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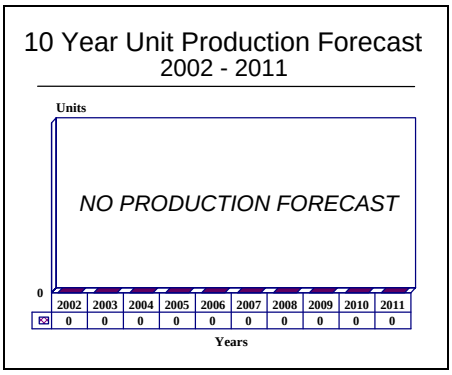
Mk 50 Barracuda Torpedo - Archived 5/2003

Outlook

- New-unit production has been concluded
- The only customer for the Mk 50 is the US Navy
- US Navy is developing the Mk 54 Lightweight Hybrid Torpedo (LHT). This weapon will not replace the Mk 50
- The Mk 50 could remain in inventory through 2020
- Low-rate initial production of the Mk 54 is under way



Orientation

Description. Lightweight torpedo.

Sponsor. US Navy, Naval Sea Systems Command, Arlington, Virginia, USA, is responsible for program management. US Navy, Naval Ocean Systems Center, San Diego, California, USA, is the lead laboratory.

Contractors. Raytheon Systems Company, Defense Systems Division, Portsmouth, Rhode Island, USA. This torpedo was manufactured by Alliant Techsystems Marine Systems Group. In March 1997, Alliant Marine was acquired by Hughes.

Second Source. Northrop Grumman Corp (formerly Westinghouse Electric Corp), Naval Systems Division, Cleveland, Ohio, USA.

Major Subcontractors. Analysis & Technology Inc, North Stonington, Connecticut (Support Services); McLaughlin Research Corp, Middletown, Rhode Island (Support Services); and Vitro Corp, Rockville, Maryland (Support Services).

Status. In operational service. Production of complete torpedoes ended, but a software improvement effort is currently in development. Funding is in place for an ongoing Mk 50 Torpedo Improvement program in order to maintain the technological edge for US Navy torpedoes.

Total Produced. Based on known orders, an estimated 1,090 Mk 50 combat operational torpedoes were procured by the US Navy. This figure includes 611 fully produced Mk 50s and 479 turnabout kits, to retrofit earlier Mk 50s used in testing and make these torpedoes combat operational for fleet use.

Application. The Mk 50 can be launched from either aircraft or surface warships.

Price Range. Per unit, the Mk 50 torpedo is estimated to cost between $750,000 and US$1 million. Average price is $800,000, including support (based on known contract cost averaging).

Technical Data

Design Features. The Mk 50 is the outgrowth of a long-standing US Navy requirement for a lightweight ASW torpedo that would replace the Mk 46 torpedo. The Mk 46 has been in production since the early 1960s. Besides being used on aircraft, ships, and submarines, the Mk 50 also serves as the payload for ASROC. Having greater range, speed, and depth, the Mk 50 offers several major improvements over the Mk 46 Mod 5 Torpedo. In addition, the Mk 50's warhead is about five to 10 pounds heavier and has a much-improved guidance system.

	Metric	US
Dimensions		
Length:	2.8 meters	9.24 ft
Diameter:	324 mm	12.75 in
Weight:	364 kg	800.8 lb
Performance		
Speed:	102 kmph (est.)	55 kt (est.)
Range:	13,710 meters	15,000 yards
Depth (approximately):	762.5 meters	2,500 feet

Propulsion. The propulsion system is a solid block of lithium that generates full power at all depths because it is exhaust-free.

Control & Guidance. The sonar is an active/passive type with multiple selectable transmit and receive beams. The command and control system provides navigational and attitude controls. The command and control system uses a standard AYK-14 computer with tactical software and enough memory for future expansion.

Launcher Mode. Though the Mk 50 was originally designed for use against fast, deep-diving nuclear submarines, today its main target is diesel-electric submarines, which are operating increasingly in littoral environments.

Warhead. The Mk 50 uses a shaped-charge warhead.

