

Goodrich Sensors and Integrated Systems Health and Usage Management Systems



MH-60R/S



CH-47D



CH-53E



EC145



LUH



AH-1Z



S-76D



S-92



UH-60

right attitude / right approach / right alongside
www.goodrich.com

GOODRICH

Health and Usage Management Systems

Proven, reliable condition-based maintenance solutions for military and commercial rotorcraft



Ready - Set - Go Fly

Whether you are a military or a commercial helicopter operator, dispatch reliability and successful completion of flight missions are critical metrics. The Goodrich Health and Usage Management System (HUMS) automatically monitors hundreds of aircraft signals and through synthesis and analysis of the data, tracks the usage and health of the aircraft and its major assemblies. With Goodrich HUMS on board, aircraft readiness is boosted, flight safety is enhanced and maintenance costs are lowered.

Early indication of potential problems means operators can plan appropriate actions to correct the issue during the next major maintenance interval or to immediately make a fix before the situation escalates into a damaged component. With insight into the total health of the helicopter, operators greatly reduce the surprise problems that cause flight delays, cancellations or early terminations.

Lower Fleet Operating Costs with Goodrich HUMS

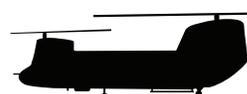
Unlike preventative maintenance which relies on time-based upkeep, Goodrich HUMS enable condition-based maintenance practices by giving flight crews and ground personnel advance notice before components break to avoid vehicle downtime and greatly reduce maintenance costs.



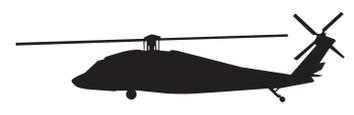
UH-60



EC145



CH-47



MH-60

Armed with a complete view into the health of the helicopter drivetrain and other components — by vehicle or entire fleet — operators are empowered with these best practices to make informed maintenance-related decisions:

- **Early detection of incipient flaws.**

The system provides insight into small problems that developed on the last flight or immediately after maintenance. Early detection of imbalances, faulty installation, gear and bearing deterioration or other conditions allows operators to quickly address easily fixed problems before they grow or cause collateral damage to the aircraft.

- **Reduction of test flights.**

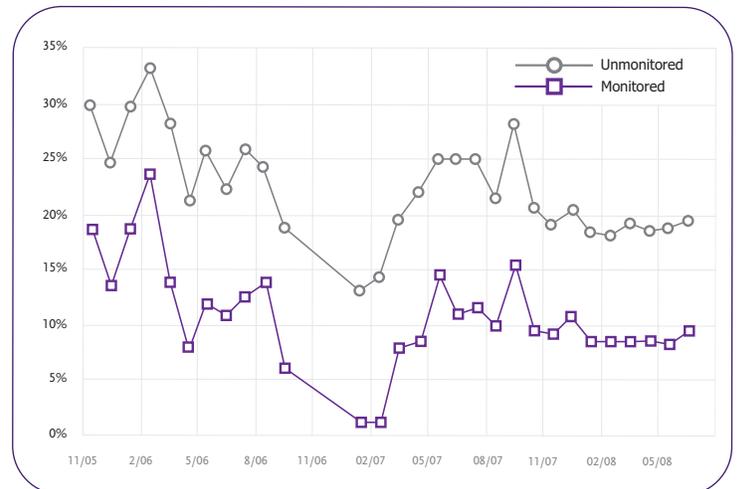
By automating inspections and data collection on every flight, pinpointing the root cause of problems and identifying issues immediately after maintenance, the system greatly reduces the number of ground turns or other maintenance-related test flights, rendering significant savings through lower use of fuel, engine and aircraft cycles as well as man hours.

Maintenance Reductions

* U.S. Army Deployed Blackhawk UH-60 with Goodrich HUMS

Unscheduled MMH/FH	-52%
Mission Aborts MMH/FH	-48%
Total MMH/FH	-17%
Actual UH-60 Data	

UH-60L ACFT deployed—NMCM rates



The U.S. Army recognized a reduction in Non-Mission Capability Maintenance rates of 10% for aircraft deployed into combat operations.



