24th EUROPEAN ROTORCRAFT FORUM
Marseilles, France – 15th – 17th September 1998

REFERENCE : OP04

TITLE : Approaching the All-weather Capability for Helicopters: The AWRH/HTT Program

AUTHORS :
Dr. W. KREIMAIR-STECK (Eurocopter Deutschland - GERMANY)
P. SAMON (Eurocopter - FRANCE)

For many years, helicopters have been performing with great success in the field of Emergency Medical Service (EMS), air ambulance, Search and Rescue (SAR) as well as in a large variety of governmental and commercial applications. However, a drawback in the use of helicopters for EMS and SAR in the civil sector is their limitation to daytime and VMC (Visual Meteorological Conditions) where Visual Flight Rules (VFR) must be applied. At adverse weather conditions and at night with poor visibility, those missions usually cannot be flown. In addition, new, even more restrictive rules will be applied in the near future following the investigation of helicopter accidents by international civil authorities.

Since many accidents occur in bad weather conditions and/or at night, Eurocopter Deutschland (ECD) and Eurocopter (EC) have launched the research program « AllWetterfähiger RettungHubschrauber » (AWRH: All Weather Rescue Helicopter) and « Hélicoptère Tout Temps » (HTT). Target of the complementary programs is to develop and integrate sensors and very accurate navigation aids, which will enable the pilot to fly and land under adverse weather conditions even in unknown and unprepared terrain. Both programs are the basis for a future « All Weather Helicopter » (AWH), which is based on the exposed technology. Each helicopter will be equipped with a subset of this equipment, depending on the specific type of operation.

1. OBJECTIVES

One of the main operating limitations of today's civil helicopters is their inability to fly in adverse, low visibility conditions, by night or in poor meteorological conditions.

There are few IFR-equipped helicopters for many reasons:

◊ the cost of the equipment and training involved.
◊ the IFR flight levels are too high for helicopter operations in some countries.
◊ the helicopter has to be integrated with the airplane traffic which has completely different flight characteristics.
◊ there are not enough heliports equipped with IFR ground facilities.

The air regulations applicable to helicopters are identical to airplanes. They are quite suitable for the latter but they significantly restrict the operational flexibility and mobility of helicopters that are capable of high gradient and low speed approaches and must often take-off from or land on partially or even totally unprepared ground.

The future regulations should even be worse as far as those constraints are concerned. On another hand, it depends partly on the helicopter business as a whole to suggest and propose new changes to the regulation authorities which improve helicopter operational uses.

Current technological advances could offer new solutions - safe and accurate navigation, efficient detection means, low cost deicing - and would help design All Weather helicopter capability.

Five main technological themes seem interesting to meet the needs of the All Weather helicopter capability:

◊ Allow safe and accurate navigation without external visibility to authorize IMC flight down to the area where final approach is initiated.

- ◊ Enhance the assistance given to the pilot with flight management systems and thereby reduce pilots workload.
- ◊ Provide take-off / landing aids reliable enough to allow the pilot to accurately and safely follow climb / descent gradients steeper than the current ones, to land on prepared or unprepared ground with less restrictive minima than those currently applicable.
- ◊ Avoid collisions with fixed or mobile obstacles to authorize flight in poor visibility conditions outside the air traffic control zones specified in the IFR regulations while offering an equivalent safety level with autonomous equipment.
- ◊ Authorize icing conditions flight at an acceptable cost even on medium helicopters.

It must also be pointed out that to be fully efficient the introduction in the market of an All Weather capability will impose changes to the regulations. The different studies and demonstrations to be undertaken will thus be followed by proposals regarding these changes.

First studies show that the main objectives shall be to:

- ◊ enhance flight safety,
- ◊ reduce operational minima and define specific procedures to extend the helicopter operating envelope in adverse visibility conditions,
- ◊ suggest that helicopter specifics and the All Weather helicopter concept, in particular be considered, with a modification of the current air regulations and their future developments,
- ◊ authorize operation in icing conditions at a reasonable cost.

