

Version 1.1

Health & Usage Monitoring Systems

HeliOffshore Best Practice Guidance



HeliOffshore
Safety Through Collaboration



Foreword

About Health and Usage Monitoring Systems

Health and Usage Monitoring Systems (HUMS) are sensor-based systems that measure the health and performance of mission-critical components in aircraft. They provide actionable information so that maintainers can make data-informed decisions.

HUMS are increasingly effective in providing additional data on emerging technical issues and, with the development of Advanced Anomaly Detection (AAD) systems, the accuracy and predictability of HUMS continues to improve.

This guidance will be updated regularly. If you have comments or suggested amendments, please email: info@helioffshore.org

HUMS specialists are encouraged to participate in our online, secure collaboration tool: HeliOffshore Space. This is where industry experts are collaborating to the benefit of everyone at the frontline and those who travel offshore.

Delivering HeliOffshore's HUMS Best Practice Guidance *from the co-chairs of the HUMS Working Group*

In October 2014, efforts to exchange HUMS best practice became global after HeliOffshore members identified the sharing of HUMS best practice as an industry-wide safety priority.

This guidance represents more than a year of work by our industry's top HUMS specialists – collaborating to share data, policies and experiences, and to agree what best practice looks like. Thank you to the working group and those who reviewed the guidance. We are confident that its implementation by operators, large and small, will make a difference to safety and availability.

Our work will continue as HUMS and our use of these systems continues to evolve, and our industry begins to experience the safety and efficiency benefits of implementing these best practices.

Russell Gould – Director, Global Fleet Support, Bristow

Malcolm Garrington – Manager HUMS Support, CHC Helicopter

Safety Through Collaboration *from HeliOffshore CEO, Gretchen Haskins*

On behalf of HeliOffshore members, I want to thank the HUMS working group and everyone who reviewed the guidance.

HeliOffshore is bringing people together so that our industry can achieve, and sustain, ever-higher levels of safety. The launch of HeliOffshore's HUMS Best Practice Guidance is the result of a highly engaged industry putting momentum behind those actions that will make the greatest difference to safety.

People in the frontline of our industry want to use safety tools to their full potential and this guidance will help them do that. We are now focused on supporting operators to implement best practice; our accompanying implementation guide gives suggestions on how they can achieve this.

This guidance is a start point on a journey of collaboration which will define a clear standard for operators to follow.

The HUMS working group will continue its work and to engage with stakeholders including system designers, manufacturers, and the International Association of Oil & Gas Producers. We will review and refine the guidance in response to stakeholder feedback so that the maximum safety benefit is achieved from HUMS.

Gretchen Haskins

You can find out more about HeliOffshore, our safety plan, and the workstreams at www.helioffshore.org

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Section 1 Background

The use of Health and Usage Monitoring Systems (HUMS), while not mandated by regulation in all parts of the world, has become an offshore standard and is increasingly effective in providing additional data on emerging technical issues.



Section 1

Background

Historically, HUMS has been inconsistently applied in terms of its potential pro-active nature. With the development of Advanced Anomaly Detection (AAD) type systems, the accuracy and predictable nature of HUMS has improved. OEMs are investing in this technology and, to make best use of it, operators need to understand fully the capability, share the possible operational limitations in implanting these systems in an offshore environment, and influence the development path to create standardisation and best practice, wherever possible.

The HeliOffshore HUMS working group formed in August 2014. One of its objectives was to drive publication of Standardised Operating Principles for all helicopter types fitted with HUMS.

This document provides both a definition and describes best practice to enable operators to manage HUMS related tasks in a way that provides safety benefit in all operations.

The document is not a replacement for regulatory or guidance documents (such as CS29.1465, CAP 753, etc.) but an additional document that provides enhancement and clarification on best practices.

HeliOffshore HUMS Working Group

The primary working group included the following HeliOffshore members:

Aerosurance Limited

Andy Evans (Director)

Babcock

James Strachan (Avionic Type Engineer)

Sean Newlands (HUMS Analyst)

Bell Helicopters

Brian Tucker (Associate Technical Fellow, Integrated Vehicle Health Management)

Joe Wendelsdorf (Staff Engineer – retired)

Bristow Group

Russell Gould (Director, Global Fleet Support & HeliOffshore HUMS Working Group Lead)

Richard Barnett (HUMS Manager – Bristow US)

Gayan Silva (Fleet Engineering Specialist)

Jerry Cresswell (Fleet Engineering Specialist)

Cougar

Dave Squires (HUMS Administrator)

CHC Helicopter

Malcolm Garrington (Manager, HUMS Support & HeliOffshore HUMS Working Group Co-chair)

John Cawdell (Manager, HUMS Program)

Bjorn Haga (HUMS Engineer)



ERA Helicopters

Jason Alamond (HUMS Program Manager)

PHI, Inc.

Robert Bouillon (Director – HSEQ)

Tim Doucet (Supervisor, Aircraft Data Monitoring Systems)

Weststar Aviation Services

Andy Taylor-Jones (Flight Data Manager)

Acknowledgements

We want to acknowledge the many HeliOffshore members, including manufacturers, oil companies, suppliers and consultants, who devoted their time and effort to help review this document. Also, thank you to regulatory bodies who have offered advice and support.

Section 2 Document Use

The document is written for offshore oil and gas operations based on available systems at the time of publication. The best practice may be reviewed by operators and assessed for suitability in their specific operations. Best practice guidance may be varied in certain regions or for specific missions using a risk-based approach.

Section 2

Document use

Document Review, Amendment and Update Process

The primary working group included the following HeliOffshore members:

Document Owner: HeliOffshore is the document Owner and is responsible for maintaining its currency. HeliOffshore will delegate these duties to an appropriately qualified person/group.

Change Procedures: This document and future changes and/or additions will be submitted to the HeliOffshore HUMS Working Group. Once agreed, a revised version will be presented to HeliOffshore for approval, implementation and release.

Change Markings: Changes will be identified by a black bar adjacent to the change except when there is a complete re-issue of the document. Explanation of the change will be provided with the revision/re-issue.

Acronyms

| | |
|------|---|
| AAD | Advanced Anomaly Detection Sean Newlands (HUMS Analyst) |
| AMM | Aircraft Maintenance Manual |
| CAMO | Continuing Airworthiness Management Organisation |
| CAT | Commercial Air Transport |
| CI | Condition Indicator |
| CRS | Certificate of Release to Service |
| FDM | Flight Data Management |
| FH | Flight hours |
| GSC | Ground Station Computer |
| GSS | Ground Station Software |
| HUMS | Health and Usage Monitoring System |
| KPI | Key Performance Indicator |
| MEL | Minimum Equipment List |
| MOB | Main Operating Base |
| OEM | Original Equipment Manufacturer |
| TCH | Type Certificate Holder |
| VHM | Vibration Health Monitoring |



Section 2

Document use

Definitions

| | |
|---------------------------|---|
| Analysis (Primary) | The review of HUMS data and comparison with respect to predefined threshold levels using OEM/TCH provided ground station software. |
| Secondary Analysis | Detailed comparison of HUMS data against aircraft of the same type to determine the statistical significance. |
| Download | Process of retrieving collected/stored HUMS data from aircraft for transfer and process on to the GSC to perform analysis. |
| HUMS authorised personnel | <p>Individual who will review, analyse and certify HUMS data. Depending on region, it can be referred to by different titles. Typically:</p> <p>Transport Canada Region: Aircraft Maintenance Engineer, Avionics Aircraft Maintenance Engineer or Mechanic/Technician</p> <p>FAA Region: Aircraft Maintenance Technician (AMT), Avionics, FAA licensed A&P mechanics</p> <p>EASA Region: Line Engineer, Technician, EASA Licensed B1/B2 Engineer</p> <p>Asia/Pacific Region: A&C Licensed B1.3 Type Engineer (equivalent to A&P). Technician/AME/Avionics</p> |
| Main Operating Base (MOB) | Location of an aircraft's permanent/temporarily assigned operating base for daily flight operations that has the ability of supporting HUMS download and analysis. |
| Trend | Series of typically two or more data points used to determine propagation of a series of data points over the subsequent flight hours. Under normal circumstances, and depending on the acquisition schedule and flight profile, gathering data points may be a matter of minutes or tens of minutes apart. Acquisition also depends on serviceability of instrumentation and associated vibration processing equipment. |
| Normal Monitoring | HUMS authorised personnel download and analysis in accordance with appropriate HUMS procedures, utilising applicable maintenance data, as directed/prompted by the HUMS. |
| Close Monitoring | <p>During Download and Analysis, we may determine that some trends be reviewed more closely to ensure data has been collected and that the trend has not reached an unacceptable level. Should a determined level be reached, further maintenance inspection/intervention may be required.</p> <p>Vibration level of trends can vary both up or down for a variety of reasons (shown on the following page).</p> |



Section 2

Document use

Definitions *continued*

Close Monitoring – Type A
(Rising Trend/step change with unidentified cause)

The highest priority in close monitoring, initiated by an indicator exceeding a set limit. Evidence of a trend rise or step change near a set limit. Or a rapid upward trend.

Close Monitoring – Type B
(Suspected Instrumentation/Regime Issue)

Typically identified as spiky/erratic data over the threshold with no sign of rising trend in mean value. Over the subsequent flights, a series of troubleshooting tasks will likely be implemented during which a period of close monitoring will start in order to review the effect of any maintenance intervention.

