Fade-Free Memory

Enhanced airborne flight recorders will safeguard vastly more data, including images if required.

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On the Boeing 787, the forward and aft enhanced airborne flight recorders (EAFRs), cockpit area microphone and preamplifier (CAM-P) and forward recorder independent power supply (RIPS) are directly linked via the airplane's fiber-optic data network.

So long as accidents are possible, the Airbus A380, Boeing 787 and other airplanes with cutting-edge safety technologies will have to be equipped to faithfully capture what happens during each flight. A good example is the 787, which will incorporate dual enhanced airborne flight recorders (EAFRs) designed to reflect the world's newest specifications for airplanes that have fiber-optic aircraft data networks as part of their digital architecture.

The U.S. Federal Aviation Administration (FAA), in a 2007 technical presentation to the International Civil Aviation Organization, characterized EAFRs as one of the products that have become a reality because of a 10-year effort by the aviation industry and governments to overhaul the global standards for flight recorder systems with crash-protected solid-state memory.[1] Basic international agreements on the subject have been distilled into Document ED-112, "Minimum Performance Specification for Crash Protected Airborne Flight Recorders," published by the European Organisation for Civil Aviation Equipment (EUROCAE). This document set the stage for separate working groups to develop ARINC Characteristic 767, "Enhanced Airborne Flight Recorder (EAFR)" and other applicable standards.[2] In the 787, the flight data recorder (FDR) function in the GE Aviation EAFR, as currently configured, can record approximately 2,000 parameters and 50 hours — versus up to 88 parameters and 25 hours under current requirements — before overwriting the oldest flight data, according to Jim Elliott, a systems/applications engineer for the manufacturer.[3] "Although one EAFR has the capabilities of both an FDR and a [cockpit voice recorder (CVR)], current regulations require that two EAFRs be installed on the aircraft," Elliott said. "An important benefit of the dual combined recorder installation is that there [will be] two complete copies of all of the recorded [data] available to the [accident] investigators."

Unlike typical FDRs, the FDR function within each EAFR on the 787 receives flight-parameter data directly from aircraft sensors and systems as a fiber-optic avionics full-duplex switched Ethernet data stream. The EAFRs' built-in documentation also complies with an ARINC standard for complete configuration description of the FDR data frame, which Elliott called a major time-saver, considering the nearly 23-fold increase in recorded parameters. This enables accident investigators anywhere to have "a consistent, accessible, complete and accurate interpretation of the flight data," he said.

The data link recorder function captures messages to and from the crew when digital air-ground communication is used. In the 787, the EAFRs store within their CVR-function memory partitions two hours of data from four audio channels and all data link messages. "The CVR function receives audio from three digital audio crew channels provided by the flight deck audio system and one analog audio channel from the cockpit area microphone and preamplifier," Elliott said. Data from the crew channels are sent to the forward EAFR and aft EAFR. Sounds from the cockpit area microphone also are sent as a data stream to both EAFRs. The forward EAFR, the cockpit area microphone and the preamplifier for this microphone have 10 minutes of backup power from a forward recorder independent power supply.

The GE Aviation EAFR also has sufficient memory capacity and a dedicated Ethernet network interface to support two hours of image recording if required by a civil aviation authority. So far, however, the FAA has said that while its 2005 proof-of-concept test to determine the effectiveness of using sequences of still images for accident/incident investigation was "promising," the camera technology tested was not "mature enough to be installed."

"The images [from a forward-facing camera in an FAA-operated Beech King Air] were used to derive parametric aircraft performance data as well as ascertain general conditions within the cockpit and the condition of the crew," the FAA said. "The results of the test were favorable. The U.S. National Transportation Safety Board (NTSB) derived 51 parameters [of 88 parameters that FDRs currently capture] from the recorded images and, in most cases, did so within the parameter range and accuracy tolerances of the regulations. In fact, the data from the images identified an FDR altimeter data–correlation issue." Similar to the results of a U.K. Civil Aviation Authority study (*ASW*, 4/07, p. 18), however, the challenges included difficulty finding a suitable position for only one camera, inadequate performance under specified lighting conditions, and laborious analysis. "It took several weeks for the NTSB investigators to derive the 51 parameters they obtained from five minutes of image recording," the FAA said.

Essentially, EAFRs will position the industry to respond to many issues identified by the accident investigation community. Proposals in three current FAA rule-making activities, for example, in part would increase recording durations, add data link message recording, increase the data-recording rate from sensor signals for some FDR parameters without increasing the total number required to be recorded, specify different FDR parameters to record for some aircraft types, physically separate FDRs and CVRs, and make more reliable the power supply to all recorders. ●

Notes

1. FAA. "An Outline of the Development of Work on Flight Data Recorder Systems." Paper presented by the United States to the Technical Commission of the 36th Session of the Assembly of the International Civil Aviation Organization. Information Paper A36-WP/300, Sept. 22, 2007.

2. As described in ARINC Characteristic 767, an EAFR can combine any or all of the following functions — instead of separate hardware as in previous designs — in a single line replaceable unit: the digital FDR function, CVR function, data link recording function, image recording function and integrated flight data acquisition function.

3. Elliott, Jim. "Enhanced Airborne Flight Recorder (EAFR) — The New Black Box." Paper presented at ISASI 2007 Singapore, a conference of the International Society of Air Safety Investigators, August 2007. Elliott is a systems/applications engineer, Digital Systems, GE Aviation, and was a member of EUROCAE Working Group 50 during the development of Document ED-112.