AWB 72-1 Issue 1, Engine Condition Trend Monitoring (ECTM)

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Purpose

Engine Condition Trend Monitoring (ECTM) is a process in which changes in certain performance parameters of engines are analyzed to identify engine performance deterioration and malfunction of engine components and accessories. The technical requirements of ECTM are specified by the engine manufacturer. This Airworthiness Bulletin (AWB) provides the elements to be considered while incorporating ECTM as part of an engine maintenance program to ensure reliable and consistent outcomes.

Background

In the initial findings of an investigation into an accident involving a Beechcraft King Air C90 aircraft, the ATSB has identified inadequate ECTM as a contributing factor.

Early detection of engine deterioration is of critical importance to schedule timely maintenance action, and ECTM has been widely used to facilitate this. ECTM is considered to be part of a good engine maintenance program and is mandatory in the following instances.

Turbine engine powered aircraft where the flight manual permits reduced power take off's, the flight manual will contain a mandatory requirement to have procedures to ensure that the engine will make the rated power. Incorporation of ECTM into the engine maintenance program, along with the specification of some engine parameter limits to ensure rated power, is one of the methods to meet this requirement. In circumstances where the ECTM is not carried out in real-time, it may be necessary to supplement ECTM with full rated engine runs at regular intervals to meet the flight manual requirements.
Engines operating under an on-condition program where ECTM is specified as a requirement.
Engines fitted to Approved Single Engine Turbine Powered Aircraft (ASETPA).
Engines on extended Time Between Overhauls (TBO) as approved by AD/ENG/5 where ECTM is mandatory.
Engines on extended TBO approved by the manufacturer where ECTM is specified as mandatory.

ECTM System

Effective implementation and integration of ECTM into the engine maintenance program requires the following sub-systems:

- Data acquisition
- Data entry
- Data analysis
- Follow-up actions
- Computer hardware and software

High capacity transport aircraft manufactured by Boeing and Airbus usually have highly integrated real time data acquisition and analysis systems to support ECTM. This AWB is primarily focused on ECTM systems on Pratt and Whitney Canada engines even though the elements of the follow up action requirements detailed in this AWB and emanating from ECTM analysis are applicable to all types of ECTM systems.

Data Acquisition

ECTM relies on consistent and reliable engine performance data that includes altitude, outside air temperature (OAT), aircraft speed, turbine gas temperature, engine rpm, propeller rpm, power developed, fuel flow and others. Hence it is imperative that the required data are acquired at consistent aircraft operating configurations including bleed air off-take, cabin air recirculation and anti ice. There are essentially two different systems for data acquisition, manual and automated, with the following general requirements to ensure reliability and consistency.

Manual Data acquisition

In this arrangement, the required data is collected by the flight crew under stabilized cruise conditions and entered in a form dedicated for ECTM. The following are significant elements of this data collection arrangement:

- There should be clear instructions to the flight crew regarding the flight phase and the aircraft configuration under which data are to be collected. This could include bleeds on/off condition, cabin air recirculation on/off condition, the anti-ice settings and some guidelines on the desirable altitude at which data are to be collected. The ECTM computer program corrects the data for altitude, however it cannot account for the different bleed loads at different altitudes. For pressurized aircraft, data collection above 10,000 feet should minimize data variability due to bleed loads.

One data set per day of flying is considered adequate. Multiple data per day tends to confuse data analysis and should be avoided.
There should be clear procedures to ensure that the forms containing ECTM data are sent promptly and reliably for data entry.

Automatic Data Acquisition

In this arrangement, the required data are captured automatically by the system when the required stable condition as set in the data acquisition unit are met.

Correct configuration of the automatic data acquisition unit for specific aircraft/engine combination is crucial for reliable and consistent data capture. There should be clear procedures and adequate training to ensure that this task is carried out during replacement of the acquisition unit and during engine change. Authority to change the configuration should be suitably controlled.
There should be procedures to ensure that self/functional tests and maintenance of the automatic data acquisition unit are carried out per the manufacturer's instructions.
Method and schedule for the transfer of data from the acquisition unit using data card, memory stick etc. are to be specified.
There should be clear procedures to ensure that the data transfer devices are sent promptly and reliably for data entry.

Data Entry

In the manual data acquisition arrangement, data entry constitutes an area of potential errors and needs special focus as identified by the following elements.

The software should be of the latest revision status and, along with the relevant users manual, should be managed as a controlled technical document.
The ECTM data is usually identified by aircraft registration and it is important that this is transferred to engine serial number specific data at the time of data entry. There should be arrangements for timely incorporation of engine change data into the ECTM data.
There should be arrangements to ensure that relevant data for loan and lease engines are entered into the system as part of engine fleet induction procedure.
Inaccurate and missing data can impede analysis and there should be arrangements for feed back to the data acquisition area and corrective action.
Appropriate back-up systems for electronic data should be provided to avoid inadvertent data loss.

Data Analysis

Competent and timely analysis of data is central to the identification of engine deterioration.

The ECTM analysis is to be carried out by a person with adequate experience and familiarity with turbine engines who has undergone the ECTM training provided by the manufacturer. On the job training when carried out in a structured manner is adequate, provided the training details are appropriately documented.
Data analysis is to be carried out at intervals specified by the manufacturer and the findings recorded.
Policies on resetting the base lines, acceptable ECTM data for loan/lease engines etc should be specified.
If the ECTM analysis is contracted out, the communication of analysis findings, feedback and measures to ensure the quality of ECTM must be documented.
The data analysis should include review of engine parameter exceedances where such data is available from automatic data acquisition systems.

Follow-up Actions

The objective of ECTM is to take appropriate corrective action when required based on the trend data. The following elements are to be considered to achieve this objective.

There should be clear procedures on how the recommended corrective actions emerging from the ECTM analysis are to be communicated for maintenance action.
There should be feed back on when the recommended actions have been carried out.
The corrective actions, when carried out are to be recorded and the impact of these actions assessed.

Computer hardware and software

The computer hardware and software requirements specified by the engine manufacturer are to be complied with.

PWC has introduced a Web - ECTM system in which the necessary software is updated by PWC remotely with data entry performed by the operators. In this arrangement, it is important to ensure adequate security and data back up facilities. See referenced PWC SIL PT6A-122.
Web - ECTM also allows for the analysis to be performed by remote PWC approved analysis centers.
Facilities and protocols for timely maintenance actions and feedbacks to the Designated Analysis Centers (DAC) should form part of the ECTM system.

Summary

This AWB has identified several sub-systems and their elements that form part of the ECTM system. To

ensure a reliable and robust ECTM system, it is important that elements identified in this AWB are elaborated and specified along with other relevant details in a system of maintenance. Accurate and timely trend analysis is a fundamental part of a gas turbine engine management program that can enable adverse trends in engine performance parameters to be detected early and corrective actions to be taken. An accurate parameter history is also useful when determining workscopes during engine shop visits.

References

1. Pratt and Whitney Canada, Service Information letter PT6A-122, “ New generation ECTM - WebECTM”, 26 September 2003.
2. Australian Transport Safety Bureau, Report 200105618.
3. Approved Single Engine Turbine Powered Aircraft (ASETPA), CASA AAC 1-116, 2000.

Enquiries

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