Close Monitoring – Type C
(Step Change caused by Component Replacement or Maintenance Action)

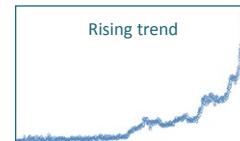
Following a component replacement, be it specifically designed to be monitored by a particular accelerometer or not, the indicator for a particular drive train component is affected. This can be either an upward or downward step.

Note: Some systems cater for this in advance in the maintenance manual or through operator-specific procedures (as agreed with the HUMS OEM/TCH).

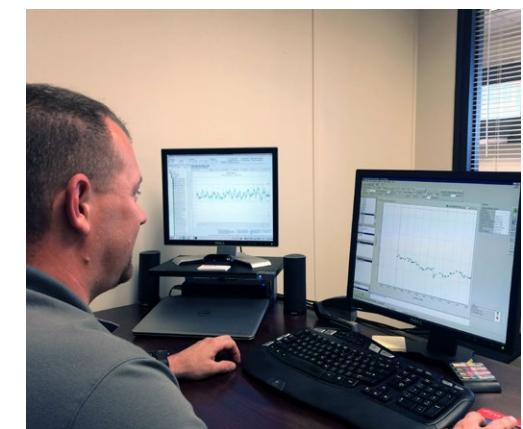
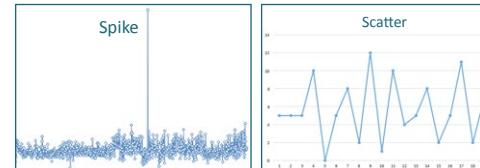
Other systems rely on the system generating an alert. For these types, a period of close monitoring will follow to ensure the trend remains at a consistent level.

Where possible, within the system a relearn of the alert level will be implemented by the operator on the recommendation of the HUMS OEM/TCH.

Example trend graph



Example trend graphs



Section 2

Document use

Definitions *continued*

| | |
|---------------------------------|--|
| Trending | Provide proactive prognostic data analysis to identify significant changes within collected data patterns to facilitate data-driven maintenance actions and overall continuous improvement of the operator's Maintenance Program. Data trending identifies changes over time in the airframe, and includes components (e.g. gearboxes, shafts, and rotors). The basis of trend analysis is to recognise a change in pattern. Several patterns can be distinguished from a trend review, including a gradual drift, rising trend, step change, and data spike. |
| Trending – Gradual Drift | Gradual drift can be caused by long term wear of a component or by bedding – or settling-in after initial installation. |
| Trending – Rising/Falling Trend | A rising/falling trend is a faster change than gradual drift. It normally indicates a developing fault in a component. Rising/falling trends are the most common patterns recognised for action. By determining the 'rate of change' within a trend pattern, it is possible to 'predict' the possibility of data reaching a threshold limit. |
| Trending – Step Change | Step change is caused by maintenance actions, sensor/calibration changes, sudden component failures, or a change in mode of operation. Step changes within a trend pattern are easily identifiable and can be remedied by a follow up to previous maintenance activities on the component in question or by a relearn of the threshold in conjunction with the HUMS OEM/TCH. |
| Trending – Data Spike | A data spike is not usually related to a fault. Therefore, exceedances caused by data spikes can normally be rejected by the data elimination process. Multiple or recurring data spikes maybe indicative of a defect and should be investigated. |



Section 3 Scope

Throughout this guidance, reference is made to HUMS policy, procedures and practices. It is expected that appropriate written procedures are put in place by an operator. This document is focused on the vibration and health monitoring aspects of HUMS with no specific reference made to usage monitoring.

Section 3

Scope

HUMS Data Monitoring



Data Collection

HUMS indicator(s) in alert, rising, or 'of concern' should be tracked and reviewed in accordance with the operators procedures. It is important that data is gathered for these indicator(s) and that they are reviewed as often as practicable.



Detection Capability

As part of reviewing data output from HUMS, the normal data gathering process is capable of detecting differing situations:

- Component replacements
- Mechanical component out-with maintenance limits, or tending towards failure
- Maintenance interventions (e.g. bearing greasing, rotor balancing, etc.)
- Instrumentation

We typically rely on thresholds set within HUMS to prompt HUMS authorised personnel whenever action is required. These are normally set by the HUMS OEM/TCH but, depending on the aircraft type, reliability statistics, and aircraft history, there may be areas of the drive train that have operator/regulator applied limitations. These would be more restrictive than the OEM/TCH set threshold.



Close Monitoring

As further data is collected and a pattern established, it can then be determined that a trend will fall into one of three type categories.

Type A – Rising Trend/step change with unidentified cause

Type B – Suspected Instrumentation/Regime Issue

Type C – Step Change caused by Component Replacement or Maintenance Action

Section 4 GSS and Data Management

A fundamental element of operating and managing HUMS is a robust ground station software and data management policy.

Section 4

Ground Station Software and Data Management

4.1 Installing a new Ground Stations Software Application

Any GSS application must be installed in accordance with OEM/TCH instructions and system requirements. Unless agreed with the OEM/TCH, operators of multiple HUMS should not install more than one GSS application type in any single operating system environment as it may produce undesirable results.

As an airworthiness maintenance tool, the integrity of the HUMS database is vitally important. HUMS authorised personnel rely on the output of HUMS data and the correctly set thresholds as a basis for aircraft airworthiness decision making.

As interaction testing of differing HUM Systems is not normally carried out by the OEM/TCH, the continued integrity of the database can therefore not be confirmed.

4.2 Establishing a New HUMS Database

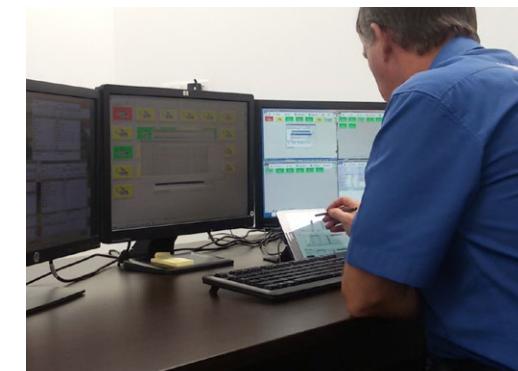
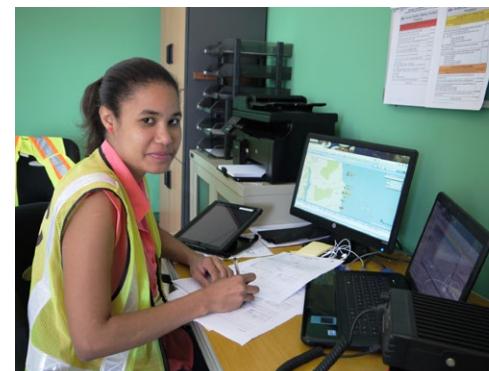
When setting up a new HUMS database, it is preferable to have at least three to four weeks of historical data available to HUMS authorised personnel on the same database (not applicable for new aircraft).

4.3 Backup and Archiving Data

Data should be retained for at least two years or 500FH, whichever is greater. Archived data should be retained on external storage media or remote server. Consideration should be given to the location, security, flood and fireproofing of archived material.

4.4 Hardware and Software Control

Only authorised Field Loadable Software may be installed on a controlled Ground Station. Ground Stations should be controlled in a similar manner to special tool control systems and software changes should be tracked.



4.5 PC and Laptop Replacement

In line with IT policy, a PC or laptop replacement plan should be established to ensure reliability. This will typically align with the manufacturer's warranty. For improved standardisation, use of data imaging software is recommended and the Company IT support is best placed to advise.

4.6 HUMS GSS Checklist

Establish a checklist of what is installed on each ground stations, for each HUMS, and a process for installation documented in company HUMS procedures.

4.7 OEM/TCH Data Transfer and Network Links

All HUMS data should be transmitted to the OEM/TCH at regular intervals and be monitored to confirm successful transfer. This should be carried out via a network link. Where this is not possible, a suitable alternative method should be employed.

Section 5 Download and Primary Analysis

Download and Primary Analysis is the collection, download, transfer and analysis of HUMS data at intervals specified by operator procedures. Download and review after each flight is key to achieving the maximum safety benefit from HUMS.

Section 5

Download and Primary Analysis

Analysis of HUMS data at line level must be performed at each download. As a minimum, HUMS authorised personnel will check for items in alert. These items must be actioned and recorded in accordance with applicable maintenance data and operators procedures before the next flight.

Download and review after each flight is key to achieving the maximum safety benefit from HUMS.

A signed record (written or electronic) by HUMS authorised personnel is required for every download and review of data. A copy of this should be retained in the aircraft records.

5.1 Download Periodicity – Normal Monitoring

Operations from Main Operating Base (MOB)

Download and analysis should be carried out at every return to the main operating base.

Download Periodicity Exceptions

Operations with Short Sector Lengths

When an aircraft is operating short sector lengths with multiple returns to the MOB, operators should assess HUMS data collection capabilities.

Consider the benefits of a download at each return to the MOB versus extending the period between downloads to allow for a full HUMS data acquisition set. This can be achieved by “rotors running” the aircraft from one flight to another, and then downloading after the end of a series of Return to MOB missions.

The number of required missions would be dependent on the timeframe in the acquisition window. Total flight time between downloads should not exceed 15FH.

