

Introduction

The purpose of this lecture is to summarize the first operational results after one year of SUPER PUMA MK 2 commercial use in the north sea with our launching customer HELIKOPTER SERVICE.

I would like before to remind you on the origin of this family of helicopters and the main characteristics of the MK 2 which is the latest version of the PUMA/SUPER PUMA family.

Formerly designed to answer French and UK ministry of defence requirements, the PUMA was delivered to the first customer in 1971. Two versions of this helicopter (civil and military) were produced during 10 years. They were replaced by a new version called SUPER PUMA.

The objectives were :

- to increase the range of the PUMA,
- to improve military characteristics and specifically crashworthiness aspects,
- to enlarge the cabin.

Although the civil and military versions of the PUMA had been significantly different, the decision was taken to keep the highest commonality between civil and military versions of the SUPER PUMA in order, in particular, to improve industrial process and reduce development costs. First delivery took place in 1981.

Despite its military origin, very, quickly, the Super Puma imposed itself and set a new standard in offshore transportation in particular in the North sea. Even if due to recession, the common flight rate is today about 100 hours per aircraft per month, during the period 1981–1991 a flight rate of 170 hours per aircraft per month was not an exception. In very few occasions, rates in excess of 200 hours were seen.

In parallel the military version was very successful within military forces and was selected by :

- 23 air forces,
- 7 army aviations,
- 4 navies.

So far, the total experience with this family is close to 3.5 millions flight hours.

This huge experience and the availability of new technology in terms of engines, rotor design, composite materials and avionics led Eurocopter to make a new significant step with the MK 2 version.

The way the aircraft has been designed to meet new market requirements :

□ safety / performance / payload

For civil applications, the JAR OPS (ICAO annex 6 part III) regulations will, in particular impose no exposure time during take-off/landing procedures. This is required to improve safety during this critical time.

It will lead to an important reduction of the payload of the existing helicopters S 61, PUMA and SUPER PUMA MK 1 affecting therefore their profitability in Offshore transport.

Good single engine characteristic are also of primary importance for military applications. This is one of the reasons why increased power and performance improvement was a key requirement in the design of the MK 2 versions.

The MK 2 design was carried out with the objective of being compliant with these requirements which would have been applicable in 1996. Delay in the applicability will allow operation of old versions until 1 st January 2000 (if built before 1978) or 1 st January 2010 (if built between 1978 and 2000).

The MK 2 is right now compliant with these requirements, making it possible to take off at maximum gross weight in North sea operation.

Single engine performance is probably one of the most important points in the SUPER PUMA MK 2 safety features.

First helicopter in the world certified with "super emergency" engine ratings, the SUPER PUMA has cancelled the exposure time during offshore operations even at maximum gross weight (9300 kg) on most of the north sea platforms.

It's new higher diameter main rotor with anhedral tip cap blades provides 500 kg improved lifting capacity compared to MK1.

The Integrated Flight and Display system is composed of the visualization system (4 Cathode Ray Tubes) the autopilot and the sensors needed to operate the complete system was designed to lighten the crew workload, in order to make it possible for the crew to concentrate on the external environment. For this purpose, deep ergonomic studies were carried out to provide the crew with the necessary informations for the present phase of the flight with an appropriate symbology.

Recent analysis have demonstrated that in most helicopter accidents human factors are deeply involved. The new IFDS concept, integrated into the basic helicopter systems, is designed to reduce sensitivity to these human factors.

Together with the increased engine power, main dynamic assemblies were redesigned. New bearingless "spheriflex" concept has been applied on the main and tail rotor heads with the following objective of :

- damage tolerant design,
- simplified maintenance.

Designed and tested to be compliant with both civil and military requirements, these rotor heads only include 3 times less parts than on conventional design.

Crashworthy fuel tanks, typically considered as military equipment have been requested by CAA for SUPER PUMA type certification. They are now within the "north sea offshore standard".

□ **comfort**

With a 55 cm longer cabin, the MK 2 can accommodate the usual 19 seats with a 32 inches pitch, thus giving a higher passenger comfort.

A 24 seats high density version is also proposed.

Despite the increased speed and operational weight, the MK 2 vibration level stays comparable to the MK 1 level. This was achieved in particular with the installation of vibrations absorbers at the root of the main rotor blades.

