U.S. COAST GUARD

HH-65A HELICOPTER AVIONICS BLOCK UPGRADE #2

LCDR J. Douglas Bogle
Avionics Systems Manager
Aviation Division
Office of Engineering, Logistics, and Development
USCG Headquarters
Washington, DC 20593

BIOGRAPHY:
Doug Bogle is currently serving as Upgrades Section Chief at CG Headquarters where he is responsible for the avionics upgrades of the HH-65A, HU-25, VC-4A, and HC-130 aircraft. He holds a Bachelor of Science in Electrical Engineering from Boston University and is presently enrolled part-time at the University of Maryland working toward a Master of Science in Engineering Management.

LCDR Bogle is a Coast Guard pilot and holds a Maintenance Officer designation. He was previously stationed at Air Station Cape Cod, MA, where he flew Sikorsky HH-3F helicopters and served as the Assistant Engineering Officer and Brooklyn, NY, where he flew Sikorsky HH-52A helicopters.

ABSTRACT:
This paper describes the current avionics block upgrade program underway for the U. S. Coast Guard HH-65A helicopter. The aircraft currently utilizes a fully integrated avionics suite provided by Collins Avionics & Communications Division (Collins) of Rockwell International Corporation.

This upgrade includes the incorporation and integration of an embedded Cockpit Voice and Flight Data Recording (CV/FDR) system and the integration of secure communications and Digital Encryption Standard (DES) control. These functions will be performed by Programmable Interface Control Units (PICUs). The PICUs have new more powerful processors and application software can be loaded via the MIL-STD-1553B data bus. The PICUs will replace the two existing Systems Coupler Computers (SCCs). Additionally, the existing Cockpit Control Displays (CCDs) will be replaced by Control Display Navigation Units (CDNUs). CDNU application software can also be loaded via the 1553B databus. The existing Mission Computer Unit (MCU) will be removed and its functions will be performed by the PICUs and CDNUs.

This effort is part of an ongoing program to provide common avionics hardware and software for all Coast Guard aircraft to the greatest extent possible. The capability to program the PICU and CDNU via the 1553B bus will allow the same part number LRU to be stocked for various aircraft. Many of the enhancements included in this upgrade will be usable on other platforms, both fixed and rotary wing. All new software development will be written in Ada and will be developed in accordance with tailored DOD-STD-2167A.

INTRODUCTION:
The Coast Guard is on contract with Collins for the integration and incorporation of several new subsystems and upgrades. The plan is to increase avionics functionality and decrease system weight. Because the HH-65A system is highly integrated the upgrade is being performed in a block approach. Only those subsystems that need upgrading are being replaced. This is the most cost effective way to upgrade the avionics system. This paper is organized as follows:
1. Brief description of existing system
2. Hardware architecture changes
3. Software functions descriptions
4. Implementation plan
5. Summary

BACKGROUND:
The USCG HH-65A Short Range Recovery (SRR) helicopter is a dual piloted IFR aircraft with a highly integrated avionics system. The system was developed by Collins in the late 70's and is on board 95 HH-65A's. The system performs cockpit management, mission navigation, flight guidance and control.
communications, and radio navigation, via a dual 1553B data bus. A flight director is also able to couple for automatic control of the helicopter. Additionally, automatic navigation is accomplished by using data from various sensors to provide a continuous best estimate of aircraft position and speed. The avionics system of the HH-65A consists of five integrated subsystems:

1. Flight Management
2. Flight Control
3. Communications
4. Radio Navigation and
5. Special Sensors

The existing Flight Management and Communications subsystems functions will be merged and integrated into new hardware as part of this upgrade. The primary focus of this paper is this upgrade.

