NAVAL UNDERWATER SYSTEMS CENTER
NEWPORT, RHODE ISLAND

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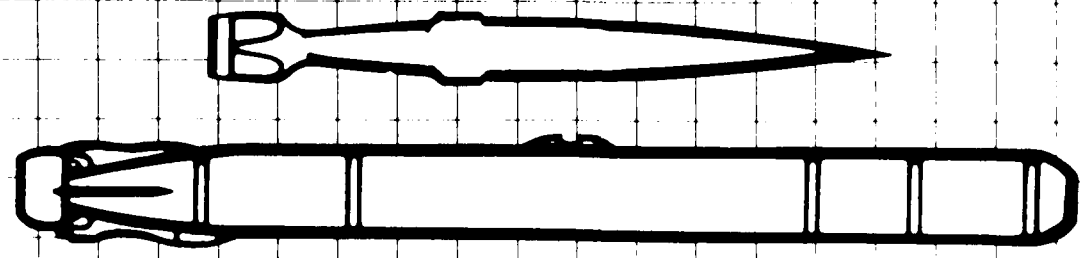
NUSC ON TORPEDOES

OVER A CENTURY OF LEADERSHIP



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..I.P. Fiori
Captain, U.S. Navy
Commander, Naval Underwater Systems Center

E.L. Messere
Technical Director
Naval Underwater Systems Center

Cover Photo:
A Mk 48 torpedo scores a direct hit on the ex-Moore (DD-240) during a 1975 warshot firing excerise.

PREFACE

The Naval Underwater Systems Center (NUSC) and its predecessor activities have had a preeminent role in U.S. Navy torpedo developments for more than a century. Over this long period, the torpedo has demonstrated itself to be one of the most remarkable weapons ever conceived by man. It has had a major impact on warship designs (compartmentation, dreadnoughts, etc.), on the evolution of new warships (destroyers, submarines, PT boats, etc.), and on naval tactics (unlimited submarine warfare, the attack on Pearl Harbor, etc.). At the strategic level, torpedoes have been used to sever the seaborne lifelines of island nations such as Great Britain and Japan.

NUSC's "taproot" predecessor organization, the Naval Torpedo Station, Newport (NTS/NPT), founded in 1869, was the world's first naval establishment dedicated to torpedoes. The U.S. Navy's first torpedo was built and tested at NTS/NPT in 1871 and, since that time, Newport has been in the forefront of U.S. Navy torpedo efforts.

This brochure documents some of the major milestones that have occurred during the past century and summarizes NUSC's long-standing leadership role in the evolution of U.S. Navy torpedoes.

OVER A CENTURY OF

■ 1870s

FIRST AUTOMOBILE "FISH" TORPEDO FOR U.S. NAVY (BASED ON WHITEHEAD CONCEPT) BUILT AND DEMONSTRATED BY NAVAL TORPEDO STATION, NEWPORT (NTS/NPT).

■ 1880s

IN-WATER EVALUATION OF COMPETITIVE TORPEDO DESIGNS BY U.S. INVENTORS (LAY, ERICSSON, HOWELL, ETC.) CONDUCTED AT NTS/NPT.

HOWELL TORPEDO SELECTED FOR USE BY U.S. NAVY (A PROTOTYPE WAS BUILT AT NTS/NPT).

FIRST FLEET TORPEDO BOAT (STILETTO) PURCHASED FROM HERRESHOFF BOAT CO. FOR EVALUATION AT NTS/NPT.

■ 1890s

FIRST AUTOMOBILE TORPEDOES (MK 1 HOWELL MANUFACTURED BY HOTCHKISS) ISSUED TO FLEET (BATTLESHIPS) BY NTS/NPT.

FIRST TORPEDO BOAT TRIALS (STILETTO WITH MK 1 HOWELL) CONDUCTED AT NTS/NPT.

FIRST FLEET TORPEDO BOATS (CUSHING CLASS) ENTER THE FLEET AT NTS/NPT.

FIRST WHITEHEAD TORPEDOES MK 1, 2, AND 3 (MANUFACTURED IN THE U.S. BY THE BLISS CO.) UNDERGO FLEET INTRODUCTION AT NTS/NPT.

■ 1900s

FIRST U.S. NAVY SUBMARINE (HOLLAND) EVALUATED AT NTS/NPT AGAINST FLEET UNITS (MANNED BY NAVY CREW FROM NTS/NPT).

FIRST TURBINE-POWERED TORPEDO (BLISS-LEAVITT) EVALUATED AT NTS/NPT.

FIRST TORPEDO (WHITEHEAD MK 5) PRODUCED BY U.S. NAVY BUILT AT NTS/NPT.

FIRST U.S. NAVY DESTROYER TRIALS (BAINBRIDGE) CONDUCTED AT NTS/NPT.

■ 1910s

FIRST TURBINE-POWERED TORPEDO (MK 7) BUILT BY U.S. NAVY PRODUCED AT NTS/NPT.

FIRST 21-INCH-DIAMETER BY 21-FOOT-LONG TORPEDO (MK 8 DESTROYER TYPE) PRODUCED AT NTS/NPT.

FIRST 21-INCH-DIAMETER SUBMARINE TORPEDO (MK 10) FOR R&S CLASS BOATS PRODUCED BY NTS/NPT.

■ 1920s

NTS/NPT BECOMES NAVY'S SOLE TORPEDO DEVELOPMENT AND PRODUCTION ACTIVITY.

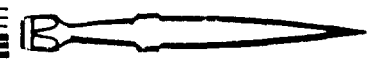
FIRST TORPEDO (MK 11 DESTROYER) DEVELOPED SOLELY BY U.S. NAVY (NTS/NPT AND WASHINGTON NAVY YARD).

FIRST TORPEDO (MK 12 DESTROYER) DEVELOPED AND PRODUCED SOLELY BY NTS/NPT.

FIRST TORPEDO PLANES (PT-1) EVALUATED AT NTS/NPT USING MK 7 TORPEDOES.

■ 1930s

FIRST AIRCRAFT TORPEDO (MK 13) DEVELOPED BY NTS/NPT (USED EXTENSIVELY DURING WORLD WAR II).



■ NTS/NPT "FISH" TORPEDO

LEADERSHIP IN TORPEDOES

NTS/NPT DEVELOPS MK 14 SUBMARINE TORPEDO (USED TO SINK APPROXIMATELY FOUR MILLION TONS OF SHIPPING DURING WORLD WAR II).

NTS/NPT DEVELOPS MK 15 TORPEDO AS PRIMARY U.S. NAVY DESTROYER TORPEDO (USED EXTENSIVELY DURING WORLD WAR II).

FIRST CHEMICAL TORPEDO PROPULSION SYSTEM DEVELOPMENT (CONCENTRATED HYDROGEN PEROXIDE) INITIATED BY NAVAL RESEARCH LABORATORY (NRL) AND NTS/NPT.

- **1940s**

NTS/NPT IS THE MAJOR PRODUCER OF TORPEDOES DURING WORLD WAR II, PRODUCING APPROXIMATELY 18,000 TORPEDOES OUT OF 58,000 TOTAL (15,000 TORPEDOES USED BY U.S. NAVY DURING WORLD WAR II).

FIRST CHEMICAL TORPEDOES (MK 16 SUBMARINE AND MK 17 SURFACE SHIP) DEVELOPED AT NTS/NPT.

- **1950s**

NTS/NPT BECOMES NAVAL UNDERWATER ORDNANCE STATION (NUOS) AND MAJOR EMPHASIS DIRECTED TOWARD DEVELOPMENT OF TORPEDO SUBSYSTEM TECHNOLOGIES AND ANTI-SUBMARINE WARFARE (ASW).

RETORC II TEST VEHICLE PROGRAM INITIATED TO DEVELOP TECHNOLOGY FOR A HIGH-PERFORMANCE SUBMARINE TORPEDO TO COUNTER NUCLEAR SUBMARINE THREAT (JOINT EFFORT BY NTS AND ORDNANCE RESEARCH LABORATORY, PENNSYLVANIA STATE UNIVERSITY (ORL/PSU)).

UNDER NUOS GUIDANCE THE FIRST WIRE-GUIDED TORPEDO (MK 37-1) ISSUED TO THE FLEET.

- **1960s**

PARTICIPATION IN EX 10/MK 48-0 WEAPON SYSTEM DEVELOPMENT (JOINT ORL/PSU AND NUOS EFFORT) TO BUILD A HIGH-PERFORMANCE ASW TORPEDO SYSTEM TO COUNTER NUCLEAR SUBMARINE THREAT.

NUOS ASSIGNED DIRECTION OF MK 48-2 PROGRAM TO DEVELOP A DUAL-PURPOSE (ANTI-SUBMARINE/ ANTI-SURFACE SHIP) HIGH-PERFORMANCE TORPEDO.

CONSTRUCTION OF EXPERIMENTAL TEST VEHICLES INITIATED AT NUOS TO PROVIDE IN-WATER DEMONSTRATION OF NEW TECHNOLOGIES (PROPULSION, DRAG REDUCTION, QUIETING).

- **1970s**

NAVAL UNDERWATER SYSTEMS CENTER (NUSC) FORMED TO PROVIDE A FULL-SPECTRUM CENTER TO ADDRESS TOTAL WEAPON/COMBAT SYSTEM DEVELOPMENT.

NUSC ASSIGNED RESPONSIBILITY FOR FLEET INTRODUCTION OF MK 48-1 WEAPON SYSTEM.

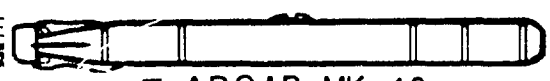
DEVELOPMENT OF MK 48-3 TORPEDO TO PROVIDE TWO-WAY WIRE COMMUNICATIONS INITIATED AT NUSC.

NUSC INVOLVED IN CRASH DEVELOPMENT OF MK 48-4 TORPEDO TO COUNTER ALFA SUBMARINE THREAT.

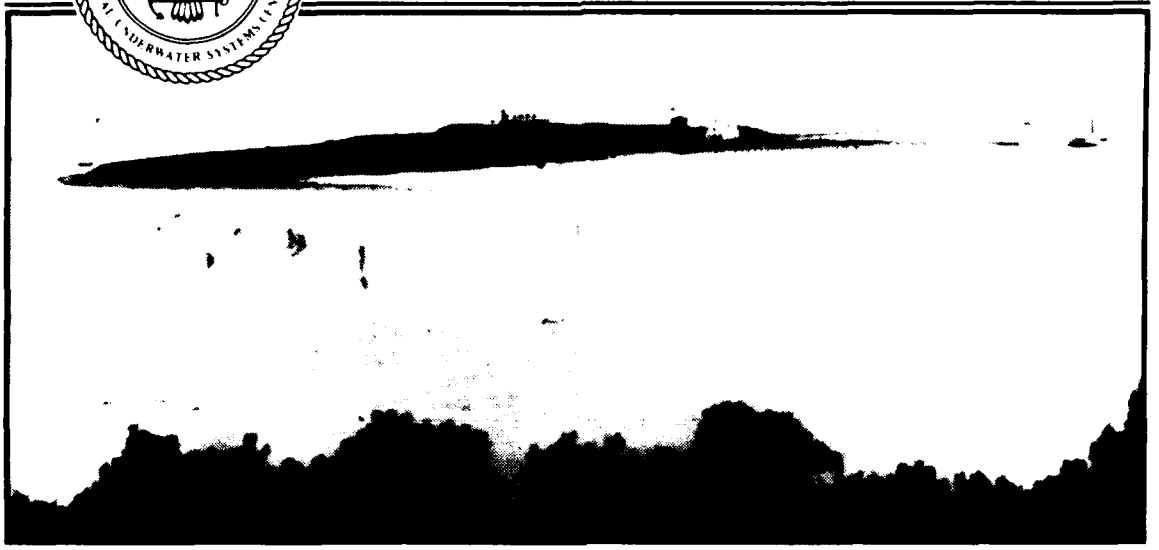
EXPERIMENTAL TEST VEHICLES (EXTOR, SLAST, FIRST, QT, ETC.) BUILT AND TESTED AT NUSC TO PROVIDE IN-WATER DEMONSTRATIONS OF NEW TECHNOLOGIES.