5.2 Download Periodicity – Close Monitoring

Type A Close Monitor

If a component is subject to Type A close monitoring and sufficient data has been gathered to enable a complete review, the download and analysis periodicity will be on a case-by-case basis in line with OEM/TCH approved maintenance data. It should however, be no less restrictive than ‘on each return to the MOB not exceeding 10FH’.

During the close monitoring period, the respective HUMS channel must be fully serviceable to enable data to be

Type B and C Close Monitor

For Type B and C close monitoring, total flight time between downloads should be ‘on each return to the MOB not exceeding 10FH’.

Section 5

Download and Primary Analysis

5.3 HUMS Data Collection

If the aircraft has not been in the required flight regime for a sufficient period of time, it is acceptable to have collected a partial HUMS data set. However, a complete HUMS data set must be collected within a 15FH period.

The HUMS should be capable of generating a warning that indicates no data has been acquired on any parameter for a period of \geq 5FH. If a specific system does not have this feature or equivalent functionality, the operator should have a process to confirm the required data has been collected.

5.4 Unserviceability/MEL/MDS

The operator should define a Minimum Equipment List (MEL), Minimum Departure Standard (MDS), or equivalent document. This should list the HUMS equipment that may be temporarily unserviceable, and include associated operating conditions, limitations, or procedures as applicable. System unserviceability and subsequent deferment of unserviceable channels should be based upon the table below, and the deferment period for individual channels should be tracked as separate defects.

Table 1: MEL/MDS Deferment Table

This table relates to 'non-acquisition of HUMS data' and HUM System/sensor failures. Both failure types will be linked to a physical component, and all component failures separately tracked.

This guidance does not supersede any OEM/TCH requirements.

Application of this table also only relates to CAT flights (e.g. Offshore), and does not include maintenance check flights.

| Deferment Period | |
|---|------|
| Failure while Close Monitoring Type A defect | 0FH* |
| Failure while Close Monitoring Type B or C defect | 10FH |
| Failure while under Normal Monitoring | 15FH |

* The HUM System and channel that is being close monitored must be fully serviceable to enable data to be gathered.

5.5 Primary Analysis

Alert Management

Any alert should be actioned immediately in accordance with the OEM/TCH holders' requirements by following applicable maintenance data and recorded.

An amber (caution) health warning will require an assessment of the trend in accordance with the OEM/TCH approved data, and aircraft systems may require inspection before further flight. The assessment of the severity of the threshold breach of an alert should also include examination of associated parameters to aid fault diagnosis. Evidence of steady or rapid upward trend and/or persistent generation of a defect should lead to a detailed investigation being carried out. A technical log entry must be raised if the indicator is to be close monitored.

An Amber Alert with evidence to indicate a significant rising trend or if continued at the same rate would result in a red alert on the next flight should be actioned as a Red Alert.

For a Red Alert, unless the OEM/TCH approved maintenance data specifies otherwise, no further flight shall take place

until an acceptable response is received from the operator's HUMS specialist. When requested, the OEM/TCH will provide support directly to the operator's HUMS specialist and, when necessary, will contact HUMS authorised personnel directly.

For existing alerts under close monitoring where there is insufficient data or no data from the previous flight, a maintenance check flight will be needed to collect the required data set.

5.6 Download and Analysis Matrix

A matrix including aircraft type, mission type, and customer requirement should be available to display the information to the operator's personnel. This will aid accurate decision making. An example is shown in Appendix 1.

Section 5

Download and Primary Analysis

5.7 Second Line HUMS Analysis

As part of a quality control process a second line review should take place each day and review:

- Latest HUMS defects on GSC
- Open HUMS support requests (include OEM/TCH communication data)
- Maintenance documents for corrective actions
- Technical log for open HUMS defects

5.8 HUMS Specialist Support

Trending

The operator should have a process in place to:

- Conduct daily aircraft specific trending against predefined condition indicators and identify threshold advisories for potential maintenance actions (minimum 14 day trend). **Note:** The list of CI's to be monitored will vary depending on the aircraft model and/or operator, based on experience and communication with the OEM.
- Validate accuracy of system data and line level trends, conduct fleet wide trend comparison, and evaluate potential immediate and long term maintenance actions.

- Notify OEMs/TCH of significant component condition indicator trends.

Threshold Management

All predefined thresholds will be set by the OEM/TCH. Threshold relearning or adjustment can only be carried out in accordance with applicable OEM/TCH maintenance data (either detailed in the aircraft maintenance manual or via technical agreement).

Relearning or adjustment may be applicable when a component has been removed and reinstalled, or replaced.

The process for threshold change should be carried out using approved maintenance data from the OEM/TCH.

Custom thresholds (if possible with system design) should always be set lower than OEM/TCH threshold to enable enhanced or earlier failure detection.

Periodic threshold reviews should be performed as follows:

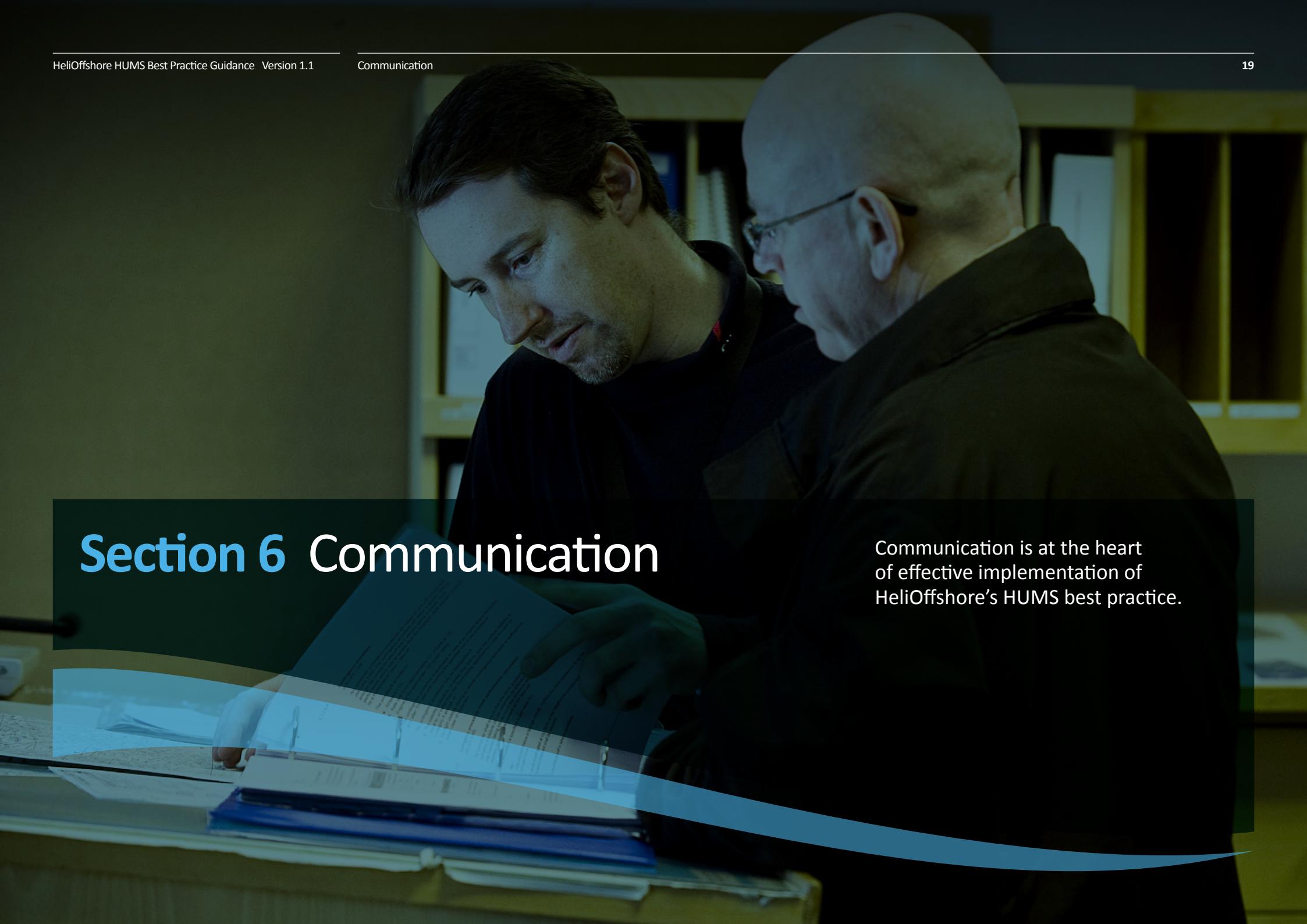
- For a false alert, thresholds used to generate the alert and any related thresholds, should be re-assessed in light of new data and results shared with the OEM.



- Thresholds will be re-evaluated for reliability:
 - For new HUM system or aircraft types this should be carried out on an annual basis for statistical analysis.
 - For mature systems or aircraft type this should be carried out at least biennially (every 2 years).
- Records are to be kept for at least two years or 500FH, indicating the relationship between the operator and OEM/TCH holder; to include the process and communication of all threshold reviews.

As part of a quality control process, a second line review should take place each day.