Cracked Spline Adapter



Debonded Tail Rotor Boot Cuff



Sand build up in Oil Cooler

- **Reduction of inspections and increased part life cycles on aircraft.** By monitoring hundreds of signals, the system performs automatic electronic examinations to eliminate the need for many maintenance inspections.
- **Faster troubleshooting.** Interactive, intuitive interfaces give the ability to conduct real-time on-aircraft troubleshooting or drill down into data sets at the ground station. Strip-chart parameter tools isolate the root cause of problems, minimizing troubleshooting time and greatly reduce no-fault-found component removals.

Superior System Functionality for Improved Flight Performance

The Goodrich HUMS on-board system constantly monitors component health from tip to tail by tapping into hundreds of aircraft flight-control signals and

specialized accelerometers distributed throughout the aircraft. By synthesizing performance information including speed, torque, temperature and pressure data as well as comprehensive vibration and rotor track and balance data, the system executes real-time diagnostics without pilot involvement. The system provides “go” or “no-go” status on the flight deck display or more detailed health assessments and recommended maintenance actions on the ground station.

In addition to automatic data recording, the system provides:

- Aircraft flight manual limit and exceedance monitoring
- Aircraft and engine usage hours and cycles
- Engine performance monitoring
- Traditional gearbox and drivetrain monitoring as well as advanced diagnostics
- Regime recognition

Better Data for Enhanced Mission Readiness

With Goodrich HUMS on board, confidence in vehicle health and usage management data equates to mission readiness:

- Unique Goodrich technology synthesizes data from many sensors to detect incipient flaws, even those that develop months ahead of a potential failure. Our advanced diagnostic algorithms have less than 10^{-6} probability of false alarm
- Comprehensive signal integrity and built-in test checks ensure the highest standard of diagnostics in the industry

Integrated Solutions Backed by Goodrich Support

Goodrich solutions are backed by our outstanding Global Maintenance, Repair and Overhaul (MRO) support and Goodrich 24-7 Aircraft on Ground (AOG) service provided by our worldwide Field Technical Support Team.

In addition, service options for HUMS customers include:

- Comprehensive engineering services, including system installation and integration with other aircraft systems
- Ongoing support services include training, product performance tracking, periodic best practices training, ground station upgrades, user conferences and telephone support with expert users

Comprehensive Ground Station Functionality for Improved Lifecycle Management

All flight data and calculations performed by the Goodrich HUMS on-board system are transferred to the Windows-based ground station via various means depending upon the aircraft. The solution integrates current and historical flight data into a comprehensive database with full reporting capabilities for use by maintenance crews as well as logistics, operations and engineering personnel.

In the first one-year deployment of 38 aircraft equipped with Goodrich HUMS in an Army battalion, the battalion executed 27% more missions than a non-equipped sister battalion with the same mission profile. The HUMS-equipped battalion set a new Army record for the most missions accomplished in a one-year period, never missing or aborting a mission due to mechanical problems.

“I never have to schedule a backup aircraft for our planned S-92 flights.”