Flight Management System:

The current FMS allows the pilot and co-pilot to interface with the avionics system and control cockpit and mission management. Hardware that is currently on board to support these functions includes:

- Dual Cockpit Control Display Units (CCDs)
- Dual Systems Coupler Computers (SCCs)
- Mission Computer Unit (MCU)
- Signal Interface Unit (SIU)
- Dual 1553 data bus

The two functions of the current FMS are mission management and cockpit control. These are performed by the MCU, SCCs, and CCDs. The cockpit control function performs control of the communications and radio navigation equipment. The mission management function performs flight plan and database management, guidance and steering information, multisensor automatic navigation, fuel alert/cruise calculations, engine/transmission monitoring, and flight plan map generation for the Horizontal Situation Video Display (HSVD).

The flight crew interfaces to the FMS through two CCDs. These functions as the only means of control of navigation and communications equipment with the exception of the XY-58 encryption and Digital Encryption Standard (DES) devices. The CCDs also provide display of mission and area navigation data (see figure 1).

The SCCs integrate the tuning, control, and data display of the communication and navigation radios. Both SCCs contain Systems Interface Modules (SIMs) which interface the systems that are unable to directly connect to the 1553B data bus. The SCCs also provide the selected pages to the crew on the CCDs and serve as the primary and backup 1553B data bus controllers.

The MCU performs mission and area navigation functions. By comparing aircraft position, speed, and altitude with flight plan data, it produces steering commands for the flight director. It utilizes a Flight Data Base (FDB) for flight plan information and position determining. The FDB currently is programmed utilizing a Flight Data Storage Unit (FSDU) through the MCU prior to flight.

Figure 1 Cockpit Control Display Unit Front Panel

THE UPGRADE:

The HH-65A Avionics Block Upgrade modifies or replaces several existing LRUs as well as rewrite a substantial amount of software. Figure 2 shows the architecture of the present system with the planned upgrades highlighted. All aspects of the new system will be designed to optimize modularity of both the hardware and software functions to
allow their reuse on other avionics systems aboard Coast Guard aircraft.

The two major additions to the system are the CDNU and the PICU. Both units are programmable via the 1553B databus, allowing the same part number component to be used on various aircraft. This will result in less sparing requirements at Air Stations with multiple aircraft types. Different aircraft will be able to use identical CDNU and PICU hardware. After the applicable SIMs are installed in the PICU, the aircraft unique application software can be loaded in the CDNU and PICU via the 1553B bus. The unit is then identified for the appropriate aircraft and put in service.

The original flight management software was written in AED (Automated Engineering Design). The new software baseline for the flight management software is Ada code that was developed for the CDNU. This is new generation FMS software derived from the previous HH-65 FMS. Current HH-65 avionics functions not provided by the CDNU will be recoded from the AED baseline.

**HARDWARE:**

**PICU:**

The existing SCCs will be replaced by PICUs. The PICUs are modified AN/ASQ-205(V) Interface Control Units (ICUs). They have been upgraded to include a 80486 microprocessor operating at 25MHz and flash memory. Each PICU will contain the following memory:

- 1024K bytes of EEPROM (Flash) for application software
- 256K bytes of RAM for temporary storage
- 128K bytes of CMOS EEPROM used for non-volatile data storage
- 128K bytes of UVPROM (board level programmable) for start up program and application software loading

As mentioned, the application software will be loaded via the 1553B data bus from the Navy Standard Mission Data Loader (SMDL) or other 1553B interfaced mass storage device.

The PICUs will perform the majority of the CV/FDR signal processing as well as communications control.

**CDNU:**

Two CDNUs, also programmable over the 1553 data bus will replace the existing CCBs. They each contain an 80386 microprocessor and 80307 math coprocessor operating at 16MHz. Each CDNU will contain the following memory:

- 1024K bytes of EEPROM (Flash) for application software
- 256K bytes of RAM for temporary storage
- 64K bytes of CMOS EEPROM used for non-volatile data storage
- 128K bytes of UVPROM (board level programming) for start up program and application software loading

They will serve as the 1553 bus controller and back up bus controller as well as the main Flight and Communication Management System processor. Other features of the CDNU include a full alpha-numeric keyboard with 8 display lines, 8 select lines, 14 top level function keys, ANVIS compatible CRT, and one menu key. (see figure 3)
The MCU will be removed as a result of this upgrade.

