



FEDERATION OF INDIAN PILOTS

FIP/AAIB/26-08

05 Jun 2026

To:

The Director General
Aircraft Accident Investigation Bureau, GOI,
Udaan Bhawan, Sri Aurobindo Marg,
New Delhi – 110003

**TECHNICAL CLARIFICATION, ACARS MESSAGES AND RELATED
TECHNICAL ISSUES CONCERNING AI-171 CRASH ON 12 JUN 26**

Dear Sir,

1. Reference is drawn to the subject and to our earlier letter FIP/MOCA/26-03 dated 01 May 2026 (enclosed as Annexure 1). Reference is also invited to the earlier submissions:

(i) Letter dated 12 March 2026 highlighting the discrepancy regarding DFDR RAT deployment timing as per the Preliminary Report; with the timeline published in OEM documents (Refer Annexure 2)

(ii) Letter dated 17 March 2026 requesting simulator correlation of RAT imagery with the DFDR timeline and evaluation of technical-failure versus pilot-action scenarios (Refer Annexure 3);

(iii) technical note dated 01 May 2026 proposing OEM document reference technical pathway subsequent to an electrical disturbance after a lithium battery thermal runaway (Refer Annexure 4).

(iv) Correspondence dated 19 May 2026 drawing attention to witness accounts concerning Captain Sabharwal's control-column position,



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the absence of discussion thereof in the Preliminary Report, and the need for simulator validation of reported event timings (Refer Annexure 5).

2.Introduction: This submission puts on record ACARS maintenance messages transmitted before after the aircraft got airborne, a design feature in the FADEC that permits auto shutdown of both engines, and the correlation of this evidence with media described retrieval of Capt Sumeet Sabharwal's body along with the control column in his grasp pointing to a rebuttal of the pilot suicide theory being explored by the AAIB.

3. The undersigned has recently obtained the following additional technical information:

a) Ten ACARS maintenance messages reportedly transmitted by AI 171 after becoming airborne at approximately 08:08:39 UTC on 12 June 2025 (Annexure 6):

- 172050004 600
- 163600003 599
- 167330003 599
- 247450002 597
- 252490002 597
- 252390002 597
- 247460002 597
- 167280002 599
- 163840003 599
- 171060003 599

b) Publicly available US Patent US5279107A relating to FADEC/fuel-metering fail-safe logic (Refer Annexure 7), which states: "A failure in the minor loop results in the fuel flow being switched to a fail-safe fuel flow...for safety reasons, the fail-safe position for aircraft power plants is a minimum flow position...the minimum flow position of the metering valve may result in an in-flight shut-down (IFSD) of the engine (see embedded extract of Annex 7)



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“In essence the, the fuel control system is comprised of two feedback loops. The major loop includes a comparison of the sensed EPR to the EPR reference to produce the EPR error. The major loop includes the comparison of the sensed metering valve position to the DR to produce the DRE. A failure in the minor loop results in the fuel flow being switched to a fail-safe fuel flow. For safety reasons, the fail safe position for aircraft power plants is a minimum flow position. The minimum flow position of the metering valve may result in an in-flight shutdown (IFSD). It is desirable to minimize the IFSD rate by minimising the likelihood of a failure in fuel system”.

c) A news report in Caravan news magazine detailing ACARS messages transmitted from 15 minutes before departure and their possible import (Refer Annexure 8).

d) Multiple mainstream media reports have published witness accounts alleging that Captain Sumeet Sabharwal's body was recovered while still gripping the flight controls after the accident (Refer Annexure 9). Based upon the newly obtained maintenance-message information and the FADEC fail-safe logic described above, a second technical theory is respectfully submitted for examination.

e) Electrical disturbance involving abnormal current flow, arcing, insulation breakdown, or grounding-path current could propagate into the Boeing 787 Common Core avionics/network environment. Such propagation could temporarily disrupt or corrupt CCR/Common Core data channels supplying engine-interface information to both EEC systems, resulting in simultaneous FADEC protective-response logic and consequent in-flight shutdown (IFSD) of both engines (Annexures 6,7 and 8).

4. It is submitted that:

a) M/s Air India Ltd may be directed to submit the original ACARS maintenance messages transmitted by AI-171 to the ongoing inquiry before AAIB and DGCA and also clarify why these were not highlighted to your office to prevent premature attribution of pilot suicide theories which were leaked by "authorities" to foreign media.

b) M/s Boeing may be directed to decode and technically interpret



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the ACARS maintenance-message strings, as it is understood that the operator may not possess independent decoding capability for these maintenance message identifiers.

c) AAIB may kindly clarify whether the above ACARS messages were evaluated as causative factors before excluding technical causes in the Preliminary AAIB Report and giving a clean chit to M/s Boeing.

d) Since the mainstream Indian media reports of multiple witnesses stating that Captain Sabharwal's body was recovered with such a tight grip on the flight controls that the control column reportedly had to be cut and brought along to the mortuary would be consistent with continued recovery attempts during the final phase of flight, it may be investigated why the autopsy findings and the Preliminary Report did not discuss these reported observations.

e) Technical issues raised in FIP submissions dated 12 March 2026, 17 March 2026, 01 May 2026 and 19 May 2026—including RAT deployment chronology, DFDR time-reference reconciliation, simulator validation of reported event sequences, electrical-system failure pathways and witness observations—may be specifically addressed in the Final Report together with the Bureau's findings on each issue.

f) ICAO Doc 9756, Part III, Chapter 1, Paragraph 1.1 **states that accident investigation is a systematic process whereby all possible causes of an adverse event are evaluated and eliminated until the remaining causes are identified as applicable to the investigation.**

5. Accordingly, technical discrepancies associated with RAT deployment chronology should be clarified and probable causes due to electrical-system failure pathways and the ACARS maintenance messages transmitted before and after the aircraft became airborne should not be excluded and until detailed responses from M/s Boeing and M/s Air India should be examined, decoded, cross-validated and analysed by the AAIB to determine whether any associated limitations, failures or operational conditions could have materially contributed to the accident.



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6. It is earnestly requested that the ICAO Annex 13 does not stipulate that the investigative agency needs to submit an “**INTERIM REPORT**”. The **INTERIM REPORT** will lead to greater confusion and speculations. Such an action could be detrimental to the investigations being done by the AAIB. Moreover, such a report cannot be conclusive due to further investigations being carried out. Thus, please do not take out the **INTERIM REPORT** in the overall interest of **SAFETY**.

Submitted for your consideration and necessary action.

Yours sincerely

Warm Regards,
CAPT CS RANDHAWA,
PRESIDENT, FIP

Copy To:

1. Minister of Civil Aviation, Rajiv Gandhi Bhawan, New Delhi
2. PMO Office, South Block, New Delhi – 110011
3. Secretary Ministry of Civil Aviation
4. DG, DGCA

Encls: Annex 1 – FIP Letter FIP/MOCA/26-03 dated 01 May 26.

Annex 2 – FIP Letter dated 12 March 2026 (RAT Timing clarification)

Annex 3 – FIP Letter dated 17 March 2026 (Simulator Correlation)

Annex 4 – FIP Technical Note dated 01 May 2026 (Electrical Reverse Voltage Pathway Theory)

Annex 5 – FIP Correspondence dated 19 May 2026 (Control Column Issues)

Annex 6 – AI 171 ACARS Maintenance Messages

Annex 7 – US Patent US5279107A

Annex 8 – Media report on pre-take-off ACARS messages and their significance

Annex 9 – Media Reports / Witness Accounts of Control column recovery along with Capt. Sumeet's body.



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FIP/MOCA/26-03

01 May 2026

**Minister of Civil Aviation,
Ministry of Civil Aviation,
MOCA, Rajiv Gandhi Bhawan,
Sri Aurobindo Marg,
New Delhi-110003**

**TECHNICAL NOTE IN COMPLIANCE OF ANNEX 13 I.R.O AIR INDIA
171 ACCIDENT OF 12TH JUNE 2025, PROPOSING OEM/ INCIDENT
INVESTIGATION REPORT EVIDENCE LED ELECTRICAL REVERSE
VOLTAGE PATHWAY DUE TO BATTERY SHORT CIRCUIT AS A
CREDIBLE CAUSE FOR DUAL ENGINE FUEL SWITCHES TRANSITION
TO CUTOFF.**

Respected Sir,

1. Reference is drawn to the subject and annexures. Also, refer to our previous emails dated 12 and 22 Mar 26.
2. **Introduction:** The Federation of Indian Pilots, vide letter dated 12 March 2026, informed the AAIB that Ahmedabad Airport security camera images show that the RAT is deployed during the take-off roll (Refer Annexure 1), suggesting a pre-lift-off technical issue. Manual deployment is unlikely, as the system is automatic with guarded control. Media reports (Annexure 2) continue to suggest pilot action; however, the International Civil Aviation Organisation Annex 13 requires all credible technical causes be ruled out first. This Technical Note suggests a credible cause.
3. **Proposed Mechanism:** Aircraft DC electrical systems require a steady positive supply and ground (return). If disturbed, systems may behave abnormally. As per OEM Hamilton Sundstrand B 787 documentation (Refer Annexure 4, Image 3), the RAT deployment occurs after loss of power to:
 - a) Captain and First Officer's instrument buses
 - b) C1 or C2 TRUs
4. Once the RAT deploys, the Captain and First Officer instrument buses are connected through the Captain Instrument Transfer



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- (CIT) and First Officer Instrument Transfer (FIT) contactors, creating a common return path for current, allowing any electrical disturbance to affect both engines (Refer Annexure 4, Image 3).
5. Although system safeguards exist (generator separation, protection devices, and independent channels), a high-current disturbance in the common return path can still affect multiple systems simultaneously as follows:
- a) Boeing 787 battery failures, investigated by the Japan Transport Safety Board (Takamatsu, 2013; Annexure 3) and the National Transportation Safety Board (Boston, 2013; Annexure 6), documented “electrical arcing between a cell case and the battery case”, “current flow... between 44 and 45 amperes into the battery”, and damage “consistent with resistive heating”, with “the appearance of the cell case and the adherence of the electrodes were consistent with localized heating, melting, separation, and solidification ..from electrical arcing” (Refer highlighted text pp. 11, 13–14, 24, 79 Annexure 6).
 - b) When high current flows through a resistive return path, the voltage of the ground point rises as per Ohm’s Law ($V = I \times R$). If the battery supply to the relay drops due to a short circuit, the voltage across the relay coils may reverse.
 - c) The Boeing 787 fuel system uses dual-coil latching relays. Leach International (a typical aerospace relay manufacturer) states, “Relay will not be damaged by applying reverse voltage to the coil, although the relay may transfer” (Refer Annexure 5, Image 4, para 8). These relays control the fuel shutoff and spar valves (Refer Annexure 4, Image 1).
 - d) With a common return path after RAT deployment, **reversal of voltage across the dual-coil relay energises the cut-off path driving the spar valve closed**, as shown in the Fuel Relay (P300) to Spar Valve section of the diagram, **which can affect both engines, causing near-simultaneous switching from RUN to CUTOFF without pilot input** (Refer Annexure 4, Image 2).
6. **Timeline Consistency:** Fuel cut-off at ~08:08:43 UTC and RAT hydraulic power at ~08:08:47 UTC (Refer Aircraft Accident Investigation Bureau Preliminary Report) show a 4-second gap; as “the RAT deploys and supplies hydraulic power in 6 seconds”, it must have deployed earlier, matching take-off-roll photos (Refer Annexure 1 & 7).
7. **Conclusion:** Based on lithium-ion battery failures, relay behaviour



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under abnormal voltage, and Boeing 787 electrical design, a pre-lift-off electrical disturbance could have caused unintended relay operation and dual engine fuel cut-off without pilot input.

8. **Submission:** It is submitted that this may be treated as a testable hypothesis and examined through detailed electrical analysis by IIT Bombay, Aeronautical Development Agency, or Hindustan Aeronautics Limited. Technical causes cannot be ruled out till this analysis is made. Also, in our last letters and emails we had requested the verification of the timings as given in the preliminary report of AAIB by carrying out a simulator session on B-787.

With warm regards,

(Capt. CS Randhawa)
President FIP

Encls:

Annexure 1– RAT Deployment Evidence: Ground photographic sequence showing RAT deployed during take-off roll.

Annexure 2: India Today report quoting Corriere Della speculative report of 12.2.26 on pilot action.

Annexure 3– Battery Failure Mechanism (Takamatsu): JTSB Takamatsu Report (2013), documenting internal short circuit and grounding path formation.

Annexure 4– Electrical & Fuel Control Architecture: B 787Powerplant, Engine, Fuel & Control, and Engine Controls – Powerplant Book 2 of 3, GEnx Engine, GE Engines – Control (2) General Description 787 Training Lab Notebook (image 1), Boeing 787 Electrical Power Distribution – 235V AC and 28V DC Control of Spar Valve (Fuel Shutoff System schematic (image 2), B 787 Document Section 24-41-00, Page 32 | Revision: 2011 MAR 14 (image 3)

Annexure 5 – Relay Behaviour: Leach KL Series relay datasheet.



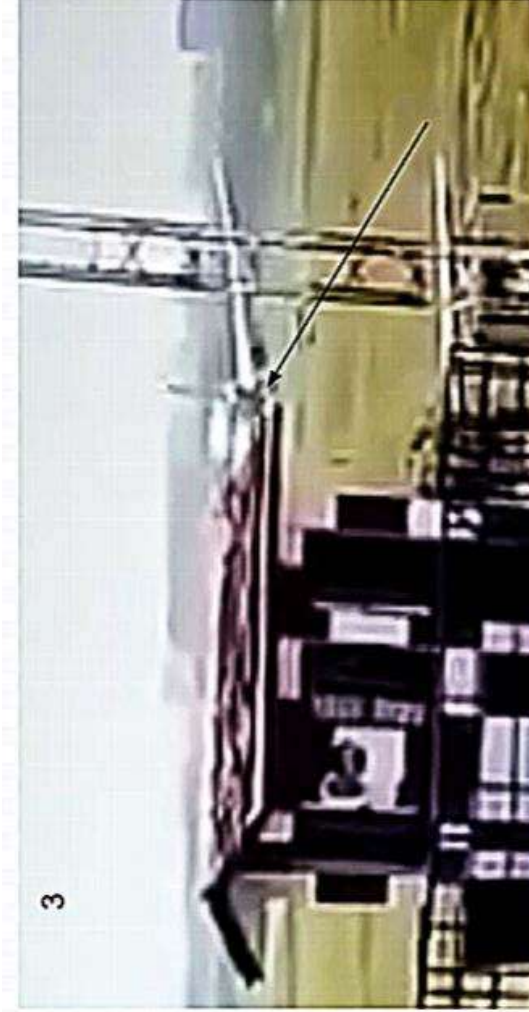
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Annexure 6 – Battery Electrical Effects (Boston); NTSB Report No. NTSB/AIR-14/01, Auxiliary Power Unit Battery Fire, Japan Airlines Boeing 787-8, JA829J, Boston, Massachusetts, January 2013
Referenced sections: pp. 11, 13–14, and 79.

Annexure 7 -Part 147 “TECHNIC DREAMLINER – ATA 29 HYDRAULIC POWER” Engineering Training Manual internal page ~174/235

Copy To:

1. **DG AAIB**, Udaan Bhawan, Safdarjung Airport, New Delhi – 110003
2. **Secretary**, MOCA, Rajiv Gandhi Bhawan, New Delhi-110003
3. **DG, DGCA**, Sri Aurobindo Marg, New Delhi-110003
4. **PMO Office**, South Block, Raisina Hill, New Delhi - 110011





AI-171 probe not concluded, says AAIB; warns against speculative reporting (Photo: ITG)



Amit Bhardwaj



New Delhi, UPDATED: Feb 12, 2026 21:06 IST

Edited By: Priyanka Kumari

ANNEX - 2



AIssist



Summarise This



Listen



Post a Reaction



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The Aircraft Accident Investigation Bureau (AAIB) on Thursday dismissed an Italian media report that claimed the probe into the Air India Flight AI-171 crash had concluded the disaster was the result of an “intentional act”, calling such suggestions “incorrect and speculative”.

