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ANALYSIS OF THE BLACK BOX AND SUGGESTIVE MEASURES TO IMPROVE PERFORMANCE

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ABSTRACT

Any commercial airplane or corporate jet is required to be equipped with a cockpit voice recorder and a flight data recorder. It is these two items of separate equipment which we commonly refer to as a 'Black Box.' While they do nothing to help the plane when it is in the air, both these pieces of equipment are vitally important should the plane crash, as they help crash investigators find out what happened just before the crash. The black box is crucial in helping piece together the causes of a plane crash. It locates the cockpit voice recorder and flight data recorder in the aftermath of a plane crash that occurs at sea, each recorder has a device fitted to it known as an Underwater Locator Beacon (ULB). This device is activated as the recorder comes into contact with water and it can transmit from a depth of 14,000 feet. A Black Box is not actually black at all, but bright orange. All recorders undergo countless tests. With that said, how helpful have these black boxes been in extracting the information regarding crashes in the recent times? Or has the time come for them to undergo further technological advances?

Keywords: Beacon, EUROCAE, Flight Data Recorder, Cockpit Voice Recorder, Open VMS.

I INTRODUCTION

Black box is an electronic recording device that is placed in ships, aircrafts, satellites etc. It includes a flight data recorder and a cockpit voice recorder. It records data regarding the flight elevation level, the distance travelled, the position of the wing flaps and rudder, fuel level etc. This device is useful only after an air crash. It helps the investigators to find out the reason behind the crash of an aircraft and the necessary measures are taken to avoid the re-occurrence of any such crashes.

The internal construction of the black box consists of an aircraft interface board, audio compressor board, high temperature insulation, stainless steel shell, acquisition processor board. The aircraft interface board interfaces data from DAS (data acquisition system) to the flight recorder. High temperature insulation and stainless steel shell help in protecting the black box.

But there have been several incidents where the black boxes have not been able to definitively identify the reasons for the crash, because either they are too damaged to be read or might have missing data due to power loss.

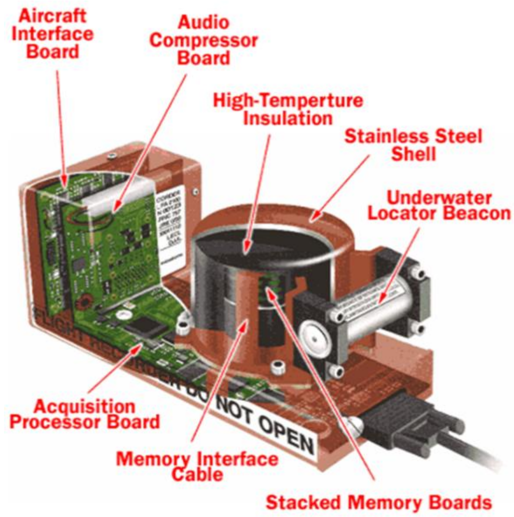

Fig. 1 Construction of the Black Box

II SPECIFICATIONS

The design of today's black box is governed by the internationally recognized standards and recommended practices relating to flight recorders which are included in ICAO Annex 6 which makes reference to industry crashworthiness and fire protection specifications. In the United States, the Federal Aviation Administration (FAA) regulates all aspects of US aviation, and puts forward design requirements in their Technical Standard Order, based on the EUROCAE documents (as do the aviation authorities of many other countries).

Currently, EUROCAE specifies that a recorder must be able to withstand an acceleration of 3400 *g* (33 km/s²) for 6.5 milliseconds. This is roughly equivalent to an impact velocity of 270 knots (310 mph; 500 km/h) and a deceleration or crushing distance of 450 cm. Additionally, there are conditions for penetration resistance, static crush, high and low temperature fires, deep sea pressure, sea water immersion, and fluid immersion.

EUROCAE ED-112 (Minimum Operational Performance Specification for Crash Protected Airborne Recorder Systems) defines the minimum specification to be met for all aircraft requiring flight recorders for recording of flight data, cockpit audio, images and used for investigations of accidents or incidents.

In order to facilitate recovery of the blackbox from an aircraft accident site they are colored bright yellow or orange with reflective surfaces. All are lettered "FLIGHT RECORDER DO NOT OPEN" in English on one side and the same in French on the other side.

To assist recovery from submerged sites they are equipped with an underwater locator beacon which is automatically activated in the event of an accident.

III HARDWARE

The black box consists of two important parts:

1. Flight Data Recorder

2. Cockpit Voice Recorder

Flight Data Recorder records 3000 parameters in flight such as the air speed, altitude, position of flaps, stabilizers, engine performance etc.

The Flight Data Recorder records 25 hours of flight data and 2 hours of digital data.

The Flight Data Recorder has a solid state memory unit which stores data. The memory board of the recorder is protected by a metallic casing capable of withstanding impacts equivalent of 3400 times the force of gravity and temperature up to 2000 degree Fahrenheit. The voice and instrument data processed by the flight recorder are stored in digital format on solid state memory boards.

One other important hardware component of the black box is the beacon that starts sending out ultrasound signals as it touches the sea level. It can send signals up to 14000 feet deep below sea level. It sends signals for every one second for the next 30 days.