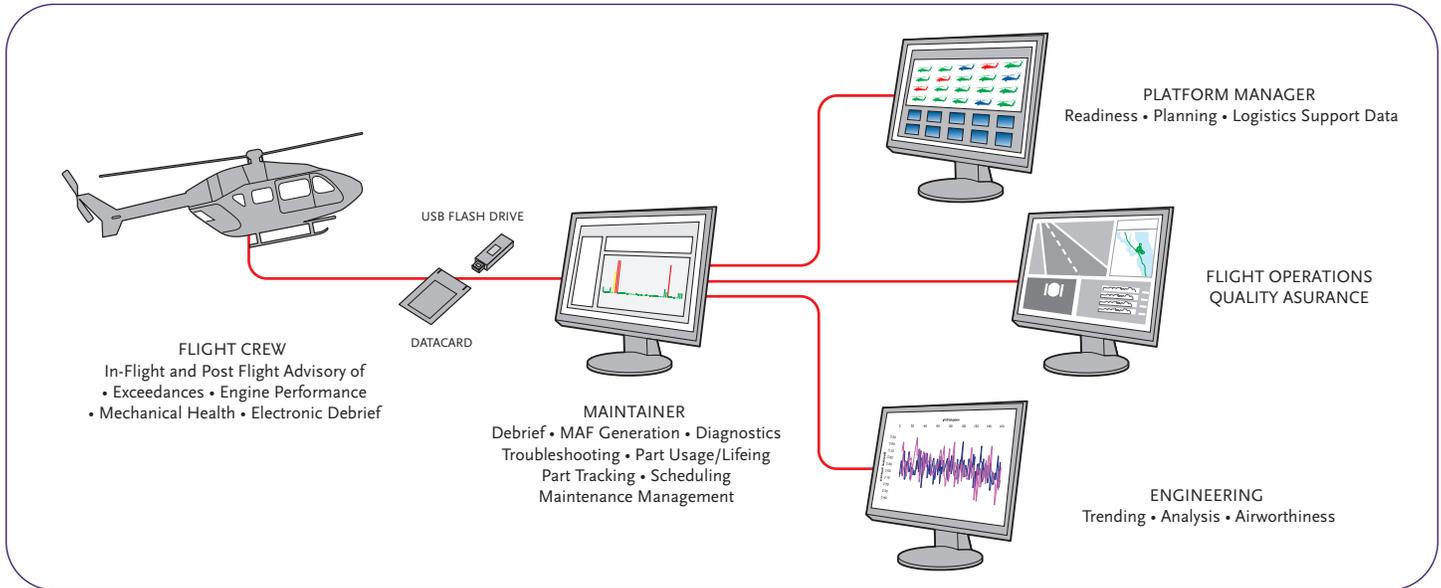
Commercial Operations Manager



V-22



S-60



The ground station facilitates day-to-day maintenance, logistics and planning with an array of functions including:

- Strip-chart analysis
- Component usage tracking as determined by cycles, flight time or other parameters
- Diagnose gear, bearing and shaft assembly and wear features requiring maintenance
- Generate rotor smoothing instructions for maintenance
- Vibration acquisition review
- Data files that can be read by Flight Operation Quality Assurance (FOQA) and Military Flight Operations Quality Assurance (MFOQA) aftermarket flight operations software

In addition, Goodrich HUMS is offered with a database interface to your preferred Maintenance Management Information System (MMIS) which automatically provides flight information, operational usage metrics and maintenance suggestions to the MMIS during the data download.

Proven Leader in Health and Usage Management Systems

With more than 50 years of aerospace experience, Goodrich Sensors and Integrated Systems is a premier provider of dependable and flexible Health and Usage Management Systems (HUMS). Goodrich offers a family of HUMS spanning the full spectrum of rotary and fixed-wing aircraft.

Legacy HUMS Solutions

Goodrich Integrated Mechanical Diagnostics – Health and Usage Management System (IMD-HUMS) provides full-system functionality for heavy-lift aircraft including the H-53E, AH-1Z and UH-1Y platforms. The Vibrational Structural Life and Engine Diagnostics solution is a hardware box developed for the V-22 aircraft, utilizing Bell Helicopter diagnostic algorithms.

HUMS

Provides all the capabilities of the IMD-HUMS but with added functionality including integrated crash-survivable cockpit voice and flight-data recording with a location beacon that is fully compliant with ED-112 standards.

HUMS is currently flying on the UH-60, MH-60, S-70, CH-47 platforms and is being adapted to the new CH-53K aircraft.

Vigor™ Systems

The Vigor™ System is the latest Goodrich HUMS solution developed exclusively for small and mid-size helicopters. Solutions provide full-system functionality for digital aircraft in an efficient size and weight, including the transfer of data between the aircraft and ground station.

With the flexibility to adapt to a number of different aircraft, Vigor™ Systems are currently being certified on commercial helicopters including the S-76D, EC135 and EC145.

For additional information

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