The final target of this research program is to allow the helicopter to fly in IMC conditions below the IFR flight levels in order to improve the helicopter efficiency in a variety of mission as:

- ◊ EMS and SAR,
- ◊ air ambulance and transport between hospitals,
- ◊ Law enforcement, Police and derivatives,
- ◊ Scheduled / shuttle passenger transport,
- ◊ Commercial cargo transport.

2. RESEARCH TOPICS

During the course of the AWRH and HTT programmes a large number of technologies and devices will be investigated and evaluated with respect to their benefits for the all-weather capability of helicopters. Future equipment kits for the Eurocopter helicopters are expected to be built of subsets of these devices depending on the specific mission or operation requirements. The coverage of our investigations include technologies for accurate localization, precise planning, visibility enhancement, avoidance systems, low cost de-icing, advanced flight management systems, and a 4-axis autopilot.

2.1 Accurate localization

The GPS/DGPS subsystem will be used for positioning and navigation. A bi-directional data link enables communication with a DGPS ground station to provide a very accurate and safe position. The relative position with respect to the landing point might be computed by comparing the helicopter position with an additional local, possibly mobile GPS equipment at the landing site. The GPS/DGPS system can be used together with the 3D digital map to locate the position on the map.

2.2 Precise Planning (Cartography / 3D Terrain Database)

In combination with the accurate localization device (esp. DGPS), the 3D digital map enables the pilot to have orientation during all flight-phases. Additionally to the information usually included in a Digital Map the AWH/HTT digital map will overlay 3 dimensional information concerning the relevant airspace.

2.3 Visibility Enhancement

2.3.1 Look Down Camera

The Look Down Camera will be used as a means to provide a vertical view directly below the helicopter in the final phase of the approach and landing. It will be used especially in the case of vertical landings in cities or on oil-platforms. The image can be presented on any kind of display. In future times, this video-image could then even be used as an input for a hover-control computer.

2.3.2 Night Vision Goggles

For operation during night the pilot can be equipped with a Night Vision Goggle which intensifies the residual light reflected by the landscape. This type of equipment is used for military operations since years, and its application is now emerging for paramilitary and civil missions. Operations down to very low light can be possible with this equipment. The cockpit of the helicopter has to be designed NVG-compatible.

2.3.3 Forward Looking Infrared

The Forward Looking Infrared (FLIR) is a sensor which detects the infrared radiation of the objects lying in its field of view (normally 30°x40°). Therefore it can be used at day- and night-time. Steering of the FLIR is possible by hand or automatically on the basis of the flight path.

2.3.4 HELIRADAR

HELIRADAR is based on the Rotating Synthetic Aperture Radar principle. With HELIRADAR several antennas are mounted in such a way that they radiate in radial direction and move along a circular path. While rotating, the antenna scans the environment from various visual angles without assuming a movement of the platform itself. By computation a high resolution of 0.2° in azimuth may be achieved which is comparable to conventional video standards. The system will be used through-out the mission for real-time image generation and obstacle warning. As already mentioned, it will provide „video-like“ images and obstacle feature extracted information. The images will be displayed on a large display, where they will be overlaid with other flight relevant information.

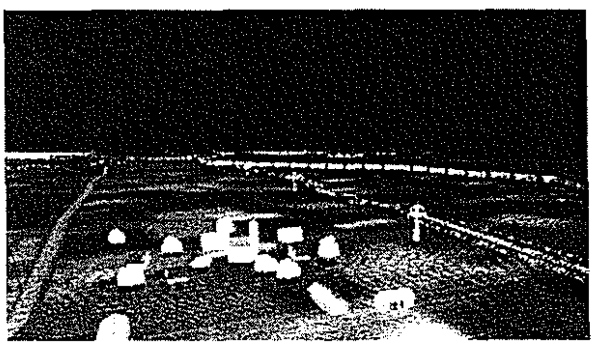

Figure 1 : example of image expected from HELIRADAR

2.3.5 Big Format Display

The Big Format Display System (BFDS) is a 16:9 format display, which allows the presentation of a 70°x40° image, which is perfectly suited for sensor flights. Symbology can be overlaid. Also a split-screen mode is possible for the parallel presentation of a complete conventional symbology and e.g. a 2D digital map.