Responding to [a report by Italian daily *Corriere della Sera*](#), which cited unnamed sources as saying investigators had ruled out technical failure and were preparing a final report, the aviation accident probe body said the investigation remains underway and no final conclusions have been reached.

SYNOPSIS

Summary of the Serious Incident

On January 16 (Wednesday), 2013, a Boeing 787-8, operated by All Nippon Airways Co., LTD., registered JA804A, took off from Yamaguchi Ube Airport for Tokyo international Airport at 08:11 local time as its scheduled flight 692. When it was climbing through 32,000 ft over Shikoku Island, an EICAS message of battery failure came on at 08:27 accompanied by unusual smell in the cockpit. The airplane diverted to Takamatsu Airport and landed there at 08:47. An emergency evacuation was executed using slides on T4 taxiway at 08:49.

Four passengers out of 137 occupants (the Captain, seven crewmembers and 129 passengers) suffered minor injuries during the evacuation.

Although the main battery was damaged, it did not lead to a fire.

Incidentally, a similar incident had occurred prior to Takamatsu event by nine days in the United States, on January 7, 2013 (Eastern Standard Time) at Logan International Airport, Boston, Massachusetts.

About one year after the serious incident, another similar main battery incident occurred at Narita International Airport on January 14, 2014.

Probable Causes

The emergency evacuation was executed on Takamatsu Airport taxiway in the serious incident, which was a consequence of emergency landing deriving from the main battery thermal runaway during the airplane's takeoff climb.

Internal heat generation in cell 6 very likely developed into venting, making it the initiating cell, resulting in cell-to-cell propagation and subsequent failure of the main battery. It is very likely that cell 6 internal heat generation and increased internal pressure caused it to swell, melt the surrounding insulation material and contact the brace bar creating a grounding path that allowed high currents to flow through the battery box. The currents generated arcing internal to the battery that contributed to cell-to-cell propagation consequently destroying the battery.

Cell 6 heat generation was probably caused by internal short circuit; however, the conclusive mechanism thereof was not identified.

In the serious incident, the internal short circuit of a cell developed into cell heat generation, thermal propagation to other cells, and consequently damaged the whole battery. The possible contributing factors to the thermal propagation are that the test conducted during the developmental phase did not appropriately simulate the on-board configuration, and the effects of internal short circuit were underestimated.

Safety Recommendations

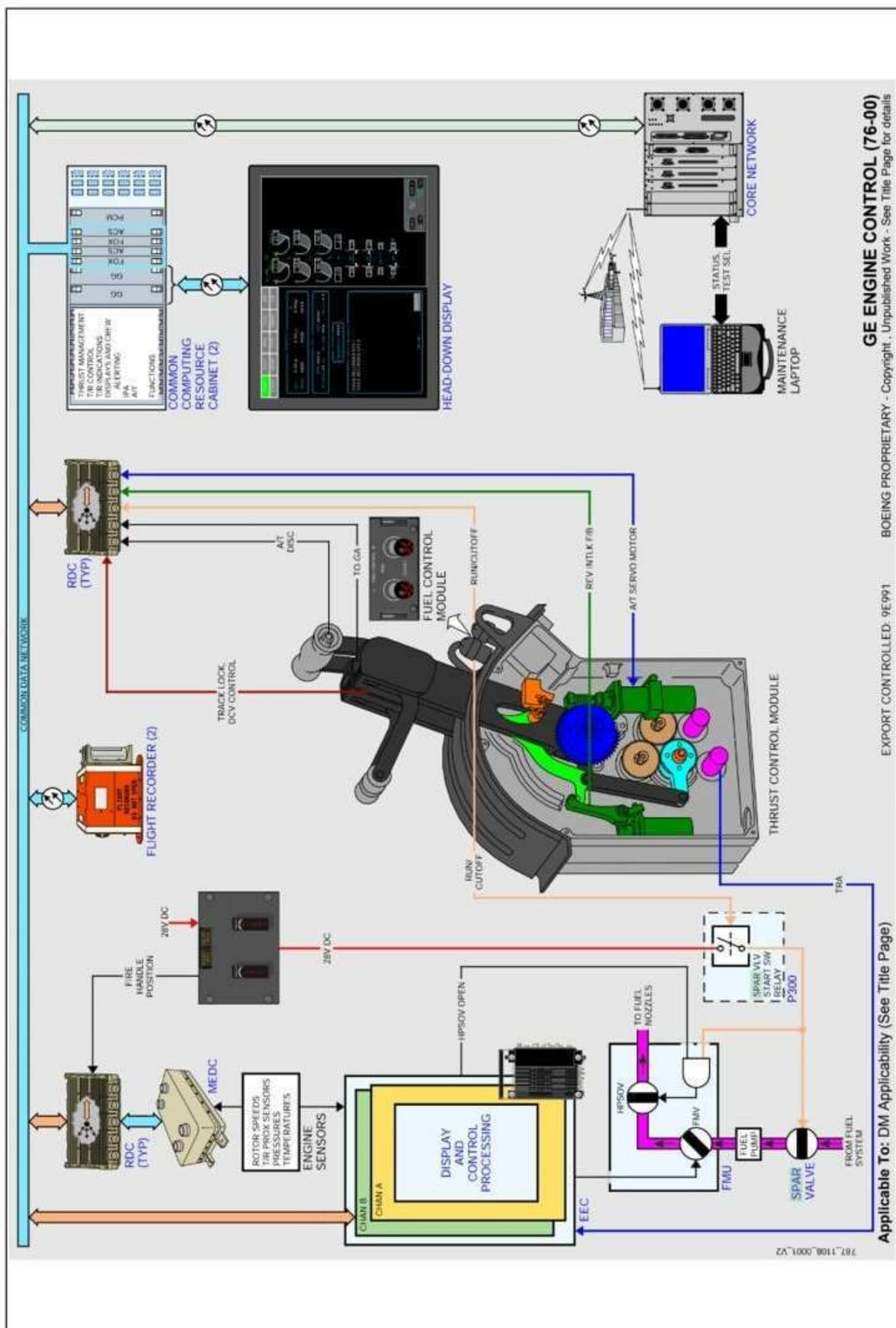
1. Actions to be taken by the Federal Aviation Administration

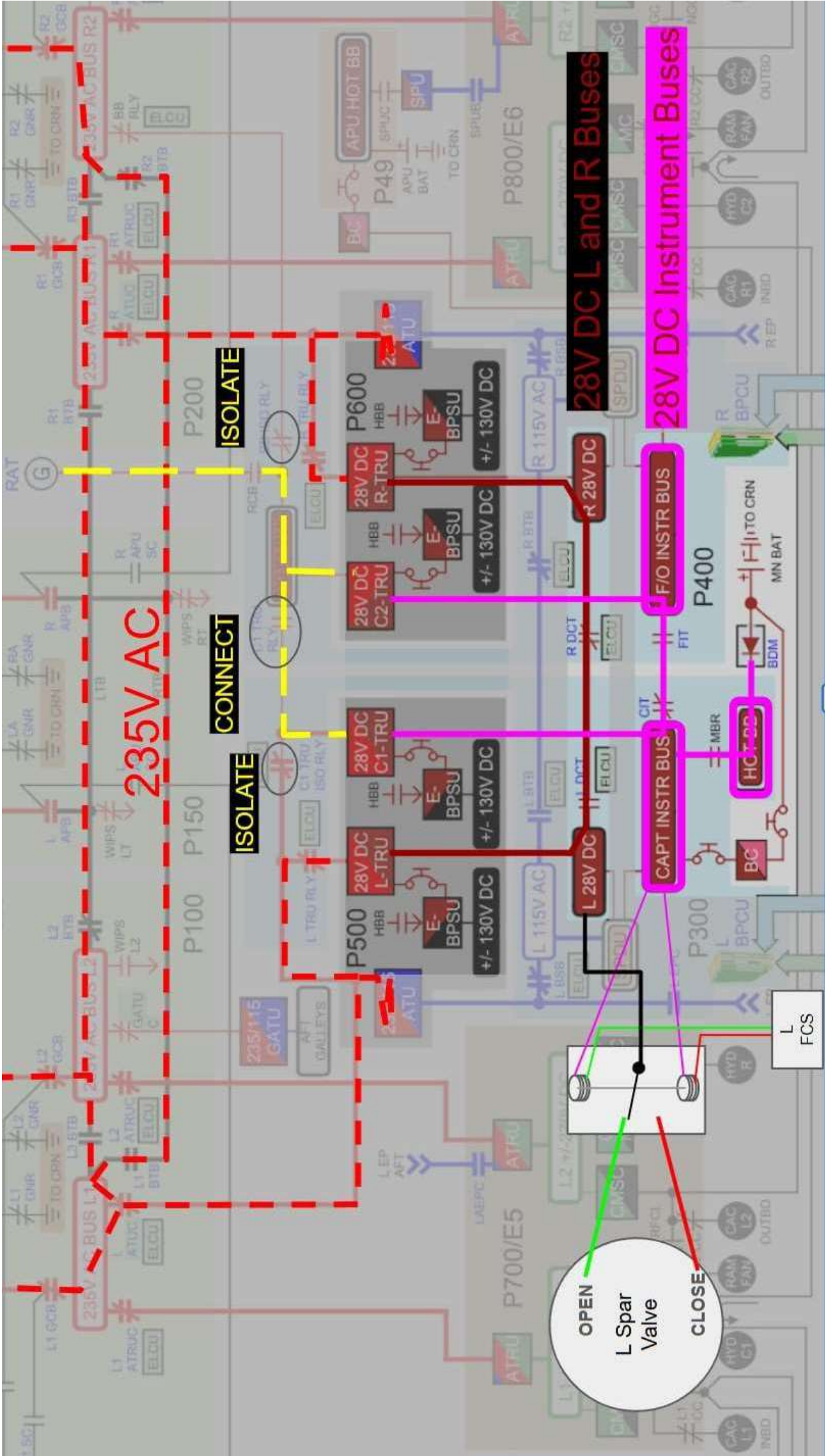
The internal short circuit test by nail penetration method under the simulated on-board configuration with the battery ground wire demonstrated a thermal runaway, while the test without the ground wire did not.

Given the facts and analyses of other tests combined, in the serious incident the

IMAGE 2

BOEING PROPRIETARY - Copyright, Unpublished Work - See Title Page for details
BOEING PROPRIETARY - Copyright ©- See Title Page for details





235V AC

28V DC L and R Buses

28V DC Instrument Buses

ISOLATE

CONNECT

ISOLATE

OPEN
L Spar Valve
CLOSE

L FCS



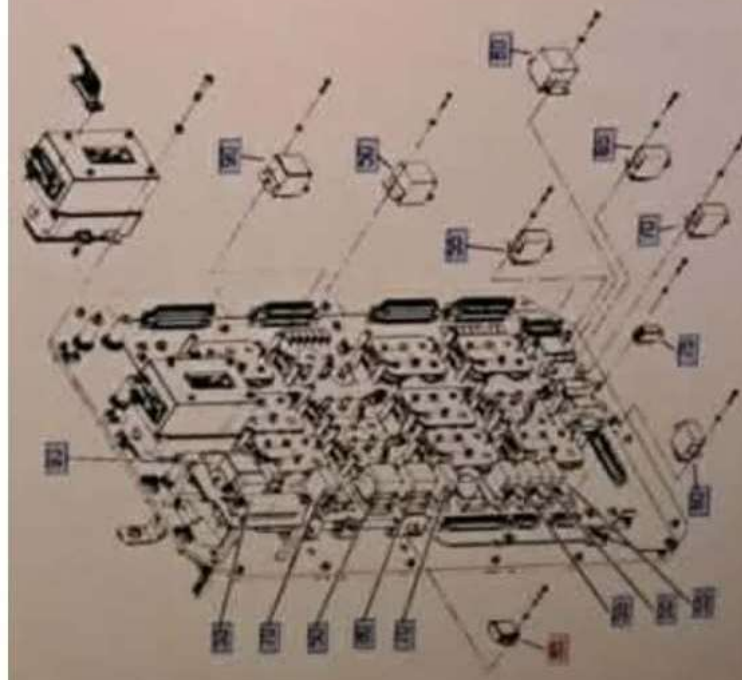
- The BPCU manages the Standby Operating Mode to ensure the Backup Bus (BB) and critical loads are powered.
- Each BPCU independently requests RAT deployment and go into Standby Operating Mode 15 seconds after detecting a continuous loss of source power to the BB and Captain's and First Officer's Instrument buses in any of the following conditions:
 - Continuous loss of 235 VAC Bus L1 and loss of BB
 - L ATUC open and loss of BB
 - C1 TRU Isolation Relay and BB Isolation Relay fail to close
- The RAT deploys automatically in the air when C1 or C2 TRUs lose power, loss of hydraulic power, or loss of all engines.
- The RAT deployment request is communicated through the CDN to the Hydraulics, Controllers which command a RAT deploy within 200 msec of receiving the request from either BPCU.
- The RAT deployment request is inhibited when not in Air mode.
- Standby Operating Mode is also entered when the RAT Circuit Breaker (RCB) is closed and no AC buses are powered.
- Standby Operating Mode is reset if any AC bus is powered from another source or the airplane is on the ground and Main Battery Switch is Off.
- In Standby Operating Mode, with primary electrical power unavailable and regardless of RAT availability, the MBR is closed and the instrument buses paralleled through closure of the CIT and FIT contactors, even if a main battery fault or main battery discharge inhibits exist.
- Other protections (e.g., overcurrent) or control functions (e.g., Electrical System Indication Control (ESIC) lockouts) are not affected or prevented by Standby Operating Mode.
- Transitions between standby and battery only mode do not cause a power interrupt to the battery only mode loads.
- If the RAT is deployed for checkout purposes, the system prevents the RAT generator from supplying the BB while 235 VAC Bus R2 is available.
- The RCB control is electrically interlocked with the BB Iso Rly, preventing the RCB from closing if the BPCU has not opened the BB Iso Rly.
- If the RAT is powering the C1 TRU/C2 TRU and a VFSG or ASG are commanded on during Standby Operating Mode, the Captains Instrument Bus and the F/O Instrument Bus continue to be powered from the RAT.
 - This configuration is terminated when the RAT Generator drops offline.

