Integrated Health & Usage Monitoring System
IHUMS
INTEGRATED HEALTH & USAGE MONITORING SYSTEM – IHUMS

Introduction

IHUMS or Integrated Health and Usage Monitoring System, combines Cockpit Voice Recording (CVR) and Flight Data Recording (FDR) with recording of maintenance data from a sophisticated on-board vibration-monitoring electronics. FDR and CVR data are used for post accident analysis and so are recorded onto a crash-worthy recorder, whilst the maintenance data is recorded onto a memory card that is not crash-worthy. The pilot is responsible for transferring the maintenance data on the memory card from the aircraft to a ground station computer where it is analysed and a printout produced for engineering.

Hardware

Data Acquisition and Processing Unit - DAPU

The heart of the system is the DAPU or Data Acquisition and Processing Unit. It retrieves data from a variety of sources including -

- Most of the cockpit engine system and flight instrument indications
- Flying Control positions
- Aircraft attitude
- Navigation system indications
- Status of warning lights and undercarriage
- Acceleration of the airframe in normal, lateral and longitudinal planes
- Vibration data from a number of accelerometers located around the airframe, engine and transmission
- Track data from the main rotor-tracking camera mounted on the nose.

The DAPU processes this data and channels much of it out to the FDR. Vibration, Usage and Rotor Track data are passed to the MDR or Maintenance Data Recorder into which the IHUMS memory card is plugged during operation of the aircraft.

Cockpit Voice & Flight Data Recorder – CV/FDR

The CVR and FDR functions are carried out by a single CV/FDR crash-proof recorder, which is fitted in the tail section of the aircraft. Attached to it is a Ducane Acoustic beacon to aid retrieval following a ditching. The unit consists of a 1 hour tape loop onto which are recorded 8 separate tracks.

Three of these tracks are used to record the captain and co-pilots station boxes and the cockpit area microphone fitted above the instrument panel. Anything that is heard on a station box is recorded including such things as nav-aid idents if the volume is turned up. After the 1 hour of the tape loop is used up the recorder starts to overwrite the recording so that the tape always contains the last 1 hour of recording.

Flight data is recorded on the remaining 5 tracks, one track at a time in sequence so that there is 5 hours of data before the data starts to be overwritten. There is a ‘g’ activated switch that stops the recorder in the event of a crash so that data is not overwritten in the event that power is still on the aircraft.

The CV/FDR is powered through a white collared circuit breaker on PP4 circuit breaker panel. It was found that the recorder was often running for prolonged periods on the ground during maintenance etc. and this was compromising its life and reliability. This circuit breaker should be pulled after shutdown and not restored until it is intended to start the aircraft.

Maintenance Data Recorder – MDR

The MDR is the receptacle into which the IHUMS memory card is inserted in the aircraft. It is located on the left front edge of the overhead panel and has a spring-loaded cover. Care must be taken to ensure the card is inserted with the correct orientation. The card must be inserted with Power OFF the system otherwise the card will not be detected by the DAPU and no data will be sent to it during flight. After shutdown, the battery must not be turned off until the yellow busy light is extinguished (visible under the spring-loaded cover); otherwise all data may be lost.
**IHUMS Memory Card**

The IHUMS memory card is a 20 Mb RAM card used to transfer data from the DAPU to the ground station and vice versa. They are very expensive and should be treated with care. The card should be removed from its receptacle by pressing the ‘eject’ button and not pulling on the card.

It is necessary to prepare the card on the ground station computer prior to inserting it in the aircraft and in particular the aircraft registration must be correct. After flight the card must be down loaded into the ground station and once the diagnostics run has started it may be removed. At the end of the diagnostics, a print out will be produced in engineering detailing any suspected defects as well as the usage data.

**Cockpit Display Unit - CDU**

The CDU is fitted on the centre console and allows the pilot access to the IHUMS system including checking the serviceability of the system, controlling manual data acquisitions and carrying out the daily power assurance check.

Sector data with weights need not be entered.

**IHUMS Maintenance Panel – IMP**

This panel is located under the electrical cabinet facing aft into the cabin. It is not generally accessed by the pilots but allows engineering to check but not listen to the CV/FDR and some systems status warning lights. It also contains one of the buttons that requires to be pressed in order to erase the CVR. The other is on the CV/FDR unit in the tail cone. Both buttons must be pressed together to erase the recordings.

**System Interrogation Unit – SIU**

The SIU is a portable PC that can be used to program the DAPU after installation, carry out general fault finding and act as a portable ground station when the aircraft is detached from base.

