft/sec}$$

T A B L E I
 STORE ANGLE AT WATER IMPACT (θ), DEGREES, AS A FUNCTION OF
 AIRCRAFT VELOCITY AND ALTITUDE-COMPUTER RESULTS

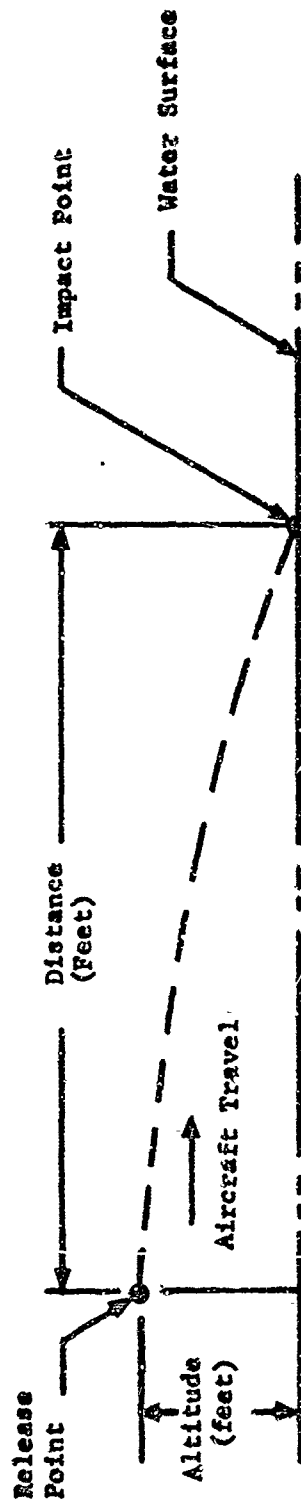
Aircraft Altitude (Feet)	Aircraft Velocity, Knots, TAS						
	150	175	200	225	250	275	300
150	67.2	70.1	72.3	74.1	75.6		
200	64.2	67.3	69.8	71.8	73.4		
300	59.2	62.8	65.5	67.8	69.7		
400	53.3	59.0	62.0	64.5	66.5		
500	52.0	55.9	59.0	61.6	63.8		
600	49.2	53.1	56.3	59.0	61.3		
700	46.7	50.7	54.0	56.7	59.0		
800	44.6	48.5	51.8	54.6	57.0		
900	42.6	46.6	50.0	52.7	55.1		
1,000	40.9	44.8	48.0	50.9	53.3		
2,000	29.5	32.8	35.7	38.3	40.5		
4,000	19.1	21.4	23.5	25.3	27.0		
6,000	13.8	15.6	17.0	18.4	19.7		
8,000	10.5	11.8	13.0	14.0	15.0		
10,000	8.2	9.2	10.1	11.0	11.7		



T A B L E I I

STORE HORIZONTAL TRAVEL, FT, AS A FUNCTION OF AIRCRAFT VELOCITY AND ALTITUDE-COMPUTER RESULTS

Aircraft Altitude (ft)	150	175	200	225	250
150	564	656	748	840	931
200	675	785	894	1003	1111
300	860	999	1137	1274	1410
400	1016	1179	1340	1500	1658
500	1151	1335	1517	1697	1874
600	1273	1475	1675	1872	2067
700	1384	1603	1818	2031	2241
800	1486	1721	1951	2178	2401
900	1582	1830	2074	2314	2550
1000	1671	1932	2189	2441	2689
2000	2363	2723	3074	3415	3748
4000	3244	3724	4186	4633	5065
6000	3836	4393	4928	5441	5934
8000	4277	4890	5477	6039	6576
10000	4621	5279	5906	6505	7077



The terminal velocity (sinking rate) is 15.4 ft/sec. The estimated time for the target to reach its assigned depth is given below:

<u>Depth (ft)</u>	<u>Time (sec)</u>
50	3
750	49
1500	98

Bubble Cloud Duration Time

The duration time of the bubble cloud depends upon the functioning time of the chemical pellets and the time for the gas bubbles to rise to the water surface from their operating depth.

Pellet Functioning Time

Each chemical pellet will generate hydrogen gas for approximately 10 minutes.

Bubble Ascent Time

The bubble ascent time from a depth of 1500 ft is estimated as follows:

Assume a 1/8 in. diameter gas bubble at a depth of 1500 ft of sea water and a constant water temperature. Boyle's Law states that, when the temperature is held constant, the volume of a given weight of a perfect gas varies inversely as the absolute pressure. The hydrogen gas will be considered a perfect gas.

The absolute pressure at a depth of 1500 ft is:

$$p = \frac{1500}{2.25} + 14.7$$

$$p = 681 \text{ lb/sq in.}$$

The volume of the 1/8 in. diameter bubble at 1500-ft depth is:

$$\begin{aligned} v &= 0.5236d^3 \\ &= 0.5236(0.125)^3 \\ &= 0.5236(0.00196) \\ v &= 0.00103 \text{ in.}^3 \end{aligned}$$

The volume of the 1/8 in. diameter bubble increases as it rises to the surface due to the decrease in water pressure. The volume of the bubble immediately below the water surface is:

$$\begin{aligned}
 pV &= p_1 v_1 \\
 (681)(0.00103) &= 14.7 v_1 \\
 v_1 &= (681/14.7) (1.03 \times 10^{-3}) \\
 v_1 &= (46.3) (1.03) (10^{-3}) \\
 v_1 &= 0.0476 \text{ in.}^3
 \end{aligned}$$

The diameter of the bubble immediately below the water surface is:

$$\begin{aligned}
 v_1 &= 0.5236d^3 \\
 0.0476 &= 0.5236d^3 \\
 d &= \sqrt[3]{0.0911} \\
 d &= 0.45 \text{ in.}
 \end{aligned}$$

The average bubble diameter during ascent from 1500 ft is:

$$\begin{aligned}
 d_a &= \frac{0.45 + 0.125}{2} \\
 d_a &= 0.29 \text{ in.}
 \end{aligned}$$

