

# THE MULTI-ROLE NATO-INTEROPERABLE LIGHT WEIGHT TORPEDO FOR THE 21<sup>ST</sup> CENTURY

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**Abstract:** The growth of the hostile submarine ability to escape detection and destruction by anti-submarine forces is an increasing concern. The proliferating conventionally-powered (SSK) submarines are pushing the shift of the operational theatres toward naval operations in littoral and coastal areas, where the complex acoustic environment represents a highly opaque operating environment and it is acting as a natural discrimination factor for the serviceability of the existing and future Light Weight Torpedos (LWT) inventory. The operational emphasis toward littoral areas and the need of NATO-interoperable torpedoes capable to be deployed at any corner of the globe resulted in the need to optimise the existing inventory of ASW weapons nowadays for both the engagement of diesel/electric boats in coastal areas and the nuclear-powered ones in the blue waters. This has resulted in several recent torpedo development efforts that often run contrary to the originally adopted torpedo design. On the other hand, the MU90/IMPACT Advanced Multi-role Light Weight Torpedo has been envisaged from the beginning to cope with any-task and any-environment; it is the only NATO-interoperable ASW weapon designed to respond to the multi-threat operational needs of the future.

## The Submarine Threat

The increase of the hostile submarine ability to escape detection and destruction by anti-submarine forces is an increasing concern. The proliferating conventionally-powered (SSK) submarines are pushing the shift of the operational theatres toward naval operations in littoral and coastal areas (green and brown waters). The latest technologies are offering to the vessels unprecedented stealth, endurance and command, control, communication and intelligence capability. The propulsion improvements that reduce the traditional drawback result in the ability to remain undetected for extended periods of time. Quieting and coating technologies render the submarines acoustically stealthy and high-strength steels are used to improve survivability. New computerised combat systems offer the greatest improvement in diesel submarine capabilities due to the integration of fire control, sonar and weapon systems functions. The effectiveness of the SSK is maximised in shallow water, littoral areas and especially in choke

points in strategic waterways where diesel submarines can exploit the restricted waters at their great tactical advantage. All listed features combined with the proliferation of expendable anti-torpedo countermeasures result in an extremely hard life to its primary threat: *the Light Weight Torpedo (LWT)*.



Figure 1: MU90 Torpedo Mass Production.

## The Torpedo Inventory

The complex acoustic environment of the shallow and coastal waters presents a highly opaque operating environment for infiltrating submarines and it is acting as a natural discrimination factor for the serviceability of the existing and future LWTs' inventory. Nowadays, the operational emphasis toward littoral areas resulted in the need to optimise the existing inventory of ASW weapons for both the engagement of diesel/electric boats in coastal areas and the nuclear-powered ones in the blue waters. This has triggered several torpedo development efforts that often run contrary to the originally adopted design. On the other hand, the *MU90/IMPACT* Advanced Multi-role Light Weight Torpedo has been conceived from the very beginning of the project to cope with *any-task* and *any-environment* capability requirement; and it is the only ASW weapon designed to respond to the multi-threat operational needs of the next decades.

## MU90 Torpedo: Generalities

The NATO-interoperable MU90 torpedo—a joint development between WHITEHEAD ALENIA Sistemi Subacquei (Italy), DCN International (France) and THALES (France)—is the only “new torpedo” on the market today. As such, it features unique system characteristics which allow real operational capability in waters as shallow as 25 m and against any threat, including bottomed midget submarines. Presently, it is in a full-steam mass production phase (over 1000 units) for major NATO countries such as *France, Italy, Germany, Denmark, Poland and Australia* (see Figure 1). The first deliveries were already made in 2002. Designed and built with the most advanced technology, the MU90 permits undersea battle-space domination well into the 21<sup>st</sup> century.

## Multi-role MU90 Torpedo: General Description

The MU90 ALW torpedo is a *multi-role* NATO-standard-calibre fire-and-forget weapon with weight of 304 Kg and length of 2850 mm, designed to counter *any type of nuclear or conventional submarine*, acoustically coated, deep and fast-evasive, deploying active or passive anti-torpedo effectors. The torpedo can be deployed by *any type of platform* such as surface vessels, fixed or rotary wing aircraft or missile (MILAS). *Hard-Kill* (anti-torpedo torpedo), *continental shelf mine* and *submarine launching capabilities* have been included during the torpedo design process. Pre-arrangements to cope with Submarine-launched Anti-air-missile (SLAAM) have been already incorporated in the system as the torpedo features unique deployment altitude (up to 900 m) and speed (up to 400 Kts from MPA), which combined with the stand-off long deployment range capability (well above 10 Km), grant the air-platform a realistic safety against such threat.