- **1980s**

NUSC PLAYS LEAD ROLE IN FIRST MAJOR UPGRADE OF AN OPERATIONAL TORPEDO (MK 48) TO PROVIDE AN ADVANCED, COMPUTER-BASED, DIGITAL GUIDANCE AND CONTROL SYSTEM (ADCAP).



■ ADCAP MK 48

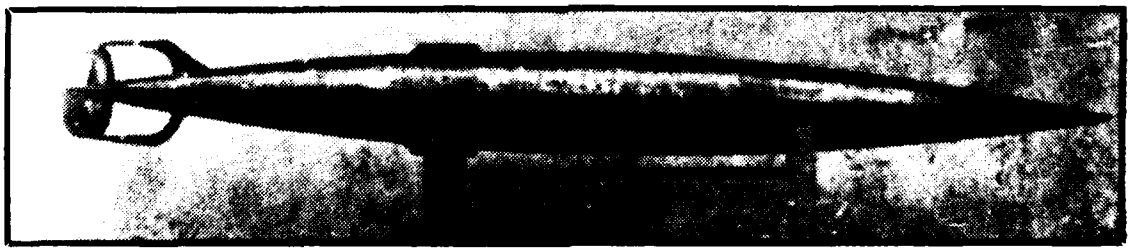


World's First Torpedo Establishment -- Goat Island, Newport

U.S. Navy establishes U.S. Navy Torpedo Station (NTS) on Goat Island in Newport, Rhode Island in July 1869.

A "Strict" Specification Prepared by the Navy for the Naval Torpedo Station to Build an Automobile "Fish" Torpedo:

- *"To go underwater to a considerable distance at a fair rate of speed."*
- *"To deviate neither to the right or left."*
- *"To proceed to and keep at a constant depth underwater no matter whether started on the surface or any point below it."*



Navy's First Automobile Torpedo -- the "Fish" Torpedo

Built and tested at NTS/NPT in 1871.

The 1870s - In The Beginning

In 1869 . . .

- **The Navy establishes a need for a Navy experimental station to evaluate emerging weapon technologies.**
- **In July, the Naval Torpedo Station, Newport (NTS/NPT) is formally established.**

The rapid technological advances made during the Civil War convinced the Navy Department of the need for an experimental activity to keep abreast of the new developments in naval warfare. In 1869 the Secretary of the Navy directed the establishment of a U. S. Navy experimental station for the development of torpedoes, torpedo equipment, explosives, and electrical apparatus. The new activity, designated the U. S. Naval Torpedo Station (NTS), was located on Goat Island in Newport harbor, and CDR E. O. Matthews was assigned as the first commanding officer. Initial torpedo efforts concentrated on stationary torpedoes (moored mines), spar torpedoes having a boom-mounted contact-explosive charge, and towed torpedoes, which had come into use during the Civil War period.

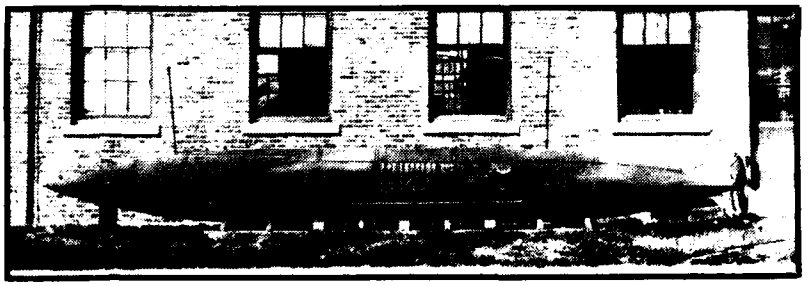
In 1869 Secretary of the Navy Robeson and Admiral Porter directed Admiral Radford, commander of the European Squadron, to visit Fuime, Austria, to evaluate a new automobile fish torpedo that Robert Whitehead (an English engineer managing a machine works in Fuime) had invented in 1866. Whitehead had recently sold his automobile torpedo to the Austrian Navy, and Admiral Radford, very impressed with the secret, new, self-propelled fish torpedo, strongly recommended that the U. S. Navy acquire such a weapon.

In response to the recommendation, Admiral Porter sent an action memo to CDR Matthews at NTS in Newport directing him to "examine carefully into this subject and ascertain if torpedoes of this plan can not be gotten up." Using the information obtained during Admiral Radford's visit to Fuime, a U. S. Navy "fish" torpedo specification and design was prepared by NTS. An in-water test of the Navy's first "automobile" torpedo was conducted in March 1871 at NTS in Newport. The 12-foot 6-inch-long by 14-inch-diameter weapon bore a striking resemblance to the early Whitehead torpedoes on which the design was based. A series of range tests was conducted with the NTS fish torpedo in 1871-72 during which improvements, including a new depth mechanism and a "diamond" cam engine, were incorporated.

The NTS fish torpedo demonstrated the basic feasibility of an automobile torpedo, and CDR Matthews, after visiting Whitehead's factory in Fuime, designed a second-generation fish torpedo in 1873. However, CDR Matthews was transferred to a new duty station and the Navy Department, concerned about the automobile torpedo's delicate and complex nature, directed NTS/NPT to concentrate on equipping the Fleet with spar and towed torpedoes. Additionally, during the late 1870s and 1880s, NTS was directed to evaluate a growing number of new self-propelled torpedo designs built by U. S. inventors who were aggressively soliciting U. S. Navy support for their designs.

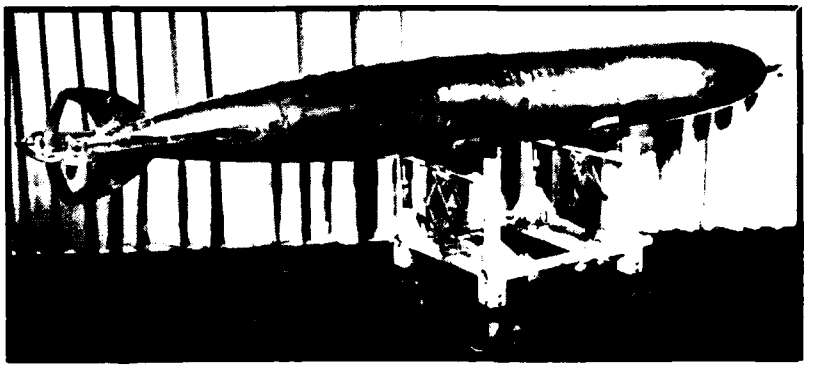
First Locomotive Torpedo

Powered by compressed air supplied through a rubber hose, the Ericsson torpedo was evaluated at NTS/NPT.



First Wire-Guided Torpedo

The Lay torpedo, a surface-running torpedo powered by carbonic acid gas, was steered electrically over a wire link during its evaluation at NTS/NPT.

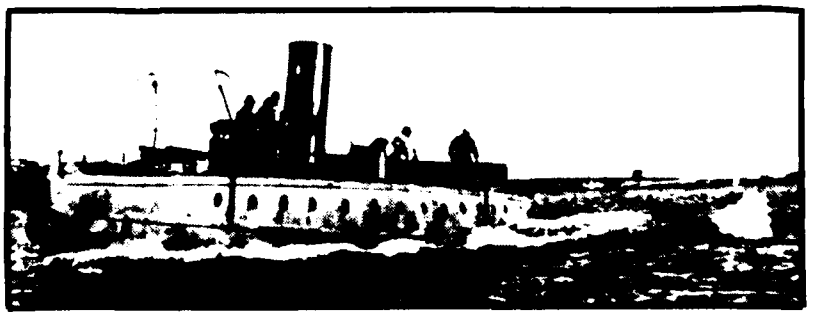


First Torpedo Issued to the Fleet (Howell Mk 1)

The flywheel-powered Howell torpedo, which underwent extensive development, test and evaluation at NTS/NPT, was the first automobile torpedo issued to the Fleet.

Rocket-Powered Torpedoes

The Cunningham torpedo was one of numerous rocket torpedoes evaluated at NTS/NPT. They were fast but their trajectories were spectacularly unpredictable.



U.S. Navy's First Torpedo Boat, the Stiletto

Purchased from Herreshoff Boat Co. in 1885, the Stiletto saw hard service at NTS/NPT as the Navy's prototype torpedo boat.

The 1880s - The Early Years

During the 1880s . . .

- **The wondrous products of Yankee ingenuity are evaluated at NTS/NPT.**
- **Torpedoes (spar, towed, and automobile), explosives, and electrical devices are just some of the innovations tested by NTS/NPT engineers.**

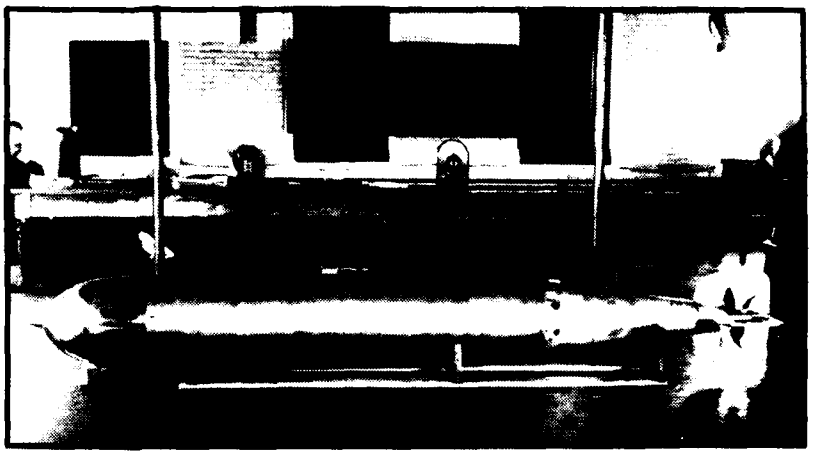
During the late 1870s and 1880s, as the concept of self-propelled torpedoes caught the fancy of U. S. inventors, the Naval Torpedo Station became increasingly involved in testing and evaluating torpedo concepts submitted to the Navy by U. S. inventors. These early torpedoes, incorporating some ingeniously innovative concepts, included designs by some of the nation's most distinguished inventors, including John Ericsson, designer of the ironclad Monitor, and Thomas Edison, inventor of the electric light bulb. Although the performance of these early torpedoes was severely limited by the available technology, some of the concepts evaluated -- such as electric propulsion, wire guidance, and rocket propulsion -- came into wide use in later years.

Most of these early torpedoes were built at the inventor's own expense, with the Navy providing the facilities to evaluate the concepts at NTS/NPT. These early torpedoes included a locomotive torpedo powered by compressed air supplied through a rubber hose from a remote compressor (the Ericsson), the first torpedo remotely controlled by a wire guidance link (the Lay), the first flywheel-powered torpedo (the Howell), rocket-powered torpedoes (Cunningham, Barber, Weeks, etc.), and a torpedo powered by an electric motor (the Sims-Edison). A Lay torpedo was purchased by the Navy, extensively evaluated, and seriously considered for Fleet issue. However, in 1883 when Congress appropriated funding to purchase automobile torpedoes, the Navy decided to issue a public solicitation for concepts and to conduct a competitive evaluation.

The Navy's torpedo specification required each competitor to build an experimental model at his own expense and demonstrate it to the Navy Torpedo Board for evaluation. The European torpedo manufacturers, Whitehead and Schwartzkopff, refused to bring their torpedoes to this country for evaluation at their own expense and, from within the United States, only three proposals were submitted. The American Torpedo Co. and Asa Weeks both proposed surface-running, rocket-powered torpedoes and LCDR Howell, USN, proposed his flywheel-powered torpedo that had been undergoing testing and evaluation at NTS.

