

# Development of Health and Usage Monitoring Systems Research and Development Plan Boeing Company (BC) Project Kick-off Meeting

FAA William J. Hughes Technical Center  
Building 210, AAR-470 Meeting Room  
Sept 29, 2004

## AGENDA

- |  |   |                       |
|--|---|-----------------------|
| 08:30 am: Introductions                                  | - | All                   |
| 08:35 am: FAA HUMS R&D Overview and Project Expectations | - | Dy Le, FAA            |
| 09:35 am: HUMS R&D Plan Development Project              | - | Robab Safa-Bakhsh, BC |
| <b>10:35 am: Break</b>                                   |   |                       |
| 10:50 am: Technical Discussions                          | - | All                   |
| <b>12:00 pm Adjourn</b>                                  |   |                       |



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AIR TRAFFIC ORGANIZATION

<http://airportaircraftsafetyrd.tc.faa.gov/>

# **Development of Health and Usage Monitoring Systems (HUMS) Research and Development Plan**

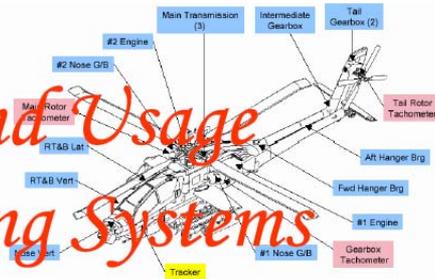
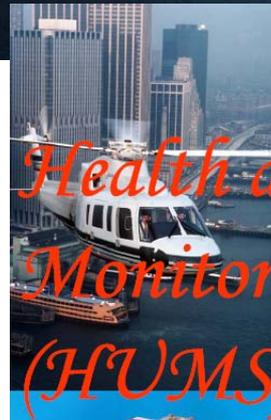
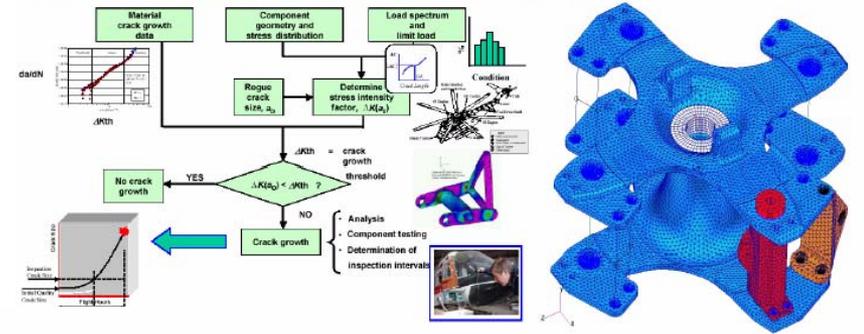
## ***FAA Perspectives***

