Black Box

Source: TH

Why in News?

The **Aircraft Accident Investigation Bureau (AAIB)** recovered **“black boxes”**, from the crash site of **Air India Flight Boeing 787-8 Dreamliner** airline in Ahmedabad.

What are Black Boxes and How do they Work?

- **About: It was invented in 1954** by Australian scientist **Dr. David Warren,** it **became mandatory in 1960**.
    - Black boxes in aviation are composed of two primary devices: **Digital Flight Data Recorder (DFDR)** and **Cockpit Voice Recorder (CVR) which continuously record data** during flight.
- **Key Features:** Despite its name suggesting black, it is painted **bright orange (**with **reflective tape** for visibility**), rectangular in shape** and **crash-resistant devices, designed to survive extreme impact and fire.**
    - It is made of strong substances such as **steel or titanium** and **placed towards the tail end of the aircraft**, where the impact of a crash is usually the least.
- **Working Mechanism: DFDR** records **important flight parameters** like **speed, altitude, engine performance, heading, and flight control movements** and stores data for the **last 25+ hours** of flight.
    - **CVR records audio from the cockpit**, including **conversations between pilots, alarms, and ambient sounds** and stores data for **at least 2 hours**.
        - This data is crucial for **identifying anomalies or failures** that may not be immediately obvious.
- **Limitations:** While black boxes are crucial in aviation accident investigations, they are **not infallible.**
    - In the case of **Malaysia Airlines Flight MH370 (2014)**, the **absence of detectable signals from the black box** hindered the search and investigation efforts.
    - Moreover, **black boxes lack video recording capability**, limiting a complete understanding of cockpit events.

Historical Evolution of Flight Recorders

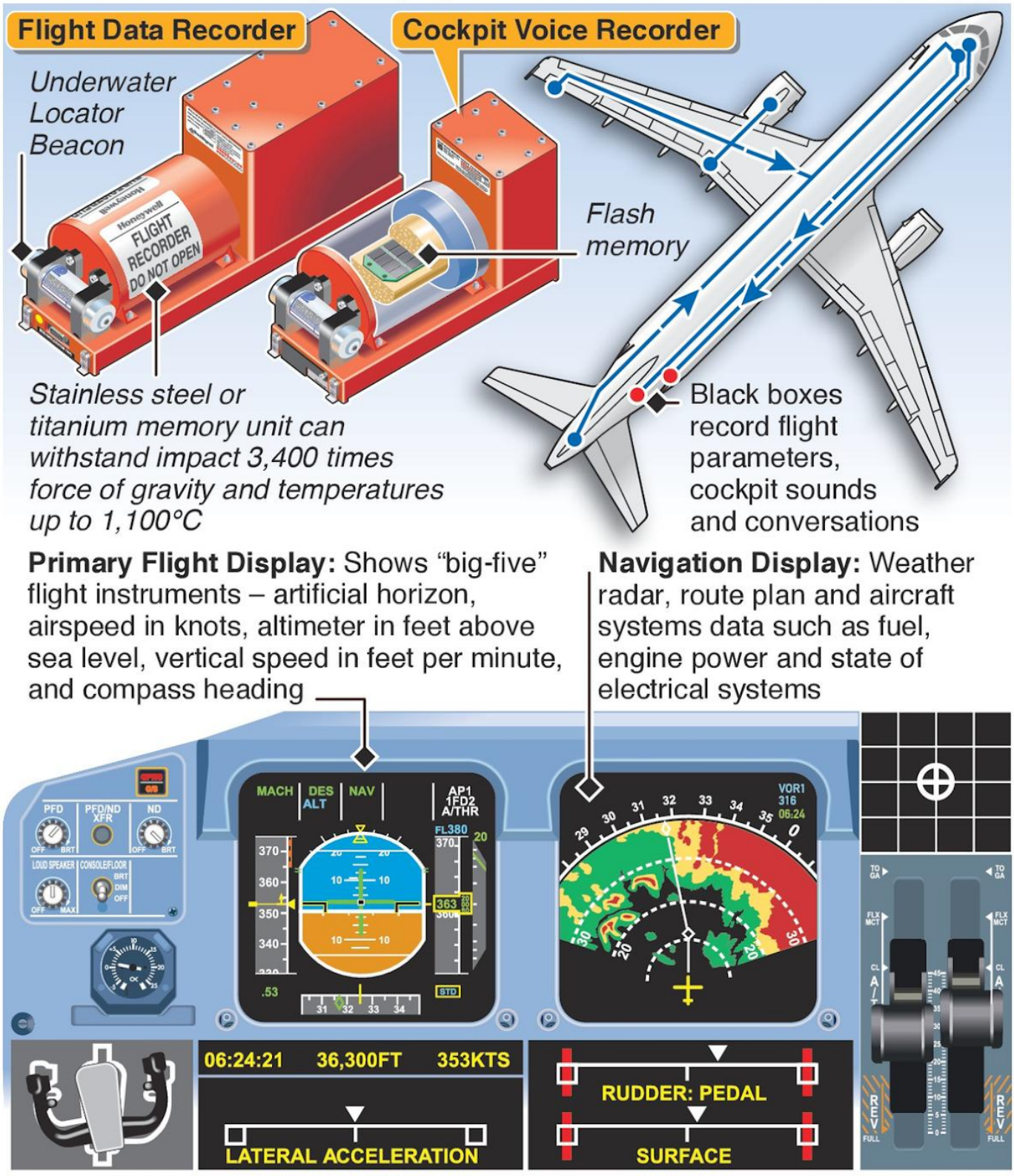
- **1950:** First generation **Flight Data Recorders (FDRs)** used metal foil to log data.
- **1953**: First commercial FDR sold by General Mills to Lockheed.
- **1954:** Dr. **David Warren (Australia)** invented the **modern FDR** after investigating Comet jet crashes.
- **1960:** FDRs and CVRs made mandatory in aircraft.
- **1965:** Mandated to be painted **bright orange/yellow for visibility.**
- **1990: Solid-state memory** replaced magnetic tapes for better durability.