Variants/Upgrades

The Mk 50 can be launched from aircraft or from surface ships. No information is available as to any differences in design – presumably this is restricted to installing a parachute pack on the version delivered by airmail. On a surface ship it can be launched from a torpedo tube or fitted to an ASROC missile (as a warhead). The latter can be launched from an eight-round box, Mk 13 or Mk 26 rail launcher, or (in modified form) from a Mk 41 VLS.

The Mk 46 Mod 8 LHT (Lightweight Hybrid Torpedo) is the new lightweight torpedo of the US Navy that will take the place of the Mk 50, incorporating in its design elements from both the Mk 50 lightweight and the Mk 46. The Mk 46 Mod 8 was intended to take the place of Mk 50 altogether once production began, but since the USN inventory of Mk 50s is still quite large, they will coexist for the time being.

The Mk 50 Shallow Water Performance Program addresses improvements in shallow-water, near-surface performance, zero Doppler target detection, and bottom target recognition necessary to counter the high-tech diesel submarines encountered in the littoral warfare arena.

Program Review

Background. The program was initiated in 1971 as the Advanced DD/Air Lightweight Torpedo (AD/ALT), and subsequently became the Mk XX. After the completion of a three-year technology assessment phase (TAP) in September 1978, the US Navy opened bids for the advanced development contract and received offers from Honeywell, Gould, McDonnell Douglas, and Westinghouse. In May 1979, NAVSEA awarded Honeywell and McDonnell Douglas each a $1.35 million sustaining engineering contract to keep their teams intact until a delayed Advanced Development (AD) contract would be ready. These contracts were issued on August 1, 1979; Honeywell received $60.5 million, and McDonnell Douglas $53.5 million.

The contracts called for a 39-month development program, encompassing the design and manufacture of 15 prototype torpedoes, a third of which were to be used for contractor testing and the remainder for US Navy testing. These awards were accompanied by a $13.8 million contract to the Autonetics Marine Systems Division of Rockwell International for the production of seven advanced mobile acoustic torpedo targets (ADMATTs). These are modified Mk 45 torpedoes towing a hydrophone/echo repeater array to simulate the spatial extent of a target submarine. The McDonnell Douglas version, the EX-51, used a Raytheon side-looking array sonar, developed under a $1.9 million contract, and a General Electric propulsion system using aluminum silver oxide batteries. Honeywell's model, the EX-50, was powered by a

Garrett Stored Chemical Energy Propulsion System (SCEPS).

On September 5, 1980, the US Navy approved the Mission Element Need Statement (MENS) for the ALWT, but late in 1980 it decided to let the McDonnell Douglas research contracts expire. The Navy would pursue only the lower-risk Honeywell version of the ALWT, due to cost constraints. In FY81, Honeywell completed fabrication of EX-50 test models, and US Navy testing was begun in FY82. Honeywell's contract called for a 39-month development program, but the Navy expanded this to 43 months. The Navy completed DSARC II for the Mk 50 to permit award of an engineering development contract in 1983. This involved construction of 40 more test torpedoes for TECH/OPEVALS. On September 23, 1983, Honeywell received a $500.1 million award for Full-Scale Engineering Development (FSED) of the Mk 50.

The US Navy had been conducting Mk 50 research under two programs, PE#0603610N: Advanced ASW Torpedo, and PE#0604610N: Advanced Lightweight Torpedo. Congress deleted all funding for the former after FY85, due to problems with the program. The ALWT program has been the scene of much activity during the past few years. Between FY85 and FY87, the US Navy conducted in-water development of the tactical computer logic algorithms for various tactical scenarios. In FY86, four prototype forebodies and three prototype afterbodies of the 200 series were fabricated, while two forebodies and four afterbodies from the prototype lot 200A were delivered to the US Navy and tested at sea beginning on July 30, 1986.

The RFP for second sourcing was issued in November 1985, and, on July 15, 1986, Raytheon and Westinghouse delivered proposals and sample hardware to the US Navy. In June 1987, Westinghouse was selected as the second source. The Navy had made its first request for operational Mk 50s in the FY87 budget request, asking for $109.9 million for 84 Mk 50 torpedoes. The House cut this to $19.3 million, while the Senate gave the US Navy $68.1 million. Congress settled for the Senate figure, giving the Navy $65 million. Congress also told the service to spend $19.3 million for second-source qualification, and asked the Navy to revise Mk 50 development. The service responded by creating an 89-month full-scale development program.

