PAPER Nr. : 79

THE NAVAL USE OF THE HELICOPTER

BY

ALVARO BARDINE

AGUSTA GROUP
MILAN, ITALY

FIFTEENTH EUROPEAN ROTORCRAFT FORUM

SEPTEMBER 12 - 15, 1989 AMSTERDAM

THE NAVAL USE OF THE HELICOPTER

Alvaro BARDINE - AGUSTA

1. INTRODUCTION

The **naval** helicopter is a rotary-wing aircraft capable of operating over the sea or in a **marine** environment and of performing the tasks required by the particular theatre or operating requirements.

To permit prolonged use in such an environment without rapid deterioration the aircraft must be **'marinized'**, i.e. be subjected to those additions and/or modifications designed to protect the airframe and systems from the corrosion and degradation caused by the combined action of moisture and salt on aircraft operating within 5-6 km of the coast and at altitudes of less than 500 feet.
This involves:

- application of polyurethane paint to protect the fuselage;
- heat treatment and/or painting of main parts whose position makes them prone to corrosion;
- use of stainless steel instead of normal steel;
- application of rubber strips to protect the leading edges of the rotor blades;
- use of engines which can be washed with distilled water (at low altitudes the salt present in the atmosphere in the form of sea spray can build up and alter the profile of the compressor blades, thus decreasing their efficiency).

Should the helicopter be used for military-type applications (hovering over the sea and prolonged low-altitude flight) or stowed on board a ship, this accumulation is increased by the splashing of the waves and long periods on the flight deck. This requires a further protection of the structure and of the electrical cables (and their connections), and the creation of drains in the box-section parts to eliminate rinsing water etc.

Other important factors are:

- frequent washing of both airframe and turbines is necessary

- a non-**marinized** helicopter left on the flight deck for two days with a sea state of 6 or above (the pitching and rolling of the platform preventing its stowage in the hangar) may require repairs costing 10% of its purchase price and taking 10 days to perform.

The naval helicopter must also be able to operate by day or by night and even in adverse weather conditions. It thus requires:

- instruments which make it possible to fly with low visibility;

- three-axis stabilization and autopilot to lighten the pilot's load so he can dedicate more attention to the operational aspects of flight;

- Hover coupler (for automatic hovering acquisition);

- HARPOON or similar deck-lock system (optional);

The equipment will be completed by the installation of emergency floats to permit crew egress in the event of a splashdown, and a rescue winch to recover survivors or personnel from vessels without flight decks.

2. THE OPERATING CONCEPTS UNDERLYING THE VARIOUS ROLES

In a modern theatre of operations the naval helicopter can perform either a single role, or several roles simultaneously, depending on its dimensions, its equipment and the make-up of the crew.

Here is an overview of the main roles which may be required.

- **ASW (Anti-Submarine Warfare)**

  This acronym covers all aspects of anti-submarine operations, i.e. **search, detection, identification, attack.**

  Search: this is performed using radar, sonar, sonar buoys, MAD, EW and FLIR apparatus to locate submarines, either submerged or on the surface. It requires:

  - good **RADAR** equipment capable of detecting even a periscope or snorkel breaking the surface;

  - a **SONAR sensor equipment** of the variable-depth type which can be lowered into the sea from a helicopter hovering at an altitude of about 50 feet (16 m). The sensor is able to pick up the boat's noise (passive sonar or hydrophone) or the reflection by the submerged hull of the sound waves emitted by a generator (active sonar or transducer).

The following may be used as an alternative to, or in addition to, SONAR and RADAR:

- **Sonobuoys:** when dropped into the water they are able to pick up underwater sound waves which are then transmitted by radio to the helicopter. They permit coverage of a much wider area than sonar but are expensive and cannot be recovered or re-utilized.

- **MAD:** as a metal object surrounded by the earth's magnetic field creates an area of magnetic anomaly around it the Magnetic Anomaly Detector can be used to detect the presence of a submerged submarine providing it is not too deep.
  This sensor, which is of the passive type, does not reveal any search activity but requires low-altitude flying and is unreliable where there are sunken wrecks or in magnetically anomalous areas.

- **EW:** EW equipment is able to reveal the presence of a submarine which is using sonar apparatus.

- **ETI** (Exhaust Trail Indicator): apparatus capable of detecting the exhaust of the diesel engines of a submarine using its snorkel. Unreliable and in disuse.

