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**HELICOPTER - SUBMARINE
CONFRONTATION ON EQUAL TERMS**

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Over the last thirty years the ASW helicopter and the submarine have become one of the most controversial antithesis of the naval operational theater.

The movement from the traditional AS warfare, performed by ships using hull sonars and depth charges to helicopters, gave rise to a variety of difficulties and perplexities on the part of the users.

The helicopter, which had so far been viewed exclusively as a gunship, suddenly extended the offensive capabilities of the Naval Unit to such a range as to reduce the risk of the ship being hit by the submarine during attack. Consequently, numerous Navies undertook sizeable programmes developing the use of helicopters and adapting ships to cater for the new vehicle by installing new flight decks on the stern and relative hangar areas. All this, however, was made possible as a result of the following technical improvements:

- the development of dedicated naval helicopters for all weather use;
- the development of "dipping sonars" with such characteristics as to be used by helicopters (light weight, minimum of 5000 yds range, active search, medium operating frequencies, great maximum operating depth - 400 ft, increased reliability);
- the development of light AS weapons with extremely high accuracy (MK 44 and subsequent self searching torpedoes);
- the development of a system able to automatically bring the helicopter into a hover (ASE/AATH/HOVER COUPLER);
- the development of naval radars, heliborne E.W. and MAD systems able to detect submarines even when sonars would be unemployable or scarcely effective;

Presently, the helicopter in its role as the long arm of the ship, is able to search for detect and attack the submarine by itself and at such distance from its "mother ship" as to not expose her to the risk of fire from the submarine: all this led to deep changes in antiship tactics. At present, the ship moves to a safe distance from the presumed location of the submarine, and uses her own weaponry only in extreme self defence.

Submarine manufacturers, on the other hand, soon realized the potential of the new threat and swiftly took steps to counteract it. The approaches to the problem varied depending on whether the submarines were conventional or nuclear powered. Consequently, it is easier to list the countermeasures by dividing them into subgroups, according to the threat and/or the localization.

Generally speaking, the main countermeasures are the following:

- Increase in immersion autonomy both in terms of range and hours;
- Increase in speed using new hull shape and operating at great depths to eliminate residual wave motion drag;
- Increase in manoeuvrability performance and speed both in terms of depth and course.

Whilst on the one hand a submarine that remains submerged for long periods of time is difficult to detect, it has become clear that and agile and fast submarine can be equally as elusive.

The ability to create continually varying cinematic situations with strong fluctuations in parameters, greatly hinders both the detection and the successive monitoring manouvres and attack by the helicopter.

The specific countermeasures may now be considered:

RADAR: - use of rounded surfaces for the turret and deck, thereby reducing the reflective surfaces;

- use of small size snorkels and periscopes for the same reasons;

- use of radar absorbing paints and/or coverings, able to transform the electromagnetic energy into heat by means of absorption.

SONAR: - use of anechoic tiles to cover the hull thereby absorbing sound waves;

- use of appropriate hull shapes.

HYDROPHONES: - maximum reduction of noise generated by the propulsion and auxiliary systems;

- use of difficult to detect ultrasonic depth sounding units;

- use of ultracavitating propellers reaching high speeds with low noise levels;

- use of suitable hull shapes.

SONAR BUOYS: - the same consideration apply as for the sonar and hydrophones.

M.A.D.: - extensive use of non magnetic materials and hulls able to withstand high pressures (the greater the depth of the submarine, the less the likelihood of M.A.D. detection).

E.T.I.: - extremely fragmented underwater diesel exhausts such as to desolve the CO and CO₂ in the water, hence avoiding detection of the fumes.

FLIR: - screening of the engine rooms and diesel underwater discharge of hot fumes.

E.W.: - use of radars using commercial frequencies, so as to mix in with merchant shipping signals;

- use of low range radars;

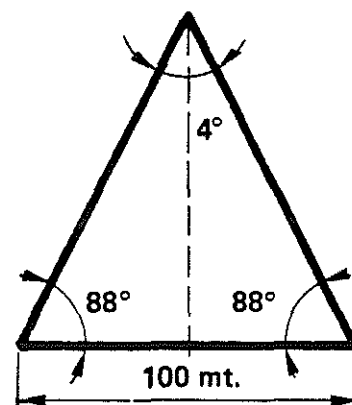
- very short series of signals with the antenna not turning so as to not be detected by passive E.W. units.

Moreover, the following technical improvements are presently being developed:

- Integrated sonar system with sensors located throughout the hull. This permits the use of the submarine's hull as a telemetric base, thus obtaining the bearing and the supposed distance from the target during passive use. The following technique is used:

Once the target has been detected on the hydrophone, the submarine positions itself with the bow angled at 90° to the averaged bearing.

Supposing the target to be 100 mt long, if the bow panel measures a target bearing of less than 2° compared to the measurement taken by the control panel, and if the stern measures a target bearing of more than 2°, this will produce an isosceles position triangle with a



base of 100 mt and with two equal 88° base angles. The height of such triangle will thus be the distance from the target.

- Long range large calibre torpedoes equipped with self guidance for the final phase and differentiated run (fast during the approach, then slow during the self guided stage so as to not hinder target detection).
- The increase in the number of torpedo launch tubes, so as to deal with a number of targets without having to suspend operations to reload.
- Mounting on SUB-SURFACE missiles for both ships and ground based targets.
- Mounting of missiles for varying multi environmental use (sub-surface-sub). This constitutes the latest development in antiship and antisubmarine weaponry (hunter killer). The missile is launched from the subemerged submarine, it emerges and follows a flying trajectory. It reimmerses releasing, at that point, its own warhead made up of a self guided antisub torpedo or, alternatively, self guided-searching antiship torpedo.
- Sophisticated underwater decoys capable of reproducing echoes of a submarine performing for a prolonged time, evasive manoeuvres with credible headings and speeds.
- Passive electronic warfare system able to identify and plot with great precision a naval target, particularly for a military kind, using its own radar system.
- Discovery radar systems equipped with mobile antennae, single and narrow transmission lobes (almost total absence of secondary lobes), programmable short duration transmissions and using civilian frequencies; the purpose of the above being to reduce the likelihood of signal detection by enemy E.W.