The US Navy completed the first 53 months of the newly planned 89-month full-scale development effort in FY87. Many events that the service had planned or expected to complete in FY86 were not finished until FY87 due to program delays. These included full-scale prototype lot warhead testing including firings, environmental and safety tests; integration/compatibility testing with different types of surface ships and aircraft; and design and testing of fixed and rotary wing parachutes and nose caps.

Activity in FY87 included the preliminary fabrication of the first Mk 644 test set, design of the Mk 653 and 661 test sets, the beginning of in-water tactical computer hardware evaluation, and the transfer of information to Westinghouse as the second source for production. Captive carry and safety certification tests were held, while research and development continued on various improvements to the warhead in order to maximize its explosive charge.

The Mk 50 program ran into trouble in June 1987 when the US Department of Defense (DoD) issued the 1987 Selected Acquisition Reports (SARs) for major weapons systems. The SARs noted that in the quarter from March 1987 through June 1987, Mk 50 program costs had risen from $263.8 million in Base Year FY79 dollars to $418.1 million in Current Year FY87 dollars. Of the $418 million, $251 million was due to developmental problems with the Mk 50, with the other $167 million due to inflation resulting from the delays. The SARs added that the original $5.35 billion estimate for the program in FY79 had risen to $6.93 billion, a larger rise than experienced by most other programs. Due to the cost jump, the US Navy revised the contract, requiring Honeywell to pay up to 70 percent of the cost increase.

The US Navy's FY88 budget request asked for $222.4 million for 152 Mk 50 torpedoes. The House voted to zero Mk 50 funding, recommending that the US Navy revise and stretch out the program. The Senate voted to spend $108 million for 152 torpedoes. Congress eventually appropriated $108 million for 16 torpedoes, while authorizing the US Navy to order up to 65 torpedoes at the reduced funding level. When the FY89 budget was released, the FY88 torpedo procurement figure was only 10 torpedoes.

PE#0604610N activity in FY88 included the completion of Operational Testing (OT)-IIA in preparation for Milestone IIIA, the completion of the in-water run program to support OPEVAL, and the fabrication of support and test equipment for OPEVAL. The US Navy conducted a Critical Design Review. The service also began afterbody turnaround at the Naval Underwater Weapons Engineering Station (NUWES) in Keyport, Washington. The final lot of 200A (prototype model) torpedoes was delivered, followed by the first deliveries of lot 200B (OPEVAL) torpedoes. Long-lead material was purchased for limited rate initial production. Intermediate Maintenance Activity personnel began to receive training in weapon use and maintenance.

When the US Navy issued its FY88/89 budget request in January 1987, it postulated a FY89 request of $12.6 million for PE#0604610N. There also was a planned request of $7.7 million for PE#0603610N, which was now called Advanced Warhead Development. The request for torpedoes had changed, from a planned $277.6 million for 224 Mk 50s to $162 million for 140 weapons. Congress gave the US Navy $136.4 million for research and $160.9 million for 140 torpedoes.

During FY90, the US Navy continued taking delivery of OPEVAL torpedoes, while beginning in-water tactical logic evaluation of these Mk 50s. Automatic Test Equipment and support & test equipment were installed at Intermediate Maintenance Activities (IMAs) for OPEVAL. The US Navy completed Mk 50 training for IMA personnel and some warship crews. Tests of the operational tactical computer code required for OPEVAL were completed and validated.

Other activities included an in-water evaluation of signal processing and tactics for complex attack scenarios from a variety of warship classes. A Physical Configuration Audit was conducted mid-year. TECHEVAL was completed and included 50 test runs and data analysis with the OPEVAL torpedoes. The US Navy also qualified Westinghouse as a second source. The service conducted test runs, with data analysis, for OPEVAL, which ended in September 1990.

