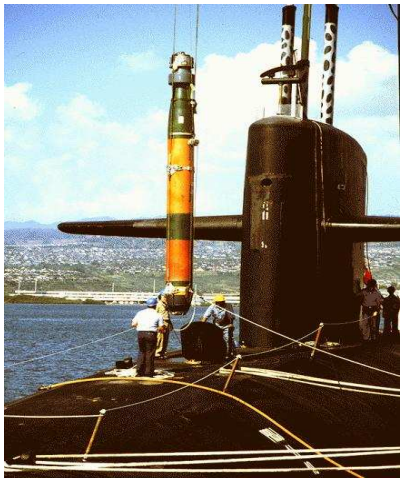
Eliminating Lead from MK-48 Torpedo Flex-Hose

TRI Austin
9063 Bee Caves Road
Austin, TX 78733-6201

Contact: Azucena Overman
Phone: (512) 263 2101 x231
Fax: *(512) 263-3530*
Email: aoverman@tri-austin.com
Website: *www.tri-austin.com*



Command: NAVSEA
Topic: N03-067

PROBLEM STATEMENT

The Mk48 Mod 5 and Mod 6 Advanced Capability (ADCAP) Heavyweight Torpedo is a primary submarine weapon that fulfills both anti-submarine and anti-surface roles and is considered a primary weapon for the United States Navy (USN) Submarine fleet. The torpedo employs a post Launch guidance wire communications link that provides accurate data exchange between the recently fired torpedo and the submarine. This link is achieved via the use of a Torpedo Mounted Dispenser (TMD) Mk10 Mod 1 that is secured in the Submarine's torpedo tube independently from the torpedo. The TMD utilizes a hollow flexible hose (the Flex-Hose assembly in Figure 1) which houses the guidance wire. The Flex-Hose pays out behind the torpedo from the TMD that is secured within the submarine's torpedo tube and breaks away from the torpedo just prior to full deployment. The Flex-Hose is used to position the guidance wire below

Torpedo Mounted Dispenser (TMD) for Mk 48 Torpedo
Guidance Wire Communication System

The TMD houses a shipboard wire coil and flex-hose which allows for high ship speeds while communicating with deployed Mk 48 Torpedoes. A high specific gravity ballast component is required to weight the flex-hose sufficiently enough to support high ship speeds. To date lead is the only cost effective ballast material that can be utilized within the flex-hose.

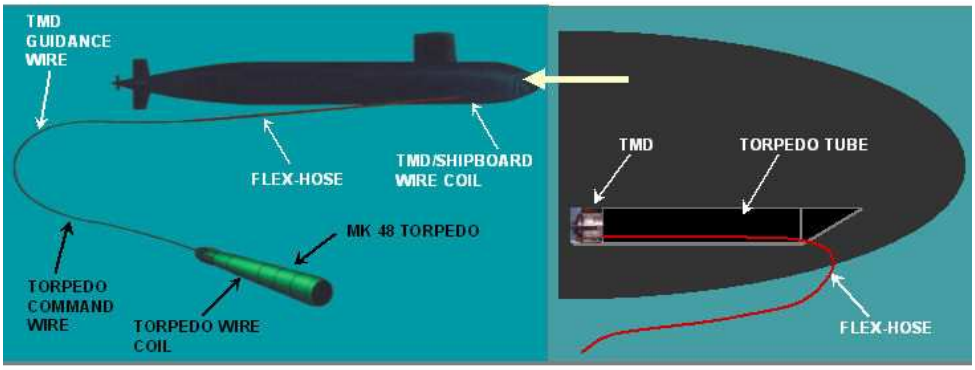


Figure 1

the submarine's keel and clear of the propellers. A lead tape ballast is used within the Flex-Hose to make it heavy enough so that the submarine can travel through the water at high speeds without the guidance wire entangling with its propeller. At the end of the torpedoes run the flex-hose is expended into the ocean.

In recognition of the serious health hazards associated with lead ingestion and the numerous sources of potential lead exposure, the Navy has established strict controls to limit both occupational and environmental exposures. While there are no existing requirements for removing the lead ballast material from the flex-hose the Navy recognizes that there is health hazards associated with ingestion of lead and that the use of lead in torpedo operations can result in an undesirable waste stream. As good stewards of the environment and the health of the sailors, the Navy is being proactive in seeking out cost efficient methods to eliminate the lead or at least take measures (such as encapsulation) to further minimize any potential for ingestion.

WHO CAN BENEFIT?

An alternate lead tape ballast material, one that is both environmentally friendly and poses no exposure or ingestion risk is being designed to replace the present lead tape ballast used in the Flex-Hose. Sailors, who are required to handle the flex-hose at locations that prepare the Mk 10 Mod 1 TMDs, install the flex-hose on the torpedo or handle it on board submarines would benefit. Additionally, the ocean environment would also benefit by the elimination of disposing of a heavy metal or encapsulation to minimize the potential for ingestion. PEO SUB is sponsoring this effort to eliminate lead from the Flex-Hose as a ballast material. It may also be applicable to the United Kingdom's Spearfish Torpedo. It is possible the technology could be adapted to other ballast applications on submarines and ships.

