CIVIL (FRENCH/U.S.) CERTIFICATION OF THE COAST GUARD'S HH-65A DAUPHIN

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ABSTRACT

One of the requirements imposed by the Coast Guard for the new Short Range Recovery helicopter is that it be FAA certified. The Aerospatiale HH-65A Dauphin is in the certification process, both in France and in the United States. The basic aircraft/engine combination is being certified in France for VFR daytime operation with FAA compliance under FAA Brussells. The night Category II IFR certification is being conducted at Grand Prairie, Texas under cognizance of FAA Southwest Region.

This paper will describe both certification programs with particular emphasis on handling qualities requirements for each. Completion of the VFR Type Certification is scheduled to be completed late this year and the IFR certification in the United States in August 1982. The authors will attempt to identify differences, if any, in the certification requirements of the two countries. This program is unique in that the Automatic Flight Control System is a four-axis system including stabilization through the collective control. Thus, stabilized flight in the low speed regime will be an integral part of the development flight test program.

In this program a dynamic simulator was designed and constructed by Rockwell Collins Government Avionics Division to support and verify the dynamic aspects of the avionics system, particularly the Automatic Flight Control System (AFCS). The role of the Dynamic Simulator in this program will be discussed.

INTRODUCTION

In June 1979 the U.S. Coast Guard signed a contract with Aerospatiale Helicopter Corporation (AHC) of Grand Prairie, Texas, for 90 HH-65A helicopters. These aircraft are intended to be used as Short Range Recovery helicopters, replacing the current HH-52's. Derived from the Aerospatiale SA 365N civil helicopter, the HH-65A is required to be FAA certified before the first delivery to the Coast Guard in late 1982. This certification includes both the aircraft and its avionic systems and will encompass VFR, dual-pilot IFR, and Category II ILS requirements. Furthermore, the nature of the rescue mission demands that the aircraft and its systems be designed to perform extended low-speed and hover operations, thus causing the certification effort to address capabilities heretofore not available.

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The FAA certification criteria for Transport Category Rotorcraft, FAR part 29, and FAA Southwest Region's Airworthiness Criteria for Helicopter Instrument Flight are the primary governing documents for the certification of the HH-65A. In addition, all of the aircraft and avionic systems will be certified to perform their intended functions, whether or not regulatory criteria exist.

Unique Aircraft/Avionics System Capabilities to Support the Night, Over-Water, Adverse-Weather Rescue Mission

The avionics system allows the crew and helicopter to confidently perform operations which would be difficult or impossible otherwise. Although only the Automatic Flight Control System, or AFCS, directly impacts the aircraft handling qualities and stability, the total impact of sensors, displays and guidance computations on the pilot workload and performance is equally great. In particular, the integration of all of these elements to automatically perform given tasks, such as an approach to hover at a rescue site, contribute significantly to crew effectiveness, safety and mission success. Singularly important system features are the following:

Four-Axis AFCS (Pitch, Roll, Yaw, Collective)

The four-axis AFCS provides full-time stability and command augmentation over the entire flight envelope for all maneuvers in pitch, roll and yaw. It also provides automatic trim, hands-off attitude and heading hold, and coupled following of the flight director commands. It is fail-passive and allows the pilot to make manual control inputs at any time. The design goal of the AFCS was to enhance the natural handling qualities of the aircraft, making them more consistent, but not substantially altering them.

Helicopter Coupled Flight Director System (FDS)

The FDS complements the pilot by providing automatic path following or maneuvering through the AFCS. The pilot selects the desired FD mode to perform the desired maneuver automatically. He then may modify that mode by using beep/sync switches on the control stick or by making manual control stick inputs. The five modes designed especially for low speed helicopter operations are the Approach mode (APPR), the Transition-to-Hover mode (T-HOV), the Airspeed and Vertical Speed/Altitude hold mode (IAS-VS), the Hover Augmentation mode (HOV AUG) and the Takeoff/Go-Around mode (GA). As a reversionary feature, the pilot may fly the pitch, roll and collective FDS steering commands on the Attitude Director Indicator to continue a task in case a partial failure of the AFCS occurs.

Mission Navigation Computer

The Mission Navigation Computer acts as a full-time navigator on board the helicopter, automatically fixing the aircraft position, managing the navigation radios and sensors, computing flight plan courses and even generating precise search patterns to be automatically followed by the FDS through the AFCS. In addition, the computer provides synthetic three-dimensional approach to hover guidance at any point where the pilot desires to hover. The pilot indicates his desired final hover position by pressing a button when overflying the point. The computer then generates a lateral course and 5 degree descending approach path to a point just downwind of the target, similar to ILS guidance. Using the flight director's APPR and T-HOV modes, the pilot may accomplish an automatic approach and transition to a stabilized hover.

Horizonal Situation Video Display (HSVD) System

To complement the guidance and the pilot's task of monitoring the flight and aircraft situation, the HSVD system displays various modes associated with a given mission phase or task. Besides conventional HSI, MAP and RADAR or FLIR video presentations, the HSVD also has a hover display mode for low-speed operations. Significant data displayed in this mode are computed wind speed and direction, the current omnidirectional airspeed vector and the flight director commanded longitudinal and lateral speed reference for automatic hovering. Such information apprises the pilot continually of the aircraft flight condition and allows him to make decisions based on known hover data. Both sideward and forward/rearward flight can be carefully controlled and used to the best advantage during low speed or hover operations. This display mode then complements the automatic hover capability of the FDS and AFCS for safe, confident maneuvering.