Section 6 Communication

A photograph showing two men in a control room. One man, with dark hair and a beard, is in the foreground, looking down at a stack of papers or a document. The other man, wearing glasses and a dark shirt, is standing behind him, looking on. The background shows a control panel with various buttons and screens. The image is partially obscured by a dark blue overlay.

Communication is at the heart of effective implementation of HeliOffshore's HUMS best practice.

Section 6

Communication

Internal Communication

The operator should define a process for action of any warnings or alerts generated by the HUMS System, utilising OEM/TCH applicable maintenance data.

An internal escalation process should be established to provide suitable tracking, management, and oversight of HUMS-related issues within an organisation.

Establishing a second tier of support within an operational organisation to manage the communication process and oversight within the HUMS program is recommended. These individuals may be experienced HUMS authorised personnel based within the Line Operation, or constitute a HUMS Support team.

External Communication

The operator should have a clear and auditable process in place for all HUMS-related communications to the OEM/TCH. Ideally, the OEM/TCH will provide the means for this style of communication; however, if this is not defined, the operator should establish a process and agree it with the OEM/TCH.

Both operator and OEM/TCH should provide a regularly updated list of any points of contact. This will typically include email and phone numbers.

Operators should establish in collaboration with the OEM/TCH an appropriate response time for HUMS related queries. These should be consistent with operational requirements.

All personnel responsible for dealing with, and responding to, HUMS related issues, should have access to OEM/TCH approved maintenance data.

The entry point for receiving approved maintenance data should be defined within the operators HUMS procedures.

Generally, having a single point of contact is the most effective way to manage the information flow between your organisation and the OEM/TCH. This also allows for the HUMS team to collect and document details to create a knowledge base that can be beneficial for future analysis and troubleshooting.

Instructions from the OEM/TCH should be followed, the result of which should be sent back. This will either prompt further instruction or closure of the communication.

Download the HeliOffshore HUMS Best Practice Implementation Guide for more advice on how to implement this guidance.

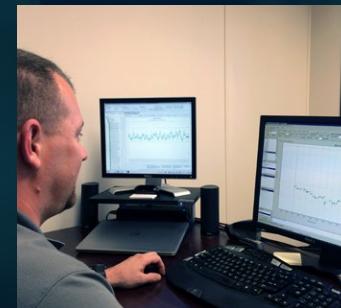
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Section 7 AAD and Web Portals

Access to Secondary Analysis systems is crucial to the success of your HUMS programme.

Section 7

AAD and Web Portals



Interconnectivity

Ground station computers should have a permanent network or internet connection to facilitate regular data transfer to secondary analysis system portals. Alternatively, a robust manual data transfer process should be in place to ensure regular data transfer.

System Use

Automated system generated alerts should be actioned and acknowledged promptly. AAD systems should be reviewed by the HUMS specialist on a regular basis (minimum weekly). Analysis of the systems should include an in-depth review of data and comparison with primary ground station systems. Analysis of the HUMS data should include a comparison of the maintenance records to identify any maintenance actions which could be correlated to the HUMS trend change.

Sharing Information

The OEM should be informed of secondary system performance by reporting cases where the system has detected or failed to detect an anomaly in advance. Performance reviews should be carried out to ensure continued system reliability.

OEM Instructions

The OEM should provide detailed instructions on AAD/Web Portal use and applicable maintenance data for fault isolation/defect rectification.

Section 8 System Performance Reports

A photograph of a man with glasses and a blue shirt, working on a large, metallic helicopter component. He is looking up at the part, which appears to be a landing gear or a similar structural element. The background is dark and out of focus, suggesting an indoor workshop or hangar environment.

Reports are produced when components are removed from the aircraft and routed to the overhaul shop or OEM/TCH for repair. Collected data is used to validate discrepancies found, or guide in troubleshooting for a root cause of removal. Additionally, this type of information is shared with the OEM/TCH.

Section 8

System Performance Reports

Operator Maintenance Action Support

The operator should have a procedure in place to compile relevant data on components removed prematurely to assist in subsequent troubleshooting, repair, and improved component reliability.

Original Equipment Manufacturer/ Overhaul Facility Support

The operator should have a procedure in place to provide timely and relevant data to the OEM/TCH Overhaul facility on HUMS related premature component removals and/or failures, to support root cause analysis efforts. Subsequently, the operator should ensure that the OEM/Overhaul facility provides a detailed component condition report for validation.

Defect Trending Reports

Defect trending should be presented to the operator's Management team during periodic review meetings. These reviews should include operational specifics of HUMS status in the day-to-day operation. In addition, current trends are provided to managers during their normal scheduled meetings and distributed at their respective field base location as feedback to HUMS authorised personnel and flight crew. Presentations may include HUMS data analysis results for each aircraft type being monitored and associated system from the previous quarter.

Performance Report

Content Examples:

- False Alert Rate
- Sensor Failure Rate
- Instrumentation Defect Rate
- Number of Diagnostic Reports/Fault Cases
- HUMS Component Reliability
- Ground Station Software Serviceability
- Usage Exceedance Reports
- Defect Trending

[Examples of HUMS Key Performance Indicators can be seen in Annex 3 on page 48]



Section 9 Responsibilities and Process Descriptions

It's important to be clear about the roles and responsibilities for everyone involved in your HUMS programme.



Section 9

Responsibilities

The table opposite describes how various HUMS duties may be assigned, and how they may overlap.

Note: These roles maybe combined based on operator size and complexity.

P Primary

S Secondary

Table 2: Example of Common Duties Distribution

| | HUMS Authorised Personnel | HUMS Specialist | HUMS Manager |
|--|---------------------------|-----------------|--------------|
| Download Data | P | | |
| First Analysis of HUMS Data | P | | |
| Troubleshoot HUMS System | P | | |
| Troubleshoot Aircraft | P | | |
| Rotor Track and Balance | P | | |
| Return to service | P | | |
| Monitor Downloads | P | | |
| Manage OEM/TCH communication | P | | |
| Record Findings | P | | |
| Support Field Efforts | P | S | |
| Analyse Data | P | S | |
| Suggest Corrective Action | P | S | |
| Manage Close Monitor items | P | S | |
| Interface with HUMS Technical Representative/OEM | P | S | |
| Trending/Fleet Comparisons | S | P | |
| AAD/Web Portals | P | S | |
| Monitor Training/Proficiency | S | P | |
| Assist with Training | S | P | |
| Root Cause Analysis | | P | |
| Procedures | P | | |
| Database Management | P | | |
| Tie-in to other Programs | P | | |
| Reporting | P | | |
| Monitor Staffing Levels | P | | |
| Link to Sr. Management | P | | |
| Participate in Working Groups/Conferences | P | | |

Section 9

Process Descriptions

Download Data

Collection, download, and transfer of HUMS data at intervals specified by company procedure.

First Analysis of HUMS Data

Review of HUMS data at the field level must be performed at each download. At a minimum, the individual performing the review will check for items in alert. These items must be addressed and documented before the next flight, in accordance with the relevant maintenance manuals and company procedures.

Troubleshoot HUM System

The responsibility to troubleshoot and maintain the serviceability of the system.

Troubleshoot Aircraft

The responsibility to initiate maintenance action on the aircraft in relation to indications originating from the analysed HUMS data.

Rotor Track and Balance

The responsibility to monitor and tune Rotor Track and Balance in accordance with OEM limits.

Return to Service

The responsibility to ensure that all maintenance actions are performed and recorded in accordance with approved maintenance data, ensuring serviceability of the aircraft.

Monitor Downloads

Ensure that data from each active aircraft was received, processed, and reviewed in accordance with company procedures.

Manage OEM/TCH Communication

The responsibility to manage and record all OEM/TCH HUMS communication for fault analysis or system faults.

Replies from the OEM/TCH HUMS Support teams will be reviewed and communicated to HUMS authorised personnel at the relevant operating base.

Record Findings

The responsibility to ensure that all maintenance actions carried out to correct the HUMS discrepancy are documented and disseminated to all relevant parties. This will enhance the knowledge database and enable beneficial reporting.

Support Field Efforts

The responsibility to respond to questions or queries regarding line level activities. This may include diagnostics, hardware, software and system functionality.

Analyse Data

In-depth analysis of HUMS data. To include additional Condition Indicator and expanded trend timeframe review, as well as wider fleet/aircraft type comparison.

Suggest Corrective Action

Provide suggested routes of troubleshooting for HUMS authorised personnel to follow.

Manage Close Monitor Items

Assess, assign, track, record and communicate all items in close monitor.

Interface with HUMS Technical Representative and OEM/TCH

At times, it will be necessary to interface with tech reps, OEM/TCH analysts, and engineering staff in order to bring an open HUMS issue to closure.

Trending/Fleet Comparison

Identify differences within a fleet type that may indicate a potential airframe specific defect. These findings may require OEM/TCH involvement, and a broader investigation could be implemented. The outcome may result in a revised inspection frequency, or change in procedure etc.

AAD and Web Portals

Where available, secondary analysis system review should be carried out at intervals specified by company procedure and OEM/TCH recommendations. Analysis should include an in-depth review of secondary analysis system data and comparison with primary ground station systems. It will also be necessary both to ensure that all necessary data flows into the web services provided by the OEM/TCH support groups, and to utilise this information to enhance the diagnostic process and communications.

Monitor Training/Competency

Identify and define training requirements. Coordinate feedback of HUMS authorised personnel competency assessments to ensure continual programme development and fit for purpose.