The volume of an average diameter bubble is:

$$\begin{aligned}
 v &= 0.5236d_a^3 \\
 v &= 0.5236(0.29)^3 \\
 v &= 0.6235(0.0244) \\
 v &= 0.0128 \text{ in.}^3
 \end{aligned}$$

The displacement of an average diameter bubble is:

$$\begin{aligned}
 S_a &= (0.0128)(0.037) \\
 &= 4.74 \times 10^{-4} \text{ lb}
 \end{aligned}$$

The ascent velocity of an average diameter bubble is determined by the following equation:

$$S_a = (C_{D,}) (1/2) \rho V^2 A$$

where,

$$\begin{aligned}
 S_a &= \text{displacement of an average diameter bubble} = 4.74 \times 10^{-4} \text{ lb} \\
 C_{D,} &= \text{drag coefficient based on projected frontal area} = 0.5 \\
 \rho &= \text{mass density} = 1.99 \text{ slugs/cu ft for sea water at } 69^\circ \text{ F} \\
 V &= \text{velocity, ft/sec} \\
 A &= \text{area} = 4.58 \times 10^{-4} \text{ sq ft}
 \end{aligned}$$

Substituting these values in the above equation gives:

$$(4.74)(10^{-4}) = (0.5)(1/2)(1.99)(V^2)(4.58)(10^{-4})$$

$$4.74 = (0.5)(V^2)(4.58)$$

$$V^2 = \frac{4.74}{(0.5)(4.58)}$$

$$V^2 = 2.07$$

$$V = 1.44 \text{ ft/sec}$$

The Reynolds number is determined as follows:

$$R_d = V d_a / 12 \nu$$

where,

R_d = Reynolds number based on diameter

V = velocity, ft/sec = 1.44 ft/sec

d_a = average bubble diameter = 0.29 in.

ν = kinematic viscosity = 1.31×10^{-5} sq ft/sec for sea water at 69° F

Substituting these values in the above equation gives:

$$R_d = \frac{(1.44)(0.29)}{(12)(1.31)(10^{-5})}$$

$$R_d = 2.66 \times 10^5$$

$\therefore C_D = 0.5$ is a satisfactory value for a sphere at a $R_d = 2.66 \times 10^5$ (See figure 10 on page 3-8 of reference 1.)¹

The average bubble ascent rate is ≈ 1.4 ft/sec

The time for an average bubble to ascent from 1500 ft is:

$$\frac{1500}{1.4} = 1070 \text{ sec} = 17.8 \text{ min}$$

The bubble cloud will have a maximum duration time of 27.8 min when initiated at a depth of 1500 ft. The time for an average bubble to ascend from 750 ft is 535 sec or 8.9 min, which gives a maximum duration time of 18.9 min when the bubble cloud is initiated at 750 ft. A bubble cloud initiated at a 50-ft depth will have a duration time of 10.6 min.

1. "Fluid-Dynamic Drag" by Sighard F. Hoerner, published by the author, 1958.

The estimated bubble cloud duration times are listed below:

<u>Target Depth (ft)</u>	<u>Time (min)</u>
1500	27.8
750	18.9
50	10.6

T E S T R E S U L T S

OUTER CONTAINER

The Lih contained in the ASW test target must be protected from moist air so each ASW test target is housed in an airtight container which has been previously described. A test program to evaluate the reliability of the container was conducted.

Ten containers were fabricated and numbered 1 through 10. The test program consisted of the following:

1. Component pressure test before tin plating
2. Component pressure test after tin plating
3. Salt spray test
4. Tear strip test
5. Flux removal test
6. Internal pressure test
7. External pressure test
8. Vibration test
9. Shock test

Component Pressure Test Before Tin Plating - The following parts were subjected to an internal air pressure of $5 \pm \frac{0}{1}$ psig for 5 min before tin plating:

1. Lower can weld assembly (10 items)
2. Top cup weld assembly (10 items)

All of the items satisfactorily passed the test.

Component Pressure Test After Tin Plating - After tin plating, in accordance with Military Specification No. MIL-T-10727, the following parts were subjected to an internal air pressure of $10 \pm \frac{0}{1}$ psig for a period of 10 min:

1. Lower can weld assembly (10 items)
2. Top cup weld assembly (10 items)

All of the items satisfactorily passed the test.

Salt Spray Test - The salt spray test, in accordance with Specification No. MIL-T-10727, was conducted to determine the corrosion resistance of the tin plating. The test was conducted on the following tin plated items:

1. Lower can weld assembly (2 items - serial No. 1 and 2)
2. Top cup weld assembly (2 items - serial No. 1 and 2)
3. Tear strip (2 items - serial No. 1 and 2)

All of the items satisfactorily passed the test.

Tear Strip Test - A test was conducted to determine if the tear strip was easily removable when using the tear strip key (see figure 2). Two outer containers were assembled (containers 3 and 4). For each assembly, the lower can weld assembly was attached to the top cup weld assembly by the tear strip that was soldered in place. In both cases the tear strip came off easily and the top cup weld assembly was easily removed.

Flux Removal Test - The tear strip is soldered to the lower can weld assembly and to the top cup weld assembly with solder and a soldering flux. The flux is removed after soldering to prevent corrosion of the container. The humidity test specification in Military Specification No. MIL-S-006872 was conducted on two soldered containers (No. 5 and 6) after removal of the flux residue. After completion of the humidity test, the containers were visually examined and there was no evidence of corrosion.

Internal Pressure Test - Two containers (No. 7 and 8) were prepared as follows for the internal pressure test. Each container was assembled (empty) and the tear strips were soldered in place. The 1/16 in. diameter hole in the cup end of each container was sealed with solder. A 1/16 in. diameter hole was drilled in the center of the other end of the container and a 1/4 in. OD by 6 in. long stainless steel tube with a flared end was placed over the hole and brazed to the container. This tube was used to apply air pressure to the inside of the container.