Dy Le

September 29, 2004

**Boeing Company (BC) HUMS Project Kick-off Meeting**

# Rotorcraft Structural Integrity and Safety



# Aging Aircraft Research Sponsorship

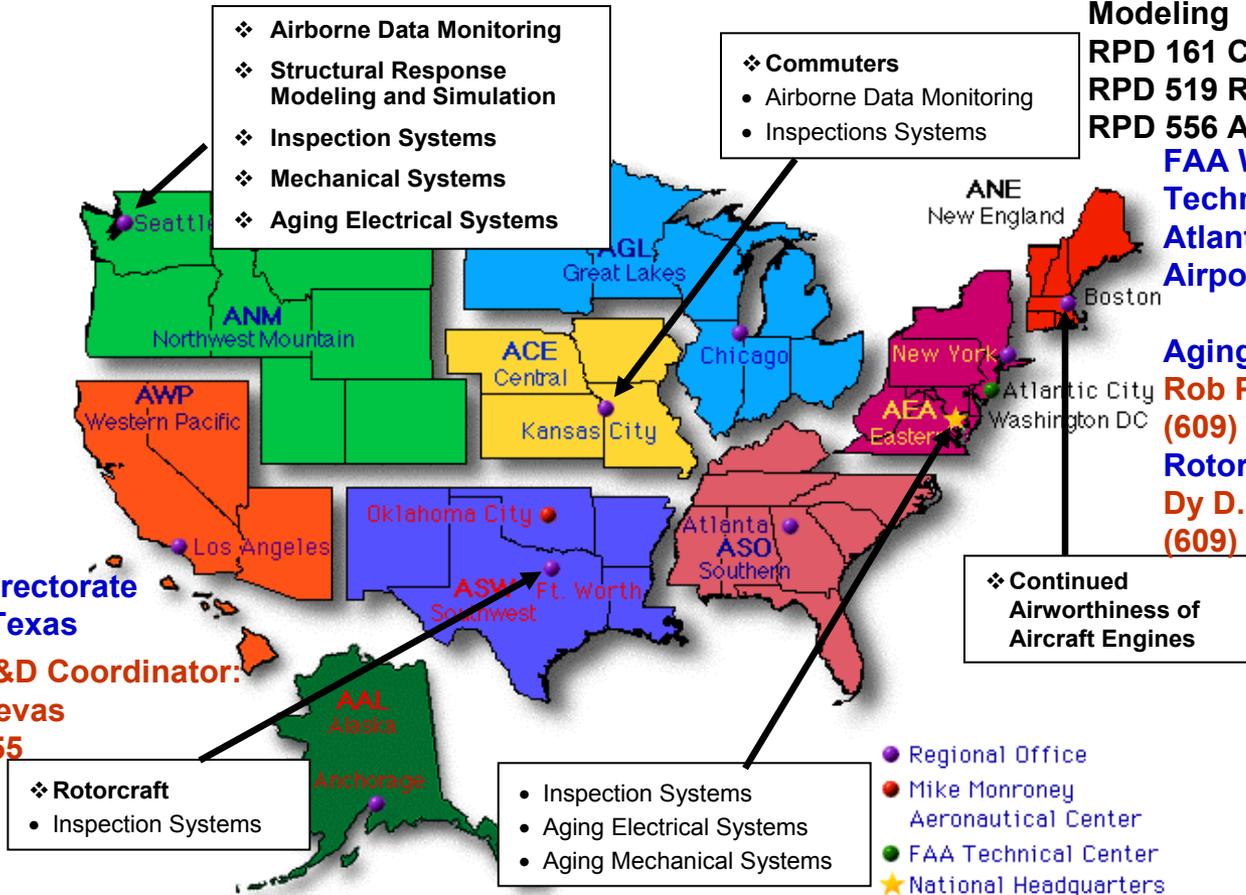
## Aging Aircraft Research

RPD 584 Inspection Systems  
 RPD 672 Mechanical Systems  
 RPD 673 Electrical Systems  
 RPD 510 Aircraft Data Monitoring  
 RPD 515 Structural Response Modeling

RPD 161 Commuter Aircraft  
 RPD 519 Rotorcraft  
 RPD 556 Airworthiness of Engines

**FAA William J. Hughes  
 Technical Center  
 Atlantic City International  
 Airport, NJ**

**Aging Aircraft Research  
 Rob Pappas, Program Manager  
 (609) 485-6181  
 Rotorcraft Research  
 Dy D. Le, Program Manager  
 (609) 485-4636**



**Rotorcraft Directorate  
 Fort Worth, Texas**

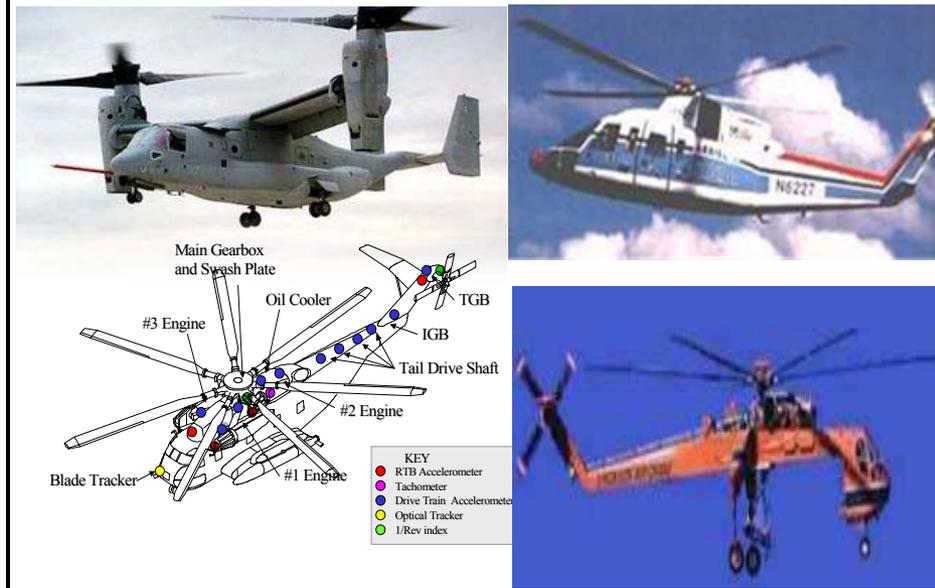
**Rotorcraft R&D Coordinator:  
 Edwin G. Cuevas  
 (817) 222-5355**

❖ *primary sponsorship for projects,*  
 ● *secondary support.*

# HUMS R&D Requirements

## Program Objectives:

- Provide ACO with guidance and and technical information including data for HUMS installation, maintenance credit, and continued airworthiness plan.
- Merge HUMS and fatigue including DT technologies to maximize safety benefits.