**System Sensors**

Where possible the system uses existing sensors to supply it with data but additional sensors are fitted as listed below –

- Control position sensors on the cyclic, collective and yaw channels
- A 3-axis accelerometer giving overall airframe acceleration in normal, lateral and longitudinal planes (This data is used to determine the flight path during accident investigation)
- Numerous small accelerometers fitted in the proximity of the major transmission and engine components to detect vibration arising from component defects.
- A number of small accelerometers fitted to the airframe to monitor airframe vibration arising from rotor track and balance errors.
- A camera mounted on the nose to measure rotor track (works in daylight only)
- A ‘DIGITAS’ transducer which outputs an electronic signal giving IAS, TAS, OAT, Pressure Altitude and Vertical Speed.
- Azimuth Markers giving 1 pulse per revolution of main rotor, tail rotor and the engine high-speed shafts

The undercarriage micro switch is used to record take-off and landing times. The vertical channel of the 3-axis accelerometer is used to detect taxying by analysing the peak to peak vertical acceleration level, which increases considerably during taxying.
SYSTEM OPERATION

Flight Events & Exceedances

The DAPU monitors flight conditions and checks against a set of equations for certain flight events to become valid. It also monitors engine and transmission parameters against another set of equations for the exceedance of any limits that require maintenance action. If any such exceedances are detected they are reported to engineering on the down load. The crew are advised by a flashing [WARN] on the top right corner of the CDU. Interrogation of the CDU menu will give more information.

Data Acquisition

Most of the health monitoring functions are automatically carried out by the system when an appropriate flight condition is detected.

Every hour when the aircraft is in the cruise, the system takes samples of vibration from every shaft in the engine and gearboxes. Data for a particular shaft or gear is extracted from the general noise by averaging the data over a number of revolutions correlated to the speed of rotation of the particular shaft or gear. The system calculates the speed of rotation of a shaft or gear using signals from the appropriate azimuth marker and dividing by the appropriate gear ratios. Thus one accelerometer can acquire data from a number of shafts and gears in the vicinity.

Only the first one and the and last three of vibration data are retained on the IHUMS card so on a long flight earlier files will be over written to prevent the card filling up unduly. Using the CDU the pilot can force a vibration sample to be taken but this is normally done at the request of engineering.

The first time that the system detects certain flight conditions, a rotor track and balance (RTB) acquire is initiated. The tracking camera in the nose monitors the blade track for 110 revolutions to average out disturbances caused by control movements or turbulence. It then measures airframe vibration and correlates this to the rotor angle using the azimuth marker on the main rotor head. Finally the vibration at the tail rotor in the radial and axial planes is checked using the tail rotor azimuth marker to correlate the data.

The following flight events will trigger an RTB -

- Minimum Collective Pitch On Ground (MPOG)
- Hover
- Climb
- Slow Cruise
- Medium Cruise
- Fast Cruise
- Descent
- Left Turn
- Right Turn

NOTE – These acquires occur only during the first time that they are detected by the DAPU for each IHUMS card so that the card will not fill up unduly during a long days flying. Using the CDU the pilot can force a RTB acquisition but it is up to the pilot to ensure that aircraft is in the correct flight condition before initiating the acquire. This is normally only done during an air test.

Power assurance data is gathered by pilot action. Although most of the data required is automatically read by the system, the pilot is required to enter some of the less important data by reading the gauges and typing into the CDU.

The pilot may trigger the ‘event’ function on the CDU. This causes the last 40 seconds of FDR data to be recorded onto the IHUMS memory card where it can be easily accessed.
Normal Operation

Before Flight – Prepare the IHUMS memory card on the ground station taking care to ensure the correct registration is specified.

Before Start – Ensure that the IHUMS memory card is inserted into the MDR in the correct orientation before switching on the battery. Push in the CV/FDR circuit breaker.

After Start – Once all systems are running and the gyros are up to speed, ensure that there is no flashing 'WARN' on the CDU. If there is, press 'ENTER' twice to view the problem.

During Flight – Carry out the power assurance checks. Carry out any pilot-initiated acquires that have been requested by engineering.

On Shutdown – Do not switch off the battery until the yellow busy light is extinguished on the MDR. Remove the IHUMS card by pressing the eject button. Pull the collared CV/FDR circuit breaker on the PP4 panel.

After Flight – Insert the IHUMS card into the ground station and carry out the post flight procedure.
Figure 1 - IHUMS – Overall Schematic