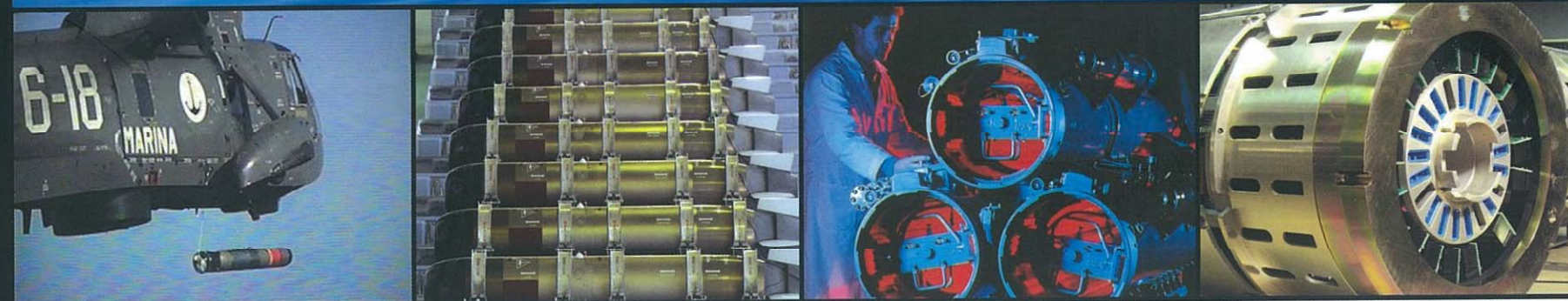




THE MU90 ALWT SYSTEM



► THE NATO LWT FOR THE XXI CENTURY

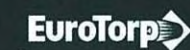


WORLD LEADER IN LWT SYSTEMS

EUROTORP is the world leader in Lightweight Torpedo Weapon Systems. It was established in the 1993 as a consequence of a Memorandum Of Understanding between the French and the Italian Governments to merge their national programs on new generation of Lightweight Torpedoes. EUROTORP's members are: WHITEHEAD ALENIA Sistemi Subacquei S.p.A (a Finmeccanica Company), DCN International and THALES.



EUROTORP is certified ISO 9001 / 2000 and AQAP 110



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1 THE OPERATIONAL REQUIREMENTS OF THE XXI CENTURY

► The submarines are not a new threat, and they are still a potent weapon against surface naval forces.

Today's threat is more and more very real and is emerging in a new kind of submarine operating environment: the littoral and coastal regions. Unlike the deep oceans, the littoral waters are extremely difficult operational environments where detecting, classifying and attacking enemy submarines is complicated; the threat here is posed by the conventionally-powered submarines and midgets. Nevertheless, the modern anti-submarine forces cannot refrain from retaining the capabilities to counter fast-evasive deep-diving nuclear submarines as the deployment of Naval Forces in different corners of the globe is more and more a common practice.

The submarine-carried weapons are also a reason of growing concern as the Submarine-Launched Anti-Air Missiles can nowadays pose a threat to the aircraft during ASW missions. All the above listed operational scenarios combined with the proliferation of submarine-launched anti-torpedo countermeasures result in the requirement of extremely sophisticated operational capabilities for the anti-submarine primary weapon: the Light Weight Torpedo (LWT).



2 THE MU90/IMPACT ALWT: GENERALITIES



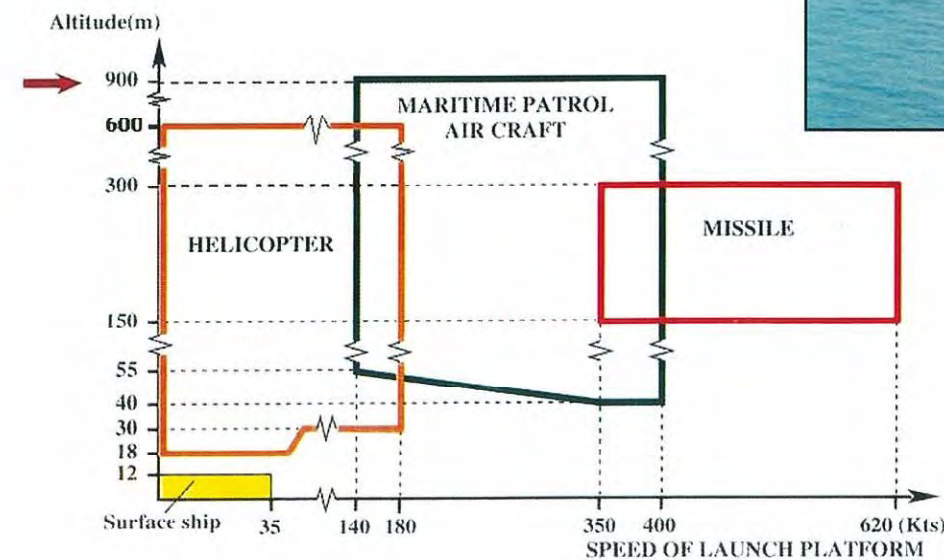
► The multi-role MU90 / IMPACT Advanced Light Weight Torpedo (ALWT) is a fire-and-forget weapon of last generation. It has been developed to respond to the ASW operational needs of the 21st century on the basis of the Common Naval Staff requirements and technical specifications of the French and Italian Navies. The torpedo features unique system characteristics which result in outstanding performances for any-task and any-environment applications well including the very shallow waters of the littoral. The MU90 impressive acoustic & dynamic capabilities allow the employment of the weapon in diversified roles as anti-torpedo torpedo (MU90HK) missions. More than 1,000 rounds have been presently produced and the weapon is already in service with a number of major NATO Navies.