CV/FDR Subsystems:

Crash Survivable Memory Unit (CSMU):

The Flight Data/Cockpit Voice recorded parameters processed by the PICU will be stored on board the CSMU. This small device will be located in a strategic point to allow ejection prior to an incident or automatically as a result of an incident. The CSMU will contain enough memory to store the last 30 minutes of flight data and cockpit voice recordings.

CV/FDR Signal Interface Unit (SIU):

The CV/FDR SIU unit will collect sensor data in the cockpit area and consolidate and supply the data to the PICU for processing via an ARINC 429 databus.

SMDL:

The Fairchild CP-2092(P)/A data loader will be used to store the application software, navigation database, and predetermined flight plans for each mission.

SOFTWARE:

The avionics system will have two operational states:

a. Mission Execution and
b. Maintenance Operations

The Mission Execution state includes all tasks associated with control, display, and navigation processing as the helicopter performs its operational missions. The Maintenance Operations state includes all tasks associated with loading software into various LRUs and performing tests which require the hardware to be taken off-line.

The Mission Execution state is broken down into three modes of operation:

a. Flight Management
b. Communications Management
c. System Status Monitoring

The Flight Management mode includes all capabilities required to establish and execute the flight plan for a given mission. It is composed of the following parts:

- Flight Plan Management
- Flight Plan Map Generation
- Area Navigation / Flight Plan Execution
- Flight Guidance
- Navigation
- Navigation Sensor Management
- Fuel Optimization and Alerting
- Mission Planning Aides
- Engine Condition Monitoring
- Special Sensor Monitoring

The Communications Management mode includes all capabilities required to establish and maintain external radio communication and internal communications between crew positions. It is composed of the following parts:

- Communications Radio Management
- Data Link Control/Display (Inactive)
- Communication Frequency/Mode Control
- Identification (IFF) Mode/Code Control
- Secure Voice Equipment Control
- Audio System
- Underwater Acoustic Beacon
- Loud Hailer

In this upgrade the existing Data Link Control will be removed. The Secure Voice Equipment Control will be added through software in the PICU.

The communication radio module controls the HF, UHF AM/FM and VHF AM/FM radio communications. Previously the control and access to cryptographic equipment was via the...
KY-58 unit located behind the co-pilot. This upgrade will add the control of the KY-58 Encryption device to the Communications Radio Management through a SIM in one of the PICU's.

The System Status Monitoring mode will process the CV/FDR data and detect failures at an LRU level utilizing to the extent available the self-test and self-monitoring of the LRUs.

All software functions that were performed by the MCU will now be accomplished by the CDNU, eliminated. This is illustrated in figure 4.

**Figure 4 System Functions and Partitioning**

**IMPLEMENTATION:**

Aircraft production installations will be completed by a rotating field team at operating Coast Guard Air Stations throughout the United States. Additionally, some modifications will be completed at the Programmed Depot Maintenance (PDM) facility at the Coast Guard Aircraft Repair and Supply Center (ARSC) in Elizabeth City, NC. Field installation teams will complete the modifications while the air station pilots receive training on the new systems. The modification is expected to take approximately two weeks per airframe.

**SUMMARY:**

This paper has described the avionics block upgrade currently underway in the U. S. Coast Guard HH-65A helicopter. The systematic block approach to the upgrade of multiple systems has and will continue to save significant resources as well as minimize the amount of time needed to effect the modifications.

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Robert A. Bolin
Flight Management Systems Engineering Manager
Collins Avionics & Communications Division
Rockwell International Corporation
Cedar Rapids, IA 52498

Mr. Bolin has managed systems, software, and hardware design in the development of Cockpit Management, Cockpit Display, Aircraft Navigation, and Flight Management Systems. He has worked on a number of projects relating to the HH-65A helicopter, most recently the software development for GPS integration into the PMS. His department is responsible for the design of the HH-65A Avionics Block Upgrade.

**REFERENCES:**