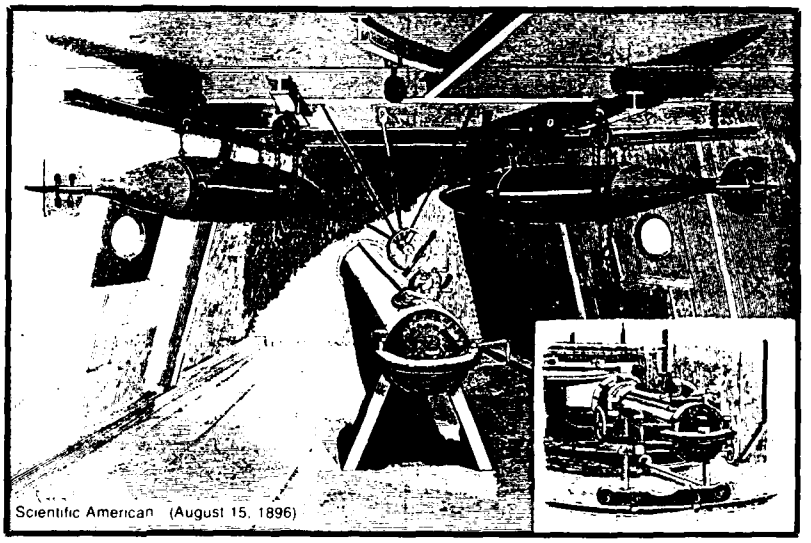
In 1885 the Navy contracted with the Herreshoff Boat Co. in Bristol, RI, for the construction of the Stiletto, a fast launch to be used at NTS for torpedo experiments. Initial plans were to use this craft for testing spar torpedoes, but the possibility of launching automobile torpedoes was also mentioned.

In 1888 the Howell torpedo was selected as the first automobile torpedo to be issued to the Fleet; CDR Howell sold his design to the Hotchkiss Ordnance Co., which in turn manufactured the new Mk 1 Howell torpedo for the U. S. Navy.



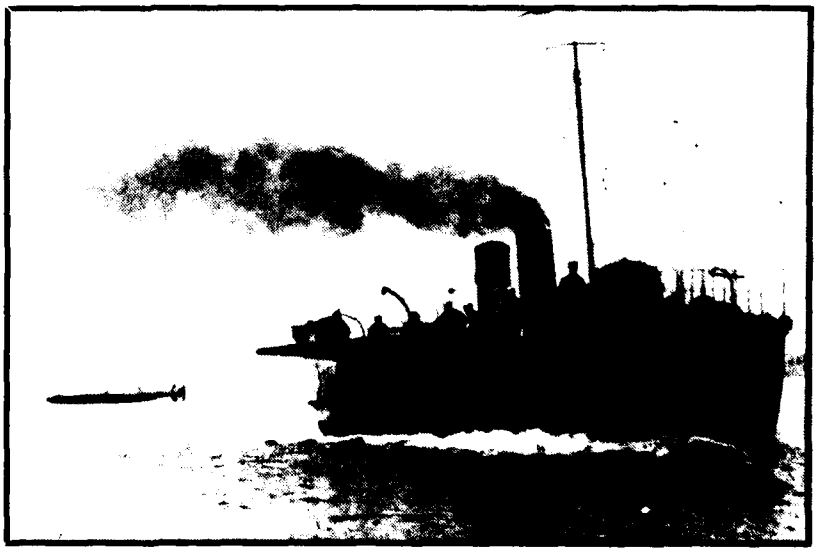
The Whitehead Mk 1 Torpedo Selected by U.S. Navy to Replace the Howell Mk1

NTS/NPT evaluated new Whitehead Mk 1, 2, 3 torpedoes, developed torpedo tubes and support equipment, acted as inventory and issue point, and oversaw Fleet introduction of new torpedoes, including training and operational evaluations.



U.S. Navy Equips Battleships with Howell and Whitehead Torpedoes

NTS/NPT was intimately involved in the Fleet introduction of new automobile torpedoes on battleships, including deck-mounted tubes, bow torpedo tubes, and fire control directors; in training; and in maintaining inventory/ logistics.



Torpedo Boats Join the Fleet

NTS/NPT played a major role in the development of the Navy's first class of vessels designed to employ the new automobile torpedoes. By the time of the Spanish-American War (1898), the Navy had 12 operational torpedo boats.

The 1890s - The Torpedo Joins The Fleet

During the 1890s . . .

- **The Howell and Whitehead torpedoes join the Fleet on battleships and torpedo boats.**
- **NTS/NPT is directly involved in a Fleet support role to introduce these new weapons to the Fleet and ensure their operational effectiveness.**

When the Mk 1 Howell torpedo was selected for issue to the Fleet, NTS was assigned responsibility for conducting the acceptance tests and for installing the new automobile torpedoes on the Navy's battleships. In this capacity, NTS was an early "systems center" since, in addition to the torpedoes, the station was also responsible for the torpedo tubes, the fire control director, and the support equipment that had to be installed to operate the torpedo. Since NTS on Goat Island in Newport was located right in the middle of a major fleet anchorage, it was a straightforward task to work directly with the Fleet, installing the new automobile torpedo system and providing hands-on training to make it operational. By 1892 the Navy's battleships were being equipped with deck-mounted torpedo tubes to fire the new Mk 1 Howell torpedo.

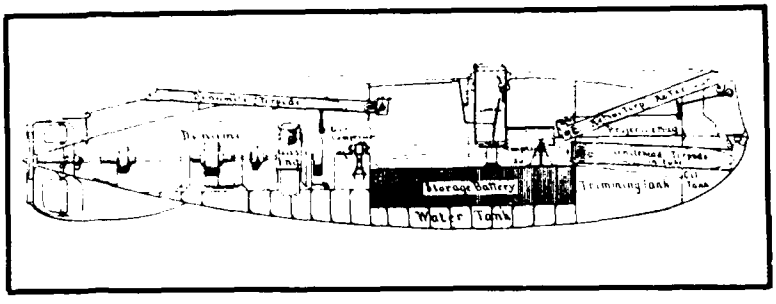
A torpedo tube had also been mounted on the station's torpedo boat, the Stiletto, and experiments were conducted using the Mk 1 Howell torpedo to evaluate the potential effectiveness of using torpedo boats to attack major warships. When the Navy ordered its first operational torpedo boats (the Cushing class), NTS was given the task of arming these new craft and training their crews to fire the new automobile torpedoes. By the time of the Spanish-American War (1898), the U. S. Navy was equipped with operational sea-going torpedo boats that were the forerunners of modern Fleet destroyers.

In the early 1890s, the Navy decided also to purchase Whitehead torpedoes. A contract was placed with the E.W. Bliss Co. in Brooklyn, NY, to manufacture Whitehead torpedoes, under license in the United States for the U. S. Navy. NTS conducted the acceptance tests of the new Whitehead Mk 1, 2, and 3 torpedoes; functioned as the storage and issue point for the new torpedoes; and supervised their installation on battleships and torpedo boats.

During the Spanish-American War, a decision was made to remove the deck-mounted torpedo tubes from the battleships and replace them with underwater torpedo tubes mounted in the bow. Rather than relocate the steam-powered engine required to spin up the Howell torpedo's flywheel, engineers decided to employ the new Whitehead torpedoes from the underwater torpedo tubes. By the end of the decade, the Howell Mk 1 torpedo was being withdrawn from the Fleet, and NTS was heavily involved in Fleet introduction of the newer Whitehead Mk 1, 2, and 3 torpedoes for use from both capital ships and torpedo boats.

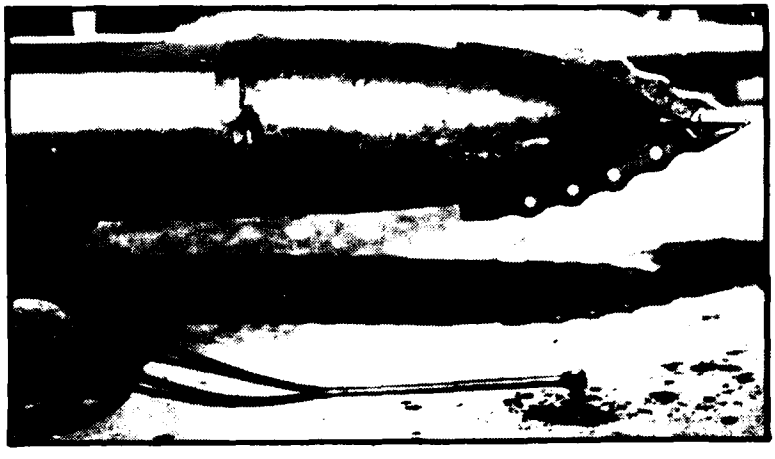
U.S. Navy's First Submarine, the Holland

Manned by LT Harry H. Caldwell and an NTS "volunteer" crew, the submarine Holland underwent evaluation at NTS/NPT in 1901. Whitehead Mk 2 torpedoes were successfully fired and an undetected approach against the battleship Kearsarge (BB-5) demonstrated the potential of the new torpedo-armed submarines as a major new class of combatants.



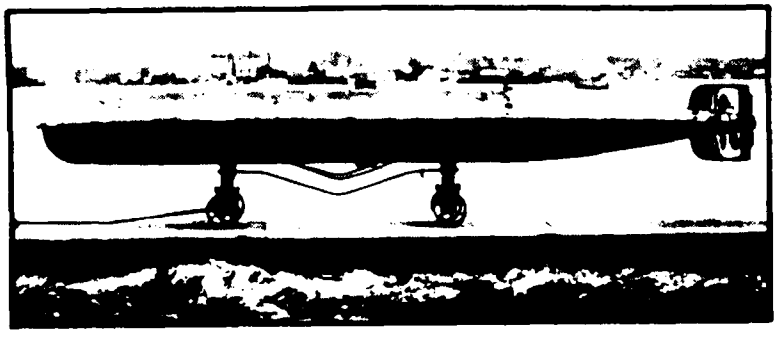
First Torpedoes Produced by the U.S. Navy, Whitehead Mk 5 Torpedoes

In 1907 the U.S. Navy authorized the construction of the first Navy-owned and operated torpedo factory at NTS/NPT to produce Whitehead Mk 5 hot gas torpedoes. (Note the special net cutter head attached.)



Bliss-Leavitt Turbine-Powered Mk 3 Torpedo

After evaluation at NTS/NPT, the new Bliss-Leavitt 21-inch-diameter, turbine-powered, hot gas torpedoes Mk 1, 2, and 3 were selected for use on battleships.



First Destroyers Enter the Fleet

NTS/NPT played a key role in the evaluation of torpedo boats, torpedo boat destroyers, and finally, in 1901, the Navy's first destroyer, the Bainbridge (DD-1). The Bainbridge, designed to exploit the new automobile torpedo, was the first of a major new class of surface combatants that ultimately became known as the workhorses of the Fleet.

The Early 1900s - The Navy Builds Its Own

From 1900 to 1910 . . .

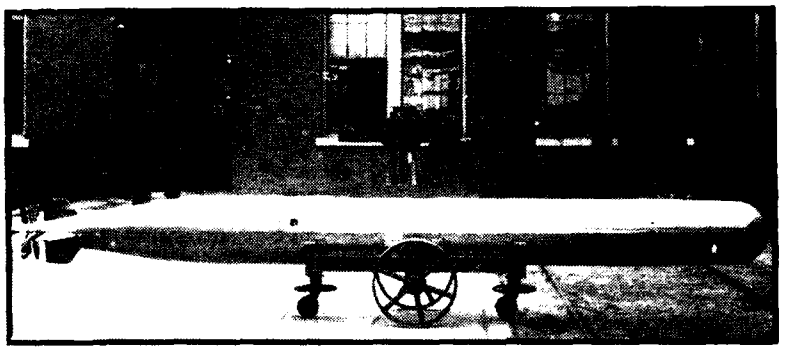
- **The torpedo's role expands as submarines and destroyers enter the Fleet.**
- **NTS/NPT is selected as the site of the U.S. Navy's first torpedo factory.**

At the turn of the century, the Navy purchased its first submarine (the Holland) and an evaluation was conducted at NTS/NPT in 1901. The U. S. Navy's first submarine, manned by LT Harry H. Caldwell and a "volunteer" crew from NTS, conducted torpedo firings with Whitehead Mk 2 torpedoes and made simulated attacks against Fleet units, including undetected attacks against the battleship Kearsarge (BB-5). The Naval Torpedo Station's pioneering efforts with the Holland led to the Fleet introduction of a revolutionary new class of fighting ships that have had a major impact on 20th century naval warfare.

