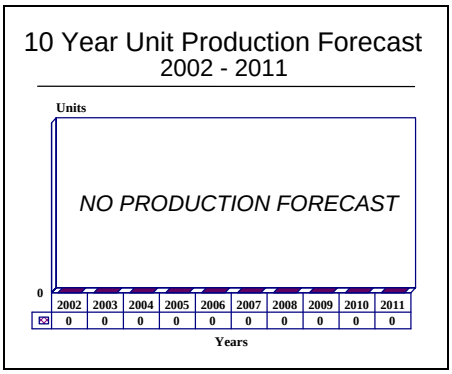
NT-37F Torpedo – Archived 2/2003

Outlook

- No longer in production
- The Mk 37 and NT-37 were sold to customers around the world
- Raytheon has ceased to market this torpedo to prospective customers
- No further orders are anticipated
- Customer attention is focused on next-generation alternatives



Orientation

Description. The NT-37 family of heavyweight, dual-purpose torpedoes and upgrade kits represents a total redesign of the original US Navy Mk 37 torpedo of the 1950s.

Sponsor. Raytheon Systems Company, Defense Systems Division, Hopkins, MN.

Contractors. Raytheon Systems Company, Portsmouth, RI. This program was originally run by Alliant Techsystems Marine Systems Group, which was bought by Hughes in March 1997.

Status. Variants of the NT-37 (as well as upgrade conversion kits) are in operational service with several navies around the world.

Total Produced. About 1,200 Mk 37/NT-37s were produced in various configurations through the end of 2000. Some of these units are Mk 37s that have had upgrade kits installed. Out of this total, 600 are estimated to be NT-37s (with around 200 being the F version), either new-production or conversion models.

Application. These torpedoes are designed to destroy both surface ships and submarines.

Price Range. Estimated price of an NT-37 torpedo was between US$400,000 and $450,000 in 1992 values (based on cost averaging past contracts).

Technical Data

Design Features. The NT-37F heavyweight torpedo represents a total upgrade to and modernization of the 1950s-vintage Mk 37 torpedo. The original torpedo's subsystems, including sonar, guidance, and propulsion, have been completely replaced by new hardware and software, leaving only the original hull of the Mk 37 intact. The NT-37 has evolved over time to a number of different level modular upgrade packages, which can be retrofitted to earlier Mk 37 configurations in various combinations.

The NT-37F upgrade family consists of two major subsystems: the Otto-fueled thermomechanical engine (as opposed to Mk 37's electric motor); and a solid-state acoustic system including a computer-designed, laminar-flow nose cone assembly. The torpedo is coated with special baffling material to reduce engine and hull flow noise. The guidance system is based on the Intel 81086 processor.

The modular design of the NT-37F is intended to minimize the cost of operating and servicing the

torpedoes during their lifetime. The plug-in assemblies, black-box items, and built-in semi-automatic self-test feature either streamline or entirely eliminate more involved deck-level repairs and adjustments. The automatic self-test also saves labor costs. Additionally, the torpedo has been designed to require major maintenance only once every six years.

The NT-37F is available at comparatively low cost, in both acquisition and support terms. Furthermore, it is a mature weapon benefiting from years of product development, and has performance characteristics comparable with other torpedoes on the export market. More important, it is relatively small and light for a weapon classified as a heavyweight torpedo, imposes few demands on the launch platform, and can be easily interfaced with the command and control systems on most submarines.

The parts are certified to the MIL-STD-883B standard. Packaging, storage, and shipping standards meet or exceed MIL-E-17555 specifications, and regarding the environmental requirements, the torpedoes are said to meet or exceed the vibration, temperature, humidity, and shock requirements of MIL-T-82590. Electromagnetic emission and susceptibility are stated as being compatible with other components when installed in the torpedo.

Operating mean time between failures (MTBF) is said to be more than 900 hours. Workmanship and material are warranted for 12 months after delivery, and the workmanship meets or exceeds the MIL-STD-454 standard. Quality program requirements are based on MIL-Q-9858A.

	Metric Mod 2	**Metric** Mod 3	**US** Mod 2	**US** Mod 3
Dimensions				
Diameter:	485 mm[(a)]	485 mm	19 in[(a)]	19 in
Length:	4,505 mm	3,846 mm	14 ft 7 in	12 ft 6 in
Weight:	750 kg	642 kg	1,653 lb	1,415 lb
Performance				
Speed:	58 kmph	58+ kmph	32 kt	32+ kt
Range:	18 km	18+ km	10 nm	10+ nm

[(a)] Designed to fit 533 mm launch tubes.