Can No. 7 initially leaked under 3 psig internal air pressure. The can was reworked by the shop by applying a hot iron to the area of the tear strip. The internal air pressure was then applied as follows:

<u>Pressure (psig)</u>	<u>Time (min)</u>
5	5
12	5
100	10

Can No. 7 did not leak when subjected to these internal pressures.

Internal air pressure was applied to Can No. 8 as follows:

<u>Pressure (psig)</u>	<u>Time (min)</u>
5	5
12	5
100	10

Can No. 8 did not leak when subjected to these internal pressures.

External Pressure Test - Container No. 8 assembled, as noted in "Internal Pressure Test" but with the 1/4 in. OD tube sealed with a pressure fitting was subjected to an external pressure of 5 psig for a period of 5 min. This test was conducted prior to the internal pressure test of container No. 8. The container did not leak.

Vibration Test - Containers No. 9 and 10 were prepared for the vibration test as follows:

Each container was loaded with an ASW test target containing inert pellets; a spring plate, a can spring, and then solder-sealed as per NAV-AIRDEVGEN Drawing No. EH-00333. A 1/4 in. OD by 6 in. stainless steel tube with a flared end was placed over the 1/16 in. diameter hole in the top cup and brazed in place. This tube was used for applying internal air pressure. Each container was tested for leaks with an internal air pressure of 5 psig for a 10 min period prior to the tests; no leaks were present. The 1/4 in. diameter tube was sealed with a pressure fitting during the vibration test.

Vibration tests were conducted in accordance with Military Specification No: MII-T-5422, Part I, curve I from 15 to 52 hz and curve III from 52 to 500 hz. All tests were made at room temperature.

Each test target container was tested separately. The welded seam of each container was used to define the two radial axes. Two accelerometers were attached to the case of each container and centered on the major axis to aid in locating resonant modes and to measure the vibration output levels on the outer cases. The input vibration levels were maintained at 0.036 in. double amplitude from 15 to 52 hz and ± 5.0 g from 52 to 500 hz. The containers were tested for leaks with an internal pressure of 5 psig for a 10 min period prior to the tests and at the conclusion of each axis orientation of the vibration tests.

A resonance survey was conducted on the containers with the specified vibration input in the three mutually perpendicular axes. The following frequencies and their vibration levels were selected for resonance vibration as determined by the output of the two accelerometers attached to test target container No. 9:

Longitudinal (Major Axis)

65 hz Vertical axis 7.4 G Horizontal axis 8.8 G

First Radial Axis (Welded Seam on Side)

275 hz Vertical axis 6.6 G Horizontal axis 5.4 G
60 hz Vertical axis 17.0 G Horizontal axis 16.5 G

Second Radial Axis (Welded Seam on Bottom)

267 hz Vertical axis 6.5 G Horizontal axis 5.6 G
158 hz Vertical axis 8.4 G Horizontal axis 6.9 G
64 hz Vertical axis 14.0 G Horizontal axis 16.0 G

Test Target Container No. 10:

Longitudinal (Major Axis)

65 hz Vertical axis 5.4 G Horizontal axis 5.5 G

First Radial Axis (Welded Seam on Side)

62 hz Vertical axis 28.0 G Horizontal axis 31.0 G

Second Radial Axis (Welded Seam on Bottom)

58 hz Vertical axis 29.0 G Horizontal axis 27.0 G

At the completion of each axis orientation of the vibration tests, the test target containers maintained an applied air pressure of 5 psig for 10 min.

The following equipment and instrumentation were used to perform and to monitor the tests:

Ling Model A246 Electro Mechanical Vibrator
Ling Model 514 Servo
Ling Model 20/24 Power Supply
L.A.B. Model 5430-30 Vapress Slip Table
Unholtz-Dickie Model 610 RM3 Vibration Level Meters
Endevco Model 221D Accelerometers (3)
Tektronix Type 564 4-Trace Oscilloscope
U.S. Master Pressure Gauge

Containers No. 9 and 10 successfully passed the vibration tests.

Shock Test - Container No. 9 (loaded) was shock tested after successfully passing the vibration test previously described. Prior to the shock test, an internal air pressure of 5 psig was applied for 10 min and the container

did not leak. The 1/4 in. diameter tube was sealed with a pressure fitting during the shock test. The shock test was conducted in accordance with Military Specification No. MIL-T-5422. The container was subjected to 18 impact shocks of 15 g's for a time duration of 11 ± 1 msec. After the 18 impact shocks, the container was subjected to an internal air pressure of 5 psig for 10 min, and it did not leak.

HYDROSTATIC PRESSURE TESTS

Laboratory Tests - Laboratory hydrostatic pressure tests were conducted on one each of the three different ASW test targets, i.e., 50-ft, 750-ft, and 1500-ft models. The tests were conducted with stores loaded with a length of 2-3/4 in. OD tubing in place of the chemical pellets and spacers. Each store was placed in a pressure chamber and the hydrostatic pressure was gradually increased to the pressure present at the store operating depth. Each of the stores functioned properly, i.e., the length of 2-3/4 in. OD tubing was ejected.

Sea Tests - A 50-ft depth store was tested in the sea near Key West, Florida. The unit was loaded with 15 wooden pellets and allowed to run to a depth of 100 ft, being restrained by a line. The nose and spring assembly were attached to the afterbody by lines so that they could be retrieved. The unit functioned properly. The test was repeated using LiH pellets (see figure 15) and the unit operated properly, with all of the chemical pellets being ejected.

CHEMICAL PELLETS TEST

Each ASW test target contains 15 chemical pellets; one pellet is shown in figure 6. The pellets used in the stores were obtained from existing false target cans, MK 2, MOD 1, federal stock No. FSN 1370-038-5007-L125. To verify the bubble generating performance of these existing pellets, a small quantity of the pellets were checked.