Section 9

Process Descriptions

Assist with Training

Ensure that courseware and training material is current and accurate. This may include developing class material, training the trainers and having a presence in classes if needed.

Root Cause Analysis

Assist with detailed investigations to discover underlying HUM System and/or aircraft related issues. This can remove the problematic symptoms, thus avoiding future undesirable results. The OEM/TCH or Repair facility should be liaised with where required.

Procedures

Establish, promote, monitor and improve company HUMS procedures. Where possible, this should align with HUMS Best Practice and be consistent across the operators organisation.

Database Management

Ensure that HUMS databases are secure and running efficiently. Ensure that there is a current backup stored in a protected, yet accessible location in the case of computer failure.

Tie-In to other Programs

Share information gained from the HUMs in order to promote continual improvement of operational and maintenance departments within the company.

Reporting

Compiling data that conveys the effectiveness of HUMS systems and company procedures. This information can be shared with management as well as distributed to field base locations as feedback to HUMS authorised personnel and flight crews.

Monitor Staffing Levels

Manage the HUMS Support staffing, to ensure responsibilities are carried out in an efficient manner to provide an acceptable level of assurance that aircraft continue to be airworthy. As well as reviewing and recommending any changes in level, based on workload capacity – this can be affected by fleet size, utilisation and additional responsibilities.



Link to Senior Management

Establish and maintain a process to ensure senior management awareness of; critical findings linked to HUMS, upcoming challenges, new product development & services, as well as HUMS activity and benefits.

Participate in Working Groups/Conferences

Engage with OEM/TCH, operators and other related entities to provide feedback on HUM System improvements and evolutions. This can be through working groups, conferences, and symposiums that bring together subject matter experts for continual improvement of HUMS. These opportunities enable best practice to be shared.

Section 10 Training

The operator should have a system of training that provides HUMS authorised and specialist personnel with suitable instruction. All training should be recorded in the employees' permanent training records.

Section 10

Training should include:

Initial/Familiarisation Training

Based on fleet size and HUMS types, initial/familiarisation training should be given to all line maintenance employees. At a minimum, it should include in-depth HUMS procedures, an overview of systems operated by the company, and general data interpretation instruction.

On-the-Job Training

On-the-job training is used when employees transition to an unfamiliar system and are waiting for a formal course. Training should highlight key points of the process. It must be administered by HUMS authorised personnel who have previously documented training and experience on the system.

Aircraft/System Specific Training (OEM or Equivalent)

When scheduling HUMS training, the OEM/TCH should tailor their HUMS courseware for each group. Courses designed to authorise personnel should focus on the system components, ground station usage, maintenance manual resources, day-to-day upkeep of the system/aircraft, troubleshooting, and basic analysis.

The analyst should be offered a similar version to that of the aircraft technician course, with an added higher-end analytical element and administrative functions.

If an operator specific HUMS training program is established, the analysts and trainers should have attended an OEM/TCH (or equivalent) course. This information should be developed into courseware catered to complement the individual operation.

Consideration should be given to additional training for Avionics Technicians and should include:

- HUMS integration into major aircraft systems; including, but not limited to, digital buses, AFCS, ADC, CVFDR, FMS.
- General maintenance practices; including accelerometer fitment and mounting, cable termination, downloadable media and hardware issues.



Recurrent/Continuation Training

This should occur every two years (minimum), and include, but not be limited to:

- HUMS procedures
- System changes
- Fleet additions
- Software updates
- HUMS case histories
- Known occurrences and issues.
- Advanced interpretation instruction

This may align with other recurrent/continuation training.

Through effective training, you provide your employees with the tools and information they need to deliver their work, safely and efficiently.

Section 11 Management Oversight

Effective HUMS programs have appropriate levels of accountability for the HUMS processes and procedures.



Section 11

Management Oversight



Corporate Oversight

The operator should have a process in place to bring HUMS Program key performance indicators (KPI) to the attention of Senior Management, regularly. KPIs should include, but not be limited to: successful data acquisition rates, current indicator trends, HUMS-initiated pro-active maintenance actions, top obstacles to achieving program objectives. Utilising the information provided, an appropriate action plan should be developed. This plan may include internal and external actions.

Departmental Oversight

The operator should have a HUMS program representative whose responsibilities include the oversight of the process of collection and analysis of HUMS data and any subsequent maintenance actions.

Line Level Oversight

The operator should have an appropriate organisational structure in place to ensure the HUMS data collection, analysis, and maintenance actions required at the HUMS authorised personnel level are carried out effectively.

Section 12 Quality Assurance

Having implemented best practice, an effective quality assurance plan is essential to test the resilience of the HUMS process and to ensure HUMS delivers the greatest safety benefit to your organisation.

Section 12

Quality Assurance

Audit Plan

The operator should have an audit plan that will be implemented by the Quality Assurance team. This may form part of the Safety Management System.

A combined annual HUMS audit of HUMS Department and a sample operating base should be carried out. The annual maintenance audit at each operating base should also include a HUMS element.

Auditing of the OEM/TCH supplier should be carried out in line with operators existing supplier audit plan, consideration should be given to the requirements of the HUMS support contract (if applicable).

The operator may also be subject to audits by Regulatory bodies, Customers and aircraft lessors.

Internal Auditor training should at least include; a basic overview & process of HUMS for that System. Knowledge of regulatory requirements and company procedures.

The below items give guidance for specific areas which should be audited as part of the operators internal audit plan.

Appendix 2 contains a suggested audit plan to cover all aspects of HUMS operation.

Documentation

This audit area should cover all HUMS related documentation including company policies and procedures and OEM/TCH data.

Training

This should cover training requirements and records of both HUMS support staff and certifying staff involved in HUMS activity for both initial and recurrent training.

Support Staff

This should cover the communication, support capability and resources available to support HUMS operation. Attention should also be paid to the level of liaison between HUMS authorised personnel and other HUMS support staff and OEM/TCH engagement.



Data Analysis, Investigation and Communication

This should cover all areas of data analysis, any investigation carried and the communication protocol when defects are found and maintenance actions are required.

Close Monitor

Review of close monitor policy and procedures and evidence of activity.

GSS & Data Management

This section covers review of software and data management and system for backing up and recovering data.

Control Service Introduction, HUMS Review and System Improvement

This section covers control of new systems and how performance is monitored and communicated for system improvement.

Appendices



Appendices

Appendix 1

Download Policy Matrix Example

| Aircraft type | Aircraft type A | Aircraft type B | Aircraft type C |
|--|-----------------|---|-----------------|
| Download periodicity – Normal monitoring | | Every return to MOB not exceeding 15FH's. | |
| Download periodicity on close monitor | | Every return to MOB | |
| Rotors running download capacity | No | YES | No |
| Is a HUMS maintenance check flight required when no HUMS data has been collected any time during a 10FH period, when not on close monitor? | No | No | No |
| Is a HUMS maintenance check flight required when no HUMS data has been collected on a component under close monitoring, any time during a 10FH period? | Yes | Yes | Yes |
| Is a HUMS maintenance check flight required if no data has been collected on any component during a period greater than 10FH? | Yes | Yes | Yes |
| HUM System to be serviceable for CAT | Yes | Yes | Yes |
| HUM System to be serviceable for non-CAT | No | No | No |
| HUMS component transposition for fault finding | No | No | No |

Appendices

Appendix 2

This guide is a suggested approach to auditing a HUMs operator to ensure best operating practices are being applied.

Note: A combined annual HUMS audit of HUMS Department and a sample operating base should be carried out. In addition the annual maintenance audit at each operating base should also include a HUMS element.

Helioffshore HUMS Audit Guide

| GSS & Data Management | Comments | Finding Level |
|--|----------|---------------|
| Is data accessible to certifying staff? (Check ground station location). | | |
| Is there a method to verify what the latest revision available is? (Check records). | | |
| Does each ground station have the latest software? (Check ground station). | | |
| Does each aircraft have its own ground station when deployed temporarily away from base? (Check records/ground station used on recent deployment). | | |
| Is all aircraft data kept in a fleet central repository that is accessible to the HUMS Support team? (Check sample aircraft data). | | |
| Is data from remotely located aircraft transferred daily to a fleet central repository? (Check sample aircraft data). | | |
| Are there backups of the HUMS data? (Check records). | | |
| Download & Primary Analysis | | |
| Is there a HUMS manual (or equivalent) with appropriate documented policies and procedures? (Reference the manual). | | |
| Are all HUMs equipped aircraft being monitored? (Check sample aircraft data). | | |
| Is the data download and review being carried out at the periodicity required in the operator's procedures? (Check sample aircraft data). | | |
| Is the OEM/TCH contacted as required? (Check records). | | |
| Is OEM/TCH maintenance data for the HUMS available and used? (Check accessibility of manuals) | | |