Propulsion. Otto-fueled thermomechanical rotary piston cam engine. The use of an Otto-fuel engine lowers the overall cost and the cost of maintenance versus the former silver-zinc battery electric motor. It also brings in more commonalities with the widely used Mk 46 lightweight torpedo, making it easier for the navies to utilize their existing spare parts and tools inventories as well as knowledge base for the torpedoes.

Control & Guidance. The NT-37F upgrade family uses a solid-state acoustic system and a computer-based digital control system built around the Intel 81086 processor. The acoustic processor and the controller are programmable solid-state units versus the vacuum tubes of the original Mk 37, lowering the cost and enhancing the operational reliability, thanks to the lower maintenance requirements of NT-37F. The upgrade package also includes a new digital (vice analog) autopilot. In one version, the autopilot can be programmed to navigate the torpedo to specific, predetermined geographical coordinates.

Launcher Mode. The NT-37 family of torpedoes can be carried by any surface ship or submarine that has torpedo tubes for the 21 inch Mk 37 torpedo. As a 19 inch weapon, it can be propelled from existing 21 inch torpedo tubes using adapters.

As for compatibility with existing platforms and their fire control systems, the NT-37F is offered for the German 205/206/MSI-70U, the German 209/HAS-SINBADS (later version), and the Dutch Zwaardvis/ HSA-M8 combination, or presumably any platform built for the Mk 37.

Warhead. The torpedo carries a 150 kilogram HE warhead with contact/proximity fuze.

Variants/Upgrades

The individual NT-37 variants are as follows: NT-37 – a modified weapon with new batteries, a more powerful motor, a quieter propeller, and a new homing panel; NT-37C – provides an increase in speed and range; NT-37D – a modified version of the C that has a new homing head; NT-37E – was believed to be a modified

version of the D; NT-37F – the primary Mk 37 upgrade version; NT-37F Mod 2 – a wire-guided version of the most recent upgrade; NT-37F Mod 3 – a non-wire-guided version of the same upgrade level; NT-37G – a next-generation torpedo rather than a modernized Mk 37; Seahuntor – an entirely new torpedo derived from the NT-37; and the Seahuntor(S) – a variation on the Seahuntor model.

The latter two models are discussed in their own respective reports in this tab.

A self-propelled mine version of the Mk 37, the Mk 67 Submarine-Launched Mobile Mine, has been introduced. This is essentially a Mk 37 torpedo body fitted with a Mk 13 mine warhead, an auxiliary controller that replaces the previous acoustic panel location, and a standard Mk 37 electromechanical guidance system.

Standoff Weapons Mk 31. This is intended for use from Mk IX SEAL Swimmer-Delivery vehicles to attack surface ships in harbors. The standoff weapon was introduced into fleet service in 1987.

Program Review

Background. The NT-37 is a derivative of the US Navy's Mk 37 torpedo, design work on which began in 1946. The weapon was evaluated in 1955, using 30 preproduction units. The weapon was accepted for service in 1959, and the first units entered the fleet the following year.

The original Mk 37 had three basic modes of operation: predicted-intercept, corrected-intercept, and bearing-rider. This unit was the Mod 0; from this evolved Mods 1, 2, and 3. The Mod 1 was the first wire-guided torpedo to enter service with the US Navy. The Mod 1 program commenced in 1958 and the first unit was tested in 1960.

In 1968, Northrop Corporation (now Northrop Grumman Corp) began improving the Mk 37 in cooperation with the Naval Torpedo Station at Keyport, Washington. This work included replacing the existing silver-zinc battery with the Otto fuel engine of a Mk 46 Mod 1. Speed increased by 40 percent, and range by 150 percent. For a service-modified torpedo (NT-37C), the published figures are 40 percent greater speed, 125 percent more range, and about 80 percent greater endurance. Tests were conducted, and by 1977 the NT-37C was in service in several NATO and South American navies. In February 1976, Norway ordered conversion kits for its Mk 37s.

In 1980, Canadian/Norwegian/Dutch trials on the Nanoose acoustic range showed a 71 percent success rate in 17 runs; an operational evaluation in the North Atlantic showed an 88 percent success in eight runs. Operational demonstrations in 1981 showed 100 percent success in 18 runs. Canadian guidance-and-control trials in 1982 (Nanoose range) showed 100 percent success in eight runs.

The next upgrade step was a new homing head and a new acoustic system, which resulted in the new torpedo version being designated NT-37D. The installation of a new guidance system produced the NT-37E. This was never placed in production, being upgraded to the NT-37F before the NT-37E was even put up for sale.