- **FLIR:** this can detect a thermal image in the infra-red (IR) band whose temperature is different from that of its surroundings. The best FLIR equipment also provide an image similar to the negative of a photo - which is also extremely useful for identification. Being passive, it does not betray the presence of the **vehicle** utilizing it.

Detection: All the apparatus just mentioned, providing it is of suitable dimensions and performance, is also capable of detecting, in addition to the presence of the submarine, the direction of the signal and, in the case of Sonar and Radar, the distance.

Identification: This can be visual, or by radar (using the IFF which transmits a pulse code) or underwater, calling the submarine and authenticating the response transmission using the **question and answer method.**

Attack: Using homing TORPEDOES, depth CHARGES and, on the surface, wire-guided MISSILES.

- **ASV - Anti surface Vessel**

  Covers all the operations involved in the search, detection, identification and attack of surface vessels (usually gunboats, motor torpedo boats, hydrofoils) performed by shipborne or shorebased helicopters. It requires RADAR, IFF, GE, FLIR apparatus and a complement of missiles capable of striking the enemy while staying outside the range of hostile anti-aircraft defences.

- **ASST - Anti-Ship Surveillance and Targetting**

  Comprises all aspects of area surveillance, search, detection, identification and designation of targets to another ship/aircraft able to carry out the attack. It excludes the execution of the actual attack due to lack of armament. ASST requires, in addition to the previously-mentioned sensors, good communication, navigation and target location systems.

- **ASMD - Anti Surface Missile Defence**

  Covers operations designed to identify pre-launch situations and to acquire surface missiles launched against friendly units. The presence, in the area of operations, of enemy aircraft patrols or of units observing radio/radar silence, can indicate preparation for launching as can the activation of fire-control or missile guidance radar. A good search radar, used at medium-high altitude, can detect a missile in flight.
  EW apparatus is also extremely useful - passive systems for **emission** monitoring and active systems designed to interfere with the guidance apparatus and/or the missiles themselves.

- **MAR/OTHT - Mid-air Reconnoitering/Over the Horizon Targeting**

  OTHT launching permits the **launching unit**, which may be either landbased or shipborne, to hit a target outside the range of its fire-control radar. This can be done by launching with data provided by another unit or correcting the trajectory in-flight using data supplied by a unit located between the launching point and the target.

In the case of the OTOMAT launches may be:

- **TG2 Launches:** the helicopter is positioned at a distance from the target in order to be out of anti-aircraft range and to track the target's echo effectively on the SMA 705 radar. Once the **mobile pointer** has been positioned over the target the TG2 apparatus will begin tracking. After establishing target position and movement data the TG2 will compile the guidance message (prow and residual flight time) to be transmitted to the missile. At this point the missile will be launched in such a way that it passes under the helicopter which then transmits the guidance message. The missile then **hauls** and heads towards the point where its homing system will take over.

  (Note: the message contains the missile's identification code so it only accepts the real guidance message).

  While the helicopter is waiting to launch it can hover around a fixed point or move in a straight line but this means the ship has to track it on its radar.

- **LINK Launches:** launching can also based on position data supplied by another unit but in general these systems are not used due to the inaccuracy of the target position calculations. The LINK system of **track transfer** is preferable. Using this equipment it is possible to transmit and continuously update the position of the targets acquired by the helicopter on its radar. The unit receiving them (it too will have the helicopter on its radar) will use its fire control computer to obtain the helicopter-target-launching unit triangle and launch the missile directly against the target. This launching system offers the following benefits:

  - missile trajectory is shorter, making it possible to hit targets at the system's maximum range;

  - missile can approach target from an unexpected direction, thus taking point defence by surprise.

- **SAR - Search And Rescue**

  Includes the whole range of operations - search, identification, rescue, recovery and transport of shipwreck survivors or wounded. It also comprises the rescue and transport of the sick or wounded to hospital. It requires a good radar, UHF, HF, marine and normal VHF apparatus, navigation apparatus (preferably using Loran C which **can give instantly, and track,** the position of a vessel to within 100 m), or using a GPS geostationary satellite, installation for the radiogoniometry of BEACON rescue radio (121.5 and 243.0 MHz), provision for stretchers and medical equipment.

- **VERTREP - Vertical Replenishment**

  Comprises all aspects of the loading, transport and unloading of supplies, mail or personnel using a helicopter, including the use of areas without suitable landing spaces. Should the hold be too small for the load it can be carried under the helicopter in a Japanese-type net hung from the cargo hook and lowered by means of the rescue winch.