24-41-00

RELAY	REFERENCE DESIGNATOR	RATING	VOLTAGE	TYPE	
RLY ENG TR DCV L	K7834811	5A	28VDC	2PDT	HELD
RLY EEC ALT PWR L	K7321101	2.5A	28VDC	2PDT	HELD
RLY ENG IGN L1	K7411811	15A	28VDC	2PDT	HELD
RLY ENG IGN L2	K7411812	15A	28VDC	2PDT	HELD
RELAY FRIT SPAR VLV START SWITCH/AIR GND LEFT	K7621801	15A	28VDC	2PDT	HELD
ALTN EXT RELAY B	K3235020	50A	28VDC	1PDT + 1PST NO	HELD
ALTN EXT RELAY A	K3235010	50A	28VDC	1PDT + 1PST NO	HELD
PITOT PROBE HTR L	K3031310	15A	115VAC	2PDT	HELD
WDO HT 1R BU	K3041402	25A	115VAC	3PDT	HELD
WDO HT 2R	K3041404	25A	115VAC	3PDT	HELD
APU REMOTE WARNING	K2615401	15A	28VDC	2PDT	HELD
APU EXT SHUTDOWN RELAY MASTER	K2615404	15A	28VDC	4PDT	HELD
APU EXT SHUTDOWN RELAY SLAVE	K2615405	15A	28VDC	2PDT	HELD
APU FIRE EXT BTL AUTO DISCHARGE	K2622403	10A	28VDC	2PDT	HELD T/D 10s
GROUND CREW CALL HORN TRANSFER RELAY	K4443001	2A	28VDC	2PDT	HELD T/D 10s
GROUND CREW CALL HORN PWR SUPPLY	K4443002	2A	28VDC	2PDT	HELD
RELAY ENG FUEL CONT #2 LEFT	K7621102	2A	28VDC	4PDT	LATCH
RELAY ENG FUEL CONT #1 LEFT	K7621101	2A	28VDC	4PDT	LATCH
RELAY ENG FUEL CONT T/D #2 LEFT	K7621104	2A	28VDC	2PDT	HELD T/D 250ms
RELAY ENG FUEL CONT T/D #1 LEFT	K7621103	2A	28VDC	2PDT	HELD T/D 250ms
NLG CTRL SYS 1	K3234001	10A	28VDC	2PDT	LATCH
NLG BYPASS/OFF SYS 1	K3235031	10A	28VDC	2PDT	LATCH
NLG DR CLOSE SYS 1	K3235035	10A	28VDC	2PDT	LATCH
RESET SYS 1	K3235039	15A	28VDC	2PDT	HELD
FLT OK GND PWR TOW RLY	K2431804	15A	28VDC	4PDT	HELD

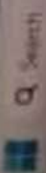
24-51-00

Change Type	Fig Item	Part Number	Nomenclature	Effect From To Upd
	85	7000292-139	RELAY ASSY SUPPLIER CODE 09167 Supplier Code : 99167 HAMILTON SUNSTRAND CORPORATION 4747 HARRISON AVE ROCKFORD, IL 61108-7929 FORMERLY 09284	25, 26, 28, 30, 32, 35, 40, 54, 60, 65, 72, 90, 91, 158, 180, 208, 232, 250, 273, 311, 489
	85	7000292-140	RELAY ASSY SUPPLIER CODE 99167 MISCELLANEOUS DATA 376B402DF28VCC IS IDENTICAL TO 7000292-140 FOR SPARES PROCEDURE 7000292-140 DESIGN ROLE REFERENCE DESIGNATOR K7621102 USED ON 7000292-749 09167 MAINTENANCE MANUAL REF 24 106 84	25, 26, 28, 30, 32, 35, 40, 54, 60, 65, 72, 90, 91, 158, 180, 208, 232, 250, 273, 311, 489, 511, 579, 592, 595, 610, 975, 993, 1027, 1049, 1107, 1145, 1251



(A)

▲ THUMBNAILS ▲

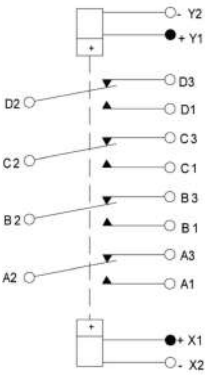


Cross Reference | NSN 5945-00-528-9724

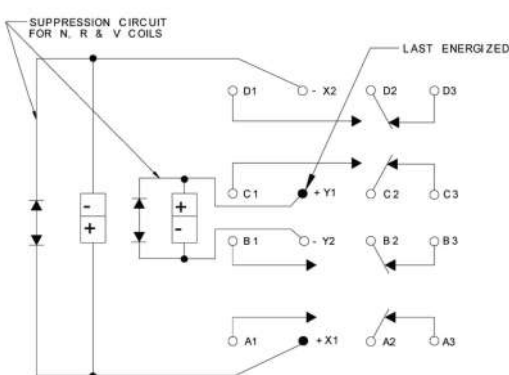
Part Number	Cage Code	Manufacturer
939D685-5	83843	SUNDSTRAND CORP ELECTRIC POWER SYSTEMS DIV
939D685-5	99167	HAMILTON SUNDSTRAND CORPORATION
DA1L010	58657	LEACH INTERNATIONAL CORPORATION DBA LEACH INTERNATIONAL NORTH

SCHEMATIC DIAGRAM

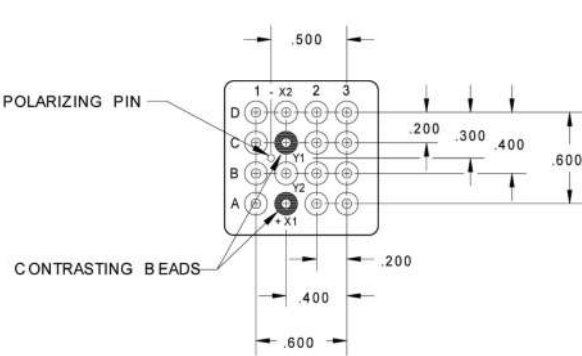
SCHEMATIC DIAGRAM



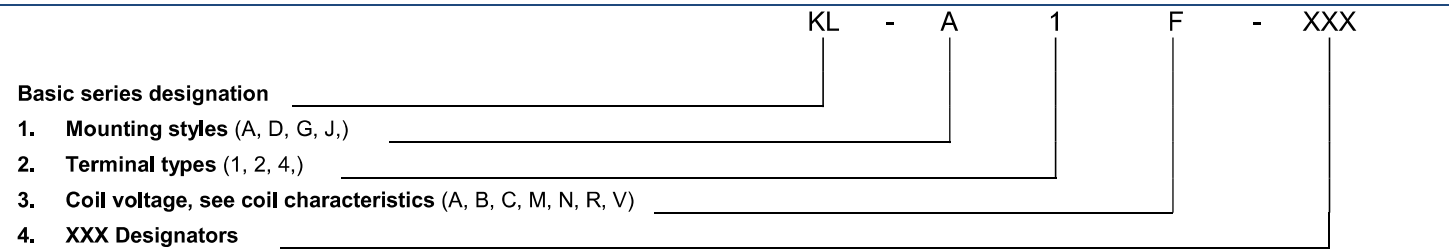
WIRING DIAGRAM



STANDARD TERMINAL LAYOUT



NUMBERING SYSTEM



NOTES

1. Standard Intermediate current test applicable.
2. 500 Vrms with silicone gasket compressed, 350 Vrms all other conditions.
3. Applicable military specification: MIL-PRF-83536
4. Special models available: Dry circuit, established reliability testing, etc.
5. Inductive load life, 20,000 cycles.
6. 60 Hz load life, 10,000 cycles.
7. "N, R, V & W" coils have back EMF suppression to -5 volts maximum.
8. Relay will not be damaged by applying reverse voltage to the coil, although the relay may transfer.
9. Time current relay characteristics per MIL-PRF-83536/18 & /19.

For any inquiries, please contact your local sales representative: leachcorp.com

The APU controller operates the valves, motors, and sensors that control the operation of the APU and contains nonvolatile memory to record various APU parameters, including battery voltage. The APU controller in the 787 airplane is located near the bulk cargo door on the right side of the aft fuselage (where it is separated from the APU battery and the BCU). The incident APU controller was manufactured by Hamilton Sundstrand.¹⁸ Examination and testing (as part of obtaining the nonvolatile memory) showed that the APU controller operated normally and that the APU's function did not affect the battery's operation at the time of the failure.

The start power unit (SPU) converts DC battery power to AC power for starting the APU and provides excitation power for the APU during startup. The SPU of the incident airplane was manufactured by Securaplane Technologies. ATP testing of the SPU found no anomalies, and the SPU's function did not affect the battery's operation at the time of the failure.

1.2.3 Postincident Airplane Examination

The aft E/E bay (the APU battery installation location) showed damage consistent with heat generated from the APU battery and smoke, hot gases, and electrolyte discharged from the battery. Evidence of material expelled from the battery (in the form of residue and **thermal damage**) was observed in an area that extended about 20 in from the battery installation. No primary structures (that is, those associated with airplane flight loads) exhibited damage; secondary structures—specifically, the avionics rack and the floor panel—exhibited thermal damage near the APU battery's installation location.¹⁹

The wires that connected to the battery case had been thermally damaged, and the front of the battery case showed thermal damage near the J1 and J3 connectors, where the mechanic's drawing indicated two small flames. The shielded bundle of signal wires, which were the circuits between the BMU and BCU, had burned away from the J1 connector. The copper conductors and shield braiding were melted, which was consistent with resistive heating due to high levels of electrical current (beyond the level that the wires were capable of carrying). The single wire designed to be the battery case ground wire (an intended electrical ground path) remained connected at each end, with the wire insulation partially melted and slightly blackened on the interior surface, which was also consistent with **resistive heating due to high levels of electrical current**.

The aft E/E bay contains electrical cabinets (referred to as panels) that house components used to distribute electrical power from each engine and the APU. The panel labeled P49 is the source of electrical power distribution for the APU battery bus. No physical damage was noted to the P49 panel. When the circuit breakers on the P49 panel were disengaged, continuity checks of the circuit breakers, contactors, and battery cables to the BCU and battery bus revealed no faults.

The environmental control system (ECS) on the incident airplane was designed to provide pressurized and heated or cooled air to the 787 passenger cabin and E/E bays. The ECS

¹⁸ Hamilton Sundstrand later merged with Goodrich Corporation to form UTC Aerospace Systems.

¹⁹ The avionics rack separated the APU battery from the BCU.

On January 14, 2014, an LVP65-8-403 main battery failed on a JAL 787 airplane that was parked at a gate at NRT. (The airplane was being prepared for scheduled flight.) The Japan Civil Aviation Bureau is investigating this incident with assistance from the JTSC and the NTSB. Maintenance personnel reported seeing smoke outside the cockpit window. Preliminary information indicated that one cell had overheated and vented electrolyte and that the enclosure for the battery case contained the vented electrolyte.

1.3 Flight Recorders

The BOS incident airplane was equipped with forward and aft General Electric model EAFR 2100 enhanced airborne flight recorders (EAFR), which recorded cockpit voice recorder (CVR) audio data and FDR parametric data.²⁵ The forward and aft recorders, which were powered by the left and right 28-volt DC buses, respectively, recorded the same set of flight data independently of each other. The forward recorder had an independent power supply to provide backup power to the recorder for about 10 min if the left 28-volt DC bus lost power.²⁶ (The aft recorder had no backup power supply.)

The CVR portion of the EAFR recorded 2 hours of audio data from the cockpit area microphone, the captain's audio selector panel/hot microphone, the first officer's audio selector panel/hot microphone, and the jumpseat/observer's position. The audio information from the forward recorder was used to produce a transcription summary for this incident. The summary began at 0828:21, when the airplane was level in cruise flight at 39,000 ft, and ended at 1031:35, when the forward EAFR stopped recording.

According to the transcription summary, at 1021:41, the CVR recorded sounds associated with the APU shutting down. Conversations among maintenance personnel and the turnaround coordinator about the APU shutdown began about 9 seconds later. At 1024:10, the turnaround coordinator reported smoke in the cabin. No voices were heard on the CVR from 1024:22 to the end of the recording (1031:35).

FDR data before 1021:01 showed no abnormal voltage or current indications. At 1021:01, the voltage of the APU battery decreased from 32 to 31 volts. Three seconds later, the data showed a change in current flow from 3 amperes out of the battery to between 44 and 45 amperes into the battery.²⁷ The current flow into the battery occurred for about 4 seconds; the remainder of the recording showed either no current flow or current flow out of the battery. Between 1021:07 and 1021:09, the battery voltage continued to decrease. At 1021:10, the battery voltage returned to 31 volts. At 1021:27, the battery voltage began decreasing again, reaching

²⁵ Specifically, the EAFR is a multifunction recorder that records flight (FDR) data; audio (CVR) data; and communication, navigation, and surveillance air traffic management messages. The EAFR is a new recording system with a new flight data recording format that allows multiple predefined frames of data that can vary in length and structure. This format provides more flexibility for storing data than older formats that use a single fixed-frame length and structure. The EAFR is currently installed only on 787 airplanes.

²⁶ A lithium-ion battery was used for the recorder independent power supply.

²⁷ This behavior was consistent with the BCU attempting to charge the battery.

28 volts at 1021:30, and the APU shut down 7 seconds later.²⁸ Table 2 shows selected events recorded before and after the APU shutdown. The FDR did not record any data indicating that the APU battery voltage had exceeded 32 volts.

Table 2. Events surrounding APU shutdown.

Time	Event
1000:24	Airplane touched down.
1004:10	APU started.
1006:15	Airplane completed turn into parking location.
1006:48	Parking brake set.
1006:52	Engine 1 shut down.
1006:54	Engine 2 shut down.
1021:01	APU battery bus voltage decreased from 32 to 31 volts.
1021:04	APU battery current increased from 3 amperes out of the battery to between 44 and 45 amperes into the battery.
1021:07	APU battery bus voltage decreased to 30 volts.
1021:08	APU battery current flow returned to 3 amperes out of the battery.
1021:09	APU battery bus voltage decreased to 29 volts.
1021:10	APU battery bus voltage increased to 31 volts.
1021:15	Engine indicating and crew alerting system (EICAS) message discrete indicated that the APU battery failed.
1021:27	APU battery bus voltage began decreasing 1 volt per second during the next 3 seconds.
1021:30	APU battery bus voltage reached 28 volts.
1021:37	APU battery bus voltage decreased to zero volts and returned to 28 volts three times, and APU battery current began to move between zero and 4 to 5 amperes out of the battery.
1021:37	APU controller went offline, and APU had shut down.
1021:37	Aft EAFR stopped recording. Forward EAFR continued recording for about 9 min 58 seconds.
1021:40	EICAS message discretes indicated that the left and right 1 and 2 AC buses became unpowered.
1021:41	EICAS message discrete showed that the APU battery failure was no longer indicated.
1022:00	EICAS message discrete indicated that the main battery was discharging.
1022:10	APU controller went back online.
1022:53	EICAS message discrete indicated that the main battery power switch was off.
1023:16	Airplane systems providing data to the EAFR had shut down.
1031:35	Forward EAFR stopped recording.

Note: The APU controller is the source of 32 recorded parameters, including APU shaft speed and APU battery bus voltage.

The EAFR has an integral flight data acquisition function, which receives data from various sources and then transmits those data to the FDR function according to a predetermined schedule for storage into crash-protected memory. If no new value has been received since the last time that a parameter's value was sent to the FDR function, the flight data acquisition function continues to transmit the last value received from the source. These data are referred to as "stale data."

For some parameters, the flight data acquisition function has multiple prioritized data sources from which it receives parameter values. For these parameters, a separate source index

²⁸ Key parameters that showed the APU battery failure and APU shutdown are presented in figure 2 of the FDR Group Chairman's Factual Report, which is available at www.nts.gov in the public docket for this incident (DCA13IA037). The EAFR records two parameters that indicate the APU battery voltage. Details about the sources of these parameters (APU_Batt_VDC_A and DCBus_APU_Battery_Volts) are included in addendum 1 of the FDR Group Chairman's Factual Report.

also impact aircraft safety if an operator's maintenance activities were based on these data.