Appendices

Appendix 2

Helioffshore HUMS Audit Guide *continued*

| Download & Primary Analysis <i>continued</i> | Comments | Finding Level |
|--|-----------------|----------------------|
| Is HUMS data assessed alongside other data, such as magnetic chip/particle detectors/oil debris? (Check maintenance records). | | |
| Is there an appropriate close monitoring policy in place? (Check manual). | | |
| Are close monitor items recorded and ultimately cleared? (Check records). | | |
| Are requests/instructions for continuing airworthiness, appropriately conducted and recorded? (Check maintenance records). | | |
| Are findings and work carried out recorded? (Check maintenance records). | | |
| Is an appropriate procedure followed when 'no HUMS data' is recorded? (Check records). | | |
| Communication | | |
| Is there adequate liaison between the HUMS support staff, management, line maintenance, OEM/TCH and the CAMO on HUMS? (Check records/discuss). | | |
| Is there an auditable trail of communication between the operating base, the HUMS support staff and the OEM? (Check records). | | |
| Are suspected software bugs being tracked and reported? (Check records). | | |
| AAD and Web Portals | | |
| Are any supplemental software tools utilised as required by OEM/TCH and/or company policy? (Check records). | | |

Appendices

Appendix 2

Helioffshore HUMS Audit Guide *continued*

| System Performance Reporting | Comments | Finding Level |
|---|----------|---------------|
| Is HUM System performance reviewed routinely? (Check records/discuss). | | |
| Is HUMS reliability examined within reliability reviews etc? (Check records). | | |
| Are strip reports requested when necessary, received and reviewed? (Check records). | | |
| Are improvements being made to the HUMS process? (Check records/discuss). | | |
| Responsibilities | | |
| Are the duties of the HUMS support staff and certifying staff clearly defined in relation to HUMS? (Check manual). | | |
| Is there an appropriate reporting line for the HUMS support staff? (Check organogram). | | |
| Are all aspects of HUMS support appropriately covered (mechanical diagnosis, HUMS avionics, ground stations)? (Validate personnel capability). | | |
| Is the HUMS support staff sufficient for the fleet monitored? (Check resources vs. fleet/discuss). | | |
| Is the organisation actively involved in HUMS Operator Conferences/Meetings? (Check records). | | |

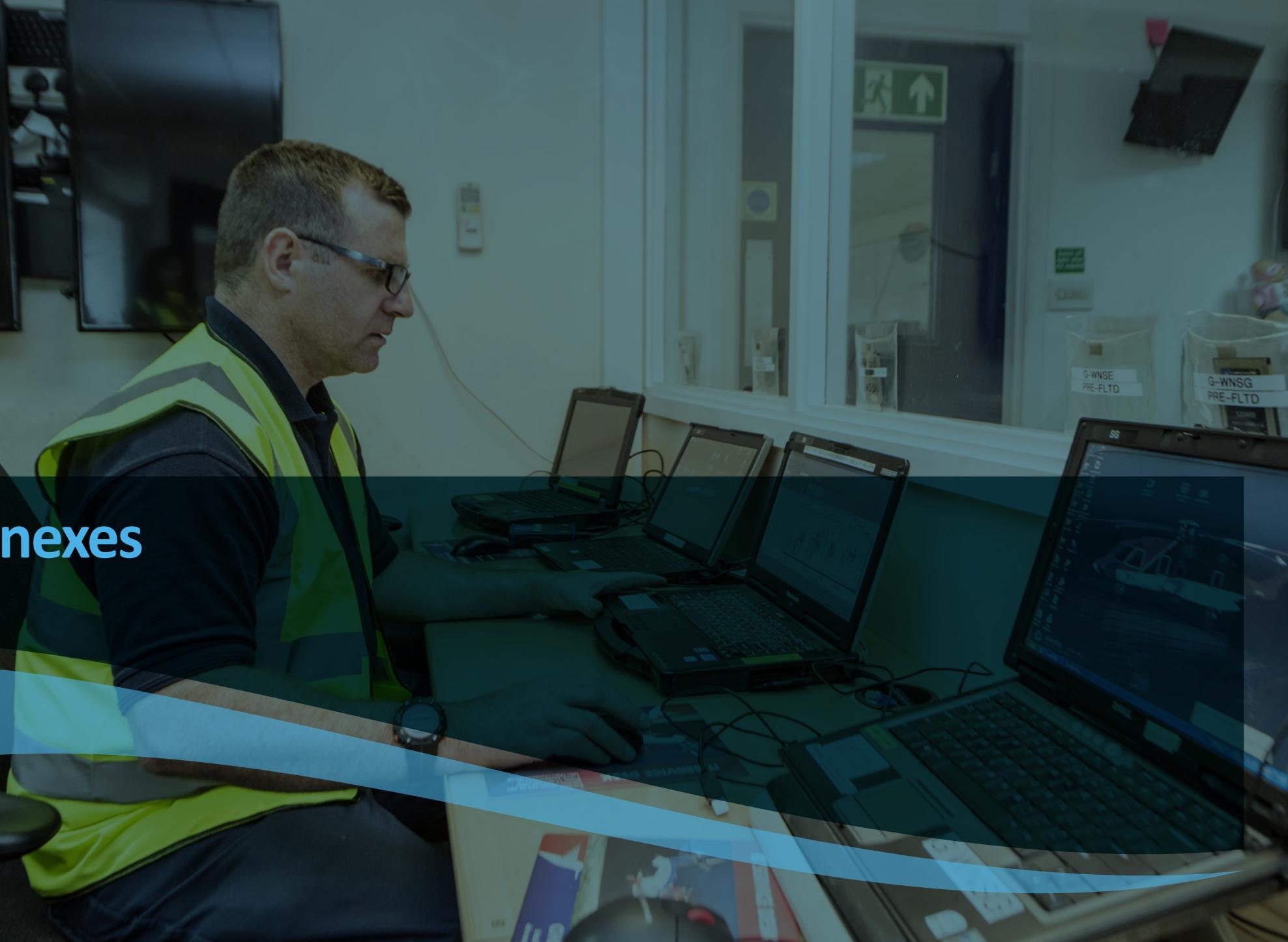
Appendices

Appendix 2

Helioffshore HUMS Audit Guide *continued*

| Training | Comments | Finding Level |
|--|-----------------|----------------------|
| Do the HUMS support staff and certifying staff have the necessary HUMS training? (Check training records). | | |
| Are HUMS related issues fed back into training material for HUMS authorised personnel? (Check course material). | | |
| Are HUMS support staff receiving regular recurrent training/ development training? (Check training records/discuss). | | |
| Management Oversight | | |
| Control Service Introduction (CSI), HUMS Review and System Improvement | | |
| If the system is undergoing a CSI, is the organisation actively involved? (Check records/discuss). | | |

Annexes



Annexes

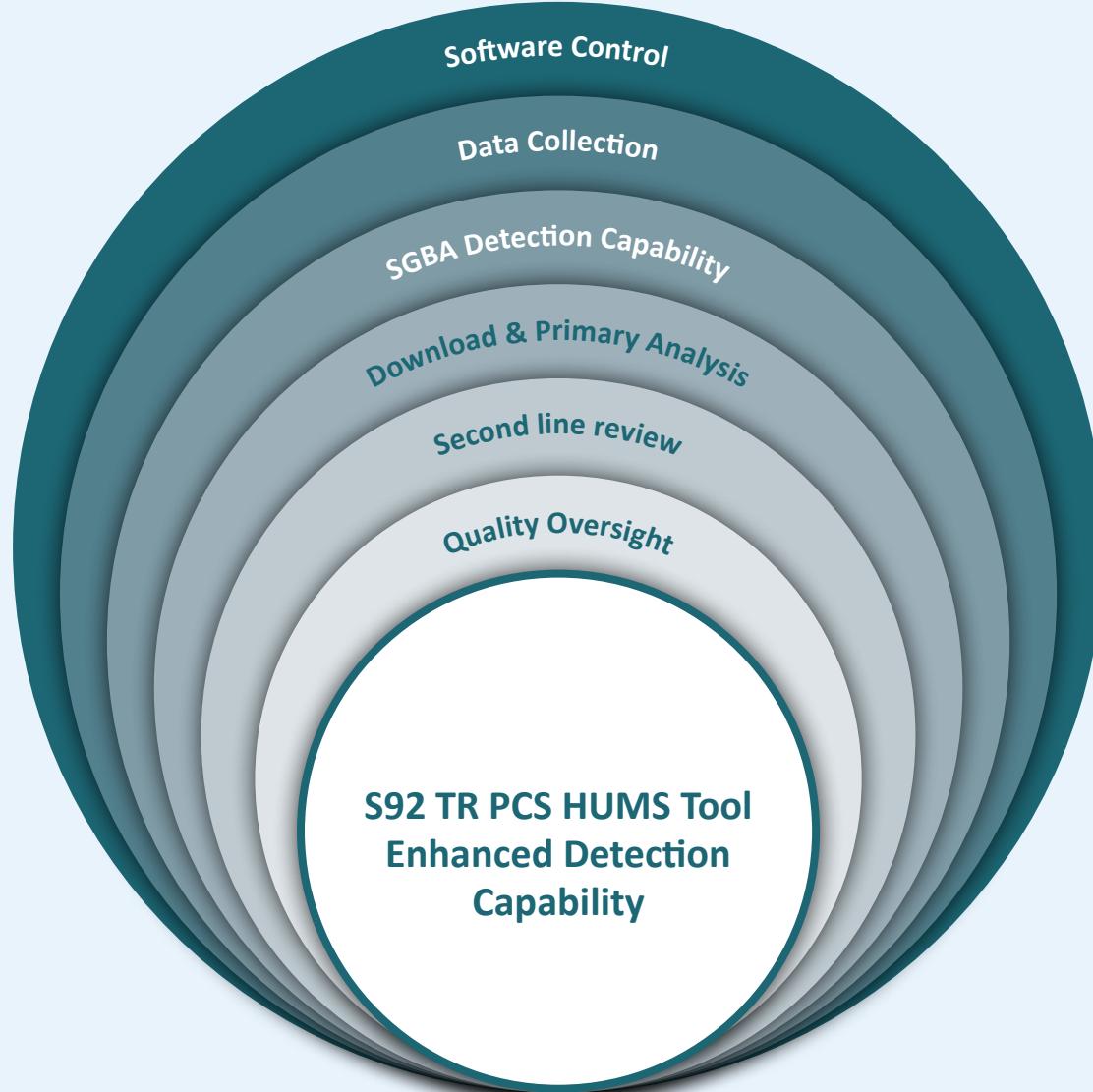
Annex 1

This document is a type-specific appendix to HeliOffshore's Global Health and Usage Monitoring Systems (HUMS) Best Practice Guidance.