3 THE MU90 LAUNCHING PLATFORMS



The MU90 / IMPACT torpedo can be deployed from ANY TYPE of surface and air platform including missiles. It can also be encapsulated into continental shelf mines as well as launched by submarines.

Its unmatched deployment altitudes and extremely long stand-off launching capabilities allow the ASW forces to cope with the threat posed by the modern submarine-launched anti-air-missiles (SLAAM).



- ▶ **Deployable from Any Type of platform**
- ▶ **Unmatched release altitude up to 900m**
- ▶ **Long stand-off range: > 15,000 m**

4 MU90 MAIN OPERATIONAL CHARACTERISTICS

- Destruction of ANY TYPE of nuclear or conventional submarine, double hulled, acoustically coated, deep-diving, fast-evasive and deploying anti-torpedo defence systems.
- Unmatched minimum bottom depth at launch: 20 m (ship launch), 25 m (all other cases), achieved through the use of an innovative and unique built-in buoyancy bag.



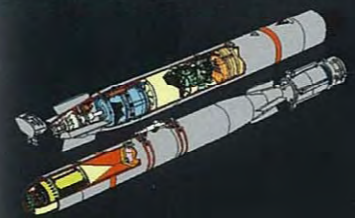
- Operational depth from 3 m to >>1000 m.
- Operational sea state: up to 6, any platform.
- Depth-independent torpedo endurance and range.
- Serviceable in ANY TYPE of environment; no limitations for the sea salinity, sea temperature and bottom type.
- No platform's maneuver constraints for the operation of the system.
- Minimum sustained temperature at launch: -26°C; full ice prevention through specific devices including tail cone cap.
- Sustained wind speed up to 50 kts through reinforced structure and tail cap.
- Hazard-free and Pollution-free, compliant with the most stringent anti-pollution laws.
- Stand-off launching capability. Target engagement range well in excess of 15,000 m.
- Unmatched pre-settable stealthy forerun length in excess of 17,000 m.