11. The poor audio recording quality of the enhanced airborne flight recorder could impede future aircraft investigations because the recorded conversations and other cockpit sounds might be obscured.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of this incident was an internal short circuit within a cell of the auxiliary power unit (APU) lithium-ion battery, which led to thermal runaway that cascaded to adjacent cells, resulting in the release of smoke and fire. The incident resulted from Boeing's failure to incorporate design requirements to mitigate the most severe effects of an internal short circuit within an APU battery cell and the Federal Aviation Administration's failure to identify this design deficiency during the type design certification process.

temperature of the separator material. Sections 1.4.5.1 through 1.4.5.4 provide additional details about the teardown of cells 5 through 8, respectively.⁴⁰

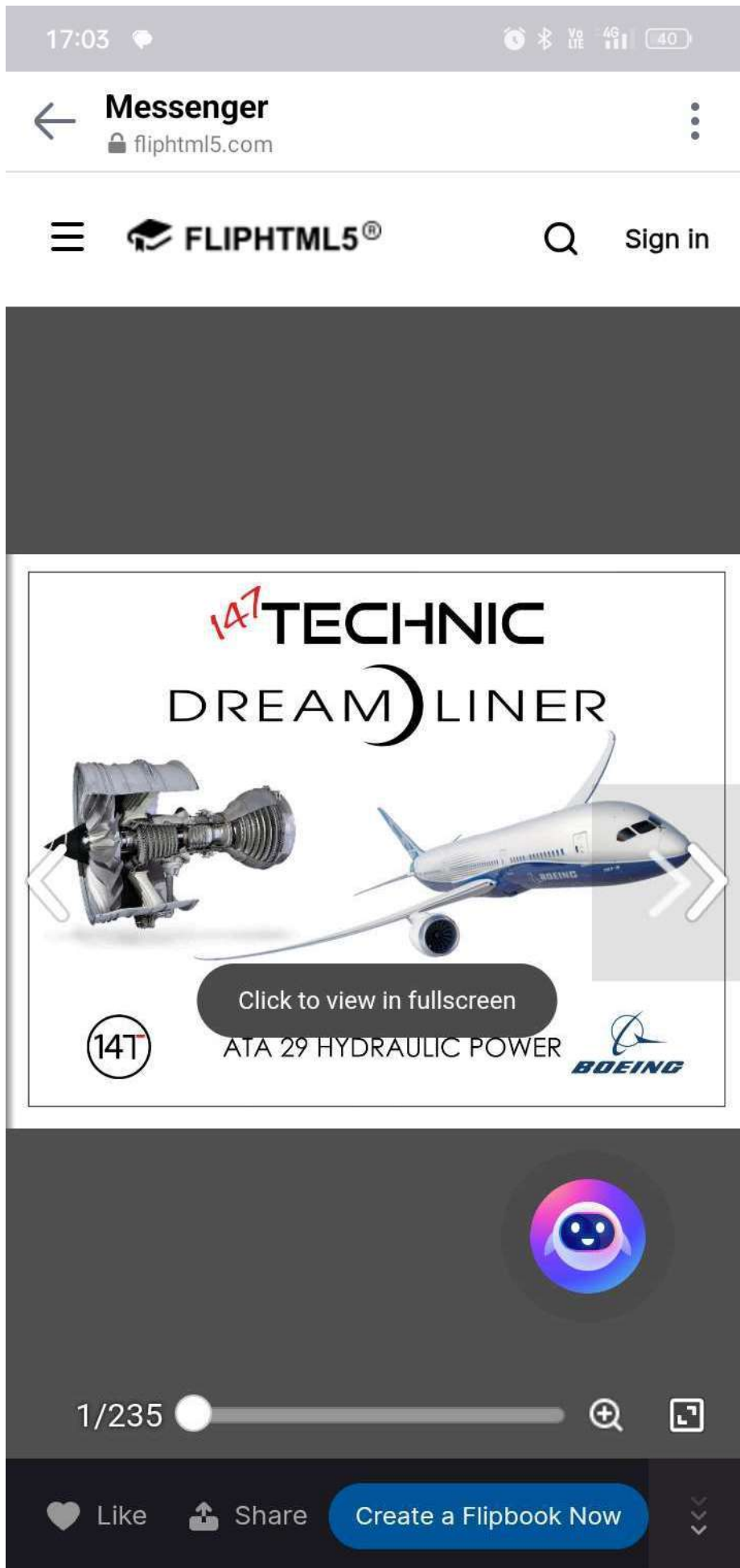
1.4.5.1 Cell 5

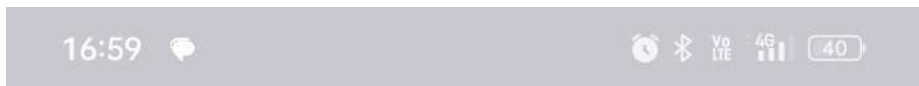
The cell 5 examination found evidence of arcing damage on the cell case interior and relatively minor damage to the winding adjacent to the protrusion in the battery case. The cell case was mostly intact. The lower half of the winding closest to battery case side 3 and adjacent to the protrusion in the battery case had adhered to the cell case. The appearance of the cell case and the adherence of the electrodes were consistent with localized heating, melting, separation, and solidification from electrical arcing. No visible portion of the thermoplastic insulation in the cell case remained. Black residue was present on the interior surfaces of the cell case and the exterior of the windings. SEM/EDS analysis found that the chemical composition of the residue was consistent with that of the thermoplastic insulation.

The condition of the aluminum cathode and the copper anode in each winding was consistent with high heat exposure. Most of the cathode material was present but was brittle. Most of the uncoated aluminum foil (at the edges of the windings) remained intact, but portions were missing. The coated aluminum foil was discolored and fractured with areas of the foil missing generally near the header (top) or footer (bottom) fold. Most of the missing aluminum foil had melted and solidified into oblong-shaped globules. The copper foil was intact but had discolorations and small pinholes that propagated through several wraps. The coating on the copper foil had mostly flaked off. The separator was not found during the examination.

For the winding that was closest to battery case side 3, the copper foil was discolored at the header fold with small ripples. The copper foil also exhibited a band of darker color adjacent to the nodular protrusion, which was consistent with high heat exposure. This band of color propagated from the exterior to interior wraps of the winding. The center winding copper foil had ripples along the header fold. This winding appeared to have more overall damage than the other two windings. The winding closest to cell 6 showed the most fragmentation of the aluminum foil and the coated material. The first and second wraps of the winding had thermally adhered to the interior of the cell case, and portions of the first wrap had also thermally adhered to subsequent wraps of the winding. One of the innermost wraps showed folds in the copper foil on the side facing cell 6, which were present through several layers of the winding, as shown in figure 13. Other notable features found during the winding examination were the lack of any sizeable repeating rifts in the windings and the greater amount of damage to the exterior wraps of the windings compared with the interior wraps.

⁴⁰ For additional information about the teardown of cells 1 through 4, see Materials Laboratory Factual Report 13-060, which is available at www.nts.gov in the public docket for this incident. Also, during the teardown of the eight cells, numerous specimens were excised to examine, using SEM and EDS, the physical and chemical characteristics of various internal components. Materials Laboratory Factual Report 13-060 also includes information from these examinations.





Messenger

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Sign in

(8) RAM AIR TURBINE – EXTENSION – FUNCTIONAL DESCRIPTION

Teaching Points

1. The RAT deploys automatically when signals are received from:
 - HYDIF
 - BPCU
2. A list of conditions which cause automatic deployment of the RAT is found in the student notes
3. Manually
 - Pressing the guarded RAM AIR TURBINE switch on the flight deck
4. The RAT blades will not turn until after it is deployed and the aircraft is in flight
 - Prevents blade contact with RAT compartment or fuselage
5. Hydraulic power available in 6 seconds
6. Electrical power available in 10 seconds

Student Notes

Description

The RAT is deployed into the airstream by a spring-loaded actuator. It can be deployed manually by a flight deck switch or automatically when the HYDIF or the BPCU. The signal for RAT deployment is sent to the RAT. Only one of the two solenoids is necessary to deploy the RAT. When commanded, the solenoids release a set of locking pawls in the RAT compartment, allowing the spring to extend and force the turbine into the airstream. This prevents accidental automatic deployment on the ground. The RAT is mechanically linked to the RAT compartment door, which is driven open by RAT deployment.

174/235

The RAT deploys and supplies 100% rated hydraulic power in 6 seconds.

Home ▶ Explore ▶ Others ▶ ATA 29



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ANNEX - 2

Fwd: Request for Technical Clarification Regarding DFDR Time References and RAT Deployment Sequencing – AI 171 Preliminary Report

From: President FIP (president@fipindia.com)

To: sudiptsen@yahoo.co.in

Date: Monday, 1 June, 2026 at 10:21 pm IST

Warm Regards,
Capt CS Randhawa,
President, FIP

Begin forwarded message:

From: President FIP <president@fipindia.com>

Date: 12 March 2026 at 16:35:20 IST

To: DG AAIB <dg.aaib-moca@gov.in>

Cc: hm.moca@nic.in, secy.moca@nic.in, dgoffice.dgca@nic.in, appt.pmo@gov.in, appt.pmo@nic.in

Subject: Request for Technical Clarification Regarding DFDR Time References and RAT Deployment Sequencing – AI 171 Preliminary Report

Dear Sir,

1. Reference is drawn to the subject regarding. The purpose of this submission is to seek technical clarification regarding DFDR time references and Ram Air Turbine (RAT) deployment sequencing as per time-stamped data published in the AAIB Preliminary Report concerning AI 171 accident of 12 Jun 2025.

2. As explicitly recorded in the EAFR data extract, the following events are time-stamped:

- a) 08:08:33 UTC — Aircraft crossed V1 (153 KIAS).
- b) 08:08:35 UTC — VR achieved (155 KIAS).
- c) 08:08:39 UTC — Air/ground sensors transitioned to AIR mode (lift off).
- d) About 08:08:42 UTC — First fuel cut-off switch transitioned RUN → CUTOFF.
- e) 08:08:43 UTC — Second fuel cut-off switch transitioned RUN → CUTOFF (calculated value from stated time gap of "1 second after the first").
- f) About 08:08:47 UTC — RAT hydraulic pump began supplying hydraulic power (4 seconds after second cut-off switch movement).
- g) About 08:08:52 UTC — Engine 1 cut-off switch returned to RUN.
- h) About 08:08:56 UTC — Engine 2 cut-off switch returned to RUN.

3. **Elapsed time calculation:** Since the second fuel cut-off switch transitioned at 08:08:43 UTC, and RAT hydraulic power supply was established at 08:08:47 UTC, the Preliminary Report has documented that the elapsed time from achievement of RAT deployment conditions to supply of hydraulic power is (08:08:47 – 08:08:43) is 4 seconds.

4. The enclosed extract of B-787 Ram Air Turbine (RAT) training documentation (Page 288) issued by M/s Hamilton Sundstrand (now Collins Aerospace, a unit of RTX Corporation, which is the original equipment manufacturer (OEM)) shows that the Ram Air Turbine deployment signal is generated **10 seconds after loss of electrical supply** (Annexure 1). However, Page 292 of the same document records "Each BPCU independently requests RAT deployment **15 seconds** after either continuous loss of..electrical buses(Annexure 2).

5. It is respectfully submitted that a 5-second discrepancy between the 10-second and 15-second RAT trigger thresholds materially alters the timeline of the short 4 second DFDR time stamped RAT deployment and hydraulic availability sequence recorded in the AAIB preliminary report, which is also 2-seconds shorter than the hydraulic availability timeline recorded in the enclosed EASA and CASA (Australia) Part 147 approved M/s 147 Technics Maintenance Training Manual (Annexure 3).

6. In view of the above, we request clarification on the following technical points:

- a) What is the precise DFDR-recorded timestamp for the RAT deployment command?
- b) What specific DFDR parameter was used to determine "RAT hydraulic pump began supplying hydraulic power"?
- c) Has the Bureau reconciled the 10/15 seconds electrical trigger logic and the 6-second documented deployment/spin-up timing with the DFDR time-stamped 4-second deployment and activation time interval?

7. Given that sections of foreign media have speculated regarding deliberate pilot action, while other commentary has suggested possible electrical or system malfunction, accurate sequencing of RAT command, deployment, and hydraulic availability is essential before any inference regarding causal mechanism — whether human action or technical malfunction — can responsibly be drawn.

8. It is also submitted that, prior to the publication of the Final Report, the Aircraft Accident Investigation Bureau should:

- a) Formally obtain written clarification from the OEM (Collins Aerospace) and Boeing identifying the exact certified aircraft configuration and software standard installed on the

accident aircraft,

- b) Reconcile the 10-second versus 15-second RAT trigger thresholds with that configuration,
- c) Technically validate the DFDR parameter definitions, sampling resolution, and time-base synchronization underlying the DFDR recorded 4-second interval in the Preliminary Report, and
- d) Publish the reconciled and configuration-specific timing analysis in the Final Report to ensure technical accuracy, transparency, and defensibility.

Submitted for your information and necessary action.

Warm Regards,
CAPT CS RANDHAWA,
PRESIDENT, FIP

<Annexure 1 Hamilton Sundstrand P 288.pdf>

<Annexure 2 Hamilton Sundstrand P 292 Deployment Logic.pdf>

<Annexure 3 147 Technic B 787 Maintenance Training Manual Extract.pdf>

ANNEX - 3

Fwd: REQUEST FOR SIMULATOR CORRELATION WITH RAT IMAGERY AND DFDR TIMELINE (AI 171, CRASH) AND INCORPORATION IN FINAL REPORT

From: President FIP (president@fipindia.com)

To: sudiptsen@yahoo.co.in

Date: Monday, 1 June, 2026 at 10:20 pm IST

Warm Regards,
Capt CS Randhawa,
President, FIP

Begin forwarded message:

From: President FIP <president@fipindia.com>

Date: 17 March 2026 at 17:45:00 IST

To: DG AAIB <dg.aaib-moca@gov.in>

Cc: hm.moca@nic.in, secy.moca@nic.in, dgoffice.dgca@nic.in, Office FIP <office@fipindia.com>

Subject: REQUEST FOR SIMULATOR CORRELATION WITH RAT IMAGERY AND DFDR TIMELINE (AI 171, CRASH) AND INCORPORATION IN FINAL REPORT

Dear Sir,

1. Reference is drawn to the subject and the trailing e-mail.
2. It is submitted that four sequential photographic frames (attached as Annexures 1), obtained from the CCTV/security camera located at Ahmedabad Airport, depict a small dark object (highlighted with a black arrow) appearing and progressively increasing in size on the aircraft underbelly at the location corresponding to the Ram Air Turbine (RAT) door. The sequence from Frame 1 to Frame 4 appears consistent with RAT door opening and/or RAT deployment **while the aircraft is rolling on the runway.**
3. It is requested that the above visual sequence be formally correlated with the DFDR timeline recorded in the Preliminary Report, namely:
 - 08:08:33 UTC — Aircraft crossed V1 (153 KIAS)
 - 08:08:35 UTC — VR achieved (155 KIAS)
 - 08:08:39 UTC — Air/ground sensors transitioned to AIR mode (lift-off)
 - About 08:08:42 UTC — First fuel cut-off switch transitioned RUN → CUTOFF
 - 08:08:43 UTC — Second fuel cut-off switch transitioned RUN → CUTOFF
 - About 08:08:47 UTC — RAT hydraulic pump began supplying hydraulic power

4. It is further requested that a flight simulator reconstruction be conducted with time-synchronised overlay of the photographic sequence (Annexures 1–4) under the following scenarios:

- (a) Electrical failure leading to automatic RAT deployment;
- (b) Manual selection of fuel control switches to CUTOFF by the flight crew.

5. The purpose of the above exercise is to ascertain whether the root cause relates to a technical failure or to deliberate pilot action.