- **AEW - Airborne Early Warning**

  In this case the helicopter is equipped with a powerful radar able to detect and designate targets in movement or targets which cannot be detected by naval vessels because their radar antennas are too low, limiting their range.

- **EW - Electronic Warfare**

  Indicates the various aspects of electronic warfare. They are:

  a. **passive electronic warfare**

     ELINT - Electronic Intelligence
     All operations designed to acquire data on the enemy's electronic emissions (means of communication, detection and attack).

This requires apparatus capable of detecting such emissions and measuring them to a high degree of accuracy (this apparatus, however, is bulky and cannot be installed on medium helicopters).

Instead aircraft are fitted with:

RWR - Radar Warning Receiver

This detects emissions and warns the crew.
It is normally composed of:

- Antenna system	Detector
- Goniometer	Calculates the direction of the source
- Frequency meter	Controls all the modules, samples the signals received and compares them with those stored in the library cards.
- Indicator	Displays the signal together with the direction of the source and additional information.

In practice the system receives the radiofrequency signals present in the helicopter's environment, measures them and displays them to the crew, indicating the source direction and the frequency band received.

If there is a library in which known signals are stored it compares them with those received and, in the event of identification, indicates the apparatus generating them.

Such apparatus can either be fully automatic or operator-controlled. In the latter case the operator evaluates the signals received and selects suitable countermeasures.

b. **ECM - Electronic Counter Measures**

Electronic countermeasures are designed to:

- prevent the enemy from acquiring data (presence and position of units, exchange of communications and information);

- supply enemy with false data.

They may be either active or passive.
Active countermeasures generally involve:

Jamming: special apparatus is used to emit signals which disturb reception by enemy apparatus.

Deception: transmission of false signals with higher power and of such a nature that they will be acquired and evaluated as genuine by enemy apparatus.

Passive countermeasures are those designed to create false radar echoes or false optical and/or thermal images. They are generally:

CHAFF: fragments of aluminium or other materials released into the air in order to create false radar targets.

DECOYS: objects with the **thermal-luminous** characteristics of targets which are launched into the air (suspended from small parachutes) and which emit **heat or light** to deceive aiming systems or IR missiles.

In practice:

- passive EW apparatus contributes to the detection of the enemy, including aircraft and anti-ship missiles using SEEKER radar to home in on the target during the final phase;

- active EW apparatus is used both to prevent the enemy from gathering data and to provide him with false ones.

A particular aspect of passive use is to permit the homing in of a missile or aircraft on an enemy vessel by disturbing the point defence sensors to prevent self-defence fire.

- **EEZ Defence and Control**

The surveillance of the exclusive economic zone may extend well beyond coastal waters, and as far as 200 nm.

Its objectives are:

- control merchant traffic;
- monitor the marine economy (fishing, prospecting, oil & mineral extraction);
- prevent illegal activities such as smuggling and clandestine immigration;
- prevent ... and defend offshore platforms.

While the first two types of activity require a considerable investment of time the second pair can be performed rapidly - perhaps faster than naval vessels could perform them.

An oilslick detected late could, in addition to allowing the polluter to get away scot free, seriously jeopardize the fishing and tourist industries. A helicopter equipped with a good radar, an accurate navigation system, adequate radio connections, FLIR, and a camera can comfortably handle such tasks. The FLIR and possibly an infrared-ultraviolet vision system such as Dedalus are able to detect differences of temperature and density and thus pinpoint pollution in its early stages and, surprisingly, also the discharge of pollutants under the surface of the sea (from undersea pipes, for example, by industries trying to get rid of polluting liquid waste cheaply).

It should also be remembered that a polluting waste is not necessarily a poisonous one: the bentonite slurry used for drilling (as a drill lubricant) is not poisonous but causes fish to die of anorexia by preventing them from absorbing oxygen from the water.

3. ROLE MAKEUP

It is unlikely that a naval helicopter will be called upon to undertake, and be equipped for, only one of the previously mentioned roles. Part of the apparatus is obviously common to both roles. However, the limiting factor is the payload capacity or, more simply, the weight.

Transition from the ASST role to the ASV role requires the ability to carry weapons which can strike the enemy, i.e. at least two anti-ship missiles weighing at least 200 kg each and relative launching and guidance apparatus.