Lead is also used as a sheathing material for power cables in several areas, e.g., the petrochemical industry, undersea and for underground high voltage cables. The largest consumers of lead cable sheathing in 1999 were France (13,000t), UK (9,600t), Italy (3,300t), India (3,000t) and South East Asia (7,7000t).

BASELINE TECHNOLOGY

Currently, the only technology that is capable of allowing the Flex-Hose to adequately perform at the required high submarine speeds is the present tin-platted lead tape ballast material.

In other applications such as sheathing, other metallic materials may be used except in the case of undersea cables, which employ lead for its corrosion resistance to salt water. Lead sheathing is also preferred over aluminum for power transmission applications due to its higher resistivity. The lower resistivity of Aluminum sheaths results in higher eddy currents and reduces overall voltage transmission for power transmission.

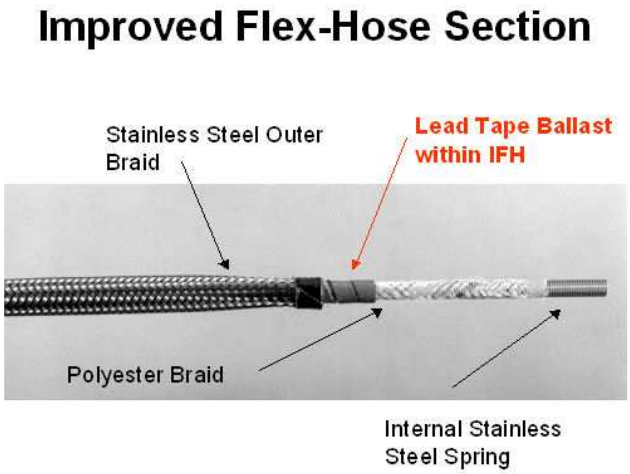


Figure 2

TECHNOLOGY DESCRIPTION

The lead tape replacement will be a high density flexible composite material that is both environmentally friendly and has no hazardous components. Table 1 summarizes design considerations for this project and compares the current technology that employs the tin-platted lead tape with new designs being developed by TRI/Austin.

The Flex Hose assembly must work in an undersea environment with high hydrostatic pressure and conditions conducive to galvanic corrosion, while maintaining flexibility over a wide temperature range. Any new ballast material must be integrated into, or simplify, the current Flex Hose manufacturing process. The new Flex Hose assembly must not cost significantly more than the current design. Finally, the material must meet or exceed the current operational requirements of the Flex Hose.

Table 1. Design Goals for New Ballast and Comparison to Baseline Technology

Description	Baseline - Tin Plated Lead Tape	Assembly with New Ballast
Obtain a limited usage category in NPSACM, S9510-AB-ATM-010	Yes	Yes
Ballast can be safely handled and used by the USN as determined by a USN Industrial Hygienist.	Yes	Yes
Environmentally non-toxic.	No	Yes
Weight not to exceed 111 pounds.	Yes	Yes
Bendability within 1/8 inch of a 5 ¼ inch radius located 5 +/- ½ feet above the ground.	Yes	Yes
Can be installed and secured within the existing Mk10 Mod 2 TMD and mates with existing connections.	Yes	Yes
Meets criteria 1, 2 and 3 in each of the following conditions		
After transportation vibration.	Yes	Yes
Shipboard Operation Vibration	Yes	Yes
Shipboard Shock (Stowage)	Yes	Yes
Handling Shock	Yes	Yes
Long term storage temperature and humidity cycling.	Yes: 1 & 2; No: 3[1]	Yes
Low Temperature Storage and Operational.	Yes: 1 & 2; No: 3[1]	Yes
High Temperature Storage and Operational.	Yes: 1 & 2; No: 3[1]	Yes
Meets criteria 1 and 4 in each of the following conditions:		
Hydrostatic Pressure Operational Cycling.	Yes	Yes
Hydrostatic Pressure Proof.	Yes	Yes
Fungus	Yes	Yes
Meets criteria 1, 3, 4 and 5 in a Sea Water Corrosion environment.	Yes: 1 & 4; No: 3 & 5[1]	Yes
Will not significantly degrade via galvanic corrosion or by other means after being subjected to this environment to the point where the functionality is compromised. In addition will not emit any hazardous/toxic effluent either during or immediately after being subjected to this environment.	No	Yes
Maintains integrity and does not show signs of damage by the effects of high altitude.	Yes	Yes
Production unit not greater than $1,000 based on an annual production quantity of 800 units.	Yes	TBD

Criteria 1 = Is deployable by hand without knotting, kinking, collapsing or tangling.
Criteria 2 = Maintains mechanical and electrical integrity of guidance wire and wire splice.
Criteria 3 = Does not emit any particles or hazardous substances.
Criteria 4 = Maintains its integrity, does not swell and meets minimum flexibility requirements.
Criteria 5 = Is resistant to Corrosion.

