

FAA
Health and Usage Monitoring
R&D Requirements

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FAA AC USAGE CREDITS R & D Requirements

DRAFT FAA HUMS Requirements

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FAA Health and Usage Monitoring Systems (HUMS) R&D Requirements

1. **Background.** Various types of HUMS have been developed, and there are likely to be more used in the future. Initially, these systems were installed to show the feasibility of gathering meaningful data to modify required maintenance and/or operational actions. The degree of qualification required for this type of installation is relatively low. However, there is an increasing number of certification applications to install HUMS and use its data to intervene in maintenance and/or operations of the rotorcraft. This type of installation requires a higher degree of qualification, commensurate to the criticality of the most severe effect of the intervention action(s) on the rotorcraft. HUMS typically consists of a variety of onboard sensors and data acquisition systems. The acquired data may be processed onboard the rotorcraft or on a ground station (or a combination of both) providing the means to measure against defined criteria and generate instructions for the maintenance staff and/or flight crew for intervention.

In 1999, the FAA issued a material to be incorporated in the FAA Advisory Circular. The purpose of this advisory circular (AC) is to provide guidance to achieve airworthiness approval for rotorcraft Health and Usage Monitoring Systems installation, credit validation, and instructions for continued airworthiness (ICA) for the full range of HUMS applications. This AC does not change regulatory requirements and does not authorize changes in, or deviations from, regulatory requirements. This AC establishes an acceptable means, but not the only means of certifying a rotorcraft HUMS. This AC will address the most complex/extensive HUMS; systems of lesser complexity may be addressed by use of only the parts of this AC that are pertinent.

2. **Certification.** The certification of HUMS must address the complete process, from the source of data to the intervention action. There are three basic aspects to HUMS certification. Certification of HUMS must address all three. The three aspects are installation, credit validation, and instructions for continued airworthiness (ICA). These aspects are not totally independent and do have varying interactions with each other. A method to address these aspects is provided by the approach described in the Airworthiness Approval of Rotorcraft Health and Usage Monitoring Systems (HUMS) - Index to Advisory Circular issued on July 15, 1999 (ref. http://www2.faa.gov/certification/aircraft/Rot_Pol_Hums.htm).

Installation includes all the equipment needed for the end-to-end application that is associated with acquiring, storing, processing, and displaying the HUMS application data, including airborne and ground-based equipment. Credit validation includes evidence of effectiveness for the developed algorithms, acceptance limits, trend setting data, tests, etc., and the demonstration methods employed. A plan is needed to ensure continued airworthiness of those parts that could change with time or usage and includes the methods used to ensure continued airworthiness.

3. **R&D Plan.** The main objective of the FAA HUMS R&D is to validate the AC on HUMS certification and new regulatory material if required. HUMS R&D will include efforts covering all aspects of HUMS development and certification. Additionally, as tools and methodologies for the rotorcraft damage tolerance have been significantly developed and our understanding of DT philosophy has been substantially improved, the combined DT and HUMS technologies to address safety will also be considered. In summary, the FAA HUMS R&D programs to be initiated in FY05 will focus at least in four areas: Rotorcraft Operation Development of HUMS, Commercial HUMS Validation, HUMS On-Board Warning, and Flight Testing With HUMS-Installed Helicopters.
4. **Funding Plan.** HUMS funding plan for FY05 and FY06 is approximately \$2.22M and \$2.45M respectively. Out of \$2.22M prioritized for FY05, approximately \$1.22M and \$1M are planned for supporting NRTC/RITA and academia HUMS research respectively. Out of \$2.45M prioritized for FY06, approximately \$1.45M and \$1M are planned for supporting NRTC/RITA and academia HUMS research respectively. The planned funding is contingent on final budget appropriation.

If interested, submit white papers (4 – 6 pages) including goals, technical approaches, deliverables, budget plan for a two-year program starting September 2004 – September 2006.

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Introduction

- The FAA Tech Center in Atlantic City, NJ has requested **White Papers** from RITA* to outline the development of a validation plan for the **HUMS Advisory Circular**
 - *RITA, Inc. is a nonprofit research organization established in 1995 under the 1958 Space Act, owned and operated by Bell, Boeing, Sikorsky, and Kaman to perform pre-competitive research.*
 - *The U.S. Army, U.S. Navy, NASA, and the FAA comprise the NRTC.*
 - *Any IP resulting from RITA activities belongs to RITA, Inc. with rights given to the participating members (Bell, Boeing, Sikorsky, and Kaman)*
 - The FAA will use RITA's White Paper to develop the Statement of Work for a 2005 & 2006 NRTC/RITA program (with a possible extension for 2007)
 - *Cooperative Agreement NCC2-9109 between NASA and RITA, Inc.*
- * RITA, Inc. – Rotorcraft Industry Technology Association, Incorporated
NRTC – National Rotorcraft Technology Center

HUMS Background

CAA/Shell drove Safety Requirements

DO-178C Level D Software ok for HUMS

Operators desire to use HUMS as an Alternate means of meeting maintenance requirements, resulting in cost savings such as Usage benefits