A special opportunity, however, is the presence of guidance apparatus for anti-ship missiles launched from another platform. In fact the helicopter can pass on OTHT targets thanks to its ability to expand its radar horizon by increasing its altitude and, using remote guidance equipment, guide a missile launched towards it by a ship which cannot see the target (for example the launching of an OTOMAT missile using TG2).

The transition from ASV and ASST roles to the ASW role requires the ability to carry detection apparatus, anti-ship weapons and auxiliary equipment, i.e. by a **load exponent at least 1000 kg greater.**

The SAR role requires good endurance, sufficient space on board for stretchers and medical personnel, and a payload of at least 600 kg.

The EW, AEW and AMSD roles can be combined but require a medium-size aircraft (12-14 tons) and the same goes for the MW role, which has not been discussed because it merits separate treatment. These roles require:

- space for apparatus and operators (Radar, EW, FLIR: Tactical Commander);
- excellent flight endurance (at least 5 hours);
- excellent operational speed (at least 150 knots);

- excellent communication/navigation systems;

- automatic communication apparatus (LINK) to **transfer** targets as quickly as possible to naval vessels;

- ability to detect missiles in flight and relative air vectors.

In the case of the recent incident involving a Perry-class frigate in the Persian Gulf an aircraft thus equipped would have:

- signalled the presence and heading of the attacking plane, alerting the ship and putting the point defences on standby;

- predicted the launching of the missile and tracked it;

- had it been in a suitable position it would have utilized active ECM to disturb the launching or prevent the missile from acquiring the target.

4. INTEGRATION OF THE HELICOPTER WITH WEAPON SYSTEMS

We have already hinted at the main integration problems faced by naval helicopters. We will now attempt a more detailed analysis of these problems, including those which have to do with the relationship between naval vessel and helicopter.

A good helicopter **weapon** armament system may be considered the result of a successful integration of the basic platform (providing the apparatus and the electro-hydraulic power required to operate it) and the weapon systems (communications, control, navigation, search, identification and attack systems) required to carry out the assigned tasks.

In general the simultaneous performance of various tasks is closely bound up with the helicopter's payload capability or, in other words, with its weight class.

Otherwise one has to accept limitations such as the replacing of apparatus (waste of time and risk of faults due to repeated fitting and removing), reduction of the weight of fuel carried (decreasing the range) or crew reduction (impossibility of operating different types of equipment simultaneously, thus limiting multi-role operation). Moreover the installation of a piece of equipment can cause problems due to:

- **electro-magnetic interference:** one piece of equipment can influence another. A typical case is interference between radio transmitters (especially HF radios) and interphone systems (headphone noise) or thermocouple instruments (engine combustion chamber temperature or EGT which fluctuates or falls to zero). In the same way lines or waves may be seen on a multi-function display;

- **random faults** in electronic equipment which is not mounted to suit the particular vibration regime of helicopters (1-3 Hz), even though it may satisfy MIL standards, or which is connected using excessively rigid cables;

- another important aspect is the thermal stress which exists in components installed in particular locations (engine exhaust/baggage bay). This stress may cause the rapid deterioration of the component, causing faults, which may be difficult to trace, or even structural failure resulting from the panels coming away/unstuck.

This shows that a helicopter platform is no "truck flatbed" and that each piece of apparatus to be installed must be carefully designed and thoroughly tested in all possible operating conditions to prevent the customer-operator from getting unpleasant surprises.

5. INTEGRATION WITH THE NAVAL VESSEL

Such integration involves 5 main problems:

- the physical integration of the aircraft with its platform which must carry, replenish and service it. This requires a flight deck with enough space to perform launching and recovery operations safely, lashing systems, illumination and fuel plants, a hangar to protect the helicopter from the elements and where inspection and maintenance can be performed;
- the integration of the communication systems of the helicopter and those of the ship, especially important in the case of LINK apparatus which dialogs directly with the ship's integrated battle system computer;
- the integration of the fuel, munitions and spare parts which the ship supplies to the helicopter for its operational requirements and maintenance;
- the accommodation of flight personnel;
- the systems for the tactical control of the aircraft.

6. CONCLUSION

These considerations clearly demonstrate that the naval helicopter can definitely extend the reach and vision of a naval vessel. To do this effectively and uninterruptedly, however, it must be integrated harmoniously and effortlessly so it can complement, assist and inform the shipboard services, thus transforming the naval vessel into a unified system able to carry out the numerous duties required of it in the open sea.