Comprehensive Rotorcraft Health Management Systems

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CRHMS History

UK Offshore O&G Operations

- CAA AAD 001-05-99
- CAP 693
  “Acceptable Means of Compliance Helicopter Health Monitoring”
- CAP 753
  “Helicopter Vibration Health Monitoring”
CRHMS Operational Benefits

Op. & Sustain Cost Savings
-17% Total Maintenance
-52% Unscheduled Maintenance

Flight Safety Enhancement
-12% Flight Incidents
3 Class A Mishaps Avoided

Readiness Improvement
9% Readiness Rate
-30% Mission Aborts

U.S. Army Fleet Operations Enduring & Iraqi Freedom
What is CRHMS?

Vibration/flight data acquisition and analysis
CRHMS Functional Capability

**DATA ACQUISITION**

- MECHANICAL DIAGNOSTICS
- ROTOR TRACK & BALANCE
- USAGE MONITORING
- FLIGHT DATA MONITORING

**MULTI FUNCTION ANALYSIS**

- TRENDS THRESHOLDS
- ROTOR SMOOTHING
- EXCEEDANCE REPORTING
- REGIME RECOGNITION

**DATA FUSION AND REPORT GENERATION**

- MULTI-LEVEL REPORT GENERATION
- SECURE DATA ACCESS
- GLOBAL CONNECTIVITY
CRHMS Data Set

- Mechanical diagnostics data
- Gear analysis waveforms
- Residual RMS
- Residual Kurtosis
- Residual Peak to Peak
- Energy Ratio (Residual RMS to TSA RMS)
- Energy Operator RMS
- Energy Operator Peak to Peak
- FM0
- Side Band Ratio
- G2 Analysis
- Narrowband Analysis RMS
- Narrowband Analysis Kurtosis
- AM Analysis RMS
- AM Analysis Kurtosis
- Derivative AM Analysis Kurtosis
- FM Analysis RMS
- FM Analysis Kurtosis
- Time
- Date
- Engine Mode
- ENG & MGB Fl Press/Temp
- Flight/Ground State
- Flight time/landings
- MRH RPM
- Mast Moment
- TOT
- TRQ
- N1
- N2
- ALT
- GPS
- P0
- Norm. acceleration
- T0
- Lat. acceleration
- OAT
- Long. acceleration
- IAS
- Vert. acceleration
- ZP
- P/R/Y rates
- HDG
- P/R/Y degrees

Cabin Lateral
Cabin Vertical
Cabin Roll
T/R radial
CRHMS Analysis

BEARING ANALYSIS

SHAFT ANALYSIS

Ultra Electronics Flightline System

making a difference

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## CRHMS CAP 753 Compliance

<table>
<thead>
<tr>
<th>Assembly</th>
<th>Component</th>
<th>VHM Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine</td>
<td>PT, GG</td>
<td>Vib spectrum during run-up. SO1, SO2 GG, PT</td>
</tr>
<tr>
<td>Engine - MGB inputs</td>
<td>Shafts</td>
<td>Imbalance, misalignment – monitored from engine and gearbox.</td>
</tr>
<tr>
<td>Main gearbox</td>
<td>Gears, Shafts Bearings</td>
<td>SO1, SO2, gear meshing frequencies, gear tooth indicators, bearing wear indicators.</td>
</tr>
<tr>
<td>Accessory gearbox</td>
<td>Gears, Shafts, Bearings</td>
<td>SO1, SO2, gear meshing frequencies, gear tooth indicators, bearing wear indicators.</td>
</tr>
<tr>
<td>Tail rotor drive shaft</td>
<td>Shafts, hanger bearings</td>
<td>Imbalance, misalignment, bearing wear.</td>
</tr>
<tr>
<td>IGB/TGB</td>
<td>Gears, shafts, bearings</td>
<td>SO1, SO2, gear meshing frequencies, gear tooth indicators, bearing wear indicators.</td>
</tr>
<tr>
<td>Oil cooler</td>
<td>Blower &amp; drive shaft</td>
<td>SO1, SO2, bearing wear.</td>
</tr>
<tr>
<td>Main rotor</td>
<td></td>
<td>Blade T&amp;B, swashplate bearings wear indicators.</td>
</tr>
<tr>
<td>Tail rotor/ fenestron</td>
<td></td>
<td>Blade T&amp;B, swashplate bearings wear indicators.</td>
</tr>
</tbody>
</table>
CRHMS Typical Installation

SYSTEM WEIGHT BUDGET

20 accelerometers:
@ 40 grams = 800 grams
3 tach @ 100 grams = 300 grams
2 ARINC I/F @40 grams = 80 grams
26 network T connectors:
@ 20 grams = 520 grams
35’ ft cabling @12 grams/ft = 420 grams
LDC@ 900 grams
SYSTEM WEIGHT
(No RTB camera) = 3020 grams

->7.0 pounds
Summary

- Historically, CRHMS (HUMS, VHM) was mandated as a safety enhancement

- In addition to safety, CRHMS provides improvement and efficiency in MRO operations.

- Future CRHMS capability: MAST
  Maintenance, Analysis, Safety, Training

- Future CRHMS systems: additional sensors, increased analytics (diagnostics and prognostics), increased knowledge extraction (MRO operations), and increased safety (NextGen/ADSB)
Thank you!

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