5 MU90 MAIN PERFORMANCES

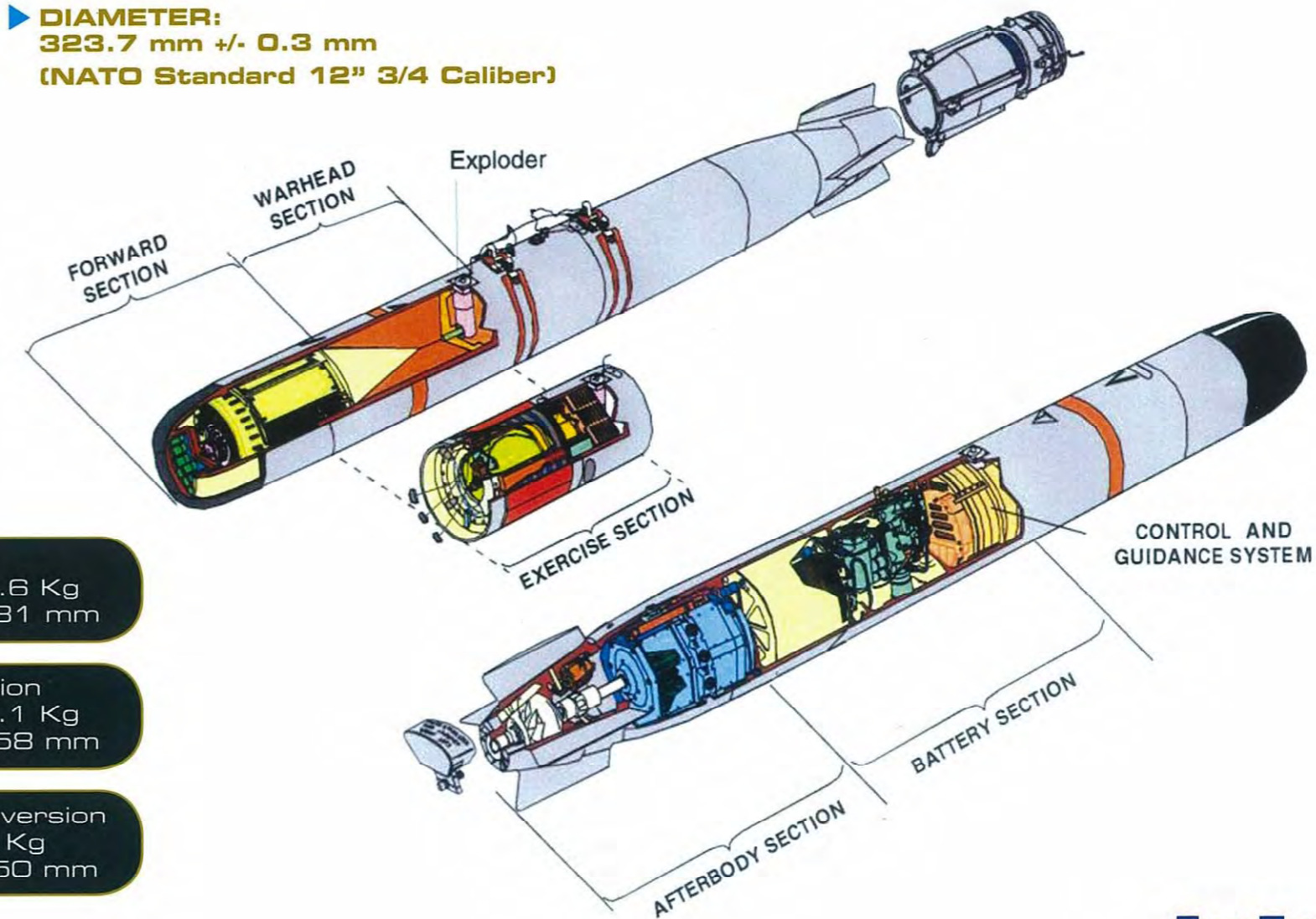


- Variable step-less speed between 29 and >> 50 knots.
- Gradual acceleration during start-up to minimize radiated noise.
- Cavitations-free and wake-free. The extremely low radiated noise achieved with the use of the pump-jet propulsion allows to minimize the submarine's alert range and maximize the torpedo killing probability.
- Torpedo Range: >12,000 m at full speed, > 25,000 m at min speed.
- Wide range of Preset Parameters.
- Pre-selectable safety zone function (safe-haven) for the protection of friendly vessels and for operations in confined waters.
- Bottom following capability through echo sounding.
- Extremely wide operational bandwidth.
- Multi-preformed Transmission & Reception beams.
- Acoustic coverage: 120°h, 70°v.
- Multi-frequency operation.
- Simultaneous multi-processing.
- Simultaneous multi-acoustic modes.
- Simultaneous tracking of up to 10 targets.
- Extremely long active detection range on slow moving and low TS subs.
- Detection of very small Target Strength levels.
- Bottom target capability, midget included.
- Extremely Advanced Counter-Countermeasures capability.
- Full INSENSITIVE MUNITION.



6 MU90 PHYSICAL CHARACTERISTICS AND COMPOSITION

▶ **DIAMETER:**
323.7 mm +/- 0.3 mm
(NATO Standard 12" 3/4 Caliber)



MPA version
WEIGHT = 315.6 Kg
LENGTH = 2,881 mm

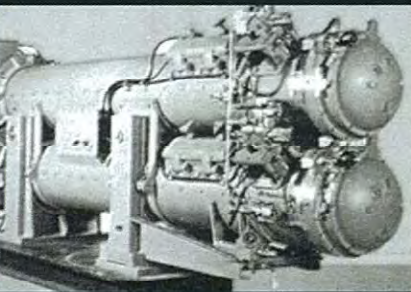
Helicopter version
WEIGHT = 314.1 Kg
LENGTH = 2,858 mm

Surface vessel version
WEIGHT = 304 Kg
LENGTH = 2,850 mm

7 MU90 INTEROPERABILITY



8 THE ACOUSTIC SEEKER

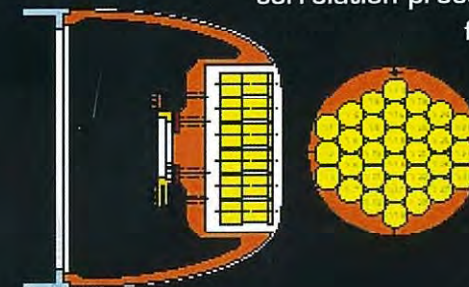
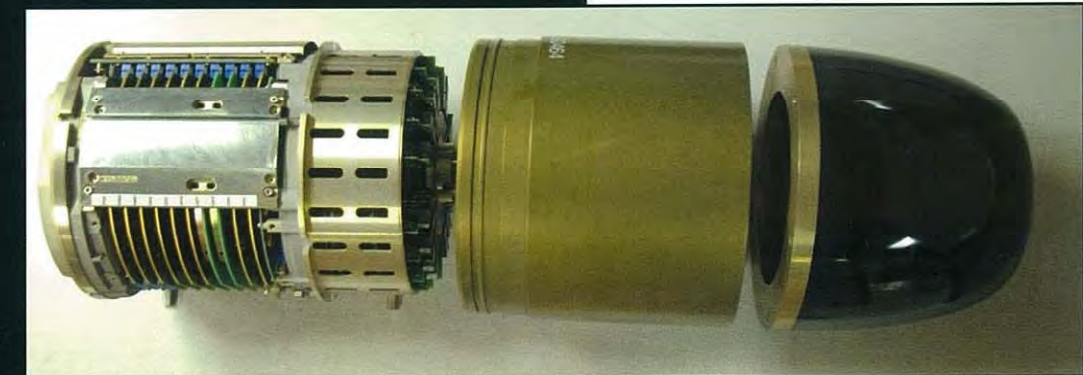


Fully Interoperable with NATO STANDARD torpedo launching tubes.



► Fully Interoperable with NATO STANDARD airborne bomb racks.