In the 19 seats configuration all passenger are close to a window which provides better visibility. In addition, the two rear cabin windows are enlarged and constitute an improved emergency exit (type IV).

A brand new ventilation system has been fitted on the MK 2 to satisfy the passenger requirements. As a matter of fact, the MK 1 system was often considered as insufficient. The air flow has been multiplied by 2.7 with individual outlets and individual flow adjustment. In addition, this system basically designed to accommodate the optional air conditioning includes two separated sub systems (cockpit and cabin) each controllable separately.

Baggage compartment has also been a point of interest for the engineers involved in the MK 2 design. The total volume available has been increased by 41% on the MK 2 compared with the MK 1. This new capacity has been obtained with the installation of external baggage compartments included in the landing gear sponsons in lieu of the external fuel tanks.

Actual behavior of the helicopter as seen by HELIKOPTER SERVICE

The first helicopter arrived in Stavanger in September 1993 and a second helicopter in November 1993.

Already more than 2000 flight hours were logged with an average dispatch reliability in excess of 97 % since the very beginning of flights and with a peak of 100 % during two consecutive months.

□ **Operational aspects**

Contractual requirements are met, in particular on the performance point of view, and margins have been found in comparison with the flight manual which is considered too conservative by the customer:

"The performance meets contractual agreement stated in contract (significantly better at 5-6000 ft)".

"The performance is significantly better than stated in the flight manual (more than 5 kts cruise speed and about 4 % less fuel consumption)".

Verified cruise speed in commercial flights is 140 kts.

The MK 2 provides payload margins when operated with 19 passengers. Therefore, the oil companies can plan on full cabin and know exactly how many passengers will be transported on all their flights whatever the weather conditions are.

Better comfort has been noticed by the passengers. This is also connected to the increased speed of the Mk 2 compared with the Mk 1 which leads to shortened flights.

In addition, the new ergonomics of the seats has given increased space for the passenger's legs.

Also, the enlarged rear cabin windows are well appreciated by the passengers for the better visibility and increased light in the cabin. In addition, these large windows would ease evacuation in case of need.

On the pilots side, the main feedback is that crew workload has been significantly reduced with the Integrated Flight and Display System. This new system is very much appreciated and pilot conversion/adaptation from the conventional technology seems to be easy.

Despite the increase of speed and helicopter weight, passengers have not noticed any vibration level modification, while pilots do feel an improvement compared with the MK 1.

□ Maintenance

"Less maintenance compared to AS 332 L/L1 in particular on the Main / tail rotor heads and shafts".



New cockpit technology has not created any peculiar maintenance problem.

Small number of modifications have been implemented during HELIKOPTER SERVICE operation, but it is considered to be quite normal for the launch customer.

The progress margin of the helicopter

The SUPER PUMA certification has originally been obtained for a maximum gross weight of 9150 Kg. As on any new helicopter, margins are available and a first step has already been made with the recent certification of an increased weight of 9300 kg.

As already mentioned, the Cougar, military version of the SUPER PUMA, is fitted with the same dynamic assemblies. The present operating weights of this version are 9750 kg (internal load) and 10 000 kg (external load). A new operating concept is even under investigation with the Cougar Mk 2 and flights have already been carried out with weights far beyond 11 000 kg.

This illustrates the margins available on the main dynamic assemblies.

CAA has required the installation of a HUMS to certify the SUPER PUMA MK 2. This item of equipment called EUROHUMS is proposed as an option and its certification is planned by end of 1994.

It has already been demonstrated that maintenance times can be reduced with the use of this system. Nevertheless, at the moment, the system is "passive" : we are logging information and experience.

In a second step the HUMS will become active and will detect in flight abnormal phenomenon so that the maintenance will be adapted to the real usage of the helicopter.

As a conclusion, HELIKOPTER SERVICE considers that :

- there is no real technical problem with the MK 2,
- new equipment are reliable and do not create adaptation difficulties,
- customer support is good,
- the maintenance is easier but time is necessary to evaluate the real cost impact,
- operation is performing well and better than expected as regards performance,
- several advantages are obtained in terms of comfort.

The good behaviour of the Super Puma under high flight rate will benefit to military users that will fly about 4 times less (250 to 300 flight hours a year). Computed with the same conservative approach, same performance margins will appear to military customers.

Already, after one successful year of operation, the launch customer confirms that the main objectives of the MK 2 are met.