SERIES

TECHnically Speaking

BY PETER ASHFORD

Part 1:

Flight Data Recorders:

The Background on the 'Black Box'

"Technically Speaking" is a new regular series in Avionics News. *Peter Ashford, writer for the new series, has an extensive engineering background, including as an aircraft instrument/electrical engineer, quality assurance engineer, quality systems and regulatory lead auditor, and many other positions. His experience ranges from installing and maintaining ISO 9000 systems to writing quality procedures manuals and auditing quality systems internationally. He has worked for the NZCAA as an airworthiness inspector since 1998. Born and educated in England, Ashford served in the Royal Air Force. He has lived in New Zealand since 1971.*

Editor's note: This is Part 1 of a two-part series examining flight data recorders.

Flight data recorders, sometimes known as accident data recorders, are devices used to record specific aircraft performance parameters.

Popularly referred to as the "black box," the data recorded by an FDR is used for accident investigation and for analyzing air safety issues, material degradation and engine performance. Contrary to the "black box" reference, the exterior of an FDR is coated with heat-resistant, bright-orange paint to provide high visibility in wreckage.

Flight data recorders are ICAO-regulated, carefully engineered and stoutly constructed to withstand the force of a high-speed impact and the heat of an intense fire.

Generally, an FDR is mounted in the rear (tail section) of an aircraft, where it is more likely to survive a severe crash. In this position, the entire front of the aircraft is supposed to act as a "crush zone" to reduce the shock on the FDR.

Modern FDRs are double-wrapped in strong corrosion-resistant stainless steel or titanium, and inside there is high-temperature insulation. The units are designed to emit a locator beacon signal for up to 30 days, and they can operate at a depth of 6,000 meters (20,000 feet).

History of the FDR

In 1939, at the Marignane flight test center in France, Paul Beaudouin and Francois Hussenot made one of the earliest attempts to produce an FDR. It was known as the type "HB" flight recorder. Essentially, it was a photograph-based device. The record was made on wide photographic film measuring 8 meters long by 88 millimeters wide. The latent image was made by a thin ray of light deviated by a mirror tilted according to the magnitude of the data to record altitude, speed and more.

HB recorders remained in use in French test centers well into the 1970s. In 1947, Beaudouin, Hussenot and associate Marcel

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Ramolfo founded the Societe Francaise d'Instruments de Mesure (SFIM) to market their design. The company went on to become a major supplier of data recorders, used not only on aircraft, but also on trains and other vehicles.

Today, SFIM is part of the Safran group, and it is still active in the flight data recorder market.

Design of the FDR

The design of today's FDR is governed by the internationally recognized standards and recommended practices contained in ICAO Annex 6, which makes reference to crash worthiness and fire protection specifications. These specifications can be found in the European Organisation for Civil Aviation Equipment documents Eurocae ED55, ED56A and ED112.

In the United States, the FAA cites design requirements in its technical standard order TSO-C124b, which is based on Eurocae documents.

Currently, Eurocae specifies an FDR must be able to withstand an acceleration of 3,400 Gs (33 km/sec squared) for 6.5 milliseconds. Roughly, this equates to an impact velocity of 270 knots and a deceleration distance of 450 cm.

Additionally, there are requirements for penetration resistance, static crush, high- and low-temperature fires, deep-sea pressure, saltwater immersion and other fluid immersion.

Modern-day FDRs receive input via specific data frames. They record significant flight parameters, including control and actuator positions, engine performance and time of day. There are 88 parameters required as a minimum under current U.S. regulations; however, some systems monitor many more variables. A few of the parameters recorded are:

- Time
- Pressure
- Altitude
- Airspeed
- Vertical acceleration
- Magnetic heading
- Control column position
- Rudder pedal position
- Horizontal stabilizer position
- Fuel flow

Solid-state recorders can track more parameters than magnetic tape because they allow for a faster data-flow. Solid-state FDRs can store up to 25 hours of flight data. Each additional parameter the FDR records gives investigators one more clue about the cause of an accident.

Future Equipment

Depending on the severity of a crash, recorders sometimes can be crushed into unreadable pieces or the wreckage located in very deep waters. Some modern units are self-ejecting, using kinetic energy at impact to separate themselves from the aircraft. These units use radio or sonar beacons to aid in their location.

Alternatively, other aircraft, such as the Space Shuttle orbiters, do not possess flight data recorders. Instead, they use downlinks to transfer such data. This kind of system has the potential for wider use, in modified form, for commercial and business aviation. ❑

Part II of this two-part series, which will publish in the March issue of Avionics News*, examines the operation and testing of flight data recorders.*