A new nose and acoustic panel were tested between 1980 and 1983.

Given the large number of Mk 37s produced, the torpedo's manufacturer, Raytheon Systems Company, offered foreign customers a variety of modified versions in an NT-37 series. The company also offered a modified Mk 37 for the abortive US requirement for an inexpensive surface-only torpedo. By late 1983, about 500 torpedoes in eight navies had been upgraded to the NT-37C configuration. Mk 37 was supplied to at least 16 navies. By 1986, NT-37C was in service with the navies of Canada, Israel, the Netherlands, Norway, and Peru.

In 1992, Alliant started work on the NT-37G. This was effectively a completely new torpedo which had little in common with the older versions of the weapon. This great advance (as marked as that from Mk 37 to NT-37) was recognized when, in 1993, Alliant announced Seahuntor (SEA-HUNting TORpedo). The prototype was tested in September 1993. Its range is 2.5 times that of the Mk 37, speed is about 1.5 times, passive and active detection ranges are double, and warhead size is about 1.75 times.

Next-Generation Heavyweight Torpedo. In 1996, Alliant announced a new version of the Seahuntor. Known as the Seahuntor(S), this new variant is a short-length heavyweight torpedo that doubles the weapon storage and firing capacity on submarines. The manufacturer considers the Seahuntor(S) to be one of the least expensive heavyweight torpedoes to procure, maintain, and operate. It is primarily designed to be used on the German Type 209 submarine, one of the major selling diesel-electric boats in the world. The Seahuntor(S) can fit right into existing torpedo tubes with no modifications and is expected to replace older versions of the Mk 37 torpedo family.

Plant Closure. In October 1998, Raytheon said it would close the Mukilteo torpedo plant in the state of Washington as part of a company-wide downsizing effort. This meant laying off 550 personnel – 90 immediately and the other 460 at the end of 1999. The work from this 356,000-square-foot plant was said to be transferred to a facility in Portsmouth, Rhode Island. This move is another indication that the torpedo market is going through a relatively sluggish period at the moment, with manufacturers everywhere consolidating and rationalizing their operations. It is also an indication that hardly any production is taking place. This is a strong indicator that the now-aging NT-37F ceased production at this time in the face of competition from more modern torpedoes on the market.

Torpedo Models. The NT-37F heavyweight torpedo (as well as the rest of the NT-37 family of torpedo variants) is basically a redesign of the US Navy's original Mk 37 torpedo. The NT-37F model completely replaces the subsystems, propulsion, sonar, and guidance systems (including new hardware and software) of the Mk 37. The only remaining commonality between the Mk 37 and the NT-37F is the original torpedo hull.

The Mk 37 has been rebuilt both as Mk 67 Submarine-Launched Mobile Mines and as Mk 31 Standoff Weapons. The standoff weapon is intended for use from Mk IX SEAL Swimmer-Delivery vehicles to attack surface ships in harbors. The standoff weapon was introduced into fleet service in 1987.

The individual NT-37 variants are as follows:

NT-37. The NT-37 was the first weapon of the class to evolve from the Mk 37 program. This is a modified weapon with new batteries, a more powerful motor, a newer and quieter propeller, and a new homing panel. These features reduced the weapon's self-generated noise and made it more of a threat to the newer, quieter submarines.

NT-37C. The NT-37C provides an increase in speed and range, as well as serving as a dual-purpose weapon. This weapon has three modes: 1) straight run at high speed with depth control; 2) delayed homing, with the torpedo running straight but searching again if it misses the target, or beginning its search at a preset range; and 3) full passive homing, as in the original Mk 37.

The torpedo can be effectively used against ships under way, towing countermeasures devices, or lying at anchor. Thanks to the flexibility inherent in this weapon's tactical role, only one type of torpedo is needed for a wide range of applications.

NT-37D. The NT-37D is a modified version of the C that has a different homing head. This homing head is provided with a new acoustic system. Both the C and D level upgrades are still in operation with several navies worldwide.

NT-37E. The NT-37E was believed to be a modified version of the D that quickly developed into the NT-37F before ever reaching the market.

NT-37F. The NT-37F is the final Mk 37 upgrade version, in a sense completing the process of upgrading the original torpedo to today's requirements. The principal change is some guidance improvement. Compared to the Mk 37, the NT-37F achieves 40 percent higher speed, 125 percent longer range, and 100 percent longer shallow-water passive and active detection ranges (a diagram shows about 90 percent longer passive-detection range). Special baffling and a new nose shape protect the sonar transducer from engine and hull noise at high speed and near the surface. The fixed analog logic of the original is replaced by a digital programmable control system (Mk 37 tactics are fixed; NT-37 tactics are programmable and thus less easily predicted by the enemy). Additional anti-ship run patterns have been added to the control system.