## Technical Approaches:

- Collaborate with rotorcraft community (e.g., NRTC, RCOE, DoD, NASA, RITA, academia, manufacturers) to conduct a wide range of HUMS R&D.
- Collaborate with DoD and helicopter operators to collect usage data.
- Fully validate and transfer HUMS technologies to rotorcraft industry and users for certification and compliance.

## Support:

- AC's 29.2A & 27.1A, HUMS, 20.95,
- FAA Order 8110.9
- Damage Tolerance Rulemaking, FAR's 29.571 & 27.571,

# Major HUMS R&D Areas

- HUMS R&D will include efforts covering all aspects of HUMS development and certification.
  - Rotorcraft Operational Development of HUMS
  - Commercial HUMS Validation
  - HUMS Onboard Warning
  - Flight Testing With HUMS-Installed Helicopters
  
- Additionally, combined DT and HUMS technologies to address safety will also be considered.

# Operational HUMS Development

## Technical Objectives:

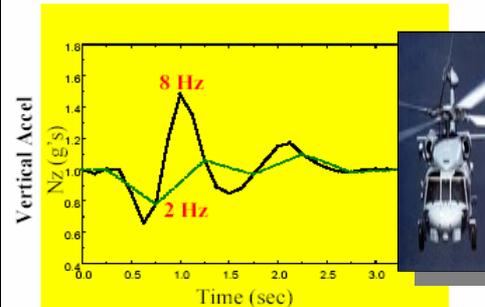
- Determination of HUMS system requirements/processes for various applications and mission mix.
  - Installation
  - Credit Validation
  - Continued Airworthiness Plan

## Technical Approaches:

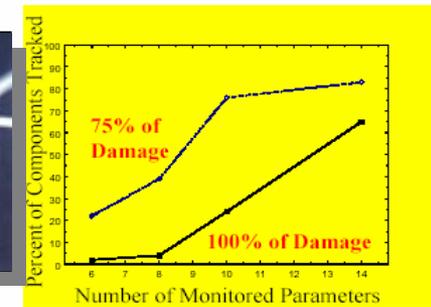
- Conduct assessment and identification of key design parameters and sampling rates required for monitoring systems.
- Conduct the functional/usage hazard assessment of a HUMS.
- Evaluate various types and levels of severity of system degradation to determine the impact on overall structural monitoring capability.
- Validate FCR algorithms and health monitoring techniques for impending problem recognition.

## Data Rate and Parameter Assessments

Data Rate Assessments  
Effect of Inadequate Data Rate



Monitored Parameter  
Damage Assessments



## Outputs:

- Guidance and technical information including data to be used in existing HUMS AC and any new regulatory material as required.
- Complete system operational requirements including ground based COTS, onboard monitors, and recording systems to be included in AC.

# Commercial HUMS Validation

## Technical Objectives:

- Evaluation of HUMS during the design, fabrication, installation, credit validation, and flight tests to assure that the means of compliance practices are adequate and just for the systems intended.



## Technical Approaches:

- A commercially-developed HUMS system will be installed and evaluated using the HUMS AC.
- Using WJHTC's S-76 flying test bed and/or other aircraft, usage credit and maintenance action issues will also be addressed.
- Flight-tests are to be conducted using scripted flights for validation of flight condition algorithms and measure loads.

## Outputs:

- Guidance and technical information including data to be used in existing HUMS AC and any new regulatory material as required.
- Outputs will also include assessments of rotorcraft fatigue spectrums and mission profiles that can be used in damage tolerance and fatigue spectrum definition.

# HUMS Onboard Warning

## Technical Objectives:

- Assessment of onboard warning and display devices to determine their reliability, functionality, and required response or action on warnings.



## Technical Approaches:

- Evaluate types of devices and information to be displayed or audible.
- Assessment of pilot interface with operational aspects of the system.
- Study of pilot's response or reaction on warnings

## Outputs:

- Requirements for onboard warning and display systems or devices.
- Guidelines for pilots or ground-based personnel required to respond to onboard warning and display.

# HUMS Flight Tests

## Technical Objectives:

- Validation and assessment of various aspects of HUMS including guidance and information obtained from:
  - Operational HUM Development
  - Commercial HUM Validation
  - HUMS Onboard Warning



## Technical Approaches:

- Utilize S-76 and others available at Technical Center.
- Collaborate with DoD including U.S. Coast Guard and NASA to install commercially-developed HUMS on their helicopters.
- Utilize commercial helicopters being used by U.S. operators and OEM's for HUMS flight tests.