6. In the interest of completeness, procedural fairness, and accurate technical determination, it is requested that the Final AAIB Report be released **only after the above flight simulator-based evaluation is completed and formally recorded in the Report.**

Warm Regards,
CAPT CS RANDHAWA,
PRESIDENT, FIP

----- Forwarded message -----

From: **President FIP** <president@fipindia.com>

Date: Thu, Mar 12, 2026 at 4:35 PM

Subject: Request for Technical Clarification Regarding DFDR Time References and RAT Deployment Sequencing – AI 171 Preliminary Report

To: DG AAIB <dg.aaib-moca@gov.in>

Cc: <hm.moca@nic.in>, <secy.moca@nic.in>, <dgooffice.dgca@nic.in>, <appt.pmo@gov.in>, <appt.pmo@nic.in>

Dear Sir,

1. Reference is drawn to the subject regarding. The purpose of this submission is to seek technical clarification regarding DFDR time references and Ram Air Turbine (RAT) deployment sequencing as per time-stamped data published in the AAIB Preliminary Report concerning AI 171 accident of 12 Jun 2025.

2. As explicitly recorded in the EAFR data extract, the following events are time-stamped:

- a) 08:08:33 UTC — Aircraft crossed V1 (153 KIAS).
- b) 08:08:35 UTC — VR achieved (155 KIAS).
- c) 08:08:39 UTC — Air/ground sensors transitioned to AIR mode (lift off).
- d) About 08:08:42 UTC — First fuel cut-off switch transitioned RUN → CUTOFF.

- e) 08:08:43 UTC — Second fuel cut-off switch transitioned RUN → CUTOFF (calculated value from stated time gap of "1 second after the first").
- f) About 08:08:47 UTC —RAT hydraulic pump began supplying hydraulic power (4 seconds after second cut-off switch movement).
- g) About 08:08:52 UTC — Engine 1 cut-off switch returned to RUN.
- h) About 08:08:56 UTC — Engine 2 cut-off switch returned to RUN.

3. **Elapsed time calculation:** Since the second fuel cut-off switch transitioned at 08:08:43 UTC, and RAT hydraulic power supply was established at 08:08:47 UTC, the Preliminary Report has documented that the elapsed time from achievement of RAT deployment conditions to supply of hydraulic power is (08:08:47 – 08:08:43) is 4 seconds.

4. The enclosed extract of B-787 Ram Air Turbine (RAT) training documentation (Page 288) issued by M/s Hamilton Sundstrand (now Collins Aerospace, a unit of RTX Corporation, which is the original equipment manufacturer (OEM)) shows that the Ram Air Turbine deployment signal is generated **10 seconds after loss of electrical supply** (Annexure 1). However, Page 292 of the same document records " Each BPCU independently requests RAT deployment **15 seconds** after either continuous loss of.."electrical buses(Annexure 2).

5. It is respectfully submitted that a 5-second discrepancy between the 10-second and 15-second RAT trigger thresholds materially alters the timeline of the short 4 second DFDR time stamped RAT deployment and hydraulic availability sequence recorded in the AAIB preliminary report, which is also 2-seconds shorter than the hydraulic availability timeline recorded in the enclosed EASA and CASA (Australia) Part 147 approved M/s 147 Technics Maintenance Training Manual (Annexure 3).

6. In view of the above, we request clarification on the following technical points:

- a) What is the precise DFDR-recorded timestamp for the RAT deployment command?
- b) What specific DFDR parameter was used to determine "RAT hydraulic pump began supplying hydraulic power"?
- c) Has the Bureau reconciled the 10/15 seconds electrical trigger logic and the 6-second documented deployment/spin-up timing with the DFDR time-stamped 4-second deployment and activation time interval?

7. Given that sections of foreign media have speculated regarding deliberate pilot action, while other commentary has suggested possible electrical or system malfunction, accurate sequencing of RAT command, deployment, and hydraulic availability is essential before any inference regarding causal mechanism — whether human action or technical malfunction — can responsibly be drawn.

8. It is also submitted that, prior to the publication of the Final Report, the Aircraft Accident Investigation Bureau should:

- a) Formally obtain written clarification from the OEM (Collins Aerospace) and Boeing identifying the exact certified aircraft configuration and software standard installed on the accident aircraft,
- b) Reconcile the 10-second versus 15-second RAT trigger thresholds with that configuration,
- c) Technically validate the DFDR parameter definitions, sampling resolution, and time-base synchronization underlying the DFDR recorded 4-second interval in the Preliminary Report, and
- d) Publish the reconciled and configuration-specific timing analysis in the Final Report to ensure technical accuracy, transparency, and defensibility.

Submitted for your information and necessary action.

Warm Regards,
CAPT CS RANDHAWA,
PRESIDENT, FIP

<Annexure 2 Hamilton Sundstrand P 292 Deployment Logic.pdf>



Annexure 1 Hamilton Sundstrand P 288.pdf
170.3 KB



Annexure 3 147 Technic B 787 Maintenance Training Manual Extract.pdf
235.2 KB



Annexure 1 Airport Camera.pdf
192 KB

ANNEX - 4

Fwd: Subject: Technical Note in compliance of Annex 13 i.r.o Air India 171 accident of 12th June 2025, proposing OEM/ Incident Investigation Report evidence led Electrical Reverse Voltage Pathway due to Battery Short Circuit as a Credible cause for Dual Engine Fuel switches transition to Cutoff.

From: President FIP (president@fipindia.com)

To: sudiptsen@yahoo.co.in

Date: Monday, 1 June, 2026 at 10:17 pm IST

Warm Regards,
Capt CS Randhawa,
President, FIP

Begin forwarded message:

From: President FIP <president@fipindia.com>

Date: 1 May 2026 at 20:43:14 IST

To: hm.moca@nic.in

Cc: DG AAIB <dg.aaib-moca@gov.in>, dgoffice.dgca@nic.in, secy.moca@nic.in, appt.pmo@nic.in, appt.pmo@gov.in

Subject: Fwd: Subject: Technical Note in compliance of Annex 13 i.r.o Air India 171 accident of 12th June 2025, proposing OEM/ Incident Investigation Report evidence led Electrical Reverse Voltage Pathway due to Battery Short Circuit as a Credible cause for Dual Engine Fuel switches transition to Cutoff.

Dear Sir

1. Reference is drawn to the subject and annexures. Also, refer to our previous emails dated 12 and 22 Mar 26.

2. **Introduction:** The Federation of Indian Pilots, vide letter dated 17 March 2026, informed the AAIB that Ahmedabad Airport security camera images show that the RAT is deployed during the take-off roll (Refer Annexure 1), suggesting a pre-lift-off technical issue. Manual deployment is unlikely, as the system is automatic with guarded control. Media reports (Annexure 2) continue to suggest pilot action; however, the International Civil Aviation Organisation Annex 13 requires all credible technical causes be ruled out first. This Technical Note suggests a credible cause.

3. **Proposed Mechanism:** Aircraft DC electrical systems require a steady positive supply and ground (return). If disturbed, systems may behave abnormally. As per OEM Hamilton Sundstrand B 787 documentation (Refer Annexure 4, Image 3), the RAT deployment occurs after loss of power to

- a) Captain and First Officer's instrument buses
- b) C1 or C2 TRUs

4. Once the RAT deploys, the Captain and First Officer instrument buses are connected through the Captain Instrument Transfer (CIT) and First Officer Instrument Transfer (FIT) contactors, creating a common return path for current, allowing any electrical disturbance to affect both engines (Refer Annexure 4, Image 3).

5. Although system safeguards exist (generator separation, protection devices, and independent channels), a high-current disturbance in the common return path can still affect multiple systems simultaneously as follows:

- a) Boeing 787 battery failures, investigated by the Japan Transport Safety Board (Takamatsu, 2013; Annexure 3) and the National Transportation Safety Board (Boston, 2013; Annexure 6), documented “electrical arcing between a cell case and the battery case”, “current flow... between 44 and 45 amperes into the battery”, and damage “consistent with resistive heating”, with “the appearance of the cell case and the adherence of the electrodes were consistent with localized heating, melting, separation, and solidification ..from electrical arcing” (see highlighted text pp. 11, 13–14, 24, 79 Annexure 6).
- b) When high current flows through a resistive return path, the voltage of the ground point rises as per Ohm’s Law ($V = I \times R$). If the battery supply to the relay drops due to a short circuit, the voltage across the relay coils may reverse.
- c) The Boeing 787 fuel system uses dual-coil latching relays. Leach International (a typical aerospace relay manufacturer) states, “Relay will not be damaged by applying reverse voltage to the coil, although the relay may transfer” (Annexure 5, Image 4, para 8). These relays control the fuel shutoff and spar valves (Refer Annexure 4, Image1).
- d) With a common return path after RAT deployment, **reversal of voltage across the dual-coil relay energises the cut-off path driving the spar valve closed**, as shown in the Fuel Relay (P300) to Spar Valve section of the diagram, **which can affect both engines, causing near-simultaneous switching from RUN to CUTOFF without pilot input** (Refer Annexure 4, Image 2).

6. **Timeline Consistency:** Fuel cut-off at ~08:08:43 UTC and RAT hydraulic power at ~08:08:47 UTC (Refer Aircraft Accident Investigation Bureau Preliminary Report) show a 4-second gap; as “the RAT deploys and supplies hydraulic power in 6 seconds”, it must have deployed earlier, matching take-off-roll photos (Annexure 1 & 7).

7. **Conclusion:** Based on lithium-ion battery failures, relay behaviour under abnormal voltage, and Boeing 787 electrical design, a pre-lift-off electrical disturbance could have caused unintended relay operation and dual engine fuel cut-off without pilot input.

8. **Submission:** It is submitted that this may be treated as a testable hypothesis and examined through detailed electrical analysis by IIT Bombay, Aeronautical Development Agency, or Hindustan Aeronautics Limited. Technical causes cannot be ruled out till this analysis is made. Also, in our last letters and emails we had requested the verification of the timings as given in the preliminary report of AAIB by carrying out a simulator session on B-787.

Warm Regards,
CAPT CS RANDHAWA,
PRESIDENT, FIP

Annexure 1– RAT Deployment Evidence: Ground photographic sequence showing RAT deployed during takeoff roll.

Annexure 2: India Today report quoting Corriere Della speculative report of 12.2.26 on pilot action.

Annexure 3– Battery Failure Mechanism (Takamatsu) : JTSB Takamatsu Report (2013), documenting internal short circuit and grounding path formation.

Annexure 4– Electrical & Fuel Control Architecture : B 787Powerplant, Engine, Fuel & Control, and Engine Controls – Powerplant Book 2 of 3, GENx Engine, GE Engines – Control (2) General Description 787 Training Lab Notebook (image 1), Boeing 787 Electrical Power Distribution – 235V AC and 28V DC Control of Spar Valve (Fuel

Shutoff System schematic (image 2), B 787 Document Section 24-41-00, Page 32 | Revision: 2011 MAR 14 (image 3)

Annexure 5 – Relay Behaviour: Leach KL Series relay datasheet.

Annexure 6 – Battery Electrical Effects (Boston); NTSB Report No. NTSB/AIR-14/01, Auxiliary Power Unit Battery Fire, Japan Airlines Boeing 787-8, JA829J, Boston, Massachusetts, January 2013
Referenced sections: pp. 11, 13–14, and 79.

Annexure 7 -Part 147 “TECHNIC DREAMLINER – ATA 29 HYDRAULIC POWER” Engineering Training Manual internal page ~174/235



<Annexure 1 AI 171 Ahmedabad Security Camera 12 June 25.JPG>

<Annexure 2 India Today article Corriere della Sera 12 February 2026.JPG>

<Annexure 3 Takatmatsu Report.pdf>

<Annexure 4 Power Plant, Engine, Fuel & Controls, Instrument buses and Standby Power.pdf>

<Annexure 5 B787 Leech Relay Specifications.pdf>

<Annexure 6 P 11,13,14,79 Auxiliary Power Unit Battery Fire Japan Airlines Boeing 787-8, Boston, MA Janury 7, 2013.pdf>

<Annexure 7 B 787 engineering training manual_merged.pdf>

Fwd: Responses needed: Capt Sumeet's actions

From: President FIP (president@fipindia.com)

To: sudiptsen@yahoo.co.in

Date: Monday, 1 June, 2026 at 10:16 pm IST

Warm Regards,
Capt CS Randhawa,
President, FIP

Begin forwarded message:

From: President FIP <president@fipindia.com>

Date: 19 May 2026 at 12:48:56 IST

To: DG AAIB <dg.aaib-moca@gov.in>

Cc: dgoffice.dgca@nic.in, secy.moca@nic.in, hm.moca@nic.in

Subject: Fwd: Responses needed: Capt Sumeet's actions

Dear Sir,

Please refer to the trailing mail by Rachel Chitra.

The reporter was doing a story on the first anniversary of AI-171 crash. She was in Ahmedabad and interacting with the relatives of the passengers who died in the crash. One of the relation of the deceased Mr Romin Vohra was identifying the bodies of the relatives when he saw Capt. Sumit Sabharwal's body was kept in one corner of the mortuary. He saw that the back of the body was burnt however, the front part of the body was intact with the yolk of the aircraft in his hand. That clearly indicates that the correct protocols were followed. When the FO is the Pilot Flying (PF), in case of an emergency the PIC takes over the controls and becomes the PF. Also, while doing so the voice commands are given " I have the controls" by the PIC and the FO will says " You have the controls". All commands are challenge and response in the cockpit. It is utmost surprising to note that that in the preliminary report the AAIB does not make a mention of the following:

1. CVR recording of handing / taking over
2. That the controls were with PIC

The above clearly indicates that the PIC Capt Sabharwal had the controls at the time of crash and may have tried to clear the buildings while crashing. Very important info was not revealed by the AAIB. For these reasons we have been insisting on a Judicial Probe into the accident. Further, many times it is stressed that the electrical systems of B-787 must be checked and the a Simulator session to confirm the timings of the prelim report must be authenticated. Unfortunately till date AAIB has failed to investigate crash probe in the right direction. We once again APPEAL that there is a need for total transparency and accountability of the probe. The electrical systems of all B-787 must be checked thorough as has been suggested in many letters and mails from FIP. Also, it is very important that a simulator session be conducted to verify the timings given in the prelim report which should be in conformity with the technical manuals of the OEM. We are not sure if all the mails/letters by the FIP have been shared with the SME's.

We once again reiterate and APPEAL that in the interest of SAFETY it is pertinent that TRUTH prevails from the AAIB crash probe after considering every aspect.