The HUMS system is often distributed for data storage and data trending reasons

- Initial HUMS systems installed for feasibility (*Enhanced Safety*)
- Low Qualification Requirements
- New requirements for HUMS to “intervene” in maintenance and/or in operations of the rotorcraft
- Processing may be On-board, in a ground station or a combination of both

HUMS Background (Cont'd)

July 15, 1999

AC provides one method of obtaining approval from the FAA

Three Parts to Process

1. Approval to install the hardware. Must prove that it is non-Hazardous
2. Validation of Credit – i.e., Exceedances, Usage etc.
3. Assures continuing safety of application or credit

The Advisory Circular provides only one means to achieve certification

- FAA Advisory Circular (AC) published in 1999
- Guidance for Airworthiness Approval
- Advisory Circular Addresses:
 - Installation
 - Credit Validation
 - Instructions for Continuing Airworthiness
- The AC addresses an **acceptable** means not the only means (Does not change regulatory requirements)

FAA Advisory Circular

*Defined in Advisory Circular
as certifying the End-to-End
Process*

- **Process** - Address the complete process from source of data to intervention action
- **HUMS Certification** - Address all three basic aspects to HUMS Certification (Installation, Credit Validation, Continuing Airworthiness)
- **Installation** - Address all equipment required for the end-to-end application
- **Credit Validation** - Address effectiveness and demonstration methods
- **Continuing Airworthiness** - Address "Plan and Methods"

R & D Plan

- **Main Objectives**

- Validation of AC for HUMS Certification
- Development of new regulatory material if required

- **Additional Objective**

- Combine HUMS with Damage Tolerance to address the safety issue

Four Areas for Focus

- Rotorcraft Operational/ development of HUMS
- Commercial HUMS validation
- HUMS On-Board Warning
- Flight Testing of HUMS installed helicopters

Bell Helicopter HUMS Activity (1)

- 1985 V-22 Diagnostic System
- 1989-1991 FDR Civil Certifications
- 1988-1991 IR&D-HUMS Requirements
- 1993 Flight Trials at PHI
- 1995 CF HUMS Deliveries (100 AC)
- 1994 – 1995 FAA Usage Feasibility
- 1995-1996 Bell Usage Credit System (BUCS) Development
- 1995-2000 FAA Operational Evaluations
 - Gulf Coast, Atlanta Short-Haul, and Utility Missions

Bell Helicopter HUMS Activity (2)

- 2000-2001 FAA Task VI - Validation of HUMS AC (Using BUCS)
- Jul 2002 Bell 412SP HUMS STC
(Usage Architecture -4 AC in Service)
- 1998-2002 RITA HUMS Cockpit Situational Awareness and Maintenance Enhancement (CSAME)/HUMS Demo Activity
- 2003 RCDD Task IV – Usage Monitoring
- 2001-2004 CF HUMS Maintenance Credit Program

Bell Proposal for FAA R&D

- Mini-HUMS Usage Monitor
- Ground Station Validation
(Smiths Industries Support)
- RIN Monitor for Repeated Heavy Lift Applications
- Usage Credit Evaluation – PHI Data

Mini-HUMS Usage Monitor

- Simplified usage monitors or ‘Mini’ HUMS usage monitors will be investigated. The goal is to reduce the number of sensors and therefore to reduce the complexity and cost of the system by only recognizing certain conditions and factoring the rest of the certification conditions accordingly.

Ground Station Validation (Bell with Smiths Support)

- Ground Station is a PC based computer that provides data storage, trending, and control for each aircraft. RITA's HUMS Ground Station (RHUGS) will be used for the HUMS AC validation using the data obtained from the 412 HUMS system.

RIN Monitor for Repeated Heavy Lift Applications

- Retirement Index Number (RIN) is a more refined means of GAG cycle counting, usually based on an automated algorithm applied to the real time torque demands of the aircraft. RIN is often implemented in combination with Flight Condition Recognition (FCR), since aircraft torque data is available as a byproduct of the FCR process. Data from the Retirement Index Number (RIN) monitor will be used for evaluating the component usage

Usage Credit Evaluation – Utilizing PHI Data

- Usage Credit benefits are of great importance to operators because they provide great potential for reducing helicopter operational costs while enhancing safety through a knowledge of otherwise unknown or unreported exceedances or overloads. This effort is highly leveraged since the data can be obtained directly from 4 existing HUMS aircraft.

Proposed Schedule/Budget

Rotorcraft Health Usage Monitoring Systems

TASK	2005				2006				2007			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Program Administration												
Mini Usage Monitor												
Ground Station Monitor												
RIN Monitor												
Usage Credit Validation												

Budget: Rotorcraft Health Usage Monitoring Systems

	2005	2006	2007
	BUDGET	\$600K	\$600K

Summary

- The FAA has requested RITA, Inc. support to validate the HUMS Advisory Circular.
- Bell and RITA welcome the opportunity to support the FAA's R&D requirements
- Bell proposes that it's efforts focus in four strategic areas: Mini-Usage Monitoring Techniques to simplify approaches and reduce cost, Ground Station Validation per the AC, RIN Monitor development for Repeated Heavy Lift per the AC, and a comprehensive evaluation of Usage Data from 4 available Commercially Fielded Aircraft
- The above efforts will be supported by the combined work of the RITA HUMS Team.