The test was conducted at the Sonar Development Facility, Oreland, Pennsylvania. Three pellets were tied together, attached to a length of string, and then placed into the water at the facility. The pellets reacted violently with the water and generated a large quantity of hydrogen gas. The reaction of the pellets with the water is shown in figure 15.

AIR DROPS - INERT STORES

Sixteen ASW test targets of a preliminary type, numbered 1 through 16, and loaded with inert pellets (see figure 17) were fabricated for use in the air drop tests. The stores were essentially the same as the final design with the following exceptions:

1. The release mechanisms were set to operate at nominal depths of 40, 750, 1250, and 1500 ft instead of 50, 750, and 1500 ft.
2. The nose cap was made of brass instead of corrosion resistant steel.

NADC-AE-6823



FIGURE 15 - ASW Test Target Disassembled



FIGURE 17 - Inert Pellet



FIGURE 16 - LiH Reacting With Water

3. The nose radius was 9/16 in. instead of 1/2 in.
4. The end cap had a center hole of 3/4 in. diameter and 10 holes of 1/2 in. diameter on a 3-5/8 in. diameter circle in place of the 10 holes of 9/16 in. diameter on a 3-5/8 in. diameter circle.
5. A slack, 1/16 in. diameter, flexible steel cable was used to fasten the nose to the afterbody to facilitate recovery of both parts after launch.

Eleven of the sixteen stores were air dropped and these are tabulated in table III. The other five stores No. 2, 3, 7, 11, and 15 were modified to conform to the final design.

T A B L E I I I
LIST OF AIR DROPPED INERT STORES

<u>Store No.</u>	<u>Nominal Depth Setting (ft)</u>
1	40
4	40
5	750
6	750
8	750
9	1250
10	1250
12	1250
13	1500
14	1500
16	1500

The following store characteristics were evaluated during this test:

- Store trajectory in air
- Attitude at water impact
- Reliability of depth selection devices
- Structural integrity of store

The stores were individually launched from a P3A aircraft at 160 kn TAS and 500 ft altitude. The stores were dropped into 60 to 90 ft of water near Key West, Florida, on 25 May 1967. All of the drops were recorded by high-speed motion picture cameras operating at 250 frames/sec. A team of Navy divers recovered some of the stores from the sea bottom.

Prior to the air drops, the operation of each nose was checked. For this check the nose was removed from the afterbody and the nose cap was removed to expose the end of the piston, see figure 18. The axial force required on the piston to move the two release pins the necessary distance for satisfactory operation was recorded. A special test fixture was used to measure this force. The operation of the nose of each recovered store was also checked after the air drops.

Run No. 1 - Store No. 1 with a nominal depth setting of 40 ft was launched nose first. After air launch, the store tumbled end-over-end all the way to the water surface. The store fell into 85 ft of water. The main parts of the unit were not located by the divers although indications are that the pellets were ejected because two pellet spacers belonging to the assembly were found.

Run No. 2 - Store No. 12 with a nominal depth setting of 1250 ft was launched tail first. Immediately after launch, the store tumbled slowly and then assumed a stable nose down attitude during the rest of the trajectory with the store hitting the water surface nose first. When the Navy divers located the store on the ocean bottom, the store was standing straight up with the nose embedded in the ocean floor. The intact store was brought on board the support ship and found to be in excellent condition, see figure 19. The following items were noted after examination of the store:

1. The operation of the nose release mechanism was satisfactory.
2. The brass nose cap was slightly dented.
3. The 3/4 in. diameter tube of the spacer weld assembly was stuck in the 3/4 in. diameter center hole of the aft end cap.

Run No. 3 - Store No. 4 with a nominal depth setting of 40 ft was launched tail first. The store tumbled slowly at first and then assumed a stable nose down attitude during the rest of the trajectory with the store hitting the water surface nose first. When the store was located on the ocean bottom the nose was separated from the afterbody. This was expected because the operating depth of the release mechanism (40 ft) was exceeded. The store was retrieved and found to be in excellent condition. The following items were noted after examination of the store:

1. The operation of the nose release mechanism was satisfactory.
2. The brass nose cap was slightly dented.

Run No. 4 - Store No. 5 with a nominal depth setting of 750 ft was launched tail first. The store tumbled slowly at first and then assumed a stable nose down attitude during the rest of the trajectory with the store hitting the water surface nose first. The store was recovered intact