Warm Regards,
CAPT CS RANDHAWA,
PRESIDENT, FIP
Mob No: 9820144418

----- Forwarded message -----

From: **Rachel Chitra** <rachelchitra@gmail.com>

Date: Tue, May 19, 2026 at 11:37 AM

Subject: Responses needed: Capt Sumeet's actions

To: <skumar.dgca@nic.in>, <akharbola.dgca@nic.in>, <dgooffice.dgca@nic.in>, <gherbert@aaib.gov.uk>, <media@boeing.com>, <andrew.h.lee2@boeing.com>, <leslie.a.thomson@boeing.com>, <connor.p.greenwood@boeing.com>, <bobbie.egan@boeing.com>, <chantal.dorange@boeing.com>, <keelan.j.morris@boeing.com>, Jha, Madhavi <madhavi.jha@boeing.com>, Chauhan, Siddhant <Siddhant.Chauhan@boeing.com>, <campbell.wilson@airindia.com>, <airindia@adfactorspr.com>, <skchokshi@tata.com>, <harsha.r@tata.com>, <andrew.tangel@wsj.com>, <aversprille@bloomberg.net>, <mmishra139@bloomberg.net>, Mihir Mishra <mishramihir05@gmail.com>, <ExecutiveSecretariat@nts.gov>
Cc: <communications@easa.europa.eu>, <Medias-Media@bst-tsb.gc.ca>, <pocorrespondence@dft.gov.uk>, <arun.thangaraj@tc.gc.ca>, <sia@anac.gov.br>, <foreign145@anac.gov.br>, <MinistredesTransports.TC@tc.gc.ca>, <presidencia@anac.gov.br>, <keir.mather.mp@parliament.uk>, <rob.bishton@caa.co.uk>, <AIGInbox@icao.int>, <icaohq@icao.int>, <apac-rso@icao.int>, <jsdg-moca@gov.in>, <michael.vandergrift@tc.gc.ca>, Joe Jacobsen <joe.jacobsen61@gmail.com>, Ed Pierson <ed.pierson@foundationforaviationsafety.org>, Michael Andrews <mike.andrews@beasleyallen.com>, Joseph Pookkatt (KR) <joseph@kronicle.in>, Prashant Bhushan <prashantbhush@gmail.com>, Pranav Sachdeva

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Dear Boeing, Air India and AAIB,

I think there was a gross miscalculation with the [WSJ](#) and Bloomberg article (In that it won't help with pinning it on Capt Sumeet). The ones where they said **there is data to show Capt Sumeet didn't pull back on the yoke - the First Officer did.**

If the intention is to imply Capt Sumeet was suicidal or intentionally crashing the aircraft, "he didn't pull back" is the **wrong behaviour for that theory.**

A suicidal pilot trying to crash immediately after takeoff would more logically be expected to push the nose down, overpower recovery, or actively prevent the aircraft from climbing — not simply fail to pull back.

1. [WSJ, article](#), dated Nov 27, 2025, says, *"The data also showed that Sabharwal, the captain, didn't pull back on the yoke in the final moments of the accident, according to people familiar with the matter and part of an investigative document reviewed by the Journal. The first officer, Clive Kunder, who was the pilot directly responsible for flying, did pull up at the end."*

2. [Bloomberg article](#), dated Jan 30, 2026, says, *"Additionally...Sabharwal did not pull back on yoke in the crucial final moments, while Kunder did make that movement at the end."*

First - claim was Capt Sumeet (not engine computer FADEC) cut the fuel switches. If so - why was this active-action-oriented pilot simply sitting back and not punching the First Officer in his face and trying to prevent his recovery of the plane? Logically, these two claims do not sit comfortably together..

If Capt. Sumeet was a suicidal maniac deliberately trying to crash the aircraft, then why would "not pulling back" even matter? A pilot intentionally trying to destroy an aircraft after takeoff would be expected to actively force it down or prevent recovery — not simply fail to pull on the controls.

But if the WSJ/AAIB/Boeing have data that Capt Sumeet had his hands on the control -- that data may end up exonerating Capt. Sumeet.

Because if there is data to show he had his hands on the controls, then that is exactly what a captain is supposed to do in an emergency — fight the aircraft and try to save it. Not let go.

Which again raises the real question: if Capt. Sumeet was trying to recover the aircraft, was the plane no longer responding normally to his side of the controls?

So the question immediately becomes technical, not psychological.

Did Capt. Sumeet's side of the cockpit still have full flight-control authority?

Because the AAIB preliminary report itself says that at 08:08:47 UTC the RAT hydraulic pump began supplying hydraulic power. But the report does not disclose how much hydraulic power was actually available to the aircraft, whether it was stable, or whether there was asymmetric [hydraulic or flight-control degradation](#) between the Captain and First Officer sides.

The report also makes no meaningful reference to the [multiple OPS faults recorded 15 minutes](#) before takeoff at around 07:53 UTC — involving flight-control modules, hydraulics, power controllers and the Capt's Electronic Flight Bags. Or the [flight critical failure](#) on the previous flight AI 423 Delhi to Ahmedabad.

If there were degraded data paths, electrical instability, asymmetric hydraulics, FCC resets, compromised flight-control logic, or Captain-side power issues, then “he didn’t pull back” stops being evidence of intent. It becomes evidence that the aircraft may not have been responding normally to Captain-side inputs.

Pilots also point out that in an emergency, one person is usually designated pilot flying. **Two pilots actively intervening on controls is not normal unless something catastrophic is unfolding.** So if FO Clive Kunder (after recycling fuel switches) was also trying to recover the aircraft, that raises another question: was the crew dealing not just with thrust loss, but also with degraded controllability?

Also by chance - I was in Ahmedabad -- when I **came across witnesses** who said they saw Capt Sumeet being brought in with the yoke. The reason did not think it was **anything significant** - is because they assumed he died doing his job. They weren't aware about the cockpit division of labour or the implications of what they saw. So why did the autopsy report or AAIB preliminary report not mention this? Why did it take 9 months for the AAIB to interview the solo survivor? Why is there no explanation for the condition of the aft-EAFR? Or the ELT not activating?

Also if WSJ's reporting is based on actual flight data, then Boeing, Air India and AAIB should release the underlying flight-control and systems data.

In light of this, I request responses from Boeing/AirIndia/AAIB for my reporting to the following questions:

1. Did AI 171 experience any asymmetric hydraulic degradation between the Captain and First Officer sides after takeoff?
2. What level of hydraulic power was actually being generated by the RAT after 08:08:47 UTC? Was it sufficient for full normal flight-control response?
3. Did investigators identify any degraded-mode transitions, FCC resets, flight-control reversions or abnormal control-law behaviour between liftoff and impact?
4. Were the OPS faults at approximately 07:53 UTC linked in any way to flight-control logic, FCC stability, electrical power routing, hydraulics or Captain-side cockpit systems?
5. Did any of the OPS faults affect the Captain-side data path, displays, Electronic Flight Bag systems or flight-control signal integrity? Did an electric-arc/power disruption impact the aft EAFR, ELT and FCMs at 08:08:42 UTC?
6. Does Boeing, Air India or AAIB possess flight-control trace data showing differing control-column activity between the Captain and First Officer sides? Was the infamous cockpit question relating to the autothrottle/TO/GA and was Capt Sumeet asking the question to FO? And did the whole chain of events start when Capt Sumeet pull the landing gear - increasing load in the aft electronics bay?
7. Did the APU get hit? As the APU was physically intact when recovered - but did the APU not activate because of the arcing already in the 270V HV drive?
8. Was there any indication of degraded or unavailable Captain-side flight-control authority in the final seconds? Given the HYDIF (Right) fault at takeoff?
9. If the WSJ reporting is based on actual flight data, will Boeing, Air India and AAIB publicly release the underlying flight-control and systems data to avoid selective interpretation through anonymous sourcing?
10. Did the relight happen for engine 1 and 2 happen after 08:08:52 UTC and 08:08:56 UTC? If so please tell us what was the electrical power source for this relight?

The real question is no longer simply whether Capt. Sumeet acted or failed to act.

The real question is whether AI 171 suffered electrical, hydraulic or flight-control degradation that left the crew fighting an aircraft that was no longer responding normally.

And my story deadline is May 21. Please send responses before then please,

Bests,
Rachel Chitra

Journalist

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5	-172050004 600 -163600003 599 -167330003 599 -247450002 597 -252490002 597 -252390002 597 -247460002 597 -167280002 599 -163840003 599 -171060003 599
321	QU BOMASAI .QXSXMXS 120808 MAS AN VT-ANB/FI AI0171/MA 395S DT QXS AMD1 120808 D31B
89	QU BOMASAI .QXSXMXS 120813 SVC - NO ACK ADDRESSEE: .VT-ANB QU QXSXMXS .BLVBOCR 120809 ENG AN VT-ANB - EM12R0
176	QU QXSXMXS .BOMASAI 120820 CMD AN VT-ANB/FI AI0171/MA 396I - QUBOMASAI~1DIS01120820 TITLE : MSG RQST DEAR CAPT CFRM ALL OPS NORMAL RGDS IOCC
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64	QU BOMASAI



US005279107A

United States Patent [19]

Meisner et al.

[11] **Patent Number:** 5,279,107[45] **Date of Patent:** Jan. 18, 1994

[54] **FUEL CONTROL SYSTEM WITH FUEL METERING VALVE FAULT ACCOMMODATION**

[75] **Inventors:** Richard Meisner, Glastonbury; Matthew J. Schryver, Rocky Hill, both of Conn.

[73] **Assignee:** United Technologies Corporation, Hartford, Conn.

[21] **Appl. No.:** 906,604

[22] **Filed:** Jun. 30, 1992

[51] **Int. Cl.⁵** F02C 9/28

[52] **U.S. Cl.** 60/39.03; 60/39.281

[58] **Field of Search** 60/39.03, 39.281

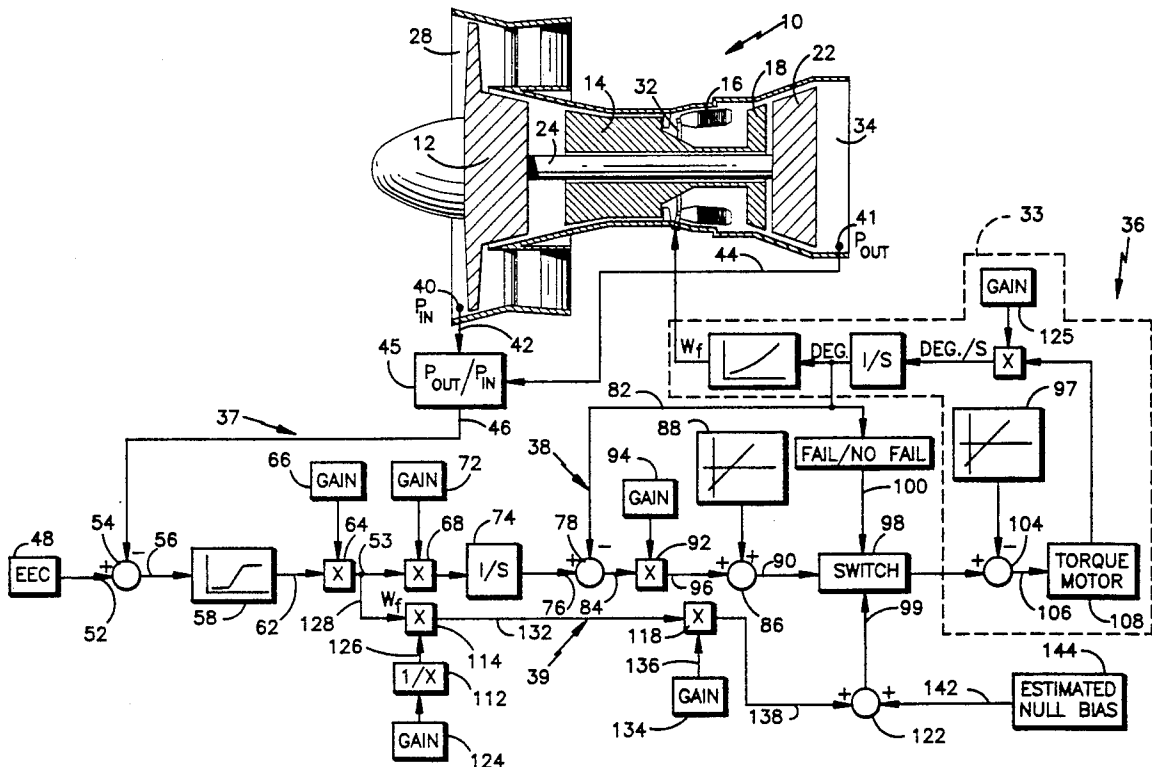
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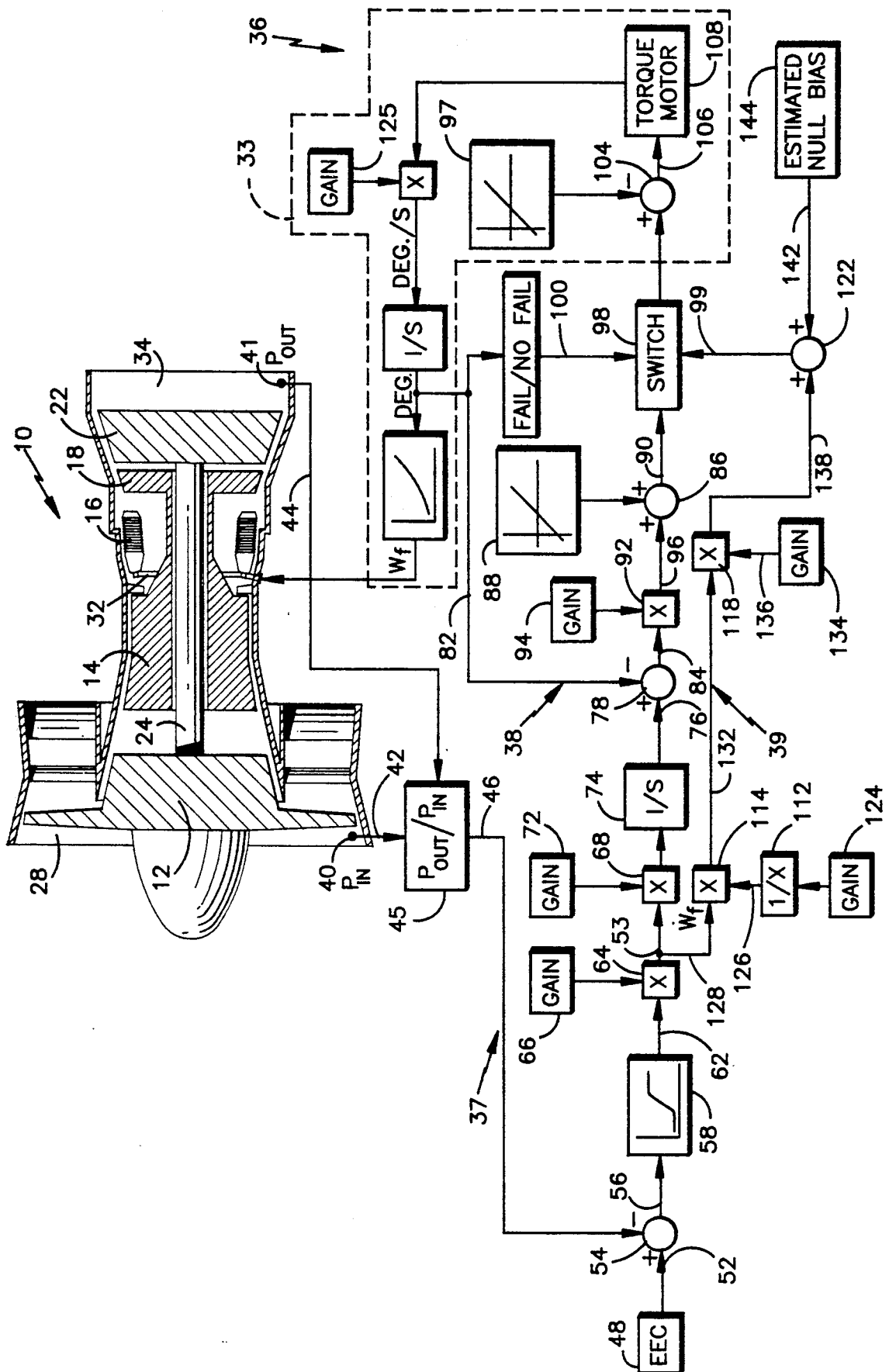
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Primary Examiner—Louis J. Casaregola
Attorney, Agent, or Firm—Randy G. Henley

[57] **ABSTRACT**

An apparatus is disclosed for a fuel control system of a turbine engine powerplant. Various construction details have been developed which provide means to generate a backup command current for controlling the fuel flow rate to the turbine engine powerplant. In one embodiment, a means to generate a backup command current includes means to convert a fuel flow derivative to a backup command current using known hardware characteristics and an estimated null bias signal. The backup command current is input to a switch along with a command current generated by comparing a reference signal to a feedback signal from a metering valve. The switch responds to means for failure recognition which detects failures in the sensing of the feedback signal. The switch responds to a failure of the feedback signal by inputting the backup command current to a torque motor for controlling a metering valve position.