It contains best practice that will enable operators to manage the SGBA Tail Gearbox Bearing Energy Analysis Tool related tasks for the Tail Rotor Pitch Change Shaft (TR PCS) Bearing.

S92 Tail Rotor Pitch Change Shaft

TR PCS Safety Barriers in place



Annexes

Annex 1

S92 Tail Rotor Pitch Change Shaft *continued*

Annexes

Software control

- Use the latest SGBA TGB Bearing Energy Analysis Tool as the primary HUMS software for monitoring the TR pitch change shaft.
- Operators should have a system in place to get the latest version of the HUMS software.
- The operator should have a management of change process in place to issue the software version promptly. This would include formal communication and where required training to all certifying staff to be aware of the changes.

Data Collection

Under normal circumstances the automatic data capture rate is every 8 minutes when the aircraft is operating at level attitude, over 60 KIAS and engine 1 and 2 torque is greater than 45%.

New installation

- The aircraft is clear for initial 'X' flight hours of operation. The operator shall attempt to collect as many data points on the "Tail Trans" option within the MFD, utilizing a combination of automatic and Forced HUMS data captures.

However, consideration should be made to ensure data collection across the other components is not compromised.

- If the required number of data points (nominally 115) has not been captured within the initial 'X' hours of operation, Sikorsky should be contacted.

Post Alert

- Ensure compliance with the Sikorsky AMM.
- When adjusting the 'Reset Alert Date' ensure the date and time set is at a point immediately after the last red acquisition.
- If the last data point is red then the tool will show insufficient data in the 'Result' box. The subsequent flight should provide the required one data point for sufficient data, assuming the correct flight regime profile is met.

'X' – As aligned with Sikorsky's approved maintenance data

SGBA Detection Capability

The latest SGBA algorithm is more sensitive. It targets vibration characteristics that are unique to the Pitch Change Shaft bearing and uses these to provide advanced warning.

Download & Primary Analysis

As per HeliOffshore HUMS Best Practice Guidance, HUMS download and analysis should continue to be conducted at every return to the main operating base.

- For this particular situation, where the SGBA Tool is being used with sufficient data, the TGB Bearing Energy Analysis Tool should be reviewed as if a close monitored item Type 'A'.
- The maximum flight hour interval shall not exceed that detailed within the Sikorsky AMM.
- Verify the sensor is passing the sensor data quality check within Mechanical Diagnostics/Accelerometers/ Tail Gearbox Bearing and no TGB sensor failures indicated on the BIT type report under Reports section'.

- Verify the time and date of the last acquisition from the latest flight and certify the status is satisfactory. This information should be kept with the aircraft records.

- The aircraft must not be dispatched for CAT flight if the time since last acquisition, or combination of the time since last accusation and the next flight exceeds the maximum flight hour interval as detailed within the Sikorsky AMM.

- If the tool has triggered a 'Recommended inspection' result, action as per Sikorsky AMM immediately.

- 'Reset Alert Date' – refer to 'Data collection > Post alert' on the left.

- 'Maintenance Date' reset should not be carried out unless directed by Sikorsky.

Second line Review

- TGB Bearing Energy Analysis should be included as a part of the daily second line HUMS analysis defined in the HeliOffshore HUMS Best Practice Guidance.
- If there has been a 'Reset Alert Date' action carried out since the last second line review, verify approved maintenance data has been used. Where applicable, ensure the 'Reset Alert Date' is set to a point immediately after the last red acquisition.

Quality oversight

This process should be included as a part of the normal audit programme.

Annexes

Annex 2

The Ideal HUM System is an annex to HeliOffshore's HUMS Best Practice Guidelines. Developed by a sub-group of the HUMS working group, it is a summary of features the group considered to be useful in a HUM system, as well as other features that it felt should be eliminated or modified because they are unnecessary or burdensome to users.

The first three sections of the report describe features that the group felt should be included in modern HUM systems. The fourth section of the report turned its attention to ideas for developing a future HUM system, without what the group called, "the constraints of current terminology, architecture or technology."

The Ideal HUM System

1. Preliminary Requirements

1.1. Aircraft Maintenance Manual

- 1.1.1. Must clearly describe theory of operation, data flow, and architecture of the system.
- 1.1.2. Must clearly describe what tasks are recommended by the OEM to the user at each download in order to properly utilize HUMS. Also, if any part of the HUMS is recommended by the OEM to be utilized at specific intervals, this must also be defined.
- 1.1.3. Must clearly define Onboard System maintenance, troubleshooting, error definitions, sensor locations, and contain wiring diagrams and parts catalogs.

1.2. OEM HUMS Manual

- 1.2.1. Must clearly define each HI/CI.
- 1.2.2. Must clearly define hardware requirements for the HGS.
- 1.2.3. Must clearly define when to put in 'Close Monitor'.
- 1.2.4. Must clearly define when to contact the OEM.
- 1.2.5. Must clearly define how to evaluate all possible alerts that can be generated by HUMS, and provide instructions for corrective action.

1.3. Training

- 1.3.1. OEM must have a HUMS training class available, which will be credited to the operator with the purchase of the HUM System.

- 1.3.2. OEM Must have a detailed Training Manual for HUMS, and distribute to each class.
- 1.3.3. OEM Training Course must reference the maintenance manual instructions.

- 1.3.4. Instructors must be well qualified to teach the course.
- 1.3.5. 'Train the Trainer' must be offered by the OEM (onsite or offsite) so that operators may conduct effective internal training.
- 1.3.6. Classes must be tailored to –
1) Aircraft Technician 2) Analyst.

1.4. Support

- 1.4.1. On-site HUMS support must be available for initial launch of a new system at a new operation.
- 1.4.2. There must be a HUMS Hotline and support group with sufficient resources to cover global time zones 24/7, 365.

2. HUMS Onboard System

2.1. Components

- 2.1.1. Accelerometers, tachometers, LRU's, tracking devices, connectors, and cabling must be robust and proven to be reliable.
- 2.1.2. Main Processor – Software loading is efficient and straightforward.
- 2.1.3. The software should be capable of supporting maintenance credits.

2.2. Data Acquisition

- 2.2.1. The time required to collect a full HUMS dataset should not exceed 15 minutes total, and ideally be less.

- 2.2.2. The HUMS recording should start from where it left off, instead of starting from the beginning each time it falls out of the recording regime. The idea is that even with short flights, we will get a full dataset without needing dedicated HUMS flights.
- 2.2.3. The system should have an 'Event' button, which would override the current acquisition and record a general vibration scan.

2.3. Onboard Processing

- 2.3.1. The total time required to complete the process of retrieving the data from the aircraft and loading into the HGS should not exceed 5 – 7 minutes total (full view) for a 'daily' download.

- 2.3.2. Provide a 'Quick Look' function for 'between flight' downloads, where the total time required to retrieve data from the aircraft and view alerts does not exceed 2 minutes for a standard flight segment.

- 2.3.3. The onboard system must have the capacity to store a minimum of 25fh of retrievable data which may span multiple flight sessions. This data must then be accessible through a data bus via various methods of interface (USB, Wi-Fi, Ethernet, etc.), which must be upgradable with the evolution of technology.

- 2.3.4. The file size of a standard 'daily' download must be manageable for data transfer and storage.

Annexes

Annex 2

The Ideal HUM System *continued*

2.4. Rotor Track and Balance

- 2.4.1. Must be able to accurately measure RTB readings.
- 2.4.2. Ability to view current RTB levels onboard is preferred.
- 2.4.3. Track Data must be automatically captured when RTB acquisitions are collected (if fitted).
- 2.4.4. Manual and Automatic acquisition modes must both be available.

2.5. Desired Functions

- 2.5.1. Must be designed to capture any OEM required vibe checks without installing additional equipment onto the aircraft.

3. HUMS Ground Station

In recent years, there has been competition in HUMS development that has resulted in diversity in functionality as well as in architecture. Some of the more common setups are mentioned below.