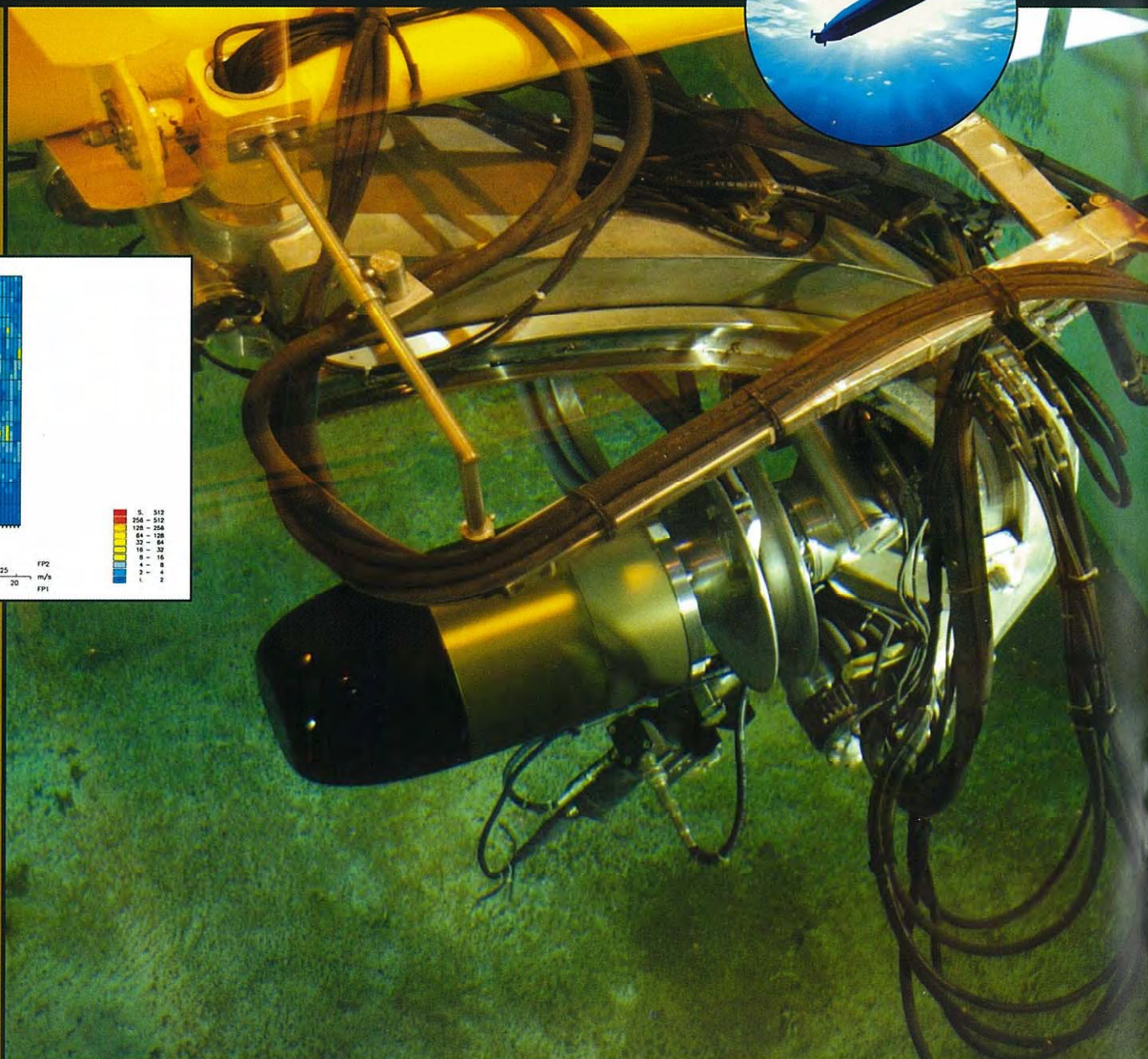
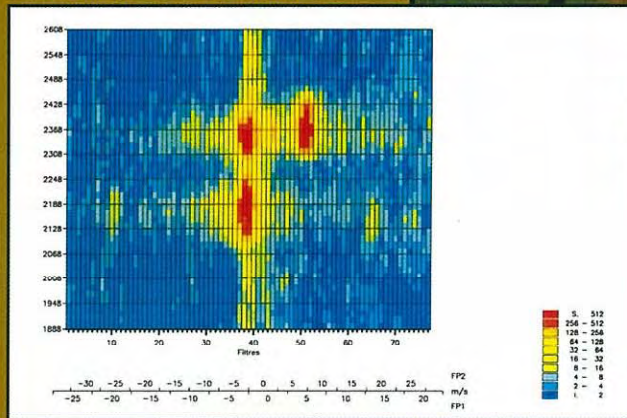
► The MU90 acoustic seeker is based on a planar array of 30 high efficiency piezoelectric transducers operating within a very wide bandwidth. The cavitations-free shape of the acoustic array has been designed to optimize the laminar-to-turbulent transition. The acoustic array is decoupled from the torpedo structure in order to nullify any inducted structural vibration and grants full performances at any operational depth of the weapon. The acoustic seeker can operate in active, passive or combined mode, automatically selected by the operational phase of the weapon. It pre-forms 33 reception beams, covering different directions, 15 of which are simultaneously operated with more than 4 operational frequencies. The 47 pre-formed narrow transmission beams are operated one-by-one or grouped in number to respond to the specific need of any operational phase. Beam-widths follow the selected frequencies. A minimum of 18° beam-widths are used in shallow waters to reduce the reverberations from the environment. Some of the downward steered beams are dedicated to the echo-sounding thus granting the weapon bottom-following capability. The MU90 acoustic seeker features the unique acoustic coverage of 120° horizontal and 70° Vertical. The high source level and the very long pulse repetition interval grant extremely long active detection ranges. The signal processing exploits two main different modalities: Fast-Fourier-Transformer-based processing and multi-copy replica-correlation processing associated to spatial filters. The target data gathered from the simultaneously-operated signal processing are then cross-correlated among them (data fusion) in order to achieve pre-classification and acoustic scoring to maximize the confidence on the detected target. Up to 10 different 'targets' can be simultaneously processed, tracked and mapped. Advanced built-in ACCM features allows the classification and rejection of the most sophisticated anti-torpedo jammers and decoys.