<b>Main Anti-Torpedo Counter-Counter Measures</b>
Stationary target detection capability
Spatial correlation and data fusion
Target classification through scoring
Frequency/time code emission pulses
Simultaneous Multi-frequency
Target size, speed, aspect computation
Target history and mapping
Simultaneous multi-type processing
Adapted sub-pulses endurance
Decoy classification
Anti-Jammer tactics

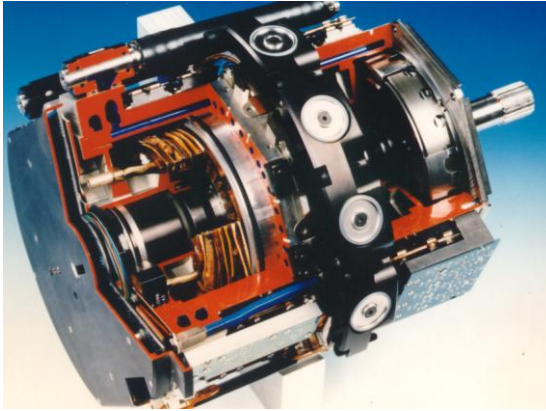


Figure 2: MU90 Motor.

### **MU90 Propulsion System**

The weapon is powered through an Aluminium-Silver Oxide (AgO-Al) sea water battery using dissolved sodium-dioxide powder as electrolyte and incorporating an advanced closed-loop electrolyte re-circulation system. The hazard-free, pollution-free electrical power-plant of 120 KW (\*)<sup>1</sup> does not only grant high speed and endurance but also high torpedo safety during transportation and carriage, reduced ILS infrastructure needs and no disposal costs. The replacement of the one-shot sea-water propulsion battery with a multi-firings rechargeable battery for exercise live trials further minimises the LCC of the weapon.



Figure 3: MU90 Pump-jet.

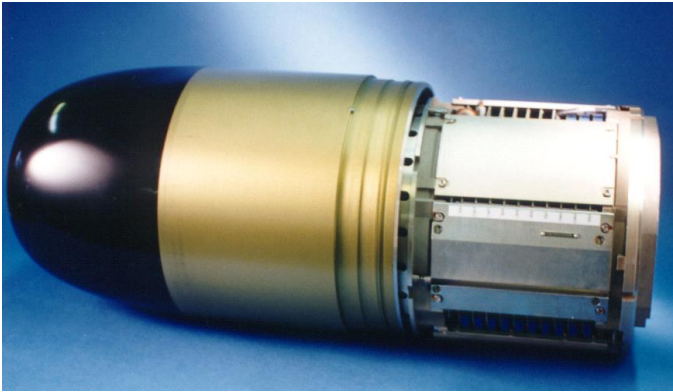


Figure 4: MU90 Acoustic Seeker.

Propelled by an innovative electronically controlled high-RPM brushless motor (see Figure 2) driving a skewed multi-blades pump-jet propulsor (see Figure 3), the torpedo features a linearly variable torpedo speed between 29 Kts and >50 Kts, automatically selected, in step of 1 Kts, by the tactics of the weapon according to the scenario, the environment and the operational phase. Speeds changes Min-to-Max and to opposite are achieved in less than 3 seconds.

Of extremely long endurance and range {>12,000 m(\*) at max. speed and >25,000 m(\*) at min. speed} the weapon operates without any speed degradation, without any limitation of salinity and temperature at depths >1000 m(\*) and as shallow as 25 m, and retaining navigation capability up to 3 m.

The cavitation-free and very low-radiated noise achieved through the use of the most modern pump-jet technologies combined with an extended selection of torpedo preset parameters and proper tactics allow the weapon a silent approach to the target minimising the alert range of even sophisticated submarine detection systems and thereby increasing the overall killing probability of the weapon.

### **MU90 Homing System**

The high-power, advanced acoustic seeker (shown in Figure 4) features 47 transmission and 33 reception pre-formed beams for a total acoustic coverage of 120°Hx70°V. It operates on six different frequency bands with an operational bandwidth well above 10 KHz (\*). Its parallel processing and simultaneous acoustic mode operations allow the mapping of up to 10 simultaneous targets, active detection distance >2500 m (\*), echo sounding navigation and high performance in very shallow waters providing the weapon with high immunity to the most advanced anti-torpedo countermeasures.

The torpedo homing system, matched with the high energy propulsion system, grants target engagement ranges  $>15,000$  m (\*) with an average killing probability  $>75$  % (\*).

The control and guidance electronics, of incomparable computation power and digital memories, accommodates the operational and tactical software including the signal processing, the data processing and the torpedo guidance laws allowing the weapon to continuously self-adapt its configuration and tactics according to the evolution of the operational situation and the threat.

The inertial system exploited for the torpedo control and guidance is based on 'strap-down' technology providing the weapon with an excellent manoeuvrability, all-altitudes capability including bottom following capability, low drift during approach phase to the target and high accuracy for the final impact on the target.

The fully-insensitive directed energy shaped charge warhead (see Figure 5) composed of V350 explosive, proven to penetrate double hulled large submarines, grants killing capability at any operational depth, including close-to-the-sea surface operational situations where the effectiveness of any blast-charge torpedo warhead is heavily jeopardised. The impact-type  $\mu$ -processor-controlled exploder is of advanced design and exploits front-located sensors to trigger the explosive chain well before any premature mechanical deformation caused by the torpedo hit may compromise its functioning. It incorporates mechanical and electrical independent safety devices. The warhead fully meets any STANAG safety requirement.