During the same timeframe, NTS evaluated a new, high-performance, turbine-powered torpedo (Bliss-Leavitt) that the Navy was considering as a replacement for the Whitehead torpedoes then in use. The 21-inch-diameter Bliss-Leavitt Mk 1, 2, and 3 torpedoes were selected for service use on battleships in 1904. However, the Navy was very concerned that the E. W. Bliss Co. was showing the new turbine-powered torpedoes to foreign nations in an effort to promote foreign sales. A decision was made to build a U. S. Navy torpedo factory at NTS/NPT to ensure the security of future U. S. Navy torpedo designs. The Bliss-Leavitt 45-cm-diameter Mk 4 torpedo, which was also evaluated at NTS during this timeframe, was the Navy's first torpedo designed specifically for use by the new submarine boats.

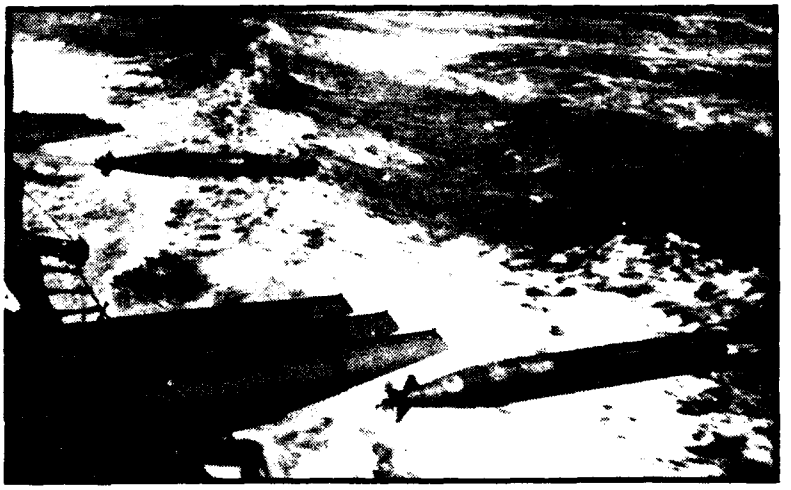
Construction of the Navy's first torpedo factory was started on 1 July 1907, and production commenced in the summer of 1908. The first order was for 20 Mk 5 Whitehead torpedoes. By the time the first order was completed in 1911, the NTS factory was also producing Bliss-Leavitt Mk 7 and Mk 8 torpedoes. The Mk 8 destroyer torpedo, the Navy's first 21-inch-diameter by 21-foot-long torpedo, provided the design base for the follow-on generation of weapons that saw extensive use during World War II.

The Navy's first destroyers (the 420-ton Bainbridge class) were launched early in this decade, and this major class of new naval combatants underwent fitting out and evaluation at NTS/NPT. These vessels were closely followed by the Smith and Paulding classes later in the decade. By 1910, NTS had firmly established itself as the Navy's primary torpedo activity with the Fleet introduction of two new major classes of torpedo-carrying warships (destroyers and submarines) and the Navy's first torpedo production plant.



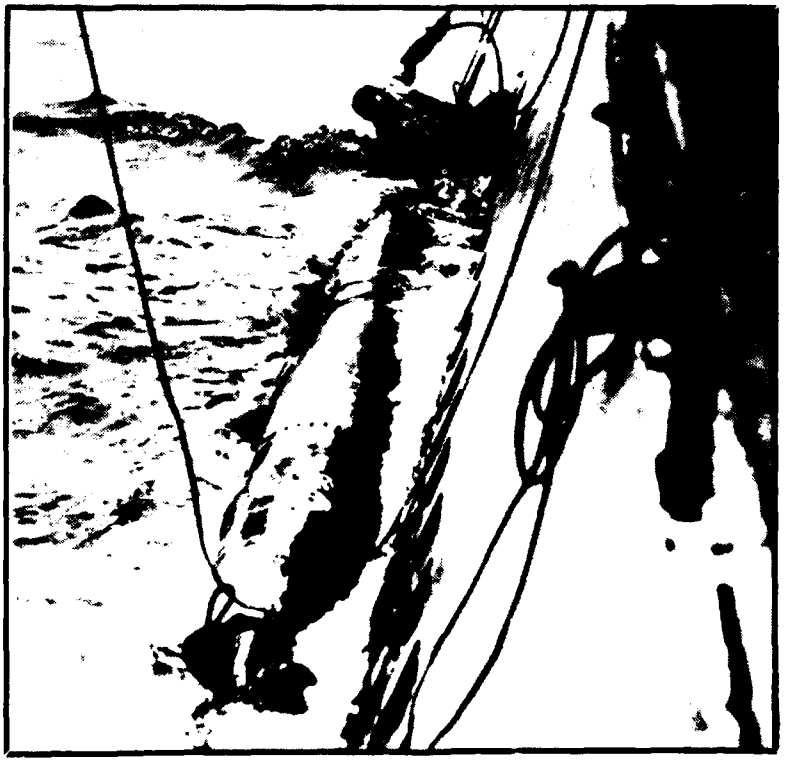
First "Steam" Torpedo

Designed by Bliss-Leavitt and produced at the NTS/NPT torpedo factory, the 45-cm (18-inch) Mk 7 torpedo, utilizing water to cool the combustion gases, produced a major increase in torpedo performance. The water-cooled combustion process led to the Mk 7s being called "steam" torpedoes.



Mk 8 Torpedo – First of the Navy's 21-Inch-Diameter x 21-Foot-Long Torpedoes

Designed by Bliss-Leavitt for use on the new Clemson/Wilkes class World War I destroyers, the Mk 8 was the first 21-inch-diameter, destroyer-launched torpedo produced at NTS/NPT. It provided the design baseline for succeeding 21-inch-diameter torpedoes and was still in service during World War II.



Mk 10 Torpedo – Navy's First 21-Inch-Diameter Submarine Torpedo

Designed specifically for use on the new R&S class submarines, the Mk 10 was the first 21-inch-diameter submarine torpedo produced at NTS/NPT. The Mk 10 torpedo, which featured the largest warhead (nearly 500 pounds) utilized to that time, continued in service until early in World War II.

The 1910s - World War I

During the 1910s . . .

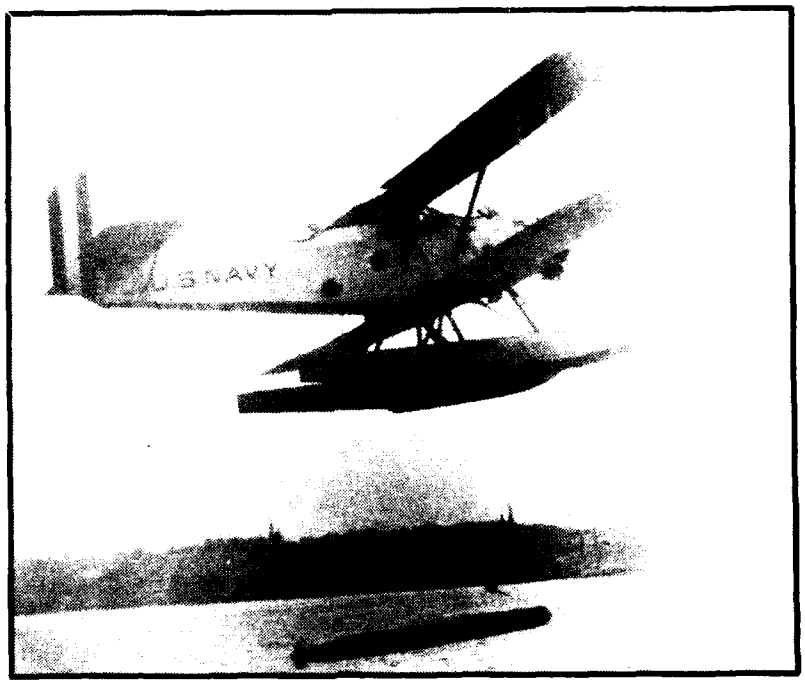
- **The NTS/NPT torpedo factory is expanded to produce 1300 torpedoes per year, and its work force grows to over 3000 employees.**
- **During World War I, NTS/NPT becomes heavily involved in pioneering ASW R&D, including the development of depth charges, mines, and aerial bombs.**

By 1911 the new torpedo factory at NTS was in production; the initial order of Whitehead Mk 5 torpedoes had been completed; and manufacture of the new turbine-powered Bliss-Leavitt torpedoes had been initiated. The Mk 6 torpedo, incorporating the first horizontal turbine wheels and a combination depth and steering unit (the forerunner of the famous Ulan gear), was soon replaced by the higher efficiency Mk 7 torpedo that used water to cool the combustion gases, making it the first "steam" torpedo. With the introduction of the larger 21-inch-diameter by 21-foot-long Mk 8 torpedo, the torpedo's configuration stabilized at a size that would be widely employed during both World Wars and that continues to this day.

As war clouds started to gather in Europe, NTS became involved in an intensive program to work the remaining bugs out of the new family of torpedoes and prepare them for volume production. Extensive range tests were conducted to correct a number of serious deficiencies, and intensive preparations were made to introduce this new generation of torpedoes to the Fleet. By 1915 a second larger manufacturing plant was under construction at NTS, along with enlarged assembly shops for preparation and issue of the new torpedoes. By the eve of World War I, NTS had the capacity to produce over 1300 torpedoes a year, and ultimately the work force grew to more than 3000 employees. In addition, NTS personnel provided support to make new torpedo manufacturing facilities operational at the Washington Navy Yard and at Alexandria, VA.

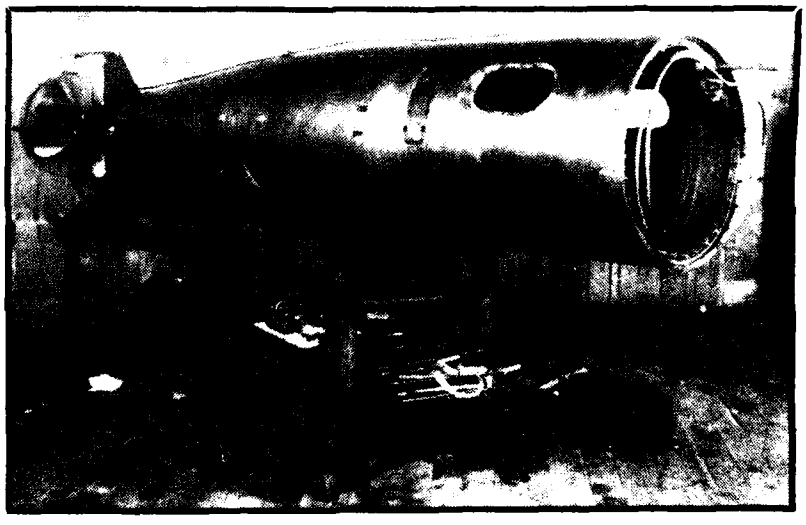
Paradoxically, when the war actually started, essentially all R&D work on torpedoes at NTS was halted. Because of the massive threat posed by the German U-boats and their torpedoes, the technical experts at NTS were assigned the task of developing anti-submarine warfare (ASW) weapons to counter the U-boat threat. NTS became the Navy's first ASW laboratory; aero-bombs, Mk 6 mines, towed bombs, and depth charges were developed on a "crash" basis to counter the U-boat threat. Thousands of Mk 6 mines were used in the North Sea mine barrier to contain the U-boat threat, and the depth bomb proved to be one of the most effective weapons developed in World War I for destroying U-boats.

Although the U. S. Navy did not make extensive use of its torpedoes during World War I, by the end of the decade NTS was firmly established as the Navy's principal torpedo development and production activity. Its ability to fulfill this important mission for the U. S. Navy had been conclusively demonstrated during World War I.



The Torpedo Becomes an Aircraft-Delivered Weapon

An aircraft detachment with the Navy's first torpedo planes was assigned to NTS/NPT and extensive experiments with Mk 7 torpedoes were conducted. This effort led to the formation of shore-based and carrier aircraft squadrons that provided the Fleet with a significant new capability.



Hammond Torpedo -- the First Radio Controlled Torpedo

Extensive experiments utilizing the world's most powerful radio transmitter were conducted at NTS/NPT to demonstrate the Hammond radio-controlled torpedo, the first successful remotely controlled torpedo.

