Rotorcraft Policy and Guidance for Health Usage Monitoring System (HUMS)

Liz Brandli (presenter Jorge Castillo)
EASA Rotorcraft Symposium: Dec 4-5, 2015
Agenda

- HUMS FAA Guidance
- HUMS Certification Approach
- HUMS Research
  - HUMS Research Roadmap
  - HUMS Research Conclusion
  - Current HUMS Research Reports
- AC MG-15 Update
HUMS FAA Guidance

- Health Usage Monitoring System (HUMS) is not a required system
- FAA has no plans for mandating HUMS
- FAA has certification guidance for installations via STC, TC
  - AC 27-1B & 29-2C. Change 3, Section MG 15
  - AC was developed by Rotorcraft Health Usage Monitoring System Advisory Group (1999)
  - Committee Members
    - FAA Aircraft Certification
    - European Joint Aviation Authorities (JAA)
    - US and European Industry Groups (AIA & AECMA)
HUMS Certification Approach (1)

Onboard Systems

INSTALLATION

CREDIT AND VALIDATION

INSTRUCTIONS FOR CONTINUED AIRWORTHINESS

Algorithms

Hardware/Software
- Maintenance
- Support Systems
  - Interface
MG -15 is comprised of three parts:

- **Installation**
  - Qualification of Airborne System
  - Qualification of the Ground Equipment
  - Allows approval for installation before Credit Validation
  - Must retain traditional maintenance program (i.e. no “Credit” provided yet)

- **Credit Validation**
  - Validates that HUMS Functions as Intended
  - HUMS “Credit” granted after validation

- **Instructions For Continued Airworthiness (ICA)**
  - HUMS operating instructions, training and controlled introduction to service
HUMS Research (1)

- Roadmap developed in 2005
- Validate/Enhance HUMS Advisory Circular (AC)
- Assist in maturing HUMS technology
HUMS Research (2)

- AC Compliance Demonstration
  - Mock certification using AC MG15
    - Direct load measurement – direct evidence
  - Military usage vs Civil usage
    - Flight regime recognition – indirect evidence
    - Validate methodologies (Sikorsky vs Army)
## HUMS R&D Roadmap

### HUMS R&D Areas and Tasks

<table>
<thead>
<tr>
<th>ID</th>
<th>Description</th>
<th>Short</th>
<th>Long Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>HUMS AC Requirement Compliance Demonstration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>HUMS Development and HUMS-Equipped Flight Testing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Usage Monitoring and Flight Regime Recognition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Direct Loads Monitoring</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>Maint Credits Validation (Indirect Load Measurement)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>Maint Credits Validation (Direct Load Measurement)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>43</td>
<td>Operational Development of HUMS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>Hardware</td>
<td></td>
<td></td>
</tr>
<tr>
<td>47</td>
<td>Sensor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>87</td>
<td>Airborne Systems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>93</td>
<td>Ground Station and Peripherals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>121</td>
<td>Software</td>
<td></td>
<td></td>
</tr>
<tr>
<td>123</td>
<td>Data Management</td>
<td></td>
<td></td>
</tr>
<tr>
<td>150</td>
<td>Diagnostics and Monitoring</td>
<td></td>
<td></td>
</tr>
<tr>
<td>166</td>
<td>Maintenance Management</td>
<td></td>
<td></td>
</tr>
<tr>
<td>173</td>
<td>Commercial Validation of HUMS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>174</td>
<td>Algorithms and Methodologies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>176</td>
<td>Safety Monitoring</td>
<td></td>
<td></td>
</tr>
<tr>
<td>180</td>
<td>Structural Usage Monitoring &amp; Credit Validation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>206</td>
<td>Diagnostics, Health, &amp; Prognostics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>232</td>
<td>Onboard Warnings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>233</td>
<td>Responses and Procedures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>234</td>
<td>Flight and Ground Crew</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
HUMS Research Wrap-Up

- 10 year research program (FY06-FY15) developed to validate MG-15
- Research conducted with US Army AEH, ARL and CERDEC, GE-Smiths, GoodRich, NASA Glenn, ERAU, Acellent, HAI, and Sikorsky
- Research ended in FY15 with a revision to the AC expected in FY 2016
- FAA attended AHS CBM & HUMS meeting in Huntsville February 2015 to wrap up research program
  - FAA/Researchers meeting held for recommendations to AC-MG15 update.
Current HUMS Research Reports

- Current HUMS Reports to be published:
  
  • Development and Validation of Structural Usage and Loads Monitoring Methods for Use in Determining Rotorcraft Usage Credits (Sikorsky)
  
  • Application of Rotorcraft Structural Usage and Loads Monitoring Methods for Determining Usage Credits (Sikorsky)
  
  • Accuracy Assessment of HUMS Regime Recognition Algorithms (HAI)
  
  • Results of Health and Usage Monitoring System Fleet Data Analysis for Usage Credits (AED)
  
  • Summary of US Army Seeded Fault Tests for Helicopter Bearings (AED)
  
  • Rotorcraft Maneuver-To-Maneuver Damage with Structural Usage Monitoring System (SUMS) Data (AED)
  
  • Rotorcraft Spectrum Reliability Comparisons by Endurance Limit Adjustments (AED)
AC MG-15 Update (1)

- Team Scope
  - Review HUMS research reports for applicability to the AC 29-2 AC MG-15.
    - Provide updates based on research, certification experience, and EASA’s recently issued AMC 29.1465

- Team Members
  - Matt Fuller – Sponsor for Research
  - Robert Grant – Structures
  - Liz Brandli – Software
  - Mark Wiley – Electrical
  - Andy Shaw – Avionics
  - Matt Wilbanks – Mechanical Systems
  - Rao Edpunganti / Eric Haight – Power-plant Systems
The structure of the draft updates to the AC has essentially remained the same ... including these major topical areas:

- Installation
- Ground-Based System Certification Guidance
- Credit Validation
- Instructions for Continued Airworthiness
– AC proposed changes will include:

  • Incorporation by reference EASA AMC 29.1465 for VHM systems classified as “Minor”
  • Installation
    – Clarification on Catastrophic Systems and Mitigating Actions
    – Systems Safety FHA and DAL Assignments
    – Examples of Systems with Different DAL’s
    – Clarification on “Credit” definitions and “Usage”
    – 27/29.1309 guidance for software and airborne electronic hardware
AC MG-15 Update (3)

- Ground-based system proposed updates:
  - Removed Independent Verification and DO-178 requirements
  - Added requirements for Data Management (Data Quality, Data Integrity, Data Processing, and Data Security)
  - Added guidance for Ground-based tools and qualification based on Criticality and output dependence using RTCA DO-330
Credit Validation proposed AC updates:

- **Usage Credit**
  - Approach used in HUMS for Usage Credit is to replace the CWC usage with the actual usage and recalculate the Remaining Useful Life (RUL)
  - Regime Recognition Accuracy Issues
  - Reliability impact of using actual usage

- **Added Usage Credit Methodologies**
  - CWC spectrum refinement (part number approach)
  - Individual component damage assessment (Serial Number approach)

- **Regime Recognition Algorithms**
  - Validation requirements
  - Accuracy requirements

- **Validation of Structural Usage Monitoring Systems (SUMS)**

Note: The AC does not contain guidance for Regime Recognition Accuracy requirements.

Note: The AC does not address reliability impacts associated to using usage monitoring systems in deriving information such as fatigue life RUL calculation.
AC MG-15 Schedule

- Initial Draft AC under FAA Management Review
- FAA Internal Review  June 2016
- Public Comment  Nov 2016