2.3.6 Head Up Display

The Head Up Display will be used to present the images and information coming from all sensors of the all-weather helicopter system. Navigation and obstacle symbology can be overlaid.

2.4 Avoidance Systems (Obstacle Warning System, Ground and Air Collision Avoidance Systems)

If the all-weather requirements are slightly weakened, alternatively to the HELIRADAR-Configuration an obstacle warning system on the basis of laser could be used. It provides obstacle information in color coded images, which indicate the distance to the ground and obstacles. Extraction of power-lines is possible. As with a HELIRADAR based system, the information can be overlaid with additional navigation symbology and / or a map view from a digital map.

2.5 Low Cost De-icing

New low cost de-icing solutions will be studied and tested to prepare a de-icing system for the small and medium helicopters. It is essential to find technologies which are both low cost and very efficient at the same time. Therefore, several technological options are compared and theoretically as well as experimentally evaluated.

2.6 Flight Management System

Future CNS/ATM concepts will require for each aircraft to fly along a preplanned trajectory within a conflict free volume of airspace. To allow the helicopters to participate in this environment, a flight management system has to be used in the first step to provide a four dimensional flight planning. Four dimension guidance algorithms can then deliver guidance symbols to help the pilot to follow the flight plan. Throughout flight plan building up, algorithms will monitor margins between 3D terrain data base and trajectory.

2.7 Autopilot controlling 4-Axis

For stabilization of the helicopter, especially for landings with high angles or during phases of hovering, the 4-axis autopilot supports the pilot. Various control laws will be investigated and optimized for best support of the pilot during his flight through bad weather.

3. OPERATIONAL ASPECTS

The programme takes care of new procedures required or allowed by a future Free Flight Scenario (e.g. the FANS scenario). From the operational point of view several type of approaches are very appealing and are therefore investigated in the context of the AWRH/HTT programmes:

◊ Steep approaches at low speed,

◊ Curved approaches,

◊ and vertical approaches.

Concerning the man machine interface, three topics will be carefully looked at:

◊ The head-up and head-down association,

◊ The association of external actual view (when available) and synthetic (provided by sensors) internal images,

◊ The improvement of flight management given by use of images or cartography build from embedded data base.

More generally, the conditions of Instrument Meteorological Conditions (IMC) flight at low altitude together with the corresponding evolution's of the regulation (IFR, Night VFR) will be studied.

Of course, other constraints coming from noise abatement requirements and security enhancement have a strong impact on the definition of the new procedures.

4. RESEARCH PROGRAM OVERVIEW

On a technical standpoint, both programs, AWRH and HTT are intended to validate the techniques, technologies and associated implementation principles which will provide the helicopter with a true all-weather capability.

As a first phase, validation and partial demonstration is carried out from laboratory tests, by simulation or in flight aboard a common utility aircraft in order to:

◊ Confirm the technological choice,

◊ Validate the implementation concept,

◊ Define the associated approach/takeoff procedures,

◊ Evaluate the performance of the various system components.

The second phase will deal with the integration of the technical solutions retained in a full system demonstrator whose prototype equipment and the man-machine interface will prefigure those of an all weather helicopter which can be used on any medium or heavy weight aircraft of the Eurocopter range.

With the aim of being as comprehensive as possible, the Eurocopter approach will explore several alternatives corresponding to different options in terms of:

- Technological choice,
- performance level accessible with respect to the economic goals (cost / potential market),
- Timeframe for application depending on the complexity and innovative features of the experimented technical solution.

Basically, to permit the approaches in condition of poor visibility, two technical solutions are explored and their effect on the man/machine interface will be studied in detail:

- The first solution is built around the Heliradar: this is the AWRH program.
- The second solution is built around a more conventional enhanced visibility concept to which a laser obstacle detection is added: this is the HTT program.

Figure 2 : The AWH/HTT demonstrator helicopter

This choice show the complementarity of Eurocopter in its research activity, which is on an other hand, well harmonized, thanks to the use of a common utility aircraft, called BK 117 Futura. Futura will perform the demonstration campaigns of both programs, in Germany and in France.