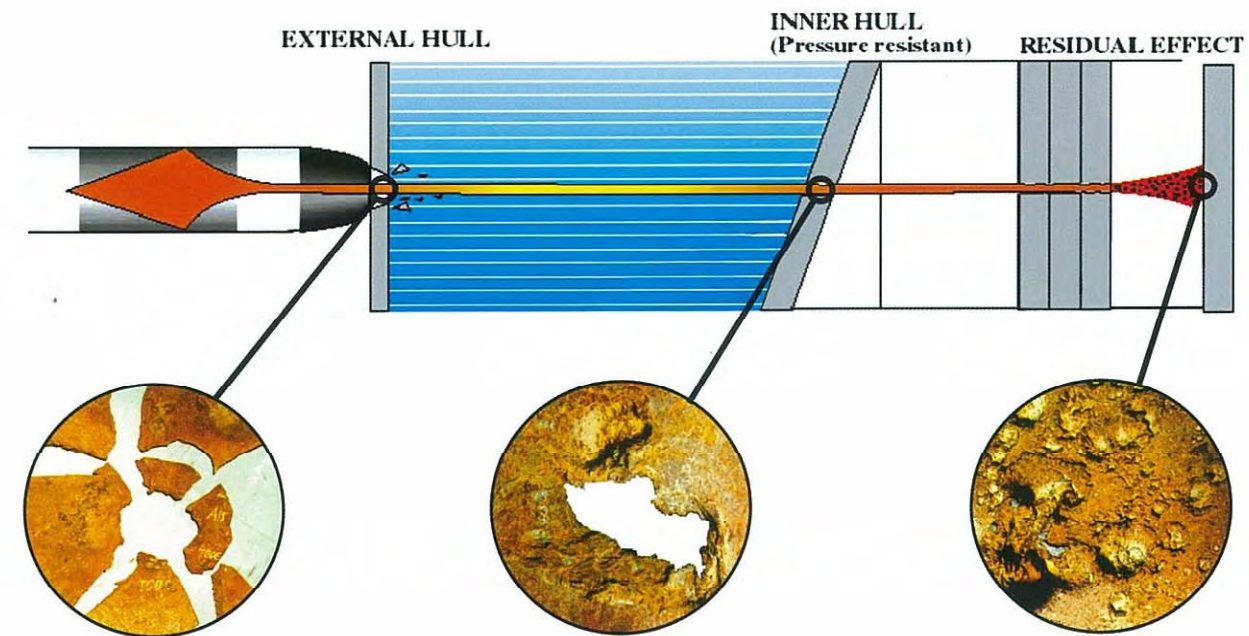
8 THE ACOUSTIC SEEKER



► The emission codes are formed of trains of sub-pulses, each one at different frequency, simultaneously emitted in Continuous Wave (CW), wide-band Frequency modulation (FM) and Phase Modulation (PSK, BPSK). The CW-based pulses allow high target range, speed and angular resolution. The FM-based emissions allow the classification the target on the basis of the separation of each highlight of the echo as well as on the characteristics of the cloud of highlights as length, width and elongation. The phase-shift type of emissions allow the seeker to distinguish slowly-moving or zero-doppler bottomed targets from the reverberation of the environment. As a result of these processing, measurements of the target range, bearing, elevation, aspect angle, speed and physical dimensions are achieved with outstanding accuracy while the perturbations originated by the target-wake and by the image-target are minimized.

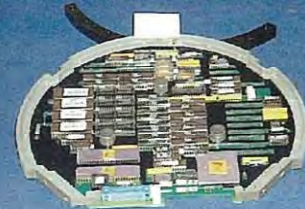
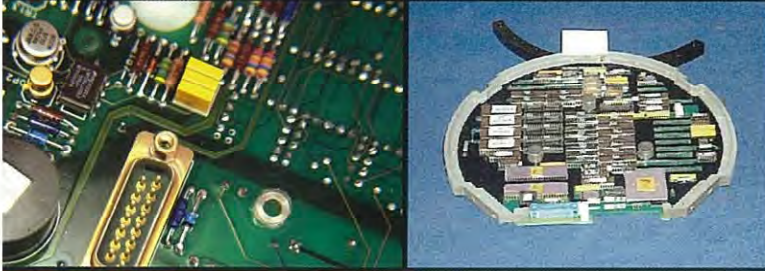


9 THE WARHEAD



► The MU90 warhead is of direct energy shaped charge type proven to penetrate ANY TYPE of submarine and granting depth-independent target destruction capability. It is composed of 32 Kg of highly compressed TATB explosive equivalent to 123Kg of TNT. The warhead is an **INSENSITIVE MUNITION**, fully compliant with the NATO standard safety requirements (DOD-STD-2105 and STANAG 4170). The unique-of-its-kind impact-type exploder incorporates multi-safety independent devices. The nose-mounted impact sensors grants ignition of the explosive chain prior any deformation of the torpedo structure occur as consequence of the target hit.

10 THE CONTROL & GUIDANCE ELECTRONIC



► The multi-processor COTS-based C&G electronic features huge computation power and digital memories. It accommodates the torpedo operational and tactical software, the signal & data processing and the torpedo guidance laws. The torpedo control & guidance is based on an inertial system of 'strap-down' technology providing the weapon with an excellent manoeuvrability, all-attitudes capability without pitch limitation and high accuracy for the final impact on the target. The 'X-fins' torpedo navigation maximizes navigation control and allows to achieve extremely high turn-rate steering capabilities.