Mk 11/12 Destroyer-Launched Torpedoes

The Mk 11/12 torpedoes were the first multi-speed torpedoes with speed selection made by setting an external spindle prior to firing the torpedo. The Mk 11 torpedo, the first all-Navy-developed torpedo, was a joint Washington Navy Yard/Naval Torpedo Station, Newport effort to develop a "universal" torpedo. The Mk 12 torpedo, the first torpedo developed by NTS/NPT, was a "beefed-up" version of the Mk 11, strengthened to withstand high-speed destroyer/cruiser launches. Approximately 200 Mk 12 torpedoes were produced by NTS/NPT.

The 1920s - The Lean Years

During the 1920s . . .

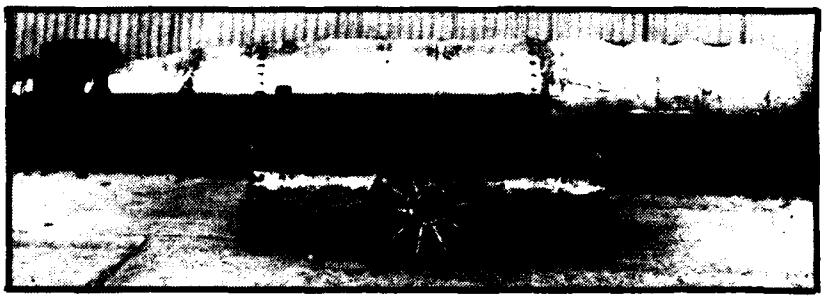
- **NTS/NPT becomes the Navy's sole torpedo R&D and production activity.**
- **The first all-Navy-developed torpedoes (Mk 11 and Mk 12) are produced.**
- **The torpedo becomes an aircraft-delivered weapon for use on new aircraft carriers.**

During the early 1920s, the worldwide reduction in naval armaments led to severe cutbacks in the U. S. Navy's torpedo programs. In 1922 a decision was made to remove torpedoes from battleships, and all torpedoes prior to the Mk 7 were declared obsolete and withdrawn from service use. In 1923 the torpedo facilities at the E. W. Bliss Co., the Washington Navy Yard, and at Alexandria, VA, were placed on inoperative status. This action placed NTS/NPT in the unique position of being the Navy's only torpedo development and production activity. For the next 16 years, until the eve of World War II in 1939, NTS/NPT remained the Navy's sole source of torpedo development and production expertise. During the rest of the decade, NTS's budget and manpower continued to shrink year by year.

In the early 1920s, NTS undertook an extensive program to renovate and modernize the Navy's inventory of World War I torpedoes, including the Mk 7, 8, 9, and 10 torpedoes, to extend their operational life. In 1925 NTS completed the development of the Mk 11, a multi-platform torpedo that the Washington Navy Yard had started to develop in the early 1920s. The three-speed Mk 11 torpedo was the first torpedo designed solely by the Navy and it was soon followed by the Mk 12, the first torpedo developed solely by NTS/NPT. Only a limited number of Mk 11 and 12 torpedoes were produced, but these weapons provided the design base for the follow-on development of the Mk 13, 14, and 15 torpedoes, which were the backbone of the U. S. Navy's torpedo inventory in World War II.

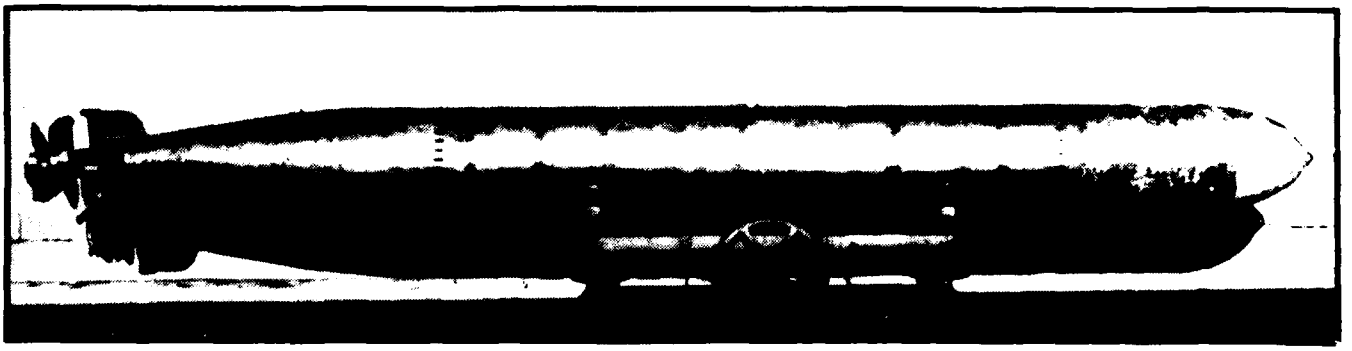
In the early 1920s when the Navy became interested in using torpedoes from aircraft, an air detachment was assigned to NTS, and extensive trials were conducted using Mk 7 torpedoes and the new experimental torpedo planes to develop yet another new weapon system for the Fleet. These trials led to the formation of torpedo squadrons (TBs) for deployment on the Navy's new aircraft carriers, and to the decision to develop a new torpedo for use exclusively by aircraft.

During this same period, NTS successfully evaluated the Hammond torpedo, the Navy's first radio-controlled torpedo, and continued a modest effort (one man, part time) to develop the Mk 1 electric torpedo. NTS also conducted subsystem level developments including air-sustained gyros, the Ulan gear (a steering and control system), a lightweight turbine propulsion system, and new liquid-filled exercise heads for use in future torpedo developments.



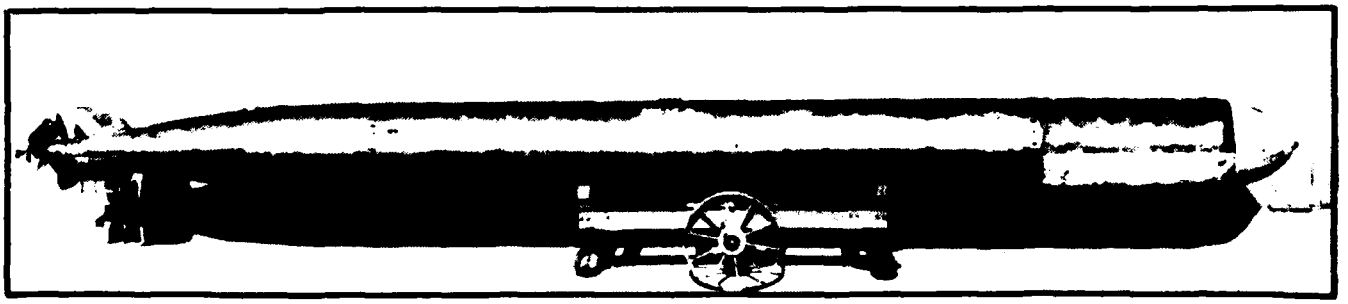
Mk 13 Torpedo -- the Navy's First Aircraft Torpedo

The 22.5-inch-diameter Mk 13 torpedo was the Navy's first torpedo designed specifically for aircraft use. Designed and developed by NTS/NPT, the Mk 13 saw extensive use during World War I from aircraft and PT boats.



Mk 14 Torpedo -- the Navy's Premier Submarine Torpedo During World War II

Designed and developed by NTS/NPT during the early 1930s, the Mk 14's warshot configuration had serious problems during early World War II. Ultimately, over four million tons of shipping were sunk by the Mk 14 torpedo.



Mk 15 Torpedo -- the Navy's Principal Multi-Speed Destroyer Torpedo During World War II

The three-speed Mk 15 torpedo, designed and developed by NTS/NPT during the early 1930s, was the Navy's principal destroyer-launched torpedo during World War II and saw extensive service during the Pacific Campaign.

The 1930s - Tooling Up

During the 1930s . . .

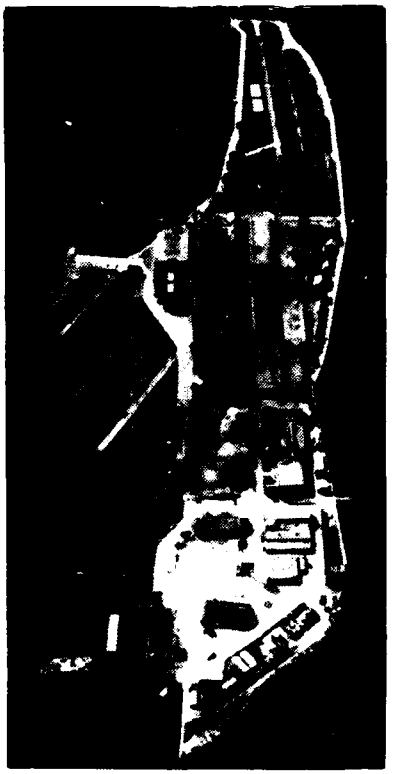
- **NTS/NPT develops a new aircraft torpedo (Mk 13), submarine torpedo (Mk 14), and destroyer torpedo (Mk 15).**
- **Torpedo production facilities are expanded to support three-shift production.**

During the early 1930s, NTS, the Navy's sole torpedo development and production activity, went from famine to feast when the Navy issued requirements for its first aircraft torpedo (the Mk 13), a new submarine torpedo (the Mk 14) to replace the World War I-vintage Mk 10 torpedo, and a new destroyer-launched multi-speed torpedo (the Mk 15). NTS was suddenly faced with the task of simultaneously developing three new torpedoes that would ultimately provide the backbone of the Navy's World War II torpedo inventory. Unfortunately, the limited R&D funding ($30,000 to $40,000 a year) available at NTS to support these three concurrent developments severely limited their scope. Available funding data indicate that from conception (1930) to initial Fleet evaluations (mid-1930s) the three new torpedoes were developed with a total R&D expenditure of approximately $200,000 (the R&D cost for each torpedo was less than $70,000). This was a truly amazing accomplishment; but, as experience during World War II was to demonstrate, it was false economy to eliminate Fleet warshot testing in peacetime and wait until the war actually started to find out that the warshot torpedoes had serious problems.

Fortunately, the Mk 13, 14, and 15 torpedoes all shared a common technology base and many of the components were very similar. Since they were all turbine-powered torpedoes sharing the same type of propulsion system, all three developments benefited from the new, welded, high-pressure air flasks developed by the A. O. Smith Co. and NTS. However, this commonality also meant that when there was a problem it could affect all three weapons. This was demonstrated with tragic consequences early in World War II when the warshot configurations of all three torpedoes were found to be defective. Because of austere budgets and the limited availability of the new weapons, most of the evaluations were conducted with exercise torpedoes, and Fleet warshot firings against real targets were almost nonexistent. For example, the new "secret" influence exploder was accepted for service use based on one successful test against a hulk under controlled conditions in spite of the fact that the exploder was known to be sensitive to variations in magnetic fields at different geographic locations.

By the end of the decade, the Mk 13, 14, and 15 torpedoes were all undergoing Fleet introduction, and the factory at NTS was being retooled to support three-shift volume production of these new torpedoes. Unfortunately, the concurrent development of new platforms (ships/aircraft) and new torpedoes in the late 1930s, combined with the critically low inventories available, prevented realistic Fleet evaluations of the new systems during the immediate pre-war period. For example, new torpedo planes were in such short supply that only very limited testing was done to examine the aerodynamic compatibility of the new Mk 13 aircraft torpedo and the new, single-wing, all-metal, torpedo planes being developed.

Late in the decade, NTS took over the Naval Research Laboratory's efforts to use concentrated hydrogen peroxide (NAVOL) as an oxidizer in torpedoes. Also, NTS initiated development of a new, high-performance NAVOL propulsion system.

