TECHnically Speaking

BY PETER ASHFORD

Part II:

Flight Data Recorders:

Built, Tested to Remain Intact After a Crash

Editor's note: This is Part II of a two-part series examining flight data recorders. Part I appeared in the February 2010 issue of Avionics News.

Solid-state recorders are considered much more reliable than their magnetic-tape counterparts. They use stacked arrays of memory chips, hence no moving parts, and have fewer maintenance issues. With solid-state recorders, there also is less chance of something breaking during an accident.

Data from a flight data recorder (the "black box") is stored on memory boards inside the crash-survivable memory unit (CSMU). The stacked memory boards are about 1.75 inches (4.45 cm) in diameter and 1 inch (2.54 cm) tall. These memory boards can accommodate up to 25 hours of flight data; in larger aircraft, recorders can track more than 700 parameters.

Built to Survive

In many aircraft accidents, the flight data recorder's CSMU is the only device that survives. Generally, the rest of the recorder's chassis and other components are damaged beyond repair.

The CSMU is a large cylinder bolted onto the flat portion of the recorder. This device is built to withstand the extremes of tons of pressure.

Using three layers of material, the CSMU in a solid-state flight data recorder insulates and protects the stack of memory boards storing the digitized inputs.

The materials providing a barrier for the memory boards, starting at the innermost and working outward, are:

- Aluminium housing: A thin layer of aluminium surrounds the memory cards.
- High-temperature insulation: A 1-inch thick (2.54 cm) dry-silica material provides high-temperature protection, which assists in the protection of the memory cards during post-accident fires.
- Stainless-steel shell: A dry-silica material is contained in a stainless-steel cast shell approximately 0.25 inches (0.64 cm) thick. Titanium also can be used for this containment.

Testing a CSMU

To ensure the survivability and quality of a flight data recorder, the manufacturer vigorously tests the CSMU. Only the CSMU needs to survive a crash; therefore, if accident inspectors can retrieve the CSMU, the information they need to analyze will be available.

To test the unit, engineers load data into all the memory boards. After testing, the data is reviewed to determine if any damage occurred during testing.

There are several tests carried out to simulate the crash-survival sequence, including:

- Crash Impact: The CSMU is shot down an air cannon to create an impact of 3,400 g. At 3,400 g, the CSMU hits an aluminium honeycomb target at a force 3,400 times its weight. This impact force is equal to or in excess of what a recorder could experience during a crash.
- Pin Drop: To test the unit's penetration resistance, a 500 lbs (227 kg) weight with a 0.25-inch steel pin protruding from the bottom is dropped onto the CSMU from a height of 10 feet (3 m). This pin, with 500 lbs behind it, hits the CSMU cylinder's most vulnerable axis.
- Static Crush: For 5 minutes, 5,000 psi of crush force is applied to each of the unit's six major axis points.
- Fire Test: The unit is placed into a propane-sourced fireball. The unit sits inside the fire at 2,000 degrees Fahrenheit (1,100 degrees C) for one hour. The FAA requires all solid-state recorders to be able to survive at least one hour at this temperature.
- Deep-Sea Submersion: The CSMU is placed into a pressured tank of saltwater for 24 hours.
- Saltwater Submersion: The CSMU

must survive in a saltwater tank for 30 days.

- Fluid Immersion: Various CSMU components are placed into a variety of aviation fluids, including jet fuel, lubricants and fire-extinguisher chemicals.

During the fire test, the memory interface cable that attaches the memory boards to the circuit board is burned away. After the unit cools, the unit is taken apart and the memory module removed. The memory modules are re-stacked and a new memory interface cable is installed and attached to a read-out system to verify all pre-loaded data is accounted for.

Underwater Locater Beacon

In addition to the flight data recorder being painted bright orange and having reflective tape, it also is equipped with an underwater locator beacon (ULB), which is attached to one end of the recorder. While it can double as a carrying handle, this cylinder is the beacon.

If an aircraft crashes into water, the ULB sends out an ultrasonic pulse. This pulse cannot be heard by the human ear; however, it is detectable by sonar and acoustical locating equipment. On the side of the beacon, there is a "bull's-eye" submergence sensor. When this sensor comes into contact with water, it activates the beacon.

The beacon sends out pulses at 37.5 kHz and can transmit from as deep as 14,000 feet (4,267 m). Once the beacon begins "pinging," it pings once per second for 30 days. A battery with a six-year shelf-life powers the beacon. On rare occasions, the beacon might snap off during a high-impact accident.

Once a flight data recorder is recovered, it usually is kept in a container of cool water, which keeps the recorder in a similar environment until it is transported to an area where it can be adequately disassembled.

Conclusion

Following any aircraft accident, there are many unanswered questions as to what caused the accident. Accident investigators turn to the flight data recorder for answers. However, the flight data recorder is only one tool that can assist investigators. The cockpit voice recorder is another "black box" that can provide vital information to the investigator.

Hopefully, analyzing the information from "black boxes" translates into less accidents and safer flying for all of us in the future. ❑