Although all of the above avionic capabilities normally operate in a coordinated fashion, they independently provide reversionary capability in case of any single failure. Thus, the pilot can still safely continue the flight or task if any single element fails.

Verification and Certification Program

The VFR, daytime, Type Certificate for the HH-65A is being issued by the French civil aviation authority, or DGAC, to Aerospatiale Division Helicopters of France, with FAA compliance via FAA Brussels. Then AHC of Grand Prairie is requesting Supplemental Type Certification (STC) of the night, IFR, and Category II operations, including all avionics and mission equipment, through the FAA's Southwest Region in Fort Worth, Texas.

Dynamic Simulator Testing

Because of the innovative nature and advanced capability of the avionics system for IFR flight and low-speed, remote area operation, along with the attendant impact upon crew workload and performance, AHC and Rockwell-Collins planned to reduce the development and certification schedule risk by initially evaluating the avionics system on a fixed-base "dynamic simulator." This engineering development simulator combined actual avionics flight hardware, displays and computers with a simulated cockpit and aircraft response model. The aircraft model was programmed to cover the entire flight envelope, from 20 knots rearward to 140 knots forward flight and up to ±1500 feet per minute vertical speed. The cockpit incorporated the aircraft and avionics controls and displays to perform a total mission profile with realistic scenarios. In addition, the actual aircraft control system with properly emplaced AFCS servos and feel/trim units duplicated the proper feel and pilot-AFCS interaction. Thus, the avionic equipment interfaced and performed exactly as it later would in flight. Two objectives were addressed and met using the dynamic simulator: (1) The system operation was verified and refined to reduce the flight test schedule and schedule risk. That this goal was successfully achieved was manifested when the AFCS successfully stabilized and controlled the aircraft the first time it was engaged in flight. (2) The test pilots and U.S. Coast Guard personnel could evaluate the suitability of the avionics system and the integrated system operation for the intended missions, especially for search and rescue. The early use of the simulator enabled many aspects of the system to be refined and modified while the program schedule impact was still minimal.

STC Flight Testing

The HH-65A flight testing of the avionics and mission equipment commenced in July 1981. The AFCS, flight director system, HSVD multifunction display system, com/nav system and omnidirectional

airspeed system have completed the engineering development testing. The testing of the mission computer functions and the combined mission suitability of the various systems is in progress. The lower end of this IFR speed envelope is limited primarily by the static stability characteristics of the aircraft. The HH-65A, as is typical of most helicopters, exhibits deteriorating static stability characteristics on the backside of the power curve. During the handling qualities survey, a reversal in the cyclic stick position versus airspeed curve was noted below 40 knots. This, of course, is contrary to FAA standards.

Low-speed IFR flight potential is further limited by the lack of displayed OADS information. This data is processed by the flight director computer for the generation of steering commands during T-HOV and GA maneuvers. Demonstrably safe IMC approaches to and departures from hovering flight are possible either in coupled or manual flight. This capability should lead, at least in theory, to landing minimums significantly lower than those currently available. This, unfortunately is not the case at the present time.

Expansion of the low-speed IFR flight envelope will require, first of all, a means of either satisfying FAA static stability standards or modifying those requirements. Secondly, inclusion of an airspeed indicating system, such as the recently developed Collins ASI-800, is necessary. This system displays both lateral and longitudinal OADS information and speeds from rearward flight to the forward flight limit of the aircraft. This indicator utilizes OADS data at speeds less than 40 knots, a blend of OADS and pitot from 40 to 60 knots, and pitot information only above 60 knots. Hopefully, further technical advances and experience gained, as a result of this and future certification programs, will make IFR certification to zero speed possible in the near future.

The currently projected date for delivery of the first aircraft to the Coast Guard is September 1982. The FAA certification process began in February with submission of system functional, interface and fault analysis data to the Southwest Region, along with meetings and presentations. Three critical safety items were of particular interest to the FAA: 1) the fail-passive design of the AFCS, which is intended for use in hands-off automatic hovering; 2) the survivability of those system functions which are redundant; and 3) the qualification of digital software for the multiple data bus, the HSVD system and the mission computer functions.

The major remaining milestones prior to FAA certification are the production conformity inspection, the Type Inspection Authorization approval, and the FAA certification flight testing. From the standpoint of handling qualities and crew workload, the IFR evaluation will examine all normal and degraded modes of operation for IFR suitability.

CONCLUSION

The requirement for FAA certification has meshed well with the originally stated Coast Guard mission and system performance requirements. Several special configuration changes have occurred due to the FAA involvement; namely, the routing of the wiring cables and the independence of certain displayed information. However, the overall process and outcome reflects how similar the Coast Guard's mission and aircraft requirements are to the typical sophisticated offshore or corporate helicopter operators.

As a result of the HH-65A program, the groundwork has been laid for the application of many

advances in helicopter avionics and
integrated systems technology to
the civil helicopters of the
1980's. Notable achievements are
the four-axis AFCS, the low-speed
coupled flight director system,
multifunction CRT displays,
omnidirectional airspeed system,
computerized automatic navigation
and other mission aids and a
multiplex data bus interconnect
system. With the groundwork of FAA
certification once accomplished,
the rapid introduction of these and
other similarly advanced concepts
is greatly facilitated.