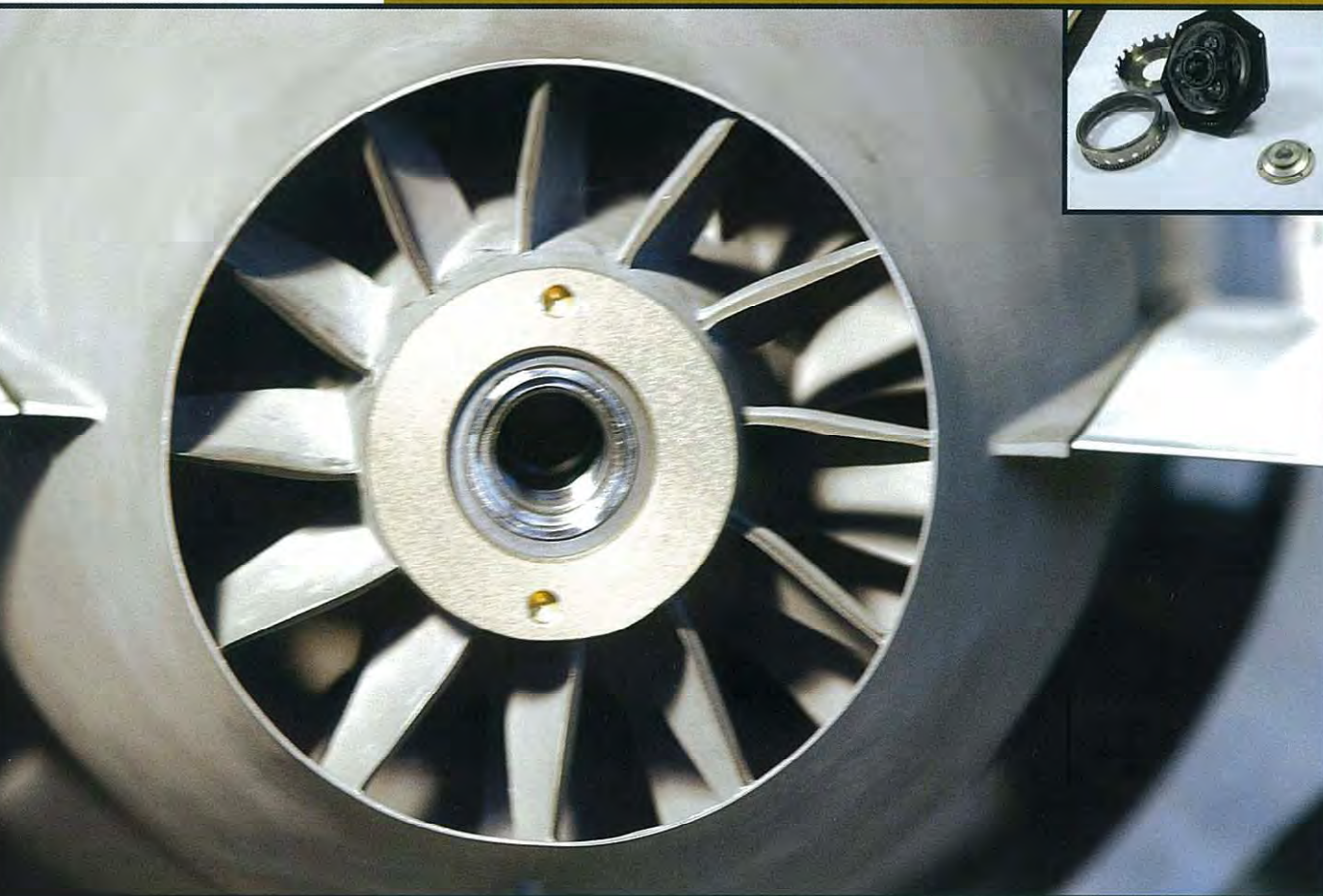
11 THE PROPULSION SYSTEM



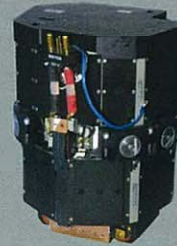
► The MU90 / IMPACT torpedo is an electrically-propelled weapon. It is powered through an Aluminium-Silver Oxide (AgO-Al) sea water battery using dissolved sodium-dioxide powder as electrolyte. The AgO-Al technology grants power/energy density ratio that well exceed any existing thermal system. The power plant incorporates an electronically-controlled closed-loop electrolyte re-circulation system and heat-exchange management system aimed to dissipate the thermal energy in excess and maintain the temperature of the electrolyte at predetermined levels. The recirculation system houses a thermal battery, burned at torpedo pull-out, and aimed to supply the re-circulation pump before the main battery is activated. Being a closed-loop system, the power plant grants depth-independent power and energy performances as well as sea water salinity and temperature independency. The hazard-free and pollution-free AgO-Al technology grants minor maintenance infrastructure requirements and no disposal costs.



11 THE PROPULSION SYSTEM



▶ The MU90 / IMPACT torpedo is propelled through an electronically controlled high-RPM brush-less motor housed into the torpedo through anti-vibration mountings. It allows a linearly-variable torpedo speed ranging between 29Kts and well exceeding 50Kts with an acceleration/ deceleration rate of 3 seconds. The torpedo speed is automatically selected by the tactics of the weapon according to the scenario, the environment and the operational phase. The electronic motor grants speed performance independent from the voltage decline of the power plant. The motor's single-shaft drives a cavitation-free pump-jet propulsor through a very low-noise speed reducer. Four independent electrical fin-actuators are housed within the torpedo after-body.



12 THE MU90 PRESET PARAMETERS

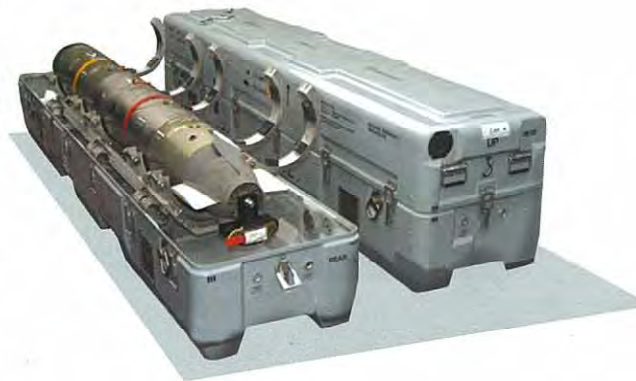
▶ The MU90 torpedo features a unique and extremely wide set of preset parameters which allow to optimize its target search and attack. Most of the preset data are entered (manually or automatically according to the type of Torpedo Launching System network) during the ASW mission while it is only a few of them that are to be selected just before the torpedo fire. A bi-directional serial lines allows high-rate data transfer from the TLS to the torpedo and viceversa. This method allows a real-time cross-check between the set parameters required and those effectively received by the round, thus nullifying prelaunch errors.