## Outputs:

- Technical information including data and processes for:
  - Ground-based COTS, on board monitors, and recording systems.
  - FCR algorithms and monitoring techniques
  - Design, fabrication, installation of HUMS
  - Guidelines for pilots or ground-based personnel required to respond to onboard warning and display devices.
  - Typical rotorcraft fatigue spectrums and mission profiles that will be used in damage tolerance and fatigue spectrum definition.

# Overview of HUMS R&D Plan Development

- In collaboration with HUMS community, the FAA is supporting the development of HUMS R&D plan.
  - ID current HUMS technologies.
  - Define critical HUMS issues and quantify gaps.
  - Develop HUMS R&D and milestones with prioritized tasks.
  - Develop HUMS output requirements and formats.
  - ID R&D resources and develop costs required to meet HUMS R&D requirements.
  - Develop HUMS R&D exit criteria.
  
- HUMS R&D roadmap and plan avail - 1<sup>st</sup> Quarter of FY05.

# Boeing Company HUMS Contract

- Contract Award – Aug 26, 2004
- Start Date – Sept 15, 2004
- Firm Fixed Cost - \$49.7K
- Period of Performance – Sept 15 – Dec 15, 2004
- FAA COTR – Dy Le – (609) 485-4636
- FAA ACOTR – Paul Swindell – (609) 485-8973
- BC PI – Robab Safa-Bakhsh – (610) 591-6154

# Task 1: HUMS Operational Capabilities

- Assess current operational HUMS systems developed or being used.
  
- Review HUMS current capabilities including HUMS systems and components for AH-64 and CH-47 helicopters.
  
- Provide a description of application process with a focus on structural monitoring applications including diagnostic and prognostic applications, rotor track and balance and ground station. Examples are vibration monitoring, usage monitoring such as applied for damage tolerance and load monitoring.
  - Application process including intended purposes, system requirements (software & hardware) with added-on accessories (if required), components to be tracked, type of HUMS and other data, and processes/methodologies used/needed to obtain/compute required information etc.

# Task 2: HUMS R&D and Technologies

- Assess current research and HUMS technologies:
  - Identify and describe barriers, deficiencies, dependencies, readiness levels, and areas of growth.
  - Review and provide a status of research and enabling technologies related to HUMS including damage tolerance and fatigue life management, rotor track and balance, drive train diagnostics related to sensors, data acquisition methods, algorithms, methodology and data management in HUMS ground station.

# Task 3: Gap Analysis & R&D Requirements

- Conduct the gap analysis and develop R&D requirements.
- Based on experience with various systems including AH-64 and CH-47 HUMS and results of tasks 1 and 2, identify gaps between current capabilities and capabilities required for certification.
- For each gap, identify strategies and R&D requirements to eliminate the gaps.
  - Outline of needed research identifying project goals and requirements, costs, and projected duration.
  - Define five and ten-year R&D requirements for HUMS.

# Task 4: Exit Criteria & Performance Metrics

- Develop measures to assess HUMS R&D performance and completion.
  - Based on results of previous tasks, develop performance metrics and exit criteria for each HUMS R&D identified and projected.
  - HUMS R&D roadmap for short (5 yrs) and long (10 yrs) term R&D requirements.

# Task 5: Final HUMS R&D Plan

- Provide and revise draft final reports documenting all tasks in accordance with Section entitled Draft and Final Reports.
  - Executive Summary
  - Introduction
  - State of HUMS Technologies, Certification, and Applications
  - Future HUMS Requirement
  - Current R&D Activities and Programs
  - Gap Analysis
  - R&D Requirements
  - Five and Ten-Year R&D Goals, Plans, and Milestones
  - Estimated Costs
  - R&D Performance Metrics and Exit Criteria
  
- All deliverables including but not limited to technical information and data generated from this contract shall be publicly and unconditionally releasable for use in FAA publications.

# Boeing HUMS R&D Plan

## Key Milestones & Deliverables

Outputs/Tasks	Sept 04	Oct 04	Nov 04	Dec 04
<b>HUMS R&amp;D Plan Contract Award – Aug 26, 04</b>  <b>Start Date: Sept 15, 04</b> 				
<b>Kick-off Meeting</b> <b>Sept 29, 04</b>				
<b>Project Review Meeting</b> <b>Nov 24, 04</b>				
<b>BC Monthly Reports</b> <b>Oct 15, Nov 15, Dec 15</b>				
<b>BC Draft Final Technical Report</b> <b>Nov 15, 04</b>				
<b>FAA Revised Draft Final Technical Report</b> <b>Nov 30, 04</b>				
<b>BC HUMS R&amp;D Plan Final Technical Report</b> <b>Dec 15, 04</b>				

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Questions?