The manufacturer claims that major service work is reduced from an 18-month cycle to once every six years, partly through the introduction of a self-testing acoustic panel and a more reliable control system.

NT-37F Mod 2. This is a wire-guided version of the most recent upgrade, featuring a new proximity fuze, two-speed engine, and higher top speed. These characteristics can also be fitted as separate options on the basic NT-37F model.

NT-37F Mod 3. A non-wire-guided version of the same upgrade level.

NT-37G. The NT-37G was a next-generation torpedo (rather than a modernized Mk 37) with a larger warhead, a proximity fuze, and increased speed (a modified engine). This has subsequently evolved into the Seahuntor torpedo.

Seahuntor. The Seahuntor (SEA-HUNting TORpedo) is an entirely new torpedo derived from the NT-37. In effect it forms the generation beyond NT-37F. The torpedo has completely new electronics, including new guidance, new sonar, a proximity fuze, and a multispeed Otto-fueled engine for higher speed.

Seahuntor(S). The Seahuntor(S) is a variation of the Seahuntor model. It is a shortened version of the standard-length heavyweight torpedo with all the operational capabilities of the full-length heavyweight model.

The latter two models are discussed in their own respective reports in this tab.

Funding

This is a company-funded program, with some funding coming from the countries that order the weapon. The US defense budget does not provide funding for any of the torpedoes.

Recent Contracts

Contractor	Award ($ millions)	Date/Description
Alliant Techsystems	30	October 22, 1992 – NT-37F modernization kits to Egypt. Deliveries began in 1994 and were reportedly completed in 1995.

Timetable

Year	Major Development
1956	Mk 37 development commences
1975	NT-37C enters service
1983	NT-37D enters service
1991	First order received for NT-37F
1994	First deliveries of NT-37F
1996-1997	Successor Seahuntor available for production
1997	Seahuntor(S), a shorter variant, developed and tested
1998	Mukilteo plant closed

Worldwide Distribution

User Countries. The following countries have purchased the Mk 37:

Argentina, **Brazil**, **Canada**, **Chile**, **Germany**, **Greece**, **Italy**, **Japan**, the **Netherlands** (retired from service), **Pakistan**, **Peru**, **Spain** (Mod 3 in Baleares class), **Taiwan**, **Turkey**, the **United States**, and **Venezuela**. Most of these navies no longer use the Mk 37; in fact, the torpedo may survive only in **Argentina**, **Greece**, and **Turkey**.

The following countries have purchased the NT-37:

Argentina (NT-37C), **Brazil** (NT-37F with larger warhead, improved exploder sensor), **Canada** (NT-37D), **Egypt** (NT-37F for Romeo class), **Greece** (may have modified Mk 37s to NT-37D standard), **Israel** (NT-37D; NT-37E/F design sold to Israel to upgrade NT-37Ds), the **Netherlands** (NT-37D), **Norway** (NT-37C bought but stored), and **Peru** (NT-37C).

Forecast Rationale

Raytheon is no longer actively marketing the NT-37 torpedo to prospective clients. As new torpedoes became available, the market for the NT-37 slowly disappeared. Those torpedoes still in inventory are expected to be used in training operations until their numbers are expended.

Some NT-37 torpedoes could be converted to mobile mines. The Mk 67 submarine-launched mobile mine concept provides a viable use for these older torpedoes. Mine warfare has always been an attractive weapon to second- and third-tier naval powers. The use of submarines to lay mines in designated choke points offers a means by which they can be used without the risk of taking on a skilled surface battlegroup.

Note: The following forecast includes small ongoing expenditure to support existing inventories and convert surplus torpedo bodies to Mk 67 mines.

Ten-Year Outlook

ESTIMATED CALENDAR YEAR PRODUCTION

			High Confidence Level				Good Confidence Level			Speculative			
Missile	**(Engine)**	**thru 01**	**02**	**03**	**04**	**05**	**06**	**07**	**08**	**09**	**10**	**11**	**Total 02-11**
RAYTHEON COMPANY													
NT-37F (a)	UNSPECIFIED	200	0	0	0	0	0	0	0	0	0	0	0
Total Production		200	0	0	0	0	0	0	0	0	0	0	0

(a) Conversion kits.