NADC-AE-6823

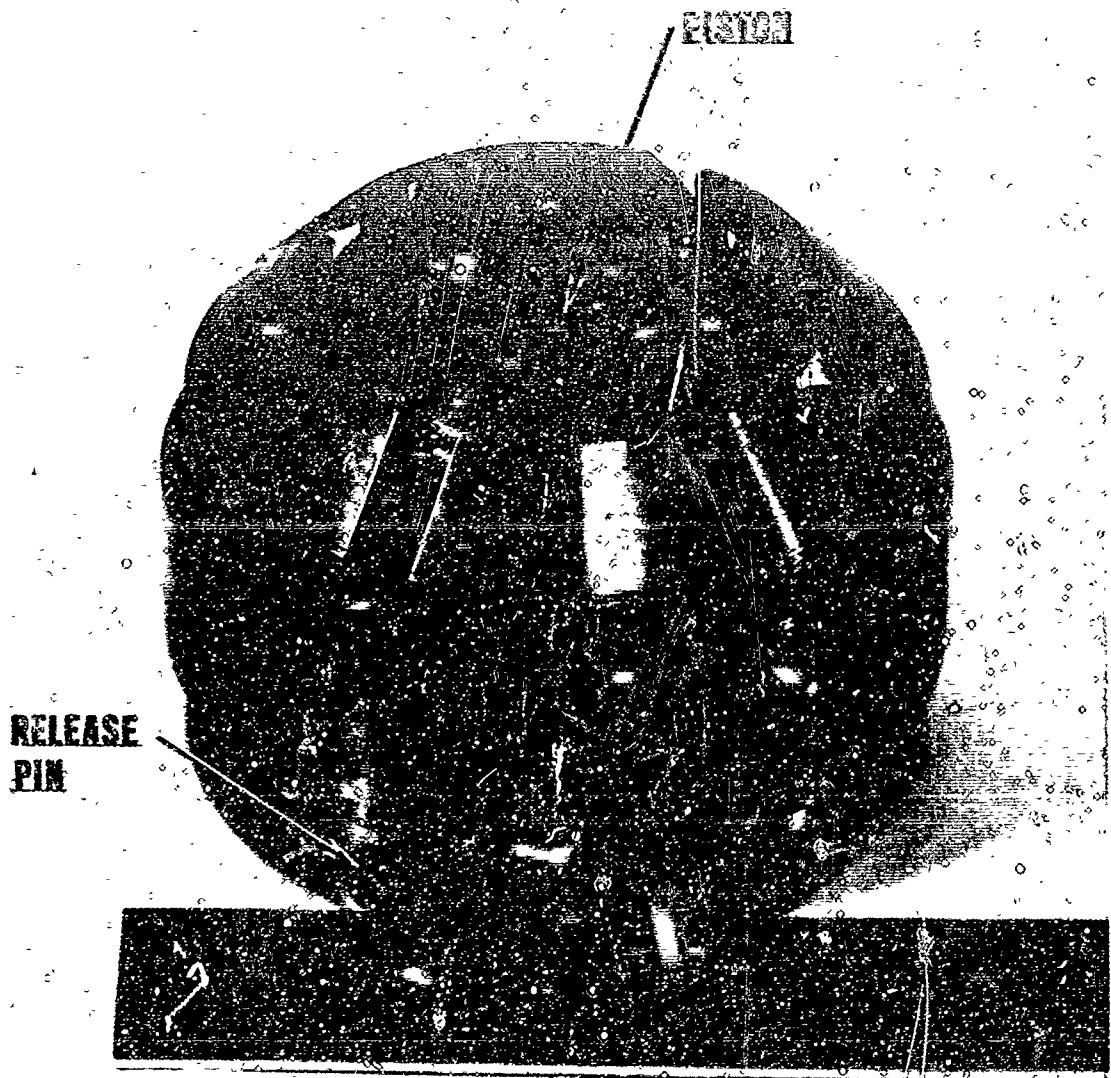


FIGURE 18 - Nose With Nose Cap Removed

NADC-AE-6823

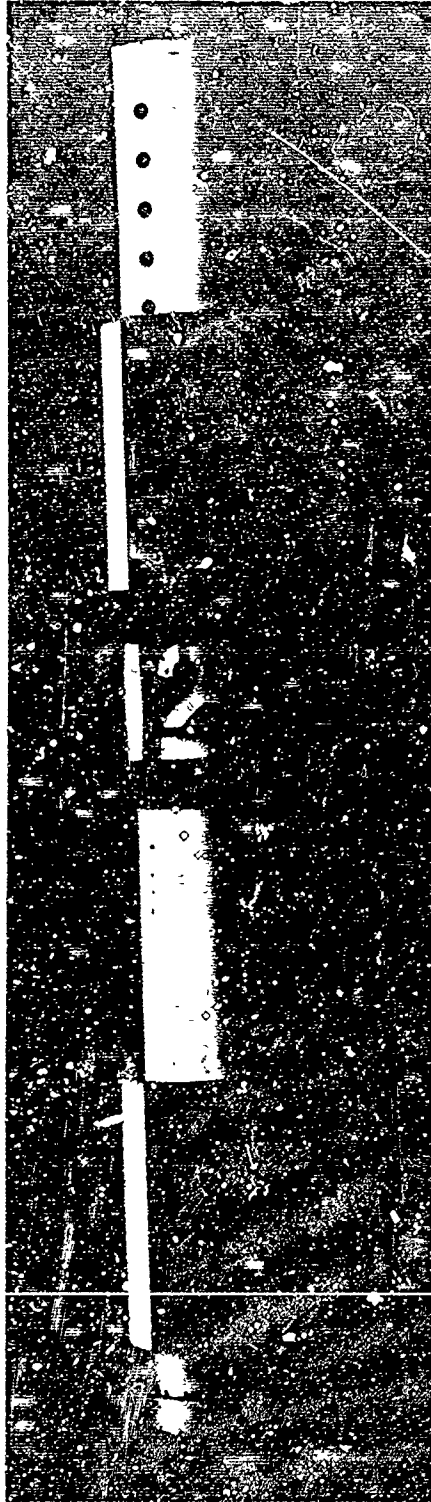


FIGURE 19 - Store No. 12 After Air Launch

and found to be in excellent condition, see figure 20. The following items were noted after the store was examined:

1. The operation of the nose release mechanism was satisfactory.
2. The brass nose cap was dented slightly.

Run No. 5 - Store No. 6 with a nominal depth setting of 750 ft was launched tail first. Immediately after launch the store tumbled slowly and then assumed a stable nose down attitude during the rest of the trajectory with the store hitting the water surface nose first. The store was not recovered.

Run No. 6 - Store No. 8 with a nominal depth setting of 750 ft was launched tail first. Immediately after launch, the store slowly tumbled and then assumed a stable nose down attitude during the rest of the trajectory with the store hitting the water surface nose first. The store was recovered intact and found to be in excellent condition, see figure 21. After examination the following items were noted:

1. The operation of the nose release mechanism was satisfactory.
2. The brass nose cap was dented slightly.
3. The 3/4 in. diameter tube of the spacer weld assembly was stuck in the 3/4 in. center hole of the aft end cap.

Run No. 7 - Store No. 9 with a nominal depth setting of 1250 ft was launched nose first. After launch the store tumbled end-over-end and hit the water surface broadside. The store was retrieved intact and found to be in excellent condition. After examination the following item was noted:

1. The operation of the nose release mechanism was satisfactory.

Run No. 8 - Store No. 10 with a nominal depth setting of 1250 ft was launched tail first. Immediately after launch the store tumbled slowly and then assumed a stable nose down attitude during the rest of the trajectory with the store hitting the water surface nose first. The store was not recovered.

