Aircraft's Black Box

Explainer: How to read an aircraft's black box

By Tim Hepher

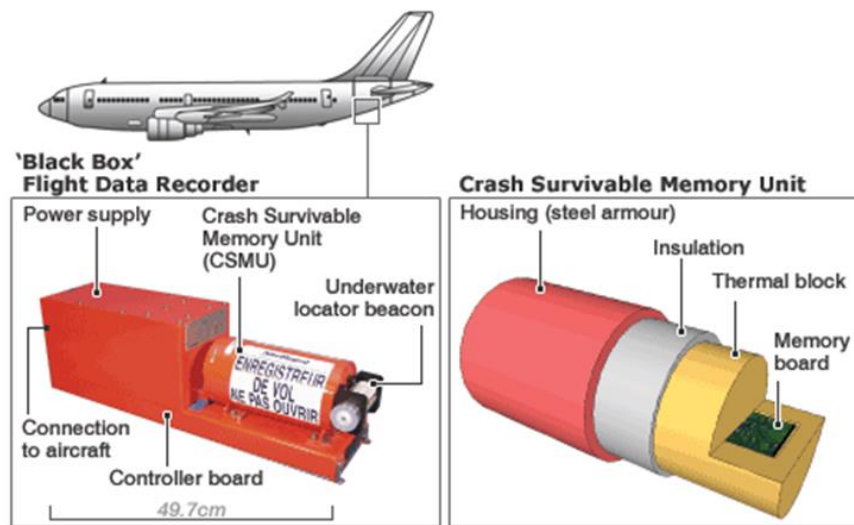PARIS (Reuters) - France's BEA safety investigators are searching for clues as to what caused an Ethiopian Airlines plane to hurtle to the ground after take-off, as they begin analyzing two black boxes that arrived in Paris on Thursday from the crashed Boeing 737 MAX.

Here is how the process works.

WHAT ARE BLACK BOXES?

They are not actually black but high-visibility orange. Experts disagree how the nickname originated but it has become synonymous with the public's quest for answers when planes crash.

Many historians attribute their invention to Australian scientist David Warren in the 1950s.

They are mandatory and the aim is to preserve clues from cockpit sounds and data to help prevent future accidents.

HOW BIG ARE THEY?

They weigh about 10 pounds (4.5 kilos) and contain four main parts:

** a chassis or interface designed to fix the device and facilitate recording and playback

** an underwater locator beacon

** the core housing or 'Crash Survivable Memory Unit' made of stainless steel or titanium

** inside there, the precious finger-nail sized recording chips on circuit boards which in the latest case could help decide the near-term fate of Boeing's grounded 737 MAX.

There are two recorders: a Cockpit Voice Recorder (CVR) for pilot voices or cockpit sounds and a Flight Data Recorder (FDR).

The BEA released a photo of the FDR from the Ethiopian jet appearing to show that the chip's crucial housing is intact while the replaceable chassis is crushed.

HOW WILL THE RECORDERS BE HANDLED?

Technicians peel away protective material and carefully clean connections to make sure they do not accidentally erase data. The audio or data file must be downloaded and copied.

The data itself means nothing at first. It must be decoded from raw files before being turned into graphs.

Investigators sometimes use "spectral analysis" - a way of examining sounds that allows scientists to pick out barely audible alarms or the first fleeting crack of an explosion.

HOW MUCH INFORMATION IS AVAILABLE?
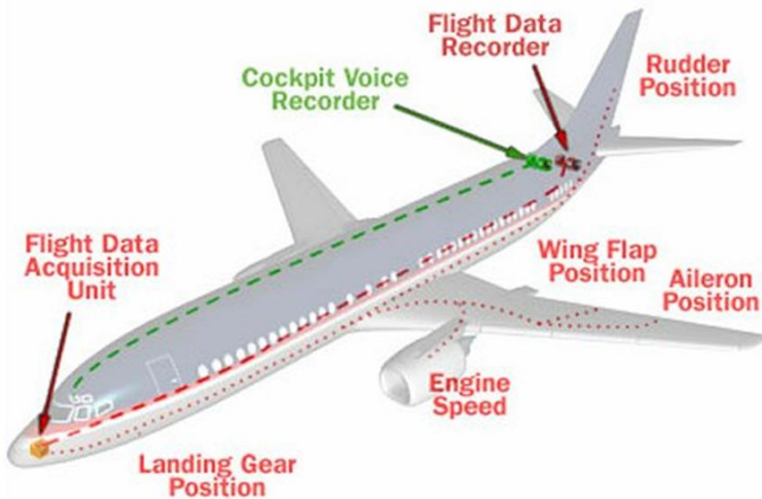
The L-3 data chip on a similar Lion Air jet that crashed in October contained 1,790 parameters over 19 flights.

The CVR contains two hours of recordings, more than enough to cover the six-minute Ethiopian flight.

"The data recorder typically tells you 'what' and 'how' the event happened and the cockpit recorder starts to help you understand 'why' but may not be enough," said an investigator.

WHO HEARS THE TAPE?

The BEA has a listening room like a recording studio with audio mixing and playback equipment linked to a screen showing synchronized data, Reuters observed on a recent visit by a group of reporters. Four channels separate voices and ambient noise.

Only the main investigator and a handful of people hear most tapes, which are then sealed. In France, where judges routinely carry out parallel probes, a police officer may be present as well as representatives from foreign investigation agencies.

A technician will first prepare the recording to ensure it is intact. In one of the most dramatic events in the 73-year-old BEA's history, legal sources say it was at this stage that staff first suspected the captain of a Germanwings jet had been locked out by a suicidal co-pilot in 2015, sending 144 people to their death while he tried to beat down a reinforced door.

Analysis starts on Ethiopia jet black boxes

Trauma counseling is available for staff hearing tapes.

HOW LONG WILL THE RESULTS TAKE?

Investigators prefer to work methodically but public and media pressure can be intense. Depending on any damage to the boxes and type of accident, some investigators acknowledge they can get a very basic idea in days or even hours. But they stress this is not always the case and rarely the whole story.

Interim reports are published after a month but are often sparse. Deeper investigations take a year or more to complete.

A Lebanese investigation into an Ethiopian Airlines crash in 2010, in which the BEA also analyzed recorders, took two years.

WHAT WILL BLACK BOXES LOOK LIKE IN FUTURE?

A new type of box now being tested by Airbus and the BEA, after it spent two years searching for Air France 447 which crashed in the Atlantic in 2009, would be built into a floatable panel embedded in the outer skin. Bolts would

retract allowing it to fall away when the plane feels it is about to crash on water, triggering a radio beacon and avoiding a deep-sea search.

Since that crash and the unresolved disappearance in 2014 of Malaysian Airlines MH370, there has been intense debate about whether black boxes should stream live data back to the ground. French regulators are skeptical, saying it would be hugely costly for little benefit, since most boxes are quickly found.

HOW HAVE THEY EVOLVED?

Older models used to record on wire, foil or reels of magnetic tape. Samples of them are now stacked like an Aladdin's cave of vintage machinery inside the BEA's headquarters at Le Bourget airport, Paris. The BEA needs some old equipment to work on systems that are still flying on decades-old aircraft.

Modern versions use computer chips housed inside "crash-survivable" containers able to withstand g-forces 3,400 times the feeling of gravity.

Reporting by Tim Hepher; Editing by Susan Fenton. Our Standards:The Thomson Reuters Trust Principles.