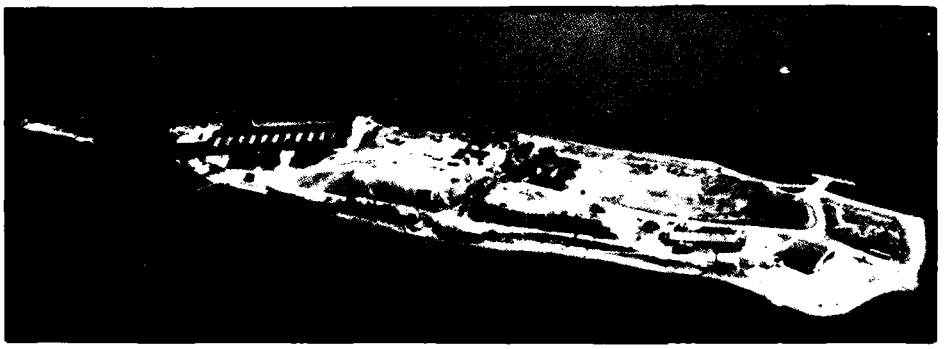


Right: Goat Island -- NTS/NPT Torpedo Manufacturing Facilities

NTS/NPT worked around the clock to manufacture over 18,000 torpedoes at the Goat Island Facility during World War II. Since the U.S. Navy expended only 15,000 torpedoes during World War II, NTS/NPT production by itself was sufficient to meet the total wartime requirements.

Below: Gould Island -- NTS/NPT Firing Pier, Overhaul Shop, Aircraft Hangar

Over 75,000 torpedoes were overhauled and proof-fired on the NTS/NPT firing ranges during World War II, and 4300 experimental air drops were made with Mk 13 torpedoes to improve their launch envelope.

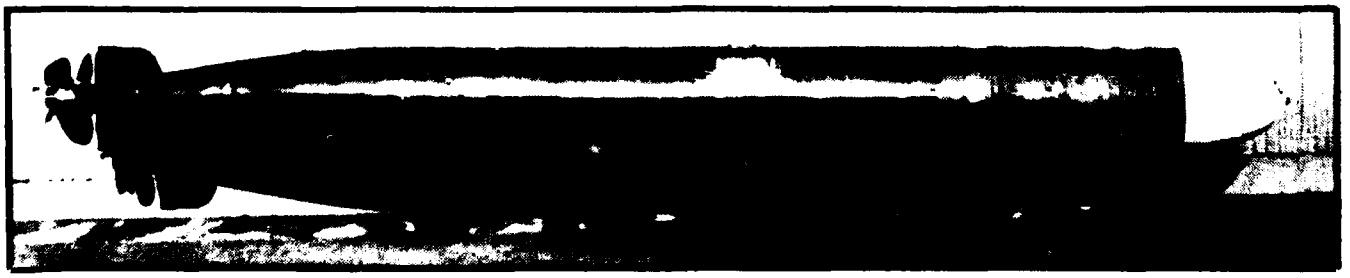


Above: Test Drop of Aircraft Torpedo Mk 13 in Narragansett Bay (1943)

To improve the effectiveness of the Mk 13 torpedo, more than 4300 experimental air drops were made at NTS/NPT during World War II. The sinking of the world's mightiest battleship, the Yamato, by aircraft-delivered Mk 13 torpedoes dramatically demonstrated the success of this effort.

Below: Mk 16 -- the Navy's First "Chemical" Torpedo

The Mk 16 torpedo was developed by NTS/NPT late in World War II to provide a wakeless, high-performance, submarine-launched torpedo. It used a 70-percent concentration of liquid hydrogen peroxide (code named NAVOL) in lieu of compressed air to support combustion. A limited number of Mk 16 torpedoes were issued to the Fleet during the post-war period.



The 1940s - World War II

During the 1940s . . .

- **NTS/NPT produces over 18,000 torpedoes, and conducts more than 75,000 proofing runs on range and 4300 experimental aircraft drops.**
- **R&D and production of Mk 16 and Mk 17 chemical (NAVOL) torpedoes are initiated.**

When the war in Europe started in 1939, the Navy's torpedo inventory was dangerously low. The NTS factories on Goat Island in Newport were tooled-up to conduct three-shift-a-day production of the three new torpedoes (Mk 13, 14, and 15) that were just undergoing Fleet introduction. Since the Navy felt additional production capacity would be required in the event of war, NTS was also tasked to assist in getting a number of additional torpedo plants operational in other parts of the country. In 1942 a Central Torpedo Office (CTO) was formed at NTS in Newport to standardize and coordinate all of the Navy's wartime torpedo production activities.

When the U. S. got into the war, it soon became evident that there were serious problems with the warshot configurations of all three new torpedoes. They were all running deeper than the set depth, the influence exploders were unreliable, the contact exploders frequently malfunctioned, and the aircraft torpedoes experienced water entry problems. This led to a bitter exchange of accusals between the builders (BUORD, NTS) and the operators (SUBPAC and the Fleet) concerning warshot torpedo deficiencies. These problems generated much ill will, and a massive technical effort was needed during the first two years of the war to identify and correct the problems that had not come to light until the torpedoes were used in combat. It was a very high price to pay for the false economy of saving money by not conducting warshot torpedo evaluations during peacetime exercises.

However, the much criticized torpedoes did an immense amount of damage (the Mk 14 sank over four million tons of shipping) and played a major role in the defeat of the Japanese. During World War II, the U. S. Navy produced more than 57,000 torpedoes but used only 15,000 in action. NTS in Newport produced over 18,000 torpedoes, indicating that the NTS production by itself would have fulfilled the Navy's World War II torpedo requirements. In addition, during World War II, NTS proof-fired over 75,000 torpedoes and conducted 4300 air drop tests to improve the Mk 13 torpedo's performance.

The NTS Coddington Cove annex in Newport underwent major expansion early in the war, and by 1943 the Research Department was heavily involved in completing the development of the Mk 16 & 17 chemical torpedoes, the development of new propulsion systems, and the evaluation of captured foreign torpedoes such as the German G-7-e and the Japanese type 92.

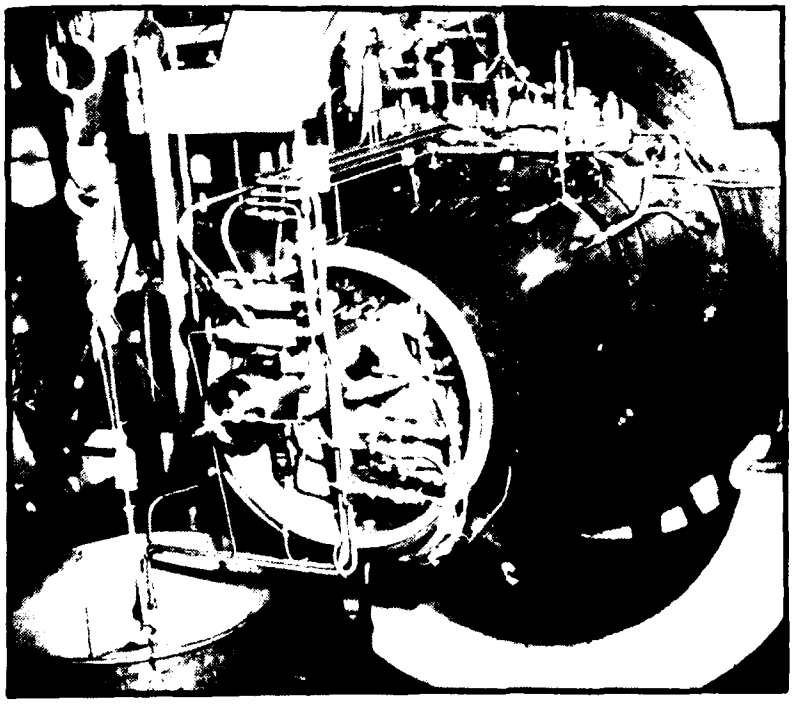
During World War II, NTS established itself as the Navy's institutional corporate headquarters for the development and production of conventional torpedoes.

First Operational Wire-Guided ASW Homing Torpedo Issued to the Fleet

The transition to an R&D activity proceeded as the newly-formed NUOS was assigned responsibility for the Fleet introduction of the Mk 37-1 torpedo, providing the Fleet with its first wire-guided ASW homing torpedo.

Component-Level Test Facility and Experimental Power Plant

NUOS built extensive component-level test facilities to support the scientific development of torpedo subsystem technologies. Shown at right is an experimental torpedo prime mover mounted for testing in a deep-depth propulsion facility. This technology provided the foundation for the scientific design of new, high-performance underwater weapons.



Research Torpedo Configuration (RETORC II) Test Vehicles

NUOS and ORL/PSU participated in a joint applied research program to demonstrate the feasibility of a high-performance, thermal-powered torpedo to counter the emerging nuclear submarine threat.

The 1950s - In Transition

During the 1950s . . .

- **NTS/NPT torpedo production facilities are closed. In 1951, the torpedo station is reorganized as an R&D activity and designated as the Naval Underwater Ordnance Station (NUOS).**
- **Emphasis shifts to homing torpedoes and ASW warfare.**

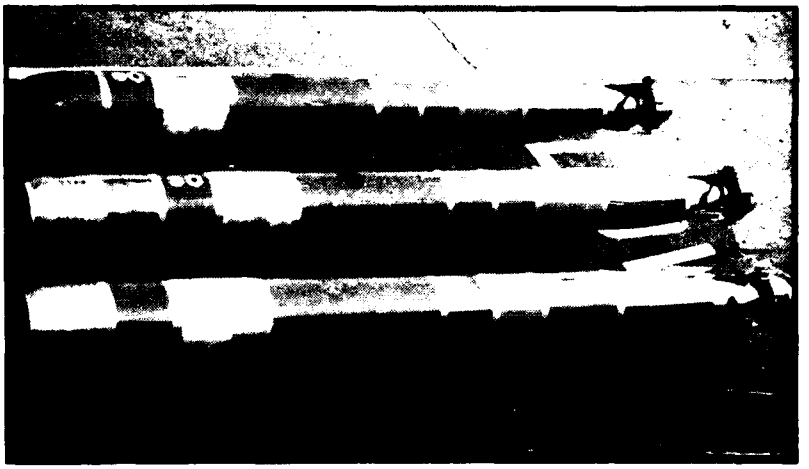
In the post-war period, the new Department of Defense made a policy decision to get out of the manufacturing business and have future weapons built by private industry. However, the Government would continue to be directly involved in research and development efforts. In 1945 large-scale production of torpedoes was discontinued at NTS, and in 1951 the activity's name and function were changed when it was renamed the Naval Underwater Ordnance Station (NUOS), with a mission to conduct research and development on undersea weapons. The production facilities on Goat Island were closed down, the headquarters were moved to Coddington Cove, and a phased expansion of new R&D facilities was initiated. By the mid-1950s, new R&D facilities to support component-level torpedo developments were becoming operational; the predominately artisan NTS staff was transitioning to an R&D-oriented scientific and engineering staff; and exploratory component-level development programs were in progress on torpedoes, launchers, and fire control systems.

When the Mk 37 torpedo was selected for Fleet issue, NUOS became directly involved in supporting the Fleet introduction of this new ASW weapon. A decision was made in the mid-1950s to modify the Mk 37 torpedo and add a mid-course wire guidance capability; NUOS was assigned the lead role to support the Fleet introduction of the new, improved Mk 37-1 ASW Torpedo System.

When the nuclear-powered submarine became an operational reality, there was an urgent need for a new generation of high-performance ASW torpedoes to counter the substantial threat that these revolutionary submarines posed. A focused technology program was initiated to build a series of Research Torpedo Configuration (RETORC) test vehicles to develop and demonstrate the technology needed for a high-performance ASW torpedo to counter the nuclear submarine threat. NUOS, working jointly with the Ordnance Research Laboratory, Pennsylvania State University (ORL/PSU), became heavily involved in the RETORC II program to demonstrate the feasibility of a new, high-performance ASW torpedo for use from submarines. NUOS' areas of involvement included high energy density thermal propulsion systems, mobile targets, and fire control systems, including the new 65-conductor cable and mid-course wire guidance.