Type	Value	Input mode
1 - Torpedo attitude	θ (teta), Φ (phi), Ψ (psi) in steps of 1° plus sign - no data	Automatic
2 - Latitude	in steps of 1° plus sign	Automatic
3 - Launch Platform	missile - ship - MPA - helo Hover - helo FF - sub - CSM	Automatic
4 - Safety zone	$\alpha 1$, $\alpha 2$ in steps of 1° plus sign (+/-180°) and X, Y 0 to 32,767 m in steps of 1 m	Before FIRE
5 - Bathy/Sea state	ISO/SS>3 - ISO/SS<3 - Grad/SS>3 - Grad/SS<3	Mission
6 - Search mode	on top - forerun - run out - missile - confined Forerun Confined on top - TTK sub - TTK ship - CSM	Mission
7 - Target type	Conventional - midget - unknown	Mission
8 - Detection range	Standard - reduced	Mission
9 - Bottom depth	very shallow - shallow - medium - deep - unknown	Mission
10 - Ceiling depth	256 values in steps of 4 m - no ceiling	Mission
11 - Floor depth	15 values - no floor	Mission
12 - Search depth	15 values - not available	Before FIRE
13 - Forerun depth	4 values in depth - pitch <input type="checkbox"/> Default or <input type="checkbox"/>	Before FIRE
14 - Forerun Length	0 to 17,850 m in steps of 70 m <input type="checkbox"/> Automatic or <input type="checkbox"/>	Before FIRE
15 - Initial Turn Angle	0° to 359° in steps of 1° <input type="checkbox"/> Automatic or <input type="checkbox"/>	Before FIRE
16 - Confined Search Radius	200 m to 1,600 m in steps of 200 m <input type="checkbox"/> Automatic or <input type="checkbox"/>	Before FIRE
17 - Confined Leg 2 FR Length	0 to 10,000 m in steps of 1 m <input type="checkbox"/> Automatic or <input type="checkbox"/>	Before FIRE
18 - Confined Leg 2 FR angle	+180° to -180° in steps of 1° <input type="checkbox"/> Automatic or <input type="checkbox"/>	Before FIRE
19 - Confined Leg 3 FR Length	0 to 10,000 m in steps of 1m <input type="checkbox"/> Automatic or <input type="checkbox"/>	Before FIRE
20 - Confined Leg 3 FR angle	+ 180° to -180° in steps of 1° <input type="checkbox"/> Automatic or <input type="checkbox"/>	Before FIRE

13 THE INTEGRATED LOGISTIC SUPPORT



► The innovative COTS-based all-in-one automated Support & Test Equipment associated with the trainings, electronic manuals and spare parts grant an easy maintenance of the system throughout its 30-years life-span. The torpedo built-in self-test reduces the torpedo preventive maintenance cycles to 3.5 years for the class B (torpedo assembled) and 10.5 years cycles for the class C (torpedo disassembled). The high torpedo reliability, the minimal need for maintenance infrastructures & human resource result in the LCC of the MU90 torpedo being significantly lower respect to all other existing LWT systems.



14 THE MU90 FLEET EXERCISE TORPEDO



► The MU90 exercise section replaces the warhead section when conducting MU90 fleet exercise runs, war-stock surveillance & training firings. In addition and whenever required, a Li-ion based rechargeable battery section can replace the sea-water battery section still granting a maximum torpedo speed of 48Kts and a maximum range of 14 Km. The warhead section and the fleet exercise section are of the same weight, dimensions and CoG thus granting same hydrodynamic performance for the exercise runs. The primary functions of the fleet exercise section are to collect performance data through a solid state memory data acquisition system, provide embedded underwater acoustic tracking means, perform vehicle shutdown, and provide positive vehicle buoyancy at end of run through a hazard-free, compressed-air-based, pneumatic inflatable collar which grants high recovery reliability & easy

localisation. The pollution-free exercise section has been designed for ease of use, ease of torpedo localization and recovery, low maintenance, and low turnaround cost. The use of a Li-ion rechargeable battery for torpedo propulsion allows to reduce the cost of an exercise run below that of all other existing LWT.





15 TORPEDO OPERATIONAL TRAINING



► In order to support operational training requirements, a Practice Delivery Torpedo (PDT) is made available to the customers. The PDT is a non-propelled version of the MU90 torpedo and is aimed to allow low-cost training for the personnel. The PDT is fully mechanically and electrically representative of a warshot MU90 torpedo. It embeds a dedicated electronic module that allows the ASW operators to accomplish a full torpedo presetting and firing sequence. The PDT is fitted with the same recovery module of the MU90 fleet exercise section. Post-firing PDT surfacing is ignited through adjustable pressure-switches that enable the inflation of the collar. Embedded solid state memories allows post-firing PDT checks to determine the correctness of the torpedo preset parameters given at the instant of the launch. Provided the availability of the applicable S&TE, the same PDT can be promptly refurbished and re-launched several times in the same mission.