3.1. Architecture

- 3.1.1. OEM Hosted Web Service.
 - 3.1.1.1. Must have 'real-time' download and review capabilities, with no delay to the process.
 - 3.1.1.2. Must have robust speed, connectivity, and accessibility so that an average internet connection is sufficient in order to fully utilize the service.
 - 3.1.1.3. Must have a backup system in place so that operations are not compromised in case of an outage or complication.
- 3.1.4.1. Data privacy must be well defined, and sharing would only be allowed with the express written consent of the operator.
- 3.1.2. Web-Based.
 - 3.1.2.1. Each HUM System should offer a software option so that the HUMS Ground Station can be accessed from a basic internet connection. If no Hosted web service is available, the operator must have an option to integrate HUMS into their individual networks and I.T. infrastructure.
- 3.1.3. Hybrid.
 - 3.1.3.1. A hybrid system may have a local installation of the HGS software, but have the ability to connect to both a local database and a networked database. In cases of hybrid systems, they should be able to push any new local data to the networked database once an internet connection is established.
- 3.1.4. Local Installation.
 - 3.1.4.1. There must be an option for local or hybrid installations of the HGS in cases of operating in remote locations. Local installations of the HGS must have the capability to export and import files. This will enable the operator to provide data for support, and also maintain a central database if so desired.

3.2. Security

- 3.2.1. HGS performs antivirus scanning of removable storage devices.
- 3.2.2. Password protected individual user login with configurable permissions.

3.3. Database

- 3.3.1. Robust database capable of storing several months of data for multiple aircraft.
- 3.3.2. User Configurable purge function that could archive Parametric data, but keep CI data for substantial trending capabilities.

3.4. Additional Software

- 3.4.1. HUMS related software outside of the main HGS that is needed to fully monitor an aircraft will be avoided whenever possible. Instead, any additional functionality that is needed must be incorporated into the main HGS.

3.5. Thresholds

- 3.5.1. An initial threshold set must be provided with each system that will cover any OEM limits, as well as items described in CAP 753. CSI Periods should last no more than one year, with threshold refinement occurring at least by the end of this period provided that at least 5 aircraft with 200fh each is collected.
- 3.5.2. Thereafter, threshold reviews should occur at least every 2 years.

Annexes

Annex 2

The Ideal HUM System *continued*

| | | |
|--|--|---|
| <p>3.5.3. OEM's must be receptive to reports from operators that detail HUMS monitored component removals in order to support threshold optimization efforts.</p> <p>3.5.4. Learned thresholds (with a fixed min/max).</p> <p>3.5.5. Individually adjustable OEM thresholds (with proper authorization).</p> <p>3.5.6. Ability to set internal advisory thresholds that are below OEM levels.</p> <p>3.6. Alarms</p> <p>3.6.1. Multi-level alarms.</p> <p>3.6.2. Standard color coding for each alert severity level (Level 0 'normal' Green, Level 1 'advisory' Blue (optional), Level 2 'caution' Amber, Level 3 'warning' Red).</p> <p>3.6.3. Within an HI indication, the OEM must provide the ability to drill down further into the data. Individual CI's must be accessible, defined, and available for analysis in order to identify and isolate a fault at the subcomponent level.</p> <p>3.6.4. The HGS must provide a 'No Data' type of warning when data has not been collected from a particular sensor or component for a set amount of time. This alarm must also be configurable by the Operator to suit their individual time preference (or as standards change).</p> <p>3.6.5. Reliable Trend Detection should be incorporated into each HUMS Ground Station (with or without a registered alert).</p> | <p>3.7. Rotor Track and Balance</p> <p>3.7.1. Must provide solutions that resolve RTB levels to within acceptable OEM limits, and be accomplished in a reasonable number of runs.</p> <p>3.7.2. Should offer a function for RTB adjustments between flights. This feature would be limited to small adjustments so as to not require a dedicated maintenance flight.</p> <p>3.7.3. Must store weight/link/tab settings and consider OEM limits when giving solutions.</p> <p>3.7.4. Must store weight/link/tab adjustments made between each operation so that settings can be viewed flight by flight.</p> <p>3.7.5. Must display predicted vibe levels of the suggested solution before it is applied.</p> <p>3.7.6. Must be able to view harmonics of the Rotor Systems (1per, 2per, etc.).</p> <p>3.7.7. Must have the ability to trend RTB data over time with a view of the threshold limit ceiling.</p> <p>3.8. Desired Functions</p> <p>3.8.1. Fleet status screen that applies one of the four different alert status colors to each tail number for quick identification of suspect aircraft.</p> <p>3.8.2. Single page aircraft status screen that clearly identifies all 'over limit' conditions for the selected aircraft.</p> <p>3.8.3. Maintenance Manual References visible in HGS with each exceedance.</p> <p>3.8.4. Should include some FDM parameters for associating alerts with flight parameters.</p> | <p>3.8.5. HGS must provide a means to quantify the number of alarms at each level, for each component, and allow for reporting.</p> <p>3.8.6. Ability to enter Maintenance Overlay notes, visible both in date/time and flight hours.</p> <p>3.8.7. Zero tolerance for obsolete operating systems. HGS must be upgraded to current OS by the OEM before older systems become unsupported.</p> <p>3.8.8. Fleet Trend Comparison capability for all components and RTB.</p> <p>3.8.9. Data must be available to analyze in both the Time and Frequency domains.</p> |
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4. Next Generation items to develop

4.1. Onboard System

- 4.1.1. Single point download location for both HUMS and FDM data. The location available to extract both HUMS and FDM is the requested change, they should remain as two separate files.
- 4.1.2. Crash protected HUMS data stream.
- 4.1.3. The HUMS data recording schedule should be 'selectable' as to prioritize the order of the data captured on a particular component. This would allow for a quick data collection on any component during a flight, no matter its order in the default recording sequence.
- 4.1.4. The HUM System will identify items in Close Monitor and items that have not collected data the longest, and prioritize them in the recording schedule.

Annexes

Annex 2

The Ideal HUM System *continued*

4.2. Ground Station

- 4.2.1. Hyperlinks to maintenance documentation directly from the HGS.
- 4.2.2. Create a 'Dashboard' function that is customizable by the operator.
- 4.2.3. De-identified 'Global Fleet' trending capability for all components and RTB.
- 4.2.4. A function that allows the user to view all CI's, and how long it has been since data was collected for each of them.

4.3. Rotor Track and Balance

- 4.3.1. If recommended RTB solutions are applied and readings stray far from what was predicted, the system should detect this and suggest a maintenance action.
- 4.3.2. The ability to offer solutions that remove weight from an already weighted blade instead of adding weight to the opposite blade.
- 4.3.3. An overlay of blades displayed on the Ground Station Polar Charts with blade #1 at 12 O'clock. This would provide a visual reference where adjustments need to be applied in relation to the actual blade position.

4.4. Data

- 4.4.1. Develop a system by which all recorded HUMS alerts (to include Onboard system events) can be exported from any OEM's HGS, into a common format (preferably Excel compatible) to support reporting and KPI initiatives.

4.5. Maintenance Data Exchange

- 4.5.1. Develop a Maintenance Data Exchange so that OEM's, Operators, and Repair facilities can better identify component replacements, and thereby associate teardown reports with HUMS data in an effort to continually monitor the effectiveness of current threshold settings.

Annexes

Annex 3

This annex to HeliOffshore's HUMS Best Practice Guidelines provides a framework of key performance indicators (KPIs) to assess the effectiveness of in-service Health and Usage Monitoring Systems.

The document, which has been developed by a sub-group of HeliOffshore's HUMS working group, gives operators a proposed framework for assessing the performance of systems. The list of 16 KPIs includes different levels of alert and alarm, as well as false alarms, close monitoring initiated events, failures, diagnostic and support system requests, and HUMS deferred defects.

The HUMS KPI document is intended to lay the groundwork for operators to be able to share and benchmark HUMS data.

HUMS Key Performance Indicators

| Number | KPIs | Denominator |
|--------|---|-----------------------|
| 1 | Red Alerts | Flying Hours |
| 2 | Red Alarms | Flying Hours |
| 3 | False Red Alarms | Flying Hours |
| 4 | Amber Alerts | Flying Hours |
| 5 | Amber Alarms | Flying Hours |
| 6 | False Amber Alarms | Flying Hours |
| 7 | Close Monitoring Initiated (Total) | Flying Hours |
| 8 | Close Monitoring Initiated (Type A) | Flying Hours |
| 9 | Close Monitoring Initiated (Type B) | Flying Hours |
| 10 | Close Monitoring Initiated (Type C) | Flying Hours |
| 11 | Diagnostic & Support System Requests Raised | Flying Hours |
| 12 | HUMS LRU Failures | Flying Hours |
| 13 | Sensor / Cable / Connector Failures | Flying Hours |
| 14 | Unscheduled Changes of Monitored Mechanical Components with HUMS Indication | Flying Hours |
| 15 | HUMS Deferred Defects | Flying Hours |
| 16 | Download Capture Rate | Percentage of flights |

Notes Alerts and Alarms based on EASA CS-29.1465 terminology

“Alerts” require analysis only

“Alarms” require on-aircraft maintenance action (excluding sensors - TBA)

“Red” & “Amber” = Upper and lower/medium thresholds (tbd for each HUMS)

Track recurring Alarm / Alert as a single occurrence.

“Aircraft component changes due to HUMS”: multiple component changes at one time = 1 component change

Automation of data gathering and the ability to export in a common format would be of use.

HUMS specialists are encouraged to participate in our online, secure collaboration tool: HeliOffshore Space.

You can find out more about HeliOffshore, our safety plan, and the workstreams at www.helioffshore.org

This guidance will be updated regularly. If you have comments or suggested amendments, please email: info@helioffshore.org



HeliOffshore

Safety Through Collaboration