By May 1993, Mk 50 procurement had been suspended pending completion of the bottom-up defense review. The Mk 50 was the only program specifically targeted by this process. The story was that limited Mk 50 production, probably at a very low level, was likely to be continued, since comparative testing had shown the Mk 50 to be superior to the Mk 46 Mod 5 in shallow water.

Program Shift. The following year, FY94, PE#0603610N Advanced Warhead Development was restructured and retitled PE#0603610N Mk 50 Shallow Water Performance. This change addressed the major development of torpedo improvements for shallow-water performance, near-surface performance, zero Doppler target detection, and bottom target recognition to better counter the high-tech diesel submarines which will be more commonly encountered in regional littoral warfare. Much of the year's activity focused on conducting shallow-water exercises against Rest-of-World submarines in order to assess existing performance and new shallow-water enhancements. Other work included developing prototype fire-control external interface to provide additional target information, evaluating shaped-charge warhead technology, enhancing existing models for shallow-water scenarios, designing prototype Fleet Exercise Section for improved reliability, and evaluating combinations of existing fuels and developing new environmentally benign fuels.

No record of activity was released for FY95.

The program agenda for FY96 called for developing tactical software to refine shallow-water search patterns and tactics, addressing multi-bounce propagation, and refining bottom avoidance. Developing improved tactical software for counter-countermeasure performance and for short-range acquisition was also planned. These activities proceeded through FY97 and were scheduled to continue through FY98 as well. All tactical software improvements were expected to be completed in FY99.

New Torpedo Development. A new program was initiated in FY94 titled PE#0604610N Lightweight Hybrid Torpedo. This program will design, integrate, and test a Lightweight Hybrid Torpedo by taking advantage of current US Navy investments in torpedo hardware and torpedo technology. The torpedo will be comprised of components from the Mk 46, the Mk 50, and the Mk 48 ADCAP torpedoes. Additionally, the Lightweight Hybrid Torpedo will incorporate improvements in the shallow-water, littoral warfare counter-countermeasure environment.

The Mk 50 was originally devised to replace the Mk 46. Unfortunately, the US Navy budget was under great pressure as the service juggled funding priorities in the face of a changing ASW threat. In addition to limiting additional procurement, the US Navy had planned to complete development of an advanced warhead for the Mk 50 in FY93. There has been no information as to whether this upgrade will go into production or will be put on the shelf for the foreseeable future.

The reduced numbers of Mk 50s produced following the defense review have been offset, to some extent, by continued reliance on the large inventory of the older Mk 46 torpedo, many of which are being upgraded to the Mod 5 configuration. The last known procurement of the Mk 50 torpedo was completed by the end of 1995. No additional orders have been made public.

Funding

The US is not funding any further procurement of full-up Mk 50 units. Major development work on the Mk 50 torpedo has been completed.

US FUNDING

	FY96		FY97		FY98		FY99	
	QTY	AMT	QTY	AMT	QTY	AMT	QTY	AMT
RDT&E (US Navy)								
Proj - 1	-	2.9	-	1.3	-	2.8	-	0

Proj - 1 PE#0603610N Mk 50 Shallow Water Performance, Project V1873 LTWT Torpedo (Adv).