[1] Tin plated lead tape is galvanically incompatible with the Austentitic stainless steel over braid in marine environments and salt water per MIL-STD-889B, *Dissimilar Metals*.

CURRENT STATE OF DEVELOPMENT

At this point, the project is at TRL 2. Three candidate material systems with a variety of densities have been evaluated in house. Test specimens with specific gravity ranging from 6 to 10.4 have been fabricated and tested for strength, flexibility, and water absorption over a wide temperature range. All samples exhibit good flexibility and low water uptake. The best material system will be selected from the candidates by March of 2006.

Several new Flex -Hose configurations incorporating the new ballast materials have been designed that meet the performance goals based on analysis. These configurations are under review by the Navy. The design that best meets the design requirements will be selected for fabrication and testing.

TRI/Austin is working with Cortland Cable to develop a new manufacturing process to incorporate the new ballast material system into the Flex-Hose design. A manufacturing plan should be in place by April of 2006.

Table 2: Phase II Milestones and TRL's

Milestone	TRL	Risk	Measure of Success	TRL Date
Material Selection	2	Low	Material Selected	Mar 2006
Manufacturing Plan	2	Moderate	Manufacturability	Mar 2006
Preliminary Prototypes	4	Moderate	Delivery	May 2006
Additional Prototypes	4	Moderate	Delivery	Mar 2007

TECHNOLOGY AVAILABILITY

TRI/Austin, Inc. is teaming with Cortland Cable, the manufacturer of the current Flex-Hose assemblies in order to ensure that there is a path to manufacture the ballast in the new assembly and that it will require minimal changes in current manufacturing facilities. It is anticipated that Cortland Cable will assist with the technology transition efforts to integrate the revised improved Flex-Hose design into the Mk 10 Mod 1 TMD design configuration.

The technology should be undergoing sea trials in 2007 and NAVSEA is currently gathering requirements for the Sea Trial and qualification of prototypes. Once the Sea Trial is defined, an estimate of required funding can be made. TRI/Austin seeks Program Office support for test and evaluation in Phase III. The option to obtain matching SBIR funds for transition will also be explored.

Table 3: Phase III Steps to Transition

TRL	Required Test and Demos	Target Date
6	Prototypes for Sea Trial	Mar 2007
7	Sea Trial	2007
8	Qualification	2008

These steps to transition will be further developed once the material has been selected and the manufacturability plan has been developed.

REFERENCES

TRI/Austin is working with the Naval Undersea Warfare Center Division Newport the In-Service Engineering Agent (ISEA) and Cortland Cable, the manufacturer of the Flex-Hose Assembly. The sponsor of this project is Mr. Richard McNamara, Deputy PEO SUB.

Phase II TPOC: David Abdow
Naval Undersea Warfare Center
4123, Bldg 1246
Newport, RI 02841
Tel: 401-832-1827
E-mail:
AbdowDA@npt.nuwc.navy.mil

Walt Nyzio, VP Operations
Cortland Cable
44 River Street, Box 330
Cortland, NY 13045 USA
Tel: (607) 753-8276
E-mail:
waltn@cortlandcable.com

Mr. Richard M. McNamara
Deputy PEO SUBS
Naval Sea Systems Command
Washington Navy Yard
E-mail:
mcnamararr@navsea.navy.mil

Additional references from TRI/Austin's other transitioned products are available upon request.

ABOUT THE COMPANY

Founded in 1975 by Dr. J. Scott Thornton, TRI is a small business specializing in engineering material solutions for defense and government applications. Over 70 scientists, researchers, and support personnel perform applied research, product development, and testing in a wide variety of physical and organic sciences. TRI/Austin's areas of recognized technical expertise include: materials science, composite materials and products, environmentally compliant alternative material development, adhesives, polymer science, coatings, nondestructive testing, accelerated life testing, reliability engineering, and specialized instrument development.

Figure 3: TRI/Austin's Tough-Grip™ non-skid coating deployed aboard the USS Truman.

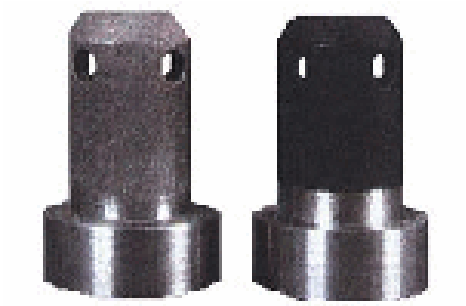


Figure 4: BondCoat coating commercialized by TRI/Austin, Inc. for submarine connectors.

TRI/Austin performs contract research and development, and product development for DOD, other government and private industry, as well as operating certification testing laboratories for compressed air, geosynthetics and protective clothing. We have developed a variety of innovations that are now commercially available, including nonskid coatings for aircraft carriers, fire resistant composites resin systems, protective coatings for electrical connectors, an environmentally friendly lead substitute, and a new aircraft adhesive.