ENGINE HEALTH MONITORING
FINDING OUT WHAT’S WRONG IN ADVANCE

To cut the cost of unscheduled maintenance, unnecessary inspection and trouble-shooting, system operators must anticipate wear and tear and recognise incipient failure conditions. That’s why, when planning operations, maintenance and inventory, they come to Meggitt for the latest sensing and condition-monitoring tools.

Meggitt has been at the vanguard of vibration and oil debris monitoring for over half a century. Today, we are monitoring even more parameters with our extreme environment sensors, integrating diagnostic and prognostic systems that turn data into explicit maintenance actions and monitoring into active management of system condition.

The architecture of our condition monitoring tools is scaleable and modular. Our systems are specified on all engine variants of the Airbus A380 and the Boeing Dreamliner but almost any aircraft can benefit from the improved operating economics and performance that Meggitt’s condition-based maintenance tools deliver.

• A fleet of multi-million dollar aircraft is worth protecting, whatever its size.

• Executive schedules must be honoured, so aircraft must always be ready to go.

• Discerning customers expect a high degree of travelling comfort so vibration must be minimal.

• And when engines run cleanly because they are well-maintained, fuel bills go down and environmental damage is minimised.
Take our short course
We work closely with engine manufacturers to develop optimised system architectures resulting in a range of scaleable, modular solutions.

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• Engine performance calculations  
• De-rate usage monitor  
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• Propulsion system incident/event monitoring  
• High-level storage and communication capability |
| On the engine fan case  
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| **Any high-tech, high performance vehicle** | **Our vision**  
Comprehensive health check technology embracing all functions and all structures and more sensors – turbine tip clearance and timing, combustion and fluid condition monitoring |
LEVEL I

Simple engine vibration monitoring lowering the cost of ownership with cold fan trim balance*

*COLD FAN TRIM BALANCE
Meggitt’s exclusive cold fan trim balance feature translates data gathered during an ordinary commercial flight into the part numbers and correction weight positions needed to address unbalanced engine conditions. These are fitted on landing with minimal disruption and cost compared to ground-running engines for the required data.

Broadband monitoring for business jets
Selected by Dassault for the Falcon 7X and 2000 EX, Gulfstream for the 150 and 200 and Bombardier for the Learjet 45 and 60, Meggitt’s broadband engine vibration monitoring unit is ideal for business jets. Multi-channel processing meets the minimum regulatory requirements for vibration monitoring with full engine-to-engine segregation, very high reliability, lightness in weight and low cost.

The concept can be adapted easily for single, twin or triple engine vibration processing.

One card, all the functionality for mid-size and regional jets
Meggitt’s integrated engine vibration monitor for the Hawker 4000 Horizon integrates all the functionality needed for airborne vibration monitoring onto a single plug-in board.

Compact and easy to replace, this pure electronics solution is carried by several regional and business jets including the Gulfstream 350 and 450 and, through Honeywell’s advanced integrated avionics system EPIC, the Embraer 170 and 190.

Digital for large jets
The majority of large civil aircraft in service use our digital engine vibration monitors. Operators can access system BITE messages, measured vibration values and FAN and LPT balancing results amongst others and the system provides digital processing and FFT analysis for trending vibration parameters and cold trim balancing.

LEVEL II

Advanced vibration monitoring enabling basic condition-based* maintenance for large jets

*CONDITION-BASED
Meggitt’s condition monitoring equipment lowers the cost of owning high-value assets by enabling owners to plan appropriate maintenance according to the real condition of a piece of equipment rather than at a given point in its lifecycle as a standard operating procedure whether it needs it or not.

On the Boeing 737
The advanced airborne vibration monitor provides traditional engine vibration monitoring and detects unusual vibration signatures using sophisticated signal processing techniques.

Like tuning a radio into specific radio frequencies and then turning up the volume, this continuously monitors specific engine bearing signatures and issues maintenance messages to prevent engine damage. Built-in functions troubleshoot system faults, review vibration data and calculate optimal rotor balance solutions for maintenance. Standard fit on New Generation Boeing 737 aircraft, with several hundred retrofitted to earlier aircraft in service, the unit allows engine manufacturers to incorporate several diagnostics functions associated with vibration analysis.

On the Airbus A340
Shares the functionality of the Boeing 737 advanced airborne vibration monitor but includes a highly developed engine interface – a gateway for discrete analogue and digital information exchange between engine and aircraft equipment.

On the Sukhoi SuperJet 100
With vibration and cold fan trim balance, this Meggitt system can handle engine-specific diagnostics algorithms related to vibration signature analysis in time and frequency domains.
LEVEL III

Advanced engine health monitoring and management systems for large jets monitoring vibration and multiple additional inputs and running the engine maker’s advanced engine management software.

IN THE ELECTRONICS BAY

On all new Tupolev 334 and 204 and Boeing B777 aircraft
Provides advanced vibration monitoring and a platform for engine and aircraft performance, mechanical condition and event data recording. Summaries are distributed via a bi-directional CAN or ARINC 629 bus which, in turn, communicates to external cockpit display, FADEC and central maintenance and aircraft monitoring systems. Detailed condition data can be downloaded to a platform’s maintenance ground support system via an ethernet bus. These health monitoring and management programmes are easily modified and field loadable.