Runs No. 9, 10, and 11 - Stores No. 13, 14, and 16 having nominal depth settings of 1500 ft were launched tail first on these runs. The results were the same as Run No. 8. The stores were not recovered.

NADC-AE-6823



FIGURE 20 - Store No. 5 After Air Launch

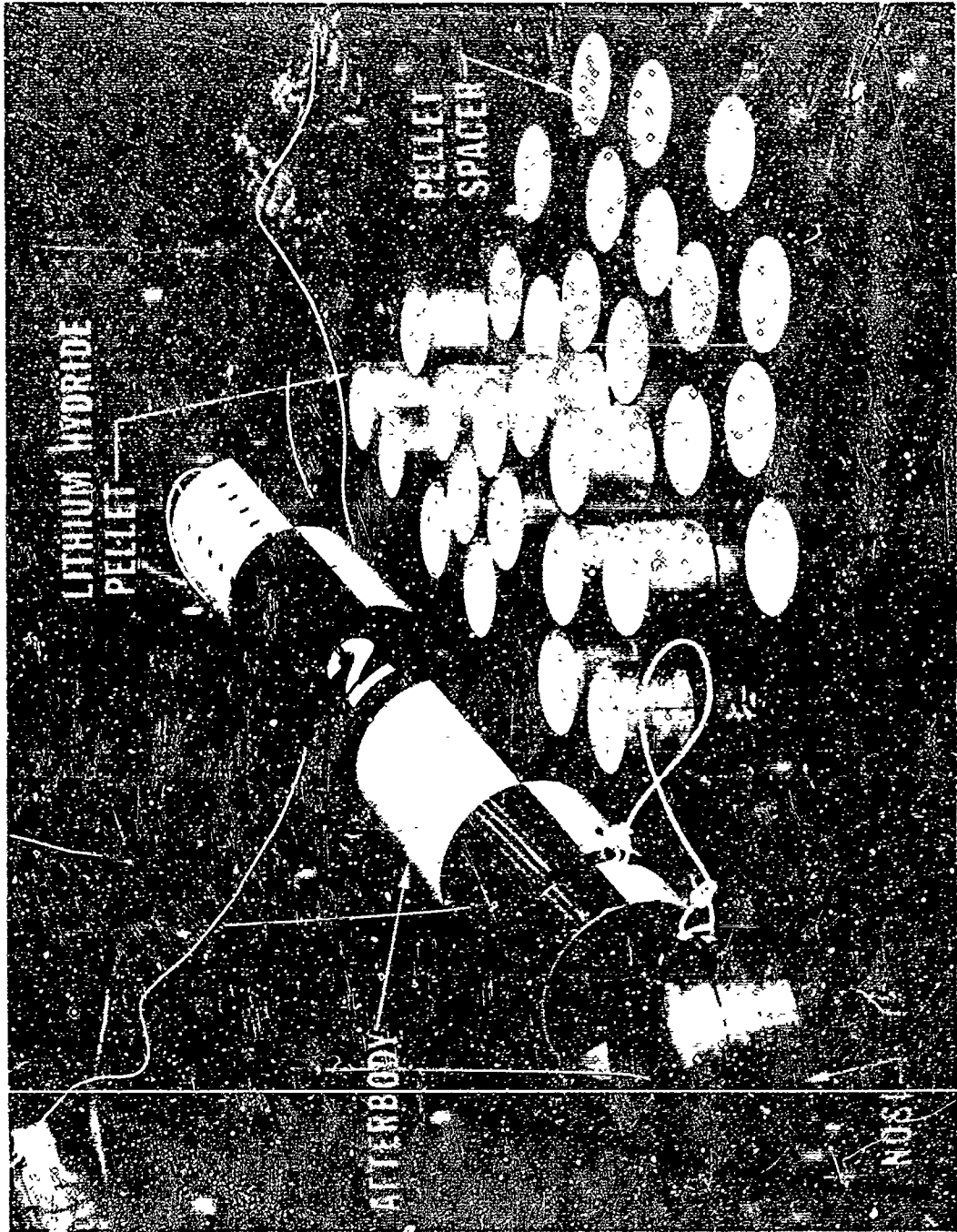


FIGURE 21 - Store No. 8 After Air Launch

ECHO RANGING TESTS**12 January 1968 Tests**

Echo ranging tests were conducted on store No. 2 (see figure 15) on 12 January 1968 off Key West, Florida. Store No. 2 has a 50-ft depth nose release mechanism. The tests were conducted by personnel of the NAVAIRDEVCON ASW Field Station, U.S. Naval Ordnance Unit, Naval Station Annex, Key West, Florida.

Receiving and recording equipment was installed on the 62-ft underwater ordnance recovery boat No. 128. A block diagram of the equipment is shown in figure 22.

Test No. 1

For this test, the support boat (No. 128) traveled to an area off Key West, Florida, where the water depth was approximately 2900 ft deep. An AN/SSW-23 and an AN/SSQ-41 sonobuoy were placed over the side. Each sonobuoy had a hydrophone at a 60-ft depth.

The nose and spring assembly of the ASW test target were attached to the afterbody by lines, and the store was attached to the support boat by a 70-ft line so that the unit could be retrieved. The ASW test target was loaded with fifteen LiH pellets. About 500 yd from the sonobuoy plant, the ASW test target was dropped over the side. The store was retrieved after the pellets were ejected. The boat then traveled back to the sonobuoy plant. MK61-0 signals, underwater sound (SUS), were then individually dropped over the side with a short interval of time between each drop. The MK61-0 SUS contains 1.8 lb of TNT and is set to explode at a depth of 60 ft². The sound from each SUS traveled to the bubble cloud. It was then reflected to the sonobuoys which detected and transmitted the signal to the support boat where it was received and recorded.