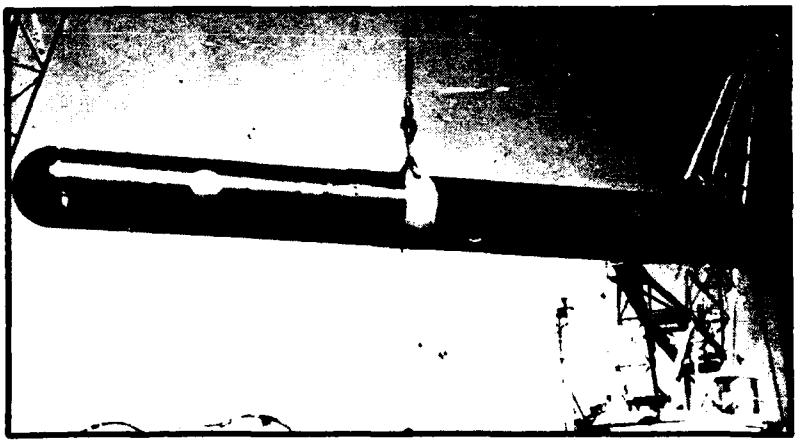
Concurrent efforts were initiated to develop entirely new, quiet, high-performance thermal propulsion systems and the special component-level, deep-depth, and noise-reduction facilities required to develop and evaluate the propulsion systems. New propulsion systems were evaluated first in dynamometer tests and then in a series of RETORC II test vehicles late in the decade to determine if the high-powered thermal prime mover would be compatible with the sensitive homing system being developed by ORL/PSU.

By the end of the decade, NUOS had transitioned from an artisan activity involved in conventional torpedoes to an R&D activity that was directly involved in the development of new ASW torpedoes, such as the Mk 37-1, and in focused research efforts to develop a new, high-performance ASW torpedo system to counter the emerging nuclear submarine threat.



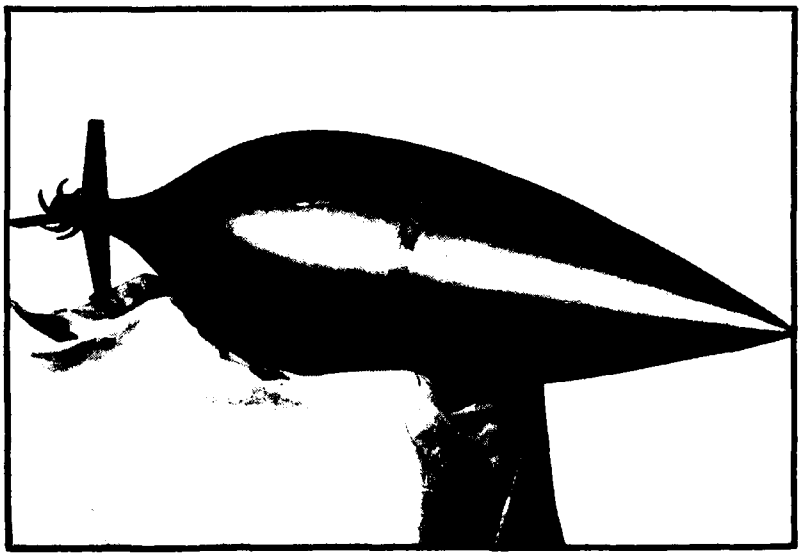
Submarine-Launched Anti-Ship Torpedo (SLAST) Test Vehicles

As a part of the SLAST advanced development program, test vehicles were built to demonstrate a reliable wakeless propulsion system (hydrogen peroxide and diesel fuel) and to evaluate new subsystem technologies. Up to three major subsystems could be evaluated during a single run.



Deep Experimental Torpedo (DEXTOR) and External Torpedo (EXTOR) Test Vehicles

The DEXTOR/EXTOR vehicle program provided an in-water demonstration of new structures and seals for deep-depth torpedoes and externally carried torpedoes. Onboard computers and a strap-down guidance system were also evaluated in the EXTOR test vehicle.



Test Vehicle for In-Water Evaluation of New Subsystem Technologies

To verify the predicted performance of new subsystem technologies, extensive in-water test vehicle runs were conducted. Drag reduction concepts, composite structures, transducers, body shapes, noise reduction techniques, propulsors and new homing system concepts were evaluated.

The 1960s - ASW and The Nuclear Submarine

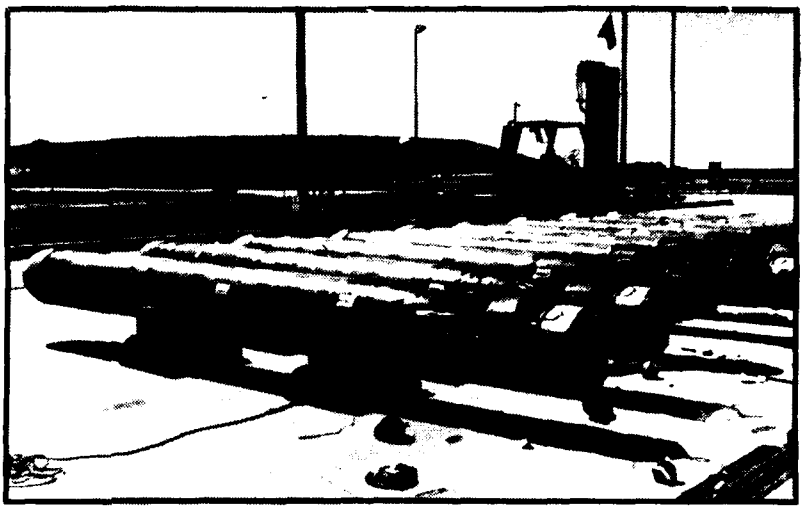
During the 1960s . . .

- **To counter the emerging nuclear submarine threat, dramatic increases in ASW torpedo performance are urgently required.**
- **In 1966, NUOS and NAVUWSEC (CTO) are merged to form a single, full-spectrum, life-cycle torpedo organization.**

Fleet introduction of the wire-guided Mk 37-1 torpedo early in the decade improved the Fleet's ASW capabilities, but the torpedo's basic performance (speed, range, and acquisition range) was marginal against high-performance nuclear submarines. During the early 1960s, the RETORC II TV-3 test vehicle program demonstrated the feasibility of a high-performance, variable-speed, acoustic homing torpedo powered by a high-speed, deep-depth, thermal propulsion system. The RETORC II program demonstrated that the emerging new technologies could provide the quantum increase in ASW torpedo performance needed to counter the nuclear submarine threat. A specification was prepared for a new full-sized, submarine-launched ASW torpedo, and a competitive procurement was initiated to have industry develop the EX-10/Mk 48 torpedo. By the mid-1960s, a high-priority program had been initiated to have private industry develop the Mk 48 weapon system.

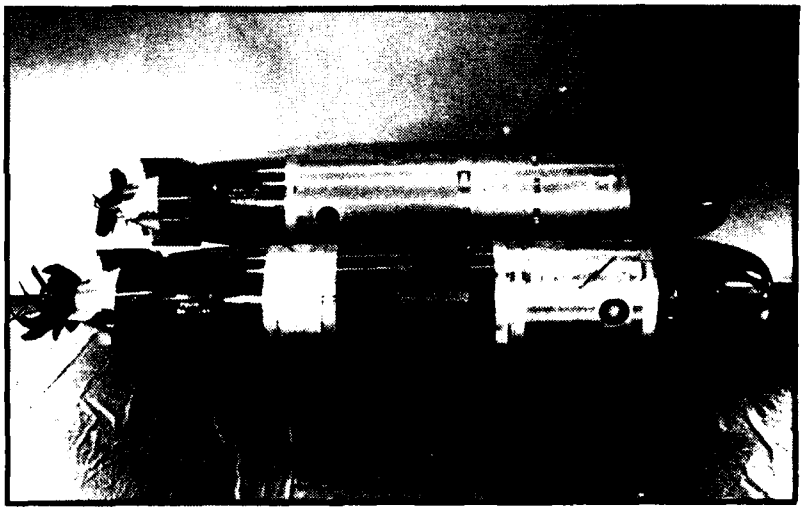
The scientific development of new component-level torpedo technologies continued to expand as structured exploratory development programs were initiated to develop new shell materials, propulsion systems, transducers, exploders, G&C units, two-way wire communication systems, and drag reduction technology. The system-level application of this new technology focused on its application in a new Submarine-Launched Anti-ship Torpedo (SLAST/EX-13) and a Deep Experimental Torpedo (DEXTOR). A series of test vehicles were built, and extensive in-water tests were conducted with the test vehicles to evaluate the new technologies under realistic conditions. By the late 1960s, a flexible modular test vehicle concept had evolved that permitted the evaluation of two or more subsystems during a single range run. The ability to scientifically design subsystems and incorporate them directly into modular test vehicles to evaluate their in-water performance provided an effective and efficient means of developing new concepts. This was especially true in the case of system/vehicle-dependent technologies such as noise reduction and drag reduction.

In 1966 NUOS was merged with NAVUWSEC (the old Central Torpedo Office) to form the Naval Underwater Weapons Research and Engineering Station (NUWS), providing the Navy with a single, full-spectrum torpedo organization with in-house expertise to cover the total life cycle of weapon systems. Late in the decade, the Navy decided to make the Mk 48 ASW torpedo a dual-purpose (anti-ship/ASW) weapon. NUWS was assigned the technical lead role for the development and evaluation of a dual-purpose Mk 48-2 torpedo to meet this new mission requirement. By the end of the decade, NUWS was directly involved in the scientific hands-on development of new high-technology subsystems and the in-water evaluation of this new technology in experimental test vehicles.



Mk 48-1 Torpedo

Fleet introduction of the Mk 48-1 torpedo (February 1972), the Mk 113 fire control system, and the BQQ-5 sonar involved the NUSC technical staff in a massive Fleet support effort, including thousands of Fleet torpedo firings to demonstrate the operational effectiveness of these new technologies.



Fixed Round Simple Torpedo (FIRST) Test Vehicles

The FIRST test vehicles, built to demonstrate the feasibility of a simple half-length, low-cost, antiship torpedo, were the first vehicles in which analytical computer programs were used to scientifically predict control system and hydrodynamic performance prior to design and construction. The experimental, artisan design approach had been superseded by scientific, predictive, torpedo design techniques.

Universal Torpedo (UT) Test Vehicle

The Universal Torpedo (UT), proposed for multiplatform usage, was NUSC's first computer-based test vehicle. Employing digital subsystems and software control, the UT provided NUSC with a test bed for experimentally examining how the new, flexible, digital technology should be utilized in a computer-based, software-controlled torpedo.

The 1970s - A Scientifically Designed Torpedo Emerges

During the 1970s . . .

- **NUWS is merged with NUSL to form the Naval Underwater Systems Center (NUSC).**
- **Focus shifts from generic ASW warfare to development of submarine weapon/combat systems.**

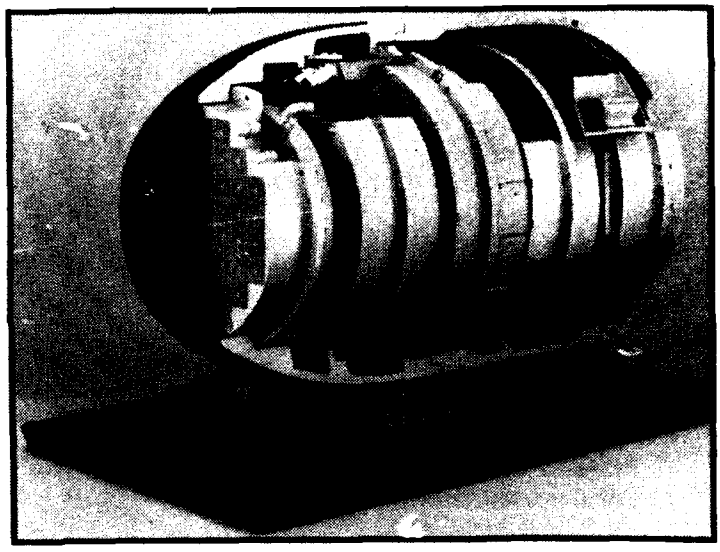
When the Naval Underwater Systems Center (NUSC) was formed in 1970 by the merger of NUWS and NUSL (Navy Underwater Sound Laboratory), NUSC's primary mission evolved from a broad ASW warfare role to the more specific function of supporting the submarine's expanding role in naval warfare. Because NUSC had the technical expertise and was intimately involved in the development of all submarine warfare subsystems (sonar, optical sensors, fire control, torpedoes, and missiles), the new activity was ideally suited to take on the role of "systems center" for submarine combat/warfare systems.