Key Advancements in Flight Recorder Technology

- **Automatic Deployable Flight Recorders:** These units, placed in the t**ail section, combine voice and data recorders** with an **emergency locator transmitter (ELT)**.
    - They **deploy automatically during a crash, float on water, transmit location,** and aid faster search and rescue.
- **Autonomous Distress Tracking: New-generation ELTs** providing **real-time location tracking during distress**, reducing the risk of aircraft becoming untraceable.
- **Combined Voice & Data Recorders (CVDR):** In compliance with ICAO's mandate to extend **voice recording from 2 to 25 hours**, modern aircraft now use CVDRs that **store both flight and cockpit data**.

How black boxes reconstruct a crash

Information from an aircraft's flight data recorder and cockpit voice recorder – the so-called "black boxes" – is used to create an interactive animation of the flight displays in the final moments before a crash



Sources: CAE Flightscape, Honeywell ED-55 Flight Data Recording System

What is the Aircraft Accident Investigation Bureau (AAIB)?

- **About:** Established in **2012** under the **Ministry of Civil Aviatio**n, the **AAIB investigates aircraft accidents and serious incidents** in Indian airspace.
    - It ensures **independent, unbiased probes**, **separating investigation from regulation,** which was earlier handled by the **Directorate General of Civil Aviation (DGCA).**
- **Key Functions and Mandate:** As per the **Aircraft (Investigation of Accidents and Incidents) Rules, 2017**, AAIB i**nvestigates all civil aircraft accidents and serious incidents** involving aircraft **over 2250 kg** or those with **turbojet engines**.
    - It may also take up **other cases in the interest of public or aviation safety**.
    - Its core functions include **collecting and analysing evidence (e.g., black boxes, witness accounts), determining probable causes, issuing safety recommendations**, and **publishing final reports.**
    - Under **Rule 3**, the sole objective of AAIB investigations is **accident prevention, not assigning blame or liability.**

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