A summary of the test results is given in tables IV and V. The target was observed for 11 min with seven shots and initially gave single echoes. Shots 3 through 7 produced double echoes with the echo level becoming weaker with time.

Test No. 2

This test was conducted on the same day and in the same manner as test No. 1, except that the store was not restrained by a line but was allowed to fall freely and was not recovered. The target was seen for 12 min time. This target gave multiple echoes with the first shot having echo ranges of 395, 500, and 570 yd.

2. *"Signals, Underwater Sound, for Explosive Echo Ranging," NAVWEPS OP 2982, First Revision, 1 Dec 1963, published by Direction of the Chief of the Bureau of Naval Weapons.*

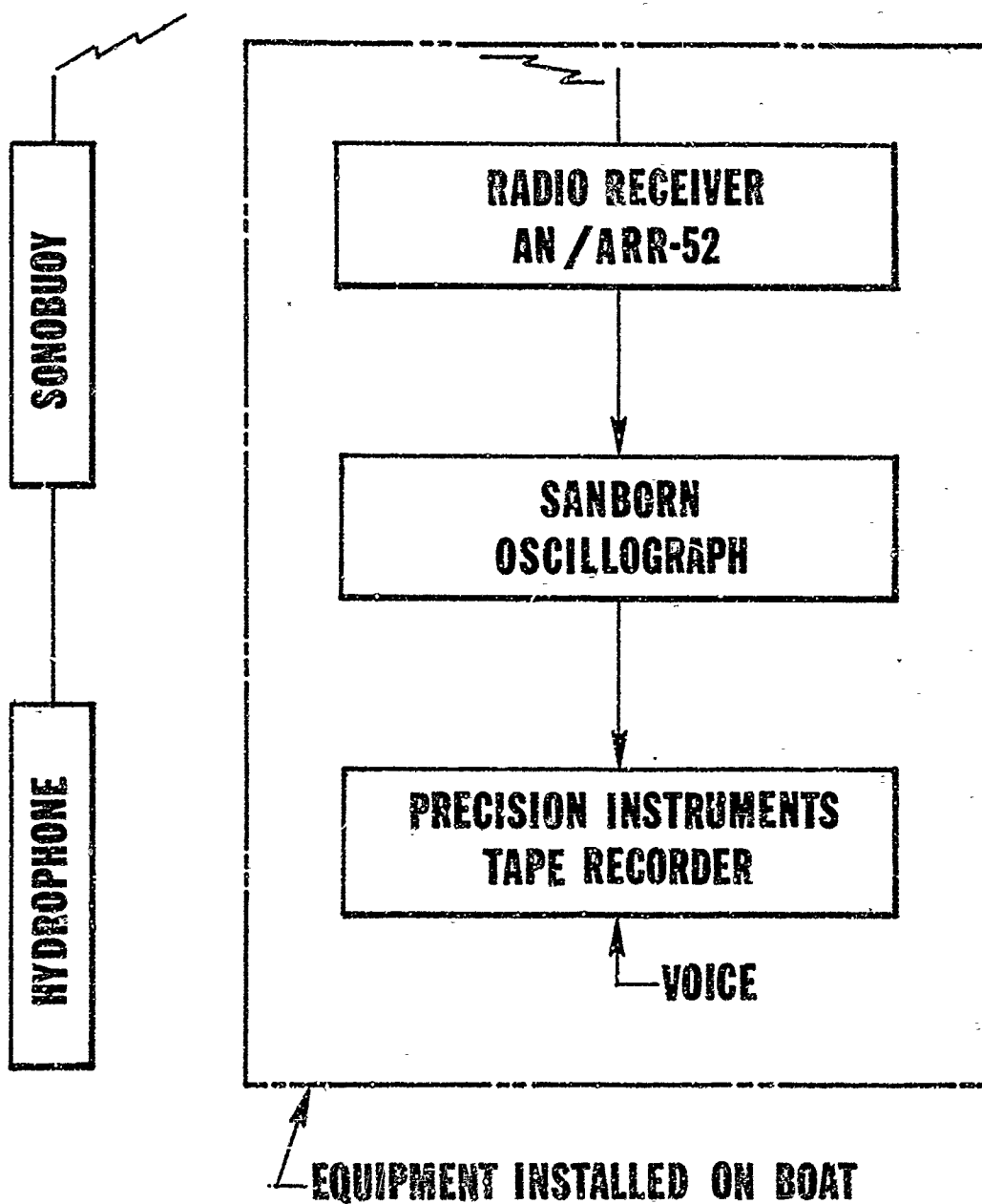


FIGURE 22 - Block Diagram - Test Equipment

NADC-AE-6823

T A B L E I V

TEST NO. 1 - ECHO RANGING DATA FROM THE AN/SSQ-41 SONOBUOY

<u>Shot No.</u>	<u>Time</u>	<u>Range 1 (yd)</u>	<u>Range 2 (yd)</u>	<u>Remarks</u>
1	1202	510	None	Good sharp single echo
2	1205	500	None	Good sharp single echo
3	1206	500	530	Two echoes
4	1209	495	535	Two sharp echoes
5	1210	480	520	Two weak echoes
6	1212	510	540	Two weak echoes
7	1213	500	530	Two very weak echoes
8	1216	None	None	No echo

T A B L E V

TEST NO. 1 - ECHO RANGING DATA FROM THE AN/SSQ-23 SONOBUOY

<u>Shot No.</u>	<u>Time</u>	<u>Range 1 (yd)</u>	<u>Range 2 (yd)</u>	<u>Remarks</u>
1	1202	550	None	Single echo
2	1205	510	None	Single echo
3	1206	508	570	Two echoes
4	1209	500	550	Two echoes
5	1210	510	560	Two medium sharp echoes
6	1212	510	550	Two medium sharp echoes
7	1213	500	550	Two very weak echoes
8	1216	None	None	No echo