16 THE MU90 TORPEDO LAUNCHING SYSTEMS

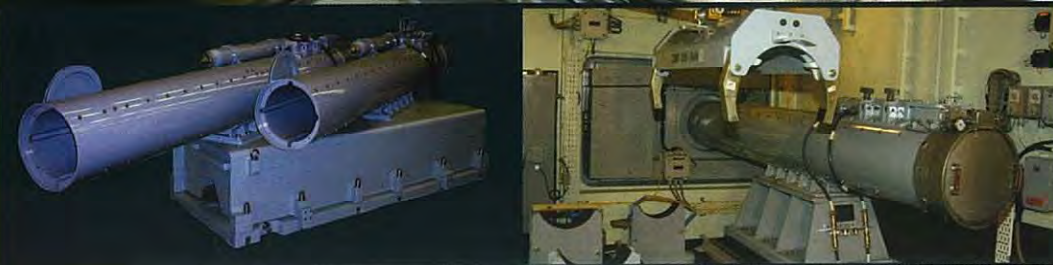


SHIPBOARD SYSTEMS

► A wide range of Shipboard Torpedo System (STS) are proposed to the customers in accordance to their needs. These include multi-torpedo-system capabilities, outstanding safeties, built-in training functions as well as compliancy with the most demanding environmental aggressions. Of mechanical and electronic modular architecture, the systems can be configured for the operation of any NATO-interoperable torpedo as the MU90, the A244/s (any model) and the MK46 (any model) as well as a combination of different torpedo types (Dual torpedo system capability). The STS consists of a shipboard presetter connected to the Torpedo Launching Stations through microprocessor based Torpedo Interface Units. Temperature Alarm Panel and Torpedo Tubes' Air Charging Stations are also provided.



The STS is commonly linked to the ship's local network resulting in its remote operation through the Multi Function Consoles of the C3. Semi-integrated or Stand-alone STS are also provided. The deck-mounted Torpedo Launching Stations are the well proven B515 trainable triple-barrels. Of modular design, the B515 can also be assembled in fixed mono-tube or fixed side-by-side bi-tubes. Whenever required, Navy-owned Torpedo Launching Stations as the MK32 (any model) can be adopted for the MU90 STS by means of a low-cost adaptation kit. Innovative Torpedo Handling & Stowage systems complete the provisions for the STS assets. EUROTORP's STS are in service with more than 20 Navies worldwide.



17 THE MU90 TORPEDO LAUNCHING SYSTEMS

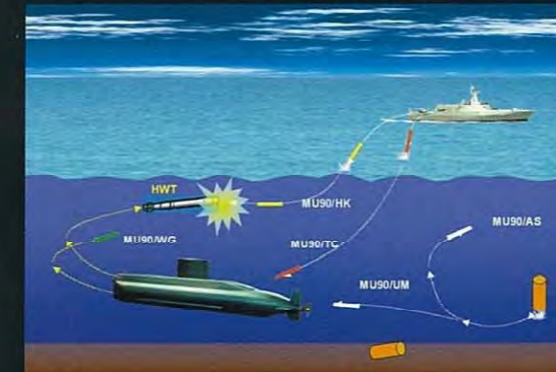
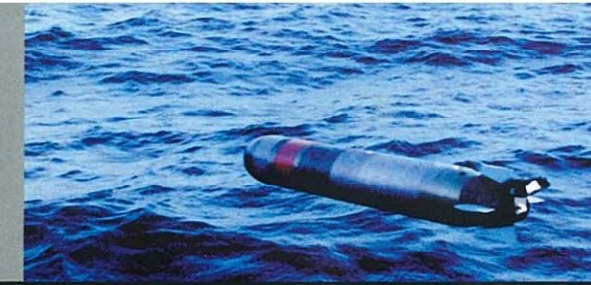


A wide range of Airborne Torpedo System (ATS) are proposed to the customers in accordance to their needs. The ATS allow presetting and controlling the LWTs release from aircraft. Of modular architecture, the systems can be integrated onboard of fixed or rotary wings aircraft and can be configured for the service of different LWT types as the MU90, the A244/s (any model) and the MK46 (any model). Three main different system configurations have been developed: the stand-alone, the semi-integrated and the fully integrated versions. In its stand-alone and semi-integrated versions the ATS are composed of a cockpit panel and a computer unit. The fully integrated ATS versions consist of a Torpedo Control Unit or Torpedo control Module; the torpedo system is fully operated through the Mission Processor console. EUROTORP's ATS are in service on a large number of air platforms worldwide.

AIRBORNE SYSTEMS



18 THE MU90 A MULTI-ROLE LWT



The MU90 Torpedo has been conceived with criteria of high flexibility of operations, and with the purpose of fulfilling a range of operational requirements. Different roles can be achieved by the exchange of sections / subassemblies or using different software packages mostly co-resident into the existing tactical and guidance system. The aim is to minimize the initial procurement costs and the maintenance costs. Among the diversified roles of the MU90 torpedo, it is worth to mention the anti-torpedo torpedo version. Of the same hardware of the warshot torpedo, the MU90HK exploits specific and embedded tactical software to achieve its mission. The MU90HK exploits the same TLS and ILS of the MU90 rounds thus resulting in major service cost savings.

Provisions for submarine and underwater magazine torpedo deployments have been considered during its design. Definition studies for a fibre-optic-based wire-guidance section are in progress, in case of specific requirements. A semi-directional warhead that could replace the present shaped charge warhead for anti-ship applications has been already fully defined. Its deployment from mine-like underwater magazine has been extensively evaluated as well as the use of the torpedo as a vehicle for surveillance and reconnaissance applications.



MU90 ALWT SYSTEM THE UNDERWATER BATTLE-SPACE DOMINATION