On the engine
On the most recently certified large civil aircraft, engine health monitoring is performed by a dedicated avionics unit fitted directly on the engine close to the sensor suite for monitoring and diagnostics. While these units operate in harsh environments, the short signal routing ensures high quality, reliable data. Engine-mounted monitors support power-by-the-hour commercial frameworks and we work closely with engine manufacturers on diagnostics and prognostics software.

On the Airbus A380 and Boeing 787
Meggitt’s health management capability is exemplified by state-of-the-art monitoring systems for the Trent 900 and Alliance GP7200 engines on the Airbus A380; and the Trent 1000 and GEnx engines for the Boeing 787. The systems use over 30 external and internal sensor inputs, discrete signals and data from engine control systems via a digital data bus interface. Meggitt proprietary and third-party algorithms continuously acquire and process the data, detecting anomalies and creating the clearest images of engine condition ever achieved.

LEVEL IV

OUR VISION

Comprehensive health check technology embracing all functions and all structures – and using more sensors.

Integrated vehicle health management
The health monitoring techniques we have evolved for aero-engines can be extended to many sub-systems including landing gear, avionics and environmental control. We share this vision with Cranfield University’s Integrated Vehicle Health Monitoring (IVHM) Centre of Excellence, which we are supporting with industry partners, Boeing (Phantom Works), BAE Systems and Rolls-Royce. Its five-year programme aims to advance existing concepts of vehicle maintenance, repair and overhaul, developing a total health check for high-tech, high value vehicles from aircraft to ships and high-speed trains to high performance cars.

What is IVHM?
Integrated vehicle health monitoring will involve a network of sensors distributed throughout a vehicle, collecting data on the condition of many components and all sub-systems. On-board processors will assess their health and predict life and potential deterioration. The analysis will be used to manage system health, reduce operating cost, increase competitiveness and enable companies to assess the efficiency and readiness of fleets.

Where we fit in
Meggitt has mastered all aspects of the condition monitoring discipline—sensing, data acquisition and management, high speed digital networking and the signal processing algorithms that can deliver prescriptive maintenance solutions—and is contributing significant empirical input to the IVHM programme. It is also working on innovative sensor designs that will introduce new capabilities and technologies to assess aircraft health.

Turbine tip clearance
Every aircraft engine manufacturer has identified rotor blade measurement and monitoring as critical to reducing greenhouse gas emissions and fuel consumption and preventing unnecessary hot-section overhauls and the destruction of engines by loose blades.

Our developing turbine tip clearance measurement tools are extending engine life by reducing the clearance between the engine case and the tip of a turbine blade to within 0.25 millimetre. This improves fuel efficiency by 1%, reduces noxious emissions by 10% and decreases exhaust gas temperature by 6º. Across large fleets of aircraft and industrial gas turbines, such gains are significant.
Turbine tip timing
Just as a glass can be made to vibrate and break by an opera singer, the blades in a gas turbine engine can vibrate under certain operating conditions, suffer fatigue and then break, often resulting in catastrophic engine damage.

Meggitt is developing microwave and eddy current technology to measure such vibrations in situ and via non-contact sensors. The measurement, known as tip timing, is made by accurately detecting the time it takes for each blade to pass the sensor. If the blades are vibrating, or damage occurs from being struck by foreign objects or they simply wear over time, blade passing times will begin to change randomly or drift. A high speed data acquisition system with signal processing algorithms will collect this data so the engine operating state can be changed to avoid potentially dangerous situations.

Combustion monitoring
To emissions of harmful, ozone-forming oxides of nitrogen and sulphur, modern gas turbine designers must control fuel burn and combustion stability tightly.

Our high temperature, high sensitivity dynamic pressure sensors can survive indefinitely within the harsh environments of combustion chambers, providing continuous outputs to control systems so the signs of damaging instabilities can be detected early. We are proving this innovative technology in the industrial gas turbine market on monster machines that can be ten times bigger than the largest aero-engines – with the same requirement for protection, optimal economic operation and conformance to environmental regulation.

Meggitt’s products are detecting fuel contaminants and harmful emissions across ground and marine-based turbines. Using the chemiluminescence effect, optical sensors peer into the heart of the engine combustion process, spectrally analysing radiation signatures to gain insights into combustion chemistry and condition.

Fluid monitoring
Our next generation digital fuel gauging system with built-in fault and failure diagnosis is based on guided wave radar. This significantly increases the accuracy of fuel level measurement and cuts the cost of maintenance and support associated with troubleshooting conventional probes. As some of the system’s microwave pulses penetrate the fluid surface and can sense of the nature of the medium, we expect this technology to have significant future potential in terms of measuring and monitoring liquid quality as well as level.

WHO WE WORK WITH
• For the last decade, Meggitt’s vibration sensors have been fitted to virtually all commercial gas turbine engines on land and in the air.
• Over 90% of the world’s commercial aircraft use our digital vibration monitoring systems.
• Our latest diagnostic and prognostic packages are on the Airbus A380, Boeing 787 Dreamliner and the Tupolev 334 and 204.
• We support Cranfield University’s Integrated Vehicle Health Monitoring Centre of Excellence with industry partners, Boeing, BAE Systems and Rolls-Royce.

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HEALTH MONITORING
Just one of the Meggitt capabilities covered in Meggitt in a Minute, the group’s e-tour.
See also Sensing and Data Acquisition