NADC-AE-6823

NAVAIRDEVCON AEH-04

25 August 1967

Revision 1

A P P E N D I X A

U.S. NAVAL AIR DEVELOPMENT CENTER
JOHNSVILLE
WARMINSTER, PENNSYLVANIA

SPECIFICATION FOR ASW TEST TARGET CAN

PREPARED BY: Francis E. Buck
D/S Div, AETD

APPROVED BY: Leo Shore
Technical Staff Assistant
Aero-Electronic Technology Department

SPECIFICATION FOR ASW TEST TARGET CAN

1. **SCOPE** - This specification governs the assembly and preparation for delivery of ASW (Anti-Submarine Warfare) Test Target Cans, NADC Part Numbers EH-00333-1, -2, and -3 and the methods of inspection and tests upon which acceptance will be based. The ASW Test Target Cans consist of a long sealed can that contains an expendable store containing chemical pellets. In operation, the sealed can is opened by means of a tear strip provided at one end of the can. The enclosed store is removed from the can and then launched from an aircraft into the airstream by an ejecting apparatus. The store lands in the water and ejects the chemical pellets at pre-selected water depths.

2. **CLASSIFICATION** - The ASW Test Target Cans shall be identical except for the following:

<u>NADC Part No.</u>	<u>Depth Setting</u>
EH-00333-1	Separation mechanism set to eject the chemical pellets at a depth of 50 feet.
EH-00333-2	Separation mechanism set to eject the chemical pellets at a depth of 750 feet.
EH-00333-3	Separation mechanism set to eject the chemical pellets at a depth of 1500 feet.

3. **APPLICABLE DOCUMENTS** - The following specifications, standards and drawings of the issue in effect on the date of invitation for bids, form a part of this specification:

SpecificationsFederal

PPP-B-601	Boxes, Wood, Cleated-Plywood
PPP-B-621	Boxes, Wood, Nailed and Lock-Corner
PPP-B-636	Box, Fiberboard

Standards

MIL-STD-129	Marking for Shipment and Storage
-------------	----------------------------------

DrawingsNADC Dwg No.

EH-00333	Assembly and Details, ASW Test Target Can
EH-00318	Assembly and Details, ASW Test Target

(2 sheets)

Naval Ordnance Lab (NOL) Dwg No.

398952	False Target Can - MK2, MOD 0 and MK2, MOD 1
398090	Lead Block
398088	Cup
398089	Chemical Mixture

4. REQUIREMENTS - The ASW Test Target Cans covered by this specification shall be assembled as per NADC Drawing Nos. EH-00318 and EH-00333. All of the subassemblies, parts and other materials required for the final assemblies will be supplied by NAVAIRDEVCON. The assembled ASW Test Target Cans are to be airtight.

The chemical pellets that are required for the assembly of the ASW Test Target Cans are also component parts of the False Target Can, MK2, MOD 1, NOL Drawing No. 398952. The False Target Cans will be supplied by NAVAIRDEVCON as a source of the pellets. Each pellet consists of the following:

NOL Dwg 398090	Lead Block
NOL Dwg 398088	Cup
NOL Dwg 398089	Chemical Mixture

Each pellet consists of 116 ±2 grams of the chemical mixture that is pressed into the cup under pressure, with the lead weight centered in the bottom of the cup. The chemical mixture consists of the following:

Lithium Hydride - 79.2%
Isopropyl Naphthalene Sodium Sulfonate (Aerosol OS) - 1.0%
Paraffin - 19.8%

5. CHEMICAL HANDLING CONDITIONS - The False Target Cans used as a source of the chemical pellets should be dry before opening and must be opened only in a dry room in which the dewpoint is -5° C or lower and subsequent handling of the chemical pellets must be carried out under the same conditions. The equipment used for handling the chemical pellets must be clean, dry and free from rust. The removal of the chemical pellets from a False Target Can is to be done immediately prior to the installation of the chemical pellets into the ASW Test Target Can, which is then to be immediately sealed. The time required for the transfer of the chemical pellets from one sealed container to the other sealed container should be kept to a minimum.

NAVAIRDEVCCEN AEH-04
25 August 1967
Revision 1

6. **ASSEMBLY** - All material used in completing this assembly shall be moisture free. Assembly shall be carried out in an atmosphere having a dewpoint of -5° C or lower. This moisture control is absolutely essential in order to assure that the cans will be safe to handle and store.

7. **SEALING** - After completion of the assembly, the container shall be airtight. Testing and acceptance shall be as follows:

Testing shall take place immediately after assembly. All of the completed cans shall be tested with dry air. An internal air pressure of four pounds per square inch shall be applied to each can through the 1/16 inch diameter hole located in the center of the end plate adjacent to the tear strip. A can shall be rejected that cannot maintain the four pounds per square inch air pressure for at least two minutes. Satisfactory cans shall be immediately sealed with solder over the 1/16 inch diameter hole as specified on NADC Dwg EH-00333. Rejected cans are to be reworked and tested again. Only those cans that pass the sealing test will be accepted by NAVAIRDEVCCEN. The sealing tests shall be observed by a representative of NAVAIRDEVCCEN.

8. **PACKAGING AND PACKING** - Each ASW Test Target Can is to be individually prepackaged in a fiberboard box conforming to Federal Specification PPP-B-636, NSC compliance symbol, with each can or fiberboard box waterproofed as per Federal Specification PPP-B-636. Prepackaged ASW Test Target Cans shall be packed in wood, cleated-plywood boxes conforming to Federal Specification PPP-B-601, overseas type; or packed in wood, nailed and lock-corner boxes conforming to Federal Specification PPP-B-621, Class 2 (overseas). ASW Test Target Cans with different part numbers (different depth settings) are to be packed in separate wooden boxes with a minimum of one and a maximum of five prepackaged cans per wooden box.

9. **MARKING** - In addition to any special marking required by the contract or order, all shipping boxes shall be marked in accordance with Standard MIL-STD-129 and the Interstate Commerce Commission Regulations for the Transportation of Explosives and other Dangerous Articles.