14 Claims, 1 Drawing Sheet



FUEL CONTROL SYSTEM WITH FUEL METERING VALVE FAULT ACCOMMODATION

TECHNICAL FIELD

This invention relates to a gas turbine engine, and more particularly to a fuel control system for a gas turbine engine.

BACKGROUND OF THE INVENTION

In a typical fuel control system of a gas turbine powerplant for an aircraft, a fuel control system modulates the fuel flow to the powerplant in response to the operator's demands. The operator's thrust demands are input to an electronic engine control (EEC) which monitors various engine parameters to determine the amount of fuel flow required to meet the operator's thrust demand. The main objective of the fuel control system is to be responsive to the operator's thrust demand while at the same time prevent engine stall, engine surge, or inefficient operation of the powerplant.

The EEC receives the operator's thrust demand and calculates a desired engine parameter which correlates to the thrust of the powerplant. Engine pressure ratio, referred to as EPR, is one such engine parameter although others, such as shaft rotational speed, may be used. EPR is the ratio of engine output pressure to engine inlet pressure. An EPR reference signal, which corresponds to the EPR required to meet the operator's thrust demand, is produced by the EEC. EPR reference is compared to a sensed or actual EPR taken from pressure sensors mounted at the inlet and outlet of the powerplant. The comparison generates an EPR error signal. EPR error is manipulated by the control system to generate a metering valve position reference referred to as a requested degrees resolver signal (DR). DR is compared to a sensed or actual DR to generate a degrees resolver error (DRE) signal. DRE corresponds to the amount of displacement of the metering valve required to meet the operator's demand. A torque motor mechanically positions the metering valve in response to a command current signal. The command current signal is generated by the fuel control system and correlates to the DRE.

In essence, the fuel control system is comprised of two feedback loops. The major loop includes a comparison of the sensed EPR to the EPR reference to produce the EPR error. The minor loop includes the comparison of the sensed metering valve position to the DR to produce the DRE. A failure in the minor loop results in the fuel flow being switched to a fail-safe fuel flow. For safety reasons, the fail-safe position for aircraft powerplants is a minimum flow position. The minimum flow position of the metering valve may result in an in-flight shut-down (IFSD) of the engine. It is desirable to minimize the IFSD rate by minimizing the likelihood of a failure in the fuel control system.

The above art notwithstanding, scientists and engineers under the direction of Applicants' Assignee are working to develop fuel control systems which result in a minimal in-flight shut-down rate for gas turbine powerplants used on aircraft.

DISCLOSURE OF THE INVENTION

According to the present invention, a turbomachine includes a fuel control system having switching means responsive to a failure in the sensed metering valve position signal and adapted to switch between a com-

mand current signal, which uses a feedback signal from a metering valve position sensor, and a backup command current signal, which is developed from a reference fuel flow derivative and from known hardware characteristics.

According to a specific embodiment of the present invention, the backup command current signal is developed by inputting the reference fuel flow derivative and an inverse hardware gain to a first multiplier, inputting the output signal of the first multiplier and a metering valve gain to a second multiplier, and inputting the output signal of the second multiplier and an estimated null bias to a summer. The backup command current and the sensed command current are input to a switching means which is responsive to means for failure recognition. The failure recognition means includes logic to detect the presence or absence of a failure in the metering valve position signal. If no failure is present, the sensed command current is input to a torque motor which mechanically controls the position of the fuel metering valve. In the event of a failure in the sensed metering valve position, the backup command current is input to the torque motor.

According further to the present invention, a method of controlling a turbomachine includes the steps of generating a command current, generating a backup command current, inputting the command current and backup command current into switching means wherein the switching means is responsive to a signal indicative of a failure in the metering valve position feedback signal, and wherein generating a backup command current includes the steps of inverting a fuel metering unit gain, multiplying the inverted fuel metering unit gain by a calculated fuel flow derivative to generate an output signal, multiplying the output signal by a metering valve gain to generate a second output signal, and summing the second output signal and an estimated null bias of the fuel metering unit.

A primary feature of the present invention is the generation of a backup command current. Another feature is the generation of a backup command current without a feedback from the fuel metering valve position sensor.

A primary advantage of the present invention is the minimal level of the in-flight shut-down rate as a result of having a backup of command current signal in the fuel control system. The backup command current provides means to continue operation of the gas turbine powerplant in the event of a loss of the sensed metering valve position. Another advantage is the operability of the fuel control system in the event of a failure in the fuel metering valve position signal as a result of the backup command current. The backup command current is generated using known hardware characteristics and sensed turbine engine parameters.

The foregoing and other objects, features and advantages of the present invention will become more apparent in light of the following detailed description of the exemplary embodiments thereof, illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The sole FIGURE is a block diagram schematically illustrating a fuel control system having a backup command current loop.

BEST MODE FOR CARRYING OUT THE INVENTION

Illustrated in the FIGURE is an axial flow gas turbine powerplant 10 including a low pressure compressor 12, a high pressure compressor 14, a combustor 16, a high pressure turbine 18, and a low pressure turbine 22. The low pressure compressor and the low pressure turbine are connected by a low pressure shaft 24. The high pressure compressor and the high pressure turbine are connected by a high pressure shaft 26. Working fluid enters the gas turbine engine through an inlet 28 and passes through the low pressure compressor and high pressure compressor. The compressors add energy in the form of increased momentum to the working fluid. The working fluid enters the combustor where it is mixed with fuel and the mixture is combusted. The fuel enters the combustor through a plurality of fuel nozzles 32 disposed about the combustor and connected to a fuel metering unit 33, which is illustrated schematically for clarity purposes. The products of the combustion are expanded through the high pressure turbine and the low pressure turbine. A portion of the energy extracted from the working fluid in the turbines is transferred to the compressor via the rotors. The fluid exiting the low pressure turbine is exhausted through an engine outlet 34.

The thrust of the gas turbine engine is controlled by a fuel control system 36 illustrated schematically in the FIGURE. To provide a general overview of the fuel control system, it may be broken down into a major loop 37, a minor loop 38, and a backup command current loop 39. The major loop encompasses the fuel control system and receives inputs from the powerplant, the EEC, the minor loop, and the backup command current loop. The major loop compares a thrust requirement signal developed from the operator's thrust demand, and a sensed thrust signal, which is measured directly by various powerplant sensors. The comparison produces a thrust measure error signal which correlates to the difference between the two measures. The thrust measure error signal indicates the amount of correction in the thrust measure which is necessary to meet the operator's demand.

The minor loop and backup command current loop take reference signals from the major loop, manipulate those reference signals to generate command currents, and input the command currents into the fuel metering unit. The minor loop compares a desired flow position for the metering valve, developed from the thrust response error signal, and a sensed flow position which is measured directly from the metering valve. This comparison produces a metering valve position error signal which correlates to the difference between these two measures. The metering valve position error signal indicates the amount of correction of the metering valve flow position necessary to meet the fuel flow demand. The minor loop, which is a high gain system, adapts the fuel control system to accommodate errors in the biases and tolerances of the specific hardware of the fuel metering unit. A fuel control system with only a major loop and no minor loop is a low gain system and is more sensitive to differences in hardware characteristics and environmentally driven fluctuations in system response.

The backup command current loop operates a fuel metering valve fault accommodation system. The backup command current loop produces a signal which is substituted for the metering valve position error sig-

nal in the event of a failure in the minor loop. This loop responds to a fuel flow derivative, developed within the major loop, and develops a backup command current. The development is accomplished by multiplying the fuel flow derivative by several gains and accounting for a null bias present in the fuel metering unit.

More specifically, the major loop receives an input from an electronic engine control (EEC) 48. The EEC is an electronic data processor which monitors various powerplant parameters and converts operator demands into electronic control signals. The EEC receives inputs from the operator which correspond to thrust level demands. The operator's demand for thrust is converted by the EEC into an engine parameter which correlates to the thrust of the engine. As shown in the FIGURE, the parameter generated by the EEC is an engine pressure ratio reference (EPR REFERENCE) signal 52. Although an EPR REFERENCE signal is shown, other reference parameters may be used for comparison purposes, such as a shaft speed reference signal.

The major loop also receives inputs from a pressure sensor 40 disposed in the inlet and a pressure sensor 41 disposed in the outlet. The inlet pressure sensor generates an inlet pressure signal 42 and the outlet pressure sensor generates an outlet pressure signal 44. The major loop includes a divider 45 which receives the inlet pressure signal and the outlet pressure signal and generates a sensed engine pressure ratio (EPR) signal 46. EPR is defined as the ratio of engine outlet pressure divided by the engine inlet pressure. EPR directly correlates to the thrust of the powerplant.

The EPR and EPR reference are input to a summer 54 where they are compared. The difference results in an engine pressure ratio error (EPRE) signal 56. The EPRE signal corresponds to the change in engine pressure ratio required to meet the change in thrust demanded by the operator. The EPRE signal is input to a compensator 58 which compensates the EPRE signal for various transient operations and generates an EPR compensated signal 62. As is well known, compensation is used to provide a responsive but smooth transition from one steady state operating condition to another. The EPR compensated signal is input to a multiplier 64 which multiplies the EPR compensated signal by a first gain 66. The first gain is an engine gain and corresponds to the gain of the fuel flow derivative as a function of EPR for the engine. Multiplication of the EPR compensated signal by the first gain generates a reference fuel flow derivative signal ($\dot{W}_f$). $\dot{W}_f$ is then branched off into the backup command current loop and input to a second multiplier 68.

The second multiplier multiplies $\dot{W}_f$ by a second gain 72. The second gain is a metering valve gain and corresponds to the gain of the metering valve position derivative as a function of the fuel flow derivative of a specific metering valve position. The product of the second multiplier is a reference metering valve position derivative, referred to as the degrees resolver derivative (DR). An integrator 74 converts the DR to a degrees resolver reference signal (DR) 76, which is input to a second summer 78. The second summer is included within the minor loop. The second summer compares the DR to a sensed metering valve position 82, hereinafter referred to as the degrees resolver sensed (DR sensed). The difference between the DR and DR sensed results in a degrees resolver error (DRE) signal 84. DRE corresponds to the change in metering valve position required to meet the change in thrust demanded by

the operator. DRE is input to a third multiplier 92 which multiplies the DRE by a third gain 94. The third gain is a fuel metering unit gain and corresponds to the gain of the command current as a function of metering valve position. The product of the third multiplier is an unbiased command current 96. The unbiased command current is input to a third summer 86 where a null bias 88 is added to the unbiased command current signal to produce a properly biased command current signal 90. The null bias is necessary to account for the initial biasing of the mechanical position of the fuel metering unit. The fuel metering unit is initially biased, as represented by item 97 in the FIGURE, to ensure that the failsafe flow position of the fuel metering unit corresponds to a minimum flow position.

In prior art fuel control systems, the command current 90 would be fed directly into the fuel metering unit. Within the fuel metering unit a torque motor, responsive to an input current, controls the positioning of the metering valve. In accordance with the present invention, however, the command current is input into a switch 98. The switch also receives a backup command current signal 99 and an input 100 from means for failure recognition. The failure recognition means includes logic for detecting the presence or absence of a failure in the metering valve position signal. The failure recognition means produces either a "no-fail" or "fail" output, depending on the operable state of the minor loop. The switch responds to a "no-fail" output from the failure recognition means by inputting the command current into the fuel metering unit. As shown in the FIGURE, the fuel metering unit is initially biased, as shown by summer 104, and includes a torque motor 108 which mechanically positions the metering valve. The switch responds to a "fail" output from the failure recognition means by inputting the backup command current signal into the fourth summer and thereby into the torque motor. In this way, in the event of a failure in the minor loop, an in-flight shutdown is avoided by the availability of the backup command current. Although the failure recognition means is described as logic for detecting a failure, other means may also be used such as a sensor responsive to the presence or absence of a feedback signal.

The backup command current loop operates by converting the fuel flow derivative to the backup command current using known hardware characteristics and an estimated null bias. The backup command current loop includes a first inverter 112, a first multiplier 114, a second multiplier 118, and a summer 122. A fuel metering unit gain 124 is input to the first inverter. The fuel metering unit gain is the gain 125 of the metering valve (measured as degrees resolver derivative) as a function of command current input to the fuel metering unit. The first inverter takes the inverse of the hardware gain and inputs the inverse hardware gain signal 126 to the first multiplier. The first multiplier also receives the $\dot{W}_f$ signal which is branched 128 off the major loop. The two signals are multiplied together and the output 132 is input to the second multiplier. A metering valve gain 134 is also input to the second multiplier. The metering valve gain corresponds to the second gain 72 and is the gain of the metering valve derivative (measured as degrees resolver derivative) as a function of the fuel flow derivative for a specific metering valve position. The output 138 of the second multiplier is then input to the summer. The summer also receives an input 142 of an estimated null bias 144. The estimated null bias is the

steady state component of the command current. The steady state component may be determined by various procedures. A suggested method is to filter the command current to remove transients. Another method is to time average the command current signal. The summed output is the backup command current which is input to the switch. During operation, the major loop receives inputs from the EEC and the engine and generates a DR signal which is input to the minor loop and a $\dot{W}_f$ signal which is input to the backup command current loop. Both the minor loop and backup command current loop generate command currents which are input to the switch. Under normal operating conditions, the switch inputs into the fuel metering unit the command current generated by the minor loop. In the event of a loss of the feedback signal from the metering valve, the switch will input the backup command current to the fuel metering unit. Switching to the backup command current may avoid an in-flight shut-down of the engine due to a loss of the feedback signal from the metering valve.

Although the invention has been shown and described with respect to detailed embodiments thereof, it should be understood by those skilled in the art that various changes, omissions, and additions may be made therein and thereto, without departing from the spirit and scope of the invention.

We claim:

1. A turbomachine including a compressor section, a combustor, a turbine section, a rotor joining the compressor section and the turbine section, a source of fuel, an electronic engine control which outputs an engine reference signal, a fuel metering unit including a torque motor and a metering valve adapted to meter fuel flow in response to inputs from the torque motor, and a fuel control system, wherein the fuel control system includes:

- means to sense the metering valve position to generate a sensed metering valve position (DR sensed) signal;
- means to produce a sensed engine signal which corresponds to the engine reference signal;
- a first summer responsive to the reference and sensed signals to generate an error signal;
- a compensator responsive to the error signal to generate a compensated error signal;
- means to apply a first gain to convert the compensated error signal to a fuel flow derivative ($\dot{W}_f$) signal;
- means to apply a second gain to convert the $\dot{W}_f$ signal to a metering valve position derivative ($\dot{D}R$) signal;
- an integrator responsive to the $\dot{D}R$ signal to generate a reference metering valve position (DR) signal;
- a second summer responsive to the DR signal and the DR sensed signal to generate a metering valve error (DRE) signal;
- means to apply a third gain to the corrected DRE signal to generate an unbiased command current signal;
- a third summer responsive to the unbiased command current signal and a null bias signal to generate a command current signal;
- a torque motor adapted to position the metering valve in response to the command current; and
- a fuel metering valve fault accommodation system adapted to provide a backup command current in the event of a failed sensed metering valve position

signal, the fuel metering valve fault accommodation system including:

- means for failure recognition, the failure recognition means being responsive to the DR sensed signal and adapted to recognize a failure of the DR sensed signal;
- a first inverter responsive to a fuel metering unit gain to generate an inverse fuel metering unit gain signal;
- a first multiplier responsive to the $\dot{W}_f$ signal and the inverse fuel metering unit gain signal;
- a second multiplier responsive to the output of the first multiplier and a metering valve gain;
- a fourth summer responsive to the output of the second multiplier and an estimated null bias signal to generate a backup command current; and
- a switch responsive to the command current, the backup command current, and the failure recognition means, wherein the switch is adapted to send the backup command current to the torque motor in response to a failure of the DR sensed signal and to send the command current to the torque motor otherwise.