By using the sonar in a passive mode (hydrophone), the submarine detects the naval surface target at a great distance and faces the problem of determining the correct distance and bearing of the target for performing its own position and attack manoeuvres. Assuming the sonar bearing to be sufficiently precise to determine the general target area, the radar antenna is manually aimed and a series of impulses emitted until the target's position and distance have been determined.

Consequently:

- . the directionality and the antenna's lack of secondary lobes ensure that the impulses be detected by the target alone or possibly by another body lying on the same trajectory;
- . the extremely low number of impulses and the frequencies used will make detection and/or classification of the signal by E.W. units very difficult: should the number of impulses be below the predetermined minimum, the signal will not even be detected;
- . short range surface-to-air or sub-to-air missile systems for use as self defence against helicopters and low level antisub vehicles.

Obviously, the aeronautical and avionic systems engineers have not remained dormant in the face of all this. In fact all airborne antisub systems are in continuous evolution.

As far as the vehicle is concerned, AS helicopters with increased range and payloads are being developed such as the EH-101.

Meanwhile the following systems are being developed:

- High precision navigational systems (GPS: Global Position System - a satellite system with an error margin of up to 6 meters);
- Instrument flight system and high reliability hover acquisition systems;
- Multifunctional displays and digital instruments instead of analogical type;
- On board computers;
- Surface discovery radars able to integrate with the navigational systems to provide the geographical coordinates of targets and automatically resolve cinematic problems;
- Medium to low frequency panoramic light weight sonars with high acquisition and precision levels and small dimensions. The latest types are umbrella like opening in the water and closing during recovery;
- A/S torpedoes capable of hitting targets both at great depths and at periscope depth;
- Totally automatic high precision and discovery E.W. systems able to detect signals of even few impulses;
- I.K. frequency optical discovery systems (FLIR) able to detect and identify periscopes and snorkels at medium-great distances.

One may well appreciate that the duel is well and truly underway and that further developments are to be expected. As with armor and cannons, so the helicopter at one stage prevails over the submarine and then vice-versa.

They remain, however, two adversaries which dare not

underestimate the opponent's capabilities, rather, they treat each other with the greatest respect.

Before summing up, it is worthwhile taking a look at the future.

The submarine is becoming more sophisticated in terms of: quietness, the ability to precisely detect targets at even greater distances, the ability to avoid infrared detection by satellite and other means, the ability to disengage once located by using decoys of all types through to using a layer of air around the hull to not reflect sonar impulses. Moreover, it is increasing its range, the level of navigational and weaponry precision: with long range torpedoes, antiship missiles, missiles with a torpedo as warhead equipped with target selection intelligence capability (video link). It is generally believed that AA missiles are already being studied despite their extremely particular application.

The submarine weakest point will become evident when it must become offensive i.e. when it must "take on" a convoy, a Naval Force, a ground based objective or the likes.

In "taking on" a target the submarine discovers the ship before she discovers the submarine. The submarine is always advantaged in range, particularly in terms of passive sensing devices which already have a greater range than the active type (around 100 miles).

The contact distances, however, become equal for both units (both use IKARA or old type ASROC missiles), but the advantage is held by the party that fires first i.e. the submarine.

In case of positive detection, it is likely that the ship will be advantaged, thanks both to the superiority in weaponry it can direct against the submarine and the relative power of useable tactical

arms (special warhead bombs).

The crucial phase extends from the time of detection (100-150 miles) to the firing position (approx. 30-50 miles, exaggerating a little). During this time the submarine has total advantage unless the Naval Forces resort to the use of suitable aircraft. This is intended in a broad sense, in that it refers to vehicles which do not rely on propulsion through water and which, therefore, cannot be detected by hydrophones (airplanes, helicopters, blimps, etc).

As far as the helicopter is concerned, its future must lie in its ability to hover at great height, so as to not cause rotor vibrations in the water; it must have extremely high navigational precision (military GPS has an error of 6 meters); it must have high range acting sensing devices and the fundamental capability to assist ships, airplanes and other helicopters in the launching of missiles with torpedoes as warheads (IKARA).

This is necessary because:

- It is a senseless waste to use operational airplanes/helicopters as weapon carriers;
- hover dropping is inconceivable when dealing with submarines capable of 45 kts speed;
- it is foolish to use up payload in weaponry other than for self defence thereby reducing range when, in a matter of minutes, weapons can be launched from onboard ships against the target or targets.
- it is well known that subamrines follow close behind their own Naval formations. It thus become impossible to approach the submarines because of the naval anti-aircraft defence systems. On the other hand, a missile which at a certain distance launches a self guided torpedo becomes again an enormous problem both for ships and for submarines, because, at present, no

countermeasures exists.

- Often strategic submarines position themselves in their own territorial waters (Typhoon): it is thus impossible to hit them even if they are identified, unless large remote controlled high speed and range must be as high as possible (EH-101 and, when available, the V-22 and X-Wing will become interesting).

Therefore, in-flight refuelling of ship based medium-large helicopters remains the only, though not final, relatively economical solution to contrast the underwater vehicle (obviously it must be interfaced with adequate communications and weapon systems).

At present and in the future the submarine will remain the most insidious threat to the Navies of all seas.