Recent Contracts

Contractor	Award ($ millions)	Date/Description
Alliant Techsystems	12.0	June 1994 – Indefinite delivery/indefinite quantity CPFF contract to provide engineering support for development test/evaluation, implementation, and maintenance of hardware and software for the Lightweight Torpedo Program. Contract completed June 1997. (N66604-94-D-A362)
McLaughlin Research	12.8	July 1994 – Indefinite delivery/indefinite quantity CPFF provisions contract for engineering and technical services in support of configuration management, production engineering, and quality assurance for the full life-cycle support of heavyweight and lightweight torpedo systems and related programs. Contract was expected to be completed by July 1999. (N66604- 94-D-A116)
Vitro	18.6	August 1994 – Indefinite delivery/indefinite quantity CPFF provision contract for technical support services for various lightweight and heavyweight torpedo programs including Mk 48, Mk 48 ADCAP, Mk 50, and Mk 46. Contract was expected to be completed by August 1999. (N66604-94-D-D142)
McLaughlin Research	8.2	July 1995 – CPFF indefinite delivery/indefinite quantity provisions contract for engineering support, functional administration, technical services, and maintenance support for the life cycle of lightweight and heavyweight torpedo systems. Contract was expected to be completed by July 2000. (N66604- 95-D-A279)
Syscon	5.2	January 1996 – Indefinite delivery/indefinite quantity contract with CPFF provisions for engineering services in the areas of design, tactical development test and evaluation, and in-service naval underwater weapon systems and weapon support systems; Torpedo Mk 48, Mk 48 ADCAP, Mk 46, and Mk 50; Targets Mk 27, Mk 30, Mk 40, Mk 28, the Advanced ASW Mobile Target and Surface Ship Torpedo Defense System. Contract was expected to be completed by January 2001. (N66604-96-D-B162)
Alliant Techsystems	2.8	June 1996 – Contract to produce Mk 50 lightweight torpedo components for the US Navy. The company will deliver them to the winner of the Lightweight Hybrid Torpedo Engineering Development Mode (EDM) program for integration into the 31 EDMs produced under terms of the contract. (No contract number available at this time.)

Contractor	Award ($ millions)	Date/Description
Sundstrand Aerospace	5.0	September 1997 – Firm fixed-price contract for Mk 50 Boiler Assemblies in support of the Lightweight Torpedo Program. Contract was to be completed by February 2000.

Timetable

Month	Year	Major Development
	1971	Advanced DD/ALT torpedo program developed
	1975	Technical Assessment of Mk 50 begun
	1978	Mk 50 Technical Assessment ended
May	1979	Development contract awarded
	FY81	Honeywell chosen as prime contractor
Jul	1983	Development testing/operational testing (DT/OT) I completed
Sep	1983	Honeywell receives FSED contract
Nov	1985	Second source RFP issued
	1987	Westinghouse chosen as second source
	FY87	Prototype warhead trials completed
May	1988	Critical Design Review conducted
Sep	1988	Operational Testing (OT) II-A completed
May	1989	Milestone IIIA completed
	1989	TECHEVAL completed
	1989	Drawings delivered
	1990	OPEVAL completed
	1991	Milestone IIIB
	1992	Full-scale production initiated
	1995	Last procurement order completed
2Q	FY98	Shallow water enhancements TECHEVAL
Oct	1998	Raytheon announces closing of Mukilteo torpedo plant
3Q	FY99	All tactical software improvements completed. Shallow water enhancements OPEVAL

Worldwide Distribution

The US Navy is not expected to make any further purchases of the Mk 50 torpedo. The service believes that it has sufficient numbers of Mk 50s in its inventory to meet anticipated mission requirements. Instead, available funding will be spent on modifying the Mk 46 torpedo for shallow-water operations and developing the new Lightweight Hybrid Torpedo. It is doubtful that the US Navy will release the Mk 50 for export, since the torpedo is considered too technologically advanced to offer on the open market.

User Country. The only operator of the Mk 50 is the **US Navy**.

Forecast Rationale

The United States has shifted its funding focus from the Mk 50 to the Mk 54 Hybrid Lightweight Torpedo (HLT). No further production of Mk 50 all-up-round is anticipated. Still, the United States will maintain the Mk 50 as part of its torpedo inventory mix. According to reports, the Mk 50 could remain in service with the US Navy until 2020.

In the meantime, the United States will continue to upgrade and modernize its Mk 50s in order to maintain the torpedo's combat effectiveness. The last major change involved the torpedo's direction-finding and propulsion systems. As already stated, no further full-up Mk 50 units will be produced, since the US plans to focus its future lightweight torpedo procurement funding on the Mk 54 LHT.

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													
MK 50	UNSPECIFIED	611	0	0	0	0	0	0	0	0	0	0	0
MK 50 (a)	UNSPECIFIED	479	0	0	0	0	0	0	0	0	0	0	0
Total Production		1090	0	0	0	0	0	0	0	0	0	0	0

(a) Forecast is for Mk 50 turnabout kits.