When the new Mk 48 torpedo entered the Fleet in 1972, NUSC became involved in a massive effort to support Fleet introduction of a sophisticated new weapon system. The BQQ-5 sonar suite, the Mk 113/117 fire control systems, and the Mk 48 torpedo provided a potential quantum increase in performance, and introducing this new technology and establishing its operational effectiveness was a major undertaking. Thousands of Fleet torpedo firings combined with Follow-On Test and Evaluation (FOT&E) exercises provided an extensive data base for assessing weapon effectiveness and analyzing overall system performance. This data base also indicated an urgent need to combine the emerging digital subsystems into a single, integrated, computer-based combat system to handle the increasingly sophisticated subsystems and the expanding submarine missions.

Additional experimental test vehicles were developed during the early 1970s and, by the middle of the decade, the scientific predictive design of torpedo subsystem-level technologies was firmly established. The Fixed Round Simple Torpedo (FIRST) test vehicles were developed to demonstrate a simple modular anti-ship torpedo. Newly developed computer programs were employed to predict vehicle performance, including hydrodynamic coefficients and control system gains. In-water performance was accurately predicted before the vehicle was run in the water. For the first time, a complete torpedo had been scientifically designed, and its in-water performance, including hydrodynamic stability and control system responses, had been accurately predicted before it ran in the water. The torpedo had finally completed its long transition from an artisan experimental-designed weapon to a modern weapon that could be scientifically designed and whose performance could be accurately predicted.

Late in the decade, NUSC projected a need for a larger sized lightweight torpedo to counter the dramatic increases in threat submarine performance. An in-house development was initiated to address the technical challenge of applying minicomputers and digital technology to configure a 16-inch-diameter lightweight torpedo test vehicle. The Universal Torpedo (UT) test vehicle was built to demonstrate that the emerging digital technology provided a firm base for developing a modern, software-controlled, lightweight torpedo if the lightweight torpedo envelope were increased to a 16-inch diameter.

By the end of the decade, with the aid of the extensive computer programs that had been developed, the scientific, predictive design of modern torpedoes had been demonstrated. The technical challenge was shifting to the use of emerging minicomputers and digital technology to develop new software-dominated torpedoes and submarine combat systems, and the ADCAP program was initiated to develop a new, high-performance, digital homing system for the Mk 48 torpedo to counter the proliferating submarine threat.



Mk 48 ADCAP

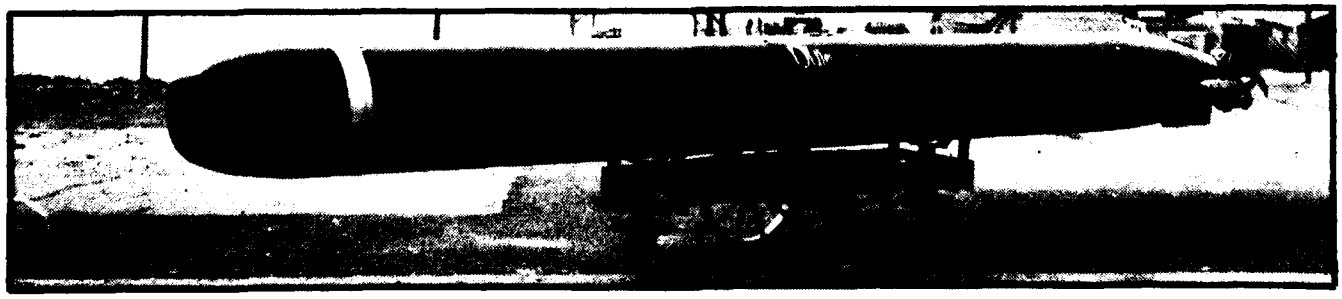
The Mk 48 Advanced Capability (ADCAP) Program incorporates a new, sophisticated, high-technology software, digital guidance and control (G&C) system directly into the Mk 48 torpedo to enhance its operational effectiveness and to extend its operational life. With new technology being transferred directly into operational torpedoes, life-cycle technical management has entered a dynamic new era in which the weapon inventory is undergoing major modifications on a routine basis to maintain operational effectiveness.

Mk 48 Torpedo Being Loaded Aboard a Submarine

Although the torpedo's effectiveness remains the keystone of the submarine's combat effectiveness, the dynamics of managing change with an increasingly sophisticated, software-based combat system is becoming increasingly complex. Rapid responses to technology and threat initiatives are essential to maintain the torpedo's operational effectiveness. However, maintaining the basic stability of the combat system (operational readiness) while at the same time incorporating the changes required to maintain/enhance effectiveness is a major challenge that NUSC is well equipped to handle.

Quiet Torpedo (QT) Test Vehicle

The QT test vehicle (below) provides experimental in-water verification of the various radiated and self-noise technology efforts conducted at NUSC to establish a scientific foundation for future torpedo development efforts. Component/subsystem tests have included shells, propellers, transducers, isolation techniques, coatings, shock mounts, structural materials, and control system configurations.



The 1980s - A New Era

During the 1980s . . .

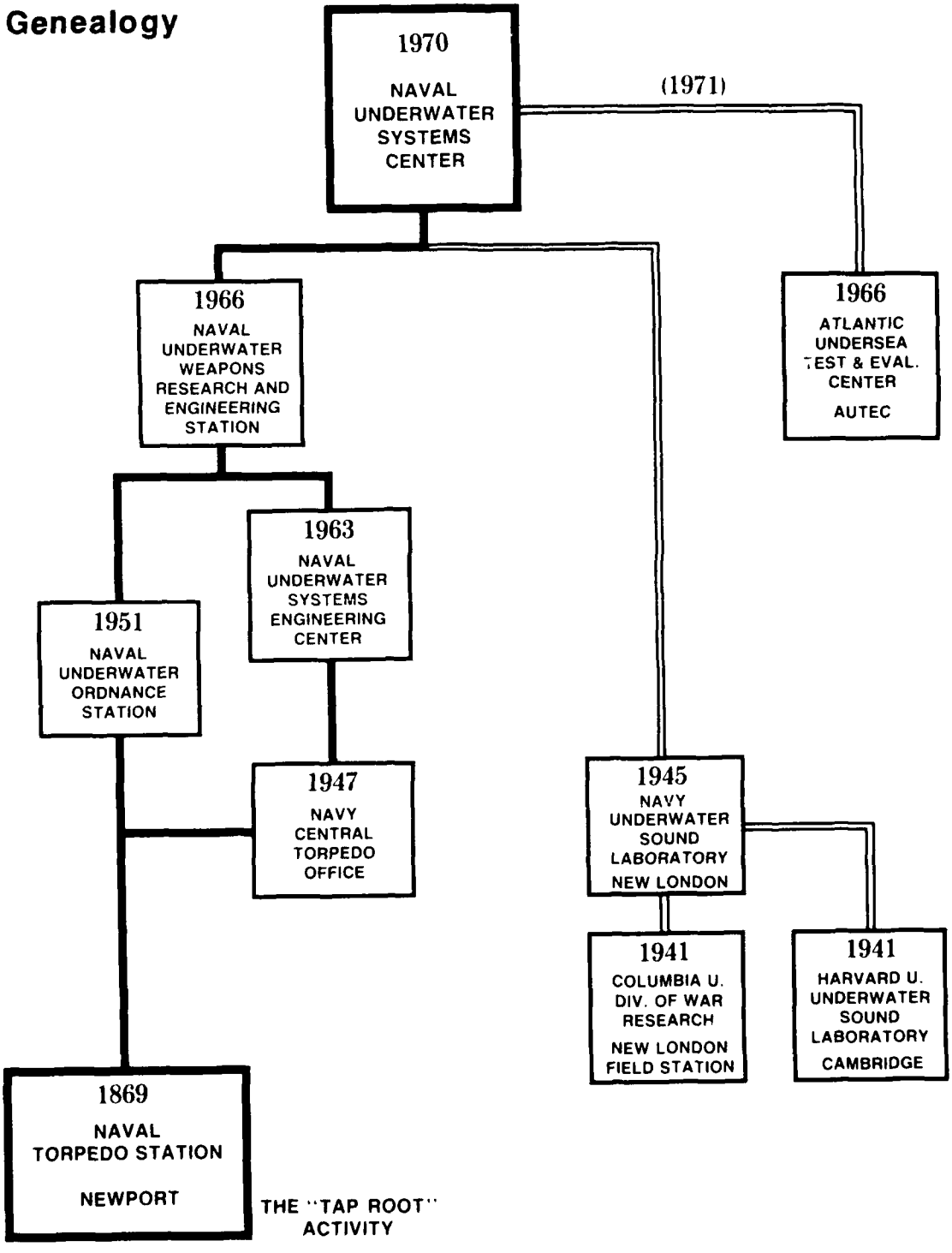
- **The submarine's missions and warfare suite expand dramatically.**
- **Microprocessors, digital technology, and software-configured systems introduce a new era.**

By the early 1980s, NUSC was heavily involved in efforts to support the submarine's expanding warfare roles. The submarine weapon suite was undergoing a dramatic expansion as the encapsulated Harpoon cruise missile was installed to provide a standoff capability against surface ships; variants of the Tomahawk missile, with both conventional and nuclear warheads, were under development for shore bombardment and long-standoff surface targets; and the SUBROC nuclear ASW standoff weapon was being replaced by a new, dual-payload, ASW standoff missile (Sea Lance) that employed either a Mk 50 torpedo or a nuclear depth bomb. Concurrent with the weapon suite expansion, a new computer-based, software-controlled, integrated combat control system development was initiated to support the submarine multimission warfare role.

The Mk 48 torpedo reached full operational capability as operational submarines underwent modification and were certified to employ the new torpedo. Early in the Fleet introduction phase of the Mk 48 torpedo, it became evident that a significant change in the traditional torpedo life cycle was in the offing. While the Fleet introduction phase was still in progress, an improved Mk 48 Mod 3 torpedo was developed to exploit two-way wire communications technology; a Mk 48 Mod 4 torpedo was developed to counter the unanticipated, high-performance Alfa submarine threat; a program was initiated to enhance the reliability of the Mk 48 torpedo; and a major guidance and control development (ADCAP) was initiated to develop a new, high-performance homing system to counter major improvements in threat submarine performance. The torpedo life cycle had become increasingly dynamic with major technological improvements being transferred directly into operational weapons on a routine basis. The classic concept of a stable warehouse inventory of war-ready torpedoes was being challenged by the rapid changes in threat and technology. The new, dynamic torpedo program required a continuing, close, and direct working relationship between the scientists and shipboard operators to ensure the successful transfusion of sophisticated new technology directly into operational torpedoes without adversely impacting operational readiness.

The advent of the scientifically designed torpedo, the emerging software-based digital technology, the expanding weapon suite, and the integrated combat control system have introduced a new era that poses significant technical management challenges. The increasingly complex and sophisticated submarine warfare system, as well as the frequent changes mandated by new technology and the changing threat, have created extremely dynamic subsystem programs. Managing change in a timely manner while maintaining operational readiness has become a major challenge requiring the dedicated services of a systems center to provide the hands-on, full-spectrum, life-cycle technical management needed to control the complex interactions involved in transfusing new technology directly into operational systems.

NUSC Genealogy



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The Future

Into the next century . . .

- **The Naval Underwater Systems Center's primary mission will focus on submarine warfare systems.**
- **The torpedo will continue to be the submarine's principal weapon, and NUSC will remain dedicated in its role as the Navy's corporate center of excellence for torpedo efforts.**

For more than a century, the Naval Underwater Systems Center and its predecessor activities have provided the in-house expertise to support the Navy's torpedo programs. Ranging from basic R&D to development, production, and in-service support of new torpedoes, these efforts have made Newport the Navy's corporate focal point for torpedoes.

NUSC's role now encompasses the total submarine combat system and, as the Navy's designated center of excellence for submarine warfare systems, its future work will focus on sophisticated, computer-based, software-controlled weapon and combat systems. But, as the torpedo continues to be the basic element of an effective submarine warfare system, NUSC fully recognizes the essential need to maintain a strong hands-on involvement in the torpedo's future evolution.

It is NUSC's intention to continue to be recognized as the Navy's center of excellence for torpedoes, and to carry on the historical role of its predecessor organizations in providing technical leadership for the Navy's torpedo programs.