Figure 5: MU90 Warhead Cut-way.

## MU90 Exercise Version

The exercise section, interchangeable with the warhead section, allows live exercise evaluation, war stock surveillance and training firings. Composed of a pneumatic recovery system based on inflatable collar technology, it features high recovery reliability and easy localisation. The exercise head also incorporates redundant safety and localisation devices, underwater tracking capability, as well as a solid state memories data acquisition system, providing computer-based post-firing evaluation analysis capability. The length, weight and CoG of the Exercise round are strictly the same as those of the war-shot weapon, thus granting fully realistic live firings. The cost of live exercise firings is significantly reduced by the use of a Li-ion rechargeable battery and of a Practice Delivery Torpedo which allows a full training at a very low operating cost.

## MU90 ILS

The all-in-one automatic torpedo test equipment TTU 102 allows an easy computer-driven preventive and corrective maintenance throughout the system shelf life. The modern approach to the MU90 ILS renders the 30-years Life Cycle Cost of the weapon significantly low with respect to all the existing torpedo systems and furthermore it minimises the need for significant infrastructures and human resources.

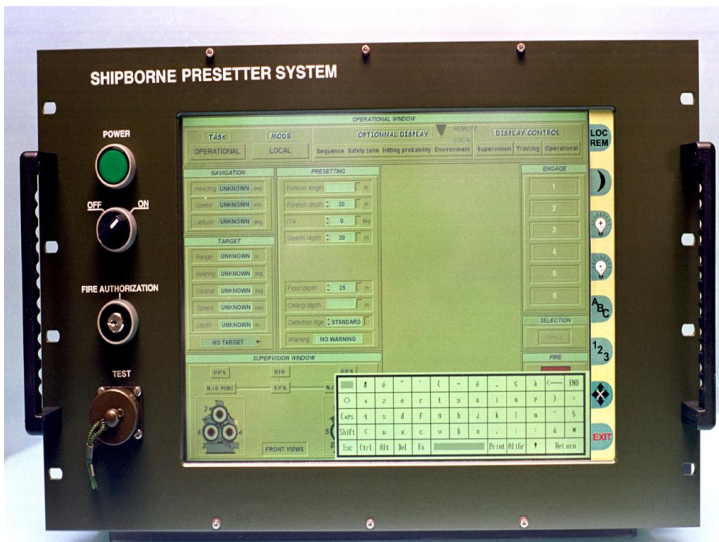


Figure 6: Shipborne Presetter.



## MU90 Torpedo: Shipborne and Airborne Launching Systems

To exploit in full the MU90 Torpedo capabilities, ‘turn-Key’ *shipborne* and *airborne* torpedo presetting and launching systems (see Figure 6) have been developed and are presently or will be in short time in service onboard the following platforms:

- Shipborne: MAESTRALE FRIGATE, ARDIMENTOSO FRIGATE, GARIBALDI CARRIER, F124 FRIGATE, STANFLEX 300, F70 FRIGATES, ANZAC, FFG-7, F123 FRIGATE, HORIZON FRIGATES, FFG-7;
- Airborne: AUGUSTA, AUGUSTA/WESTLAND, EUROCOPTER, DASSAULT, MIL, NHI, EUROCOPTER, LOCKHEED, SIKORSKY, KAMAN.



Figure 7: Example of B515/2/F Torpedo Launching Tubes.

Based on advanced *Man Machine Interface* techniques meeting the modern requirements of automation and permitting consolidation of fire control and weapon systems functions, these computerized systems are built to fulfil turn-key *stand-alone, par-*



*tially-integrated* or *fully integrated* system requirements either for the MU90 or for combined weapons capability.

Last but not least, the innovative long-term production lines in France and in Italy, together with modern concepts of COTS components for electronics, double-sourcing of critical items and partnership with major subcontractors, have enabled to significantly reduce torpedo procurement cost, rendering the MU90 highly competitive in the worldwide market.

## Notes:

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<sup>1</sup> (\*) denotes a classified figure.

**CLAUDIO CECCARINI** is born in Italy in 1953. He graduated as a Doctor in Electronic Engineering from the University of Pisa (Italy) in March 1979 and joined WHITEHEAD ALENIA (a FINMECCANICA Company) in the same year where he has been given tasks of increasing responsibility in the technical, commercial and management fields. In 1997, he entered the EUROTORP Consortium where he is presently Senior Marketing & Business Development Manager. *Address for correspondence:* 399, route des Cretes-“Les Boullides” B.P.113, 06902 SOPHIA ANTIPOLIS CEDEX, France; *Phone:* ++33 4 92 96 39 61; *Fax:* ++33 4 92 96 38 55; *E\_mail:* c.ceccarini@eurotorp.com.