IV SOFTWARE

The operating system used in black box is the Open VMS system. Open VMS is a multiuser, multiprocessing virtual memory based operating system designed for use in time sharing, batch processing and transaction processing. Apart from Open VMS, the other software that can be used is the Linux software.

There is a part in Open VMS systems called the ACMS or Application Control and Management System which is a transaction processing monitor software system for computers running the Open VMS operating system.

In Open VMS when process priorities are properly adjusted, it may approach real time operations system characteristics. The system offers high availability through clustering and the ability to distribute the system over multiple physical machines. This allows the system to be tolerant against disasters that may disable individual data processing facilities.

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V INTER-PROCESS COMMUNICATION

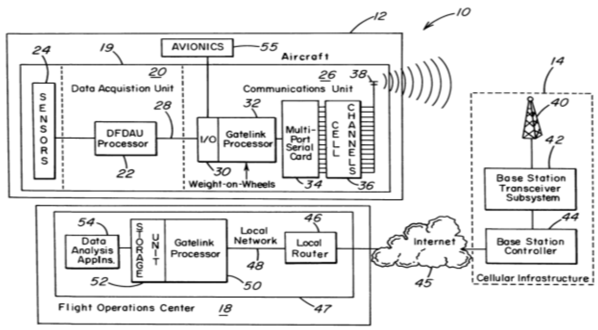

Fig. 5.1 aircraft data acquisition and transmission system

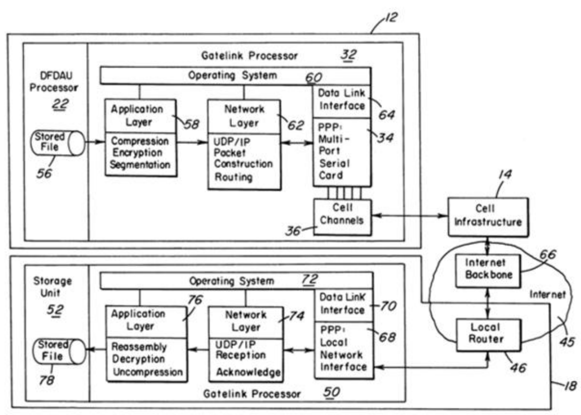

Fig. 5.2 data flow in the data acquisition and transmission system

VI BLACK BOX-USEFUL OR NOT?

There have been several incidents where black boxes have not been able to supply information regarding the crash, either due to their debilitated condition or if they go missing, thus, taking away all the data with them.

Here is the list of aircraft accidents where the information regarding the crash could not be retrieved by the black box.

Date of crash	Flight No.	Airline	Plane type	Presumed location	Notes
04-10-01	1812	Siberia Airlines	Tupolev Tu-154	Black Sea	Neither flight recorder found. Main fuselage of the aircraft, believed to contain the recorder, was believed to be at depth of 1,000 meters - too deep for divers to retrieve.
14-10-04	1602	MK Airlines	Boeing 747-244(SF)	Halifax, Nova Scotia	FDR recovered; CVR mutilated in post-crash fire
22-10-05	210	Bellview Airlines	Boeing 737-200	Lisa Village, Ogun	FDR was never found
03-06-12	992	Dana Air	McDonnell Douglas MD-83	Lagos, Nigeria	CVR recovered; FDR mutilated in post-crash fire
09-12-12	N345MC	private	Learjet 25	Iturbide, Mexico	CVR and FDR destroyed upon high speed impact
08-03-14	370	Malaysia Airlines	Boeing 777-2H6ER	South Indian Ocean	CVR missing; FDR missing search for debris and recorders underway

TABLE1 List of unsolved aircraft accidents

After performing an in-depth analysis of the above accidents and especially the Air France flight which crashed into the Atlantic in 2009, there are a few problems that are encountered with the black box:

- The voice recorder only captures the final two hours.
- Battery life is short. - The black box sends a ping activated by immersion in water that is picked up by a microphone and a signal analyzer but this battery lives only for 30 days (some of the planes have been updated to having a battery life of 90 days)

- Black box is not easy to find in the middle of the ocean even though it is orange in color.
- It does not float. - The box is made up of aluminium which helps in withstanding high pressure, fire etc. as a result of which the black box becomes very heavy.

VII CONCLUSIONS AND FUTURE SCOPE

The Black box is currently widely used in the airplanes, ships and satellites but the current Black Box cannot be used for real time operations, since there is no bandwidth that can carry such huge amount of data. A technology needs to be invented that can carry a subset of data, real time and Boeing has claimed to create such a technology and has patented for the same.

Along with the above demands, the Black Box should be able to transmit signals for 90 days when submerged in deep waters which can increase the chances of success of recovering the black box. The signal from the Black box should be able to reach the surface of the sea or ocean so that it can be picked up by floating receivers/transmitters. The floating device should be able to transmit data to SAR planes, ships or submarines or to the satellites sent into the zone or area to locate down the aircraft.

Lastly, the Black box should have its own power source to transmit signals so it is not dependent on the power of the plane and hence, can result in a secure collection and retrieval of data.

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