2. The turbomachine according to claim 1, further including means to sense inlet pressure to generate an inlet pressure signal, means to sense outlet pressure to generate an outlet pressure signal, wherein the engine reference signal is an engine pressure ratio reference (EPR Reference) signal, and wherein the means to produce a sensed engine signal is means to divide the inlet pressure signal by the outlet pressure signal to produce a sensed engine pressure ratio (EPR) signal.

3. The turbomachine according to claim 1, wherein the first gain corresponds to the gain of derivative of fuel flow rate as a function of EPR for the turbomachine, the second gain corresponds to the gain of derivative of metering valve position as a function of the derivative of fuel flow rate for the metering valve, and the third gain corresponds to the gain of the command current as a function of metering valve position.

4. The turbomachine according to claim 1, wherein the estimated null bias signal is a filtered command current, the filtering adapted to remove transients.

5. The turbomachine according to claim 1, wherein the estimated null bias signal is a time average of the command current.

6. A fuel control system for a turbomachine, the fuel control system including a fuel metering unit having a metering valve and a torque motor adapted to control positioning of the metering valve in response to an input current, means to generate a derivative of the fuel flow rate ($\dot{W}_f$), means to generate a sensed command current responsive to the $\dot{W}_f$ signal and a sensed metering valve position signal (DR sensed), and a fuel metering valve fault accommodation system, wherein the fuel metering valve fault accommodation system includes:

- means for failure recognition, the failure recognition means being responsive to the DR sensed signal and adapted to recognize a failure of the DR sensed signal;
- an first inverter responsive to a fuel metering unit gain to generate an inverse fuel metering unit gain signal;
- a first multiplier responsive to the $\dot{W}_f$ signal and the inverse fuel metering unit gain signal;
- a second multiplier responsive to the output of the first multiplier and a metering valve gain;

a summer responsive to the output of the second multiplier and an estimated null bias signal to generate a backup command current; and

a switch responsive to the command current, the backup command current, and the failure recognition means, wherein the switch is adapted to send the backup command current to the torque motor in response to a failure of the DR sensed signal and to send the command current to the torque motor otherwise.

7. The fuel control system according to claim 6, wherein the fuel metering unit gain corresponds to the gain of the command current as a function of the metering valve position and the metering valve gain corresponds to the gain of the derivative of the metering valve position as a function of the derivative of the fuel flow rate.

8. The fuel control system according to claim 6, wherein the estimated null bias signal is a filtered command current, the filtering adapted to remove transients.

9. The fuel control system according to claim 6, wherein the estimated null bias signal is a time average of the command current.

10. A method of controlling a turbomachine, the turbomachine having a compressor section, a combustor, a turbine section, a rotor joining the compressor section and the turbine section, a source of fuel, an electronic engine control which outputs an engine reference signal, and a fuel control system, the fuel control system including a metering valve adapted to meter fuel flow and a torque motor adapted to control positioning of the metering valve in response to an input current, the method including the steps of:

- computing an error signal between a reference metering valve position signal, computed from the engine reference signal, and a sensed metering valve position signal;
- generating a command current that is a function of the error signal;
- computing a reference fuel flow derivative from the engine reference signal and corresponding engine parameters;
- multiplying the reference fuel flow derivative by an inverse fuel metering unit gain to produce a first output;
- multiplying the first output by a metering valve gain to produce a second output;
- summing the second output and an estimated null bias to produce a backup command current; and
- switching between the command current and backup command current, wherein the backup command current is input into the torque motor if a failure occurs in the sensed metering valve position signal.

11. The method according to claim 10, further including the step of generating the fuel metering unit gain, wherein this step includes computing the gain of the command current as a function of the metering valve position.

12. The method according to claim 10, further including the step of generating the metering valve gain, wherein this step includes computing the gain of the derivative of the metering valve position as a function of the derivative of the fuel flow rate.

13. The method according to claim 10, further including the step of generating the estimated null bias by filtering the command current to remove transients.

14. The method according to claim 10, further including the step of generating the estimated null bias by taking a time average of the command current.

* * * * *

CRIME / REPORTAGE

Gone in 32 Seconds

How Boeing and Air India's role in India's deadliest aviation disaster is being covered up



The crash site of Air India 171 in Ahmedabad, 13 June 2025. The crash killed 242 people and is the second deadliest air aviation accident in Indian history. As more and more data points are unearthed from the investigation it is clear the plane crashed because of holes in security architecture that point to Boeing and Air India. SIDDHARAJ SOLANKI / BLOOMBERG / GETTY IMAGES

RACHEL CHITRA

01 June, 2026

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{ONE}

MUKTI ARJUNSINH VANSADIYA'S PARENTS were a study in contrast on the morning of 12 June 2025. Her mother, 60-year-old Divya Vansadiya, was bubbling over with excitement—"like a child," Mukti told me. Divya and her husband, Arjunsinh, were due to fly to London that afternoon to meet Mukti's elder sister. Mukti had wanted it to be a special experience for them and had carefully chosen the flight they were on. "I wanted them to have that Dreamliner experience," she said. The Boeing 787 is a modern wide-body aircraft with a massive cabin and nine-seat rows, something that would have felt "grand, comfortable and memorable." Arjunsinh, a farmer from the rural outskirts of Surat who had never flown before, was nervous, apprehensive. Mukti sat him down to reassure him. "Airlines have one of the best safety records," she remembers telling him. "It is not like roads where you have accidents every day, papa."

Her parents' flight, Air India 171, was one of the shortest in aviation history: 32 seconds in total, from take-off to crash. Alongside the couple, 239 passengers and crew died, with another 19 on the ground when the plane crashed into a hostel block of BJ Medical College, less than two kilometres from Ahmedabad's airport. As I spoke to Mukti, she kept thumbing a photo of her mother in her twenties. "Isn't she beautiful?" Mukti asked. "Why did this happen?" That is a question that haunts Mukti and hundreds of other families about AI171—the second deadliest aviation disaster in Indian history.

The aviation establishment seemed to coalesce early on an answer. Two days before the Aircraft Accident Investigation Bureau, an agency overseen by India's ministry of civil aviation, was due to submit its preliminary report, the *Wall Street Journal* ran an exclusive. It was titled "Air India Probe Puts Early Focus on Pilots' Actions and Plane's Fuel Switches." Citing "people familiar with U.S. officials' early assessments," the article said that

the preliminary investigation suggested the pilot had manually cut off the switches sending fuel to the engine. But the report had an unusual way of establishing this. On 12 July, the day of the deadline, the AAIB released its report at 1 am—no press conference, no technical briefing, no investigators taking questions. Just a 15-page unsigned, undated, document not directly blaming the pilot but suggesting, with cherry-picked data, that he had cut the fuel to the engines.

The report comes to this conclusion with remarkable economy. In just 15 pages, it refers to “fuel,” “fuel control switches,” “fuel cut-off” or fuel-related behaviour at least nineteen times. The central takeaway of the report, though, lies in one line: “In the cockpit voice recording, one of the pilots is heard asking the other why did he cutoff. The other pilot responded that he did not do so.” The sentence never says “fuel.” It never says “engine.” It never says “switch.” It does not even make clear which of the two pilots was speaking. No other recordings were made public. But, because the line appears immediately after a section that states that the engine fuel cutoff switches transitioned from RUN to CUTOFF, the reader mentally supplies the missing noun.

Several aviation engineers I spoke to said that the rest of the report is shoddy, missing crucial details that such reports usually highlight. Joe Jacobsen, the deputy director of the Foundation for Aviation Safety, told me that the data the report omitted were precisely the bits needed to determine whether the aircraft itself was in distress before the cockpit conversation.

“It doesn’t even cover the basics,” Jacobsen said. “There is no meaningful presentation of engine spool-down sequencing, no engine N1/N2 progression tables, no reconstruction of electrical-bus behaviour, no timing for when the RAT began supplying electrical power, what triggered it—just the hydraulic power timestamp. And no explanation of why independent systems like the aft EAFR failed.” The Enhanced Airborne Flight Recorder, conventionally called the black box, records every input and output of an aircraft’s system and is designed to be nearly impregnable. The Boeing 787 has two. The forward EAFR, which faced the full brunt of impact and the fire from over fifty thousand kilograms of fuel, managed to yield 49 hours

of data, while the aft EAFR, found on the rooftop of a building near a largely intact tail section of the plane, showing no visible fire damage, had its housing and connectors burnt, and yielded nothing. The report also mentions that the plane's distress beacon did not activate during the impact. "It's built to withstand high G force and high temperatures," Sharath Panicker, an Air India pilot, told me. "How did it not survive in AI 171?" But the report did not raise a question about this.



Mukti Arjunsinh Vansadiya (right) lost her parents Arjunsinh (left) and Divya (center left) in the Air India 171 crash. They were first-time fliers travelling to the UK to visit their eldest daughter and her family. COURTESY MUKTI VANSADIYA

The report was taken at face value by most international media. "Air India crash report shows pilot confusion over engine switch movement," Reuters reported, while the BBC noted, "Air India crash: Pilot cut off fuel to engines – no fault with plane" It was the one issue on which there was seeming consensus from the *New York Times* to *The Sun*. Right-wing outlets only differed with more dramatic headlines, such as GB News's "Air India pilot 'deliberately cut off fuel while staying eerily calm' before crash that killed 260 people." Many of the aviation world's niche outlets, such as *Simply Flying*, also toed the pilot-error line.

Indian outlets were not far behind. NDTV interviewed a former pilot who had worked with SilkAir—then a part of the Singapore Airlines group, which holds a 25.1 percent stake in Air India. The pilot said it was "definitely a case of deliberate manual selection to move it to 'off.'" The

Federation of Indian Pilots, which has a history of fighting cases over the safety and working conditions of its six thousand members, has since issued legal notices to the former SilkAir pilot, as well as to Reuters and the *Wall Street Journal*.

Within the AAIB itself, there was less certainty about the cause of the crash. I spoke to a subject-matter expert at the AAIB, who wished to remain anonymous. (Days after the crash, the civil-aviation ministry had issued an unofficial gag order on its officials speaking to the media, even banning journalists from entering the ministry building.) They told me that the independence of the investigation had been compromised very early by the companies leading the aviation industry.

“The preliminary report was a negotiated deal between Air India, Tata, GE and Boeing—GE to a lesser extent,” the expert said. “But the slew of emails being exchanged in the days running up to the 12 July 2025 deadline was primarily between the airline and the manufacturer. The Indian and US regulators were on standby.” Tata owns a majority stake in Air India and General Electric manufactured the crashed flight’s engine. The companies, the expert added, were negotiating which parts of the findings should be released until moments before publication. “The document was released a little past midnight, and I suspect it largely had to do with Boeing’s desire to influence public perception by targeting Western audiences first.”

What followed was months of scrutiny into the personal life of AI171’s pilot-in-command, Sumeet Sabharwal, rather than the mechanics of the crashed aircraft. Several of his colleagues told me that AAIB investigators had asked whether he suffered from depression, diabetes, high blood pressure or substance abuse. His ex-wife, from whom he had been divorced for more than a decade, was allegedly asked whether she would support claims that he had mental-health issues. She refused. “Good on her,” a batchmate of Sumeet from flying school told me. “They were using any and all means to get dirt on him.” AAIB investigators also questioned Sumeet’s nephew, a commercial pilot. The Federation of Indian Pilots then sent a legal notice to the AAIB, arguing that he had no connection to the crash.

I met Sumeet's 92-year-old father, Pushkaraj Sabharwal, in his neatly furnished Mumbai flat. He was no stranger to air crash investigations, having worked in the Directorate General of Civil Aviation for three decades before serving as its deputy director of training and licensing. He recalled taking his son to work as a child. Ten-year-old Sumeet became fascinated by aircraft, spending ceaseless hours watching them take off and land. "He was a good pilot," Pushkaraj said.

Pushkaraj told me how crash investigations of the past had been conducted. "One must look into the life cycle of the engine, its maintenance chain," he said. "Even minor things like the tensile strength of wiring, as, over years, wires can turn brittle and break. Then you'd have short-circuiting, electrical failures." Aviation is an exceptionally safe endeavour. The number of fatalities per kilometre travelled has seen a steep plunge since the 1970s, with aviation deaths now almost a statistical blip, an anomaly. This level of safety was carefully built over decades of work by the industry—with rigorous regulatory oversight, flights operated by highly trained professionals, who undergo continuous evaluation, and jets whose critical systems are not just duplicate, but often triplicate or quadruplicate—if one component fails there are always other fail safes. Together, these create what civil aviation professionals call the "Swiss cheese model," where a catastrophic failure can only occur if multiple holes in multiple defensive layers all align simultaneously. And thus, in a crash, every little piece of information, every string of data through each millisecond, needs to be methodically dissected. Simple explanations do a disservice to the safety of flying as a whole.



Sumeet Sabharwal inside his second home, the cockpit of a Boeing 787. SPECIAL ARRANGEMENT

This was why, Pushkaraj said, he had approached the Supreme Court, asking for an independent judicial committee to oversee the AAIB's investigation. (A similar inquiry had been conducted after a 2010 crash in Mangalore had killed 158 people.) The nonagenarian was in court to clear his son's name. The past year had wounded him deeply. "I seem to have given thirty years of my life to an institution that, today, is busy painting my son as a murderer," he told me.

At the end of August last year, Pushkaraj recalled, two AAIB officials visited his home with a huge entourage of Air India officials, saying they wanted to offer condolences. After that, the airline officials were sent downstairs to wait. An AAIB official told him, "We've come to understand why he did it." Pushkaraj asked what his son had done. "We have come to know he has cut off the fuel of the plane," they told him. "We have evidence." Pushkaraj asked them to produce evidence or leave.

WHILE MEETING EVERYONE in Sumeet's life, the AAIB did not question the only real witness to the disaster for nearly a year. The lone survivor to walk out was the 38-year-old British citizen Ramesh Viswashkumar. Speaking to the press shortly after the disaster, Ramesh mentioned hearing a loud boom in the back followed by green and white flickering lights. This was critical information that would point to a failure in the plane itself, but his testimony was recorded by the AAIB only in April 2026, after it was facing heat from lawyers in the Supreme Court. By then, Pushkaraj's case had been joined by the Federation of Indian Pilots and by Amit Singh, a senior pilot who also runs the Safety Matters Foundation, an aviation safety NGO. Referring to the FIP's membership, the senior advocate Prashant Bhushan told the chief justice, "My lord, as many as six thousand pilots in the country are saying these planes, the 787s, have had a history of serious electrical defects. The Air India 171 crash took 260 lives. We want these planes grounded." A decade and a half earlier, Bhushan had fought a case against Air India's acquisition of these same aircraft.

This case is dragging out slowly. After the AAIB did not respond within its initial deadline, the Supreme Court even offered that the bureau could submit its reply in a sealed cover. Since then, hearings have repeatedly been deferred, with the solicitor general—appearing for the Indian government, the ministry of civil aviation and the AAIB—seeking adjournments.

Meanwhile, as the petitioners place more and more data points from the investigation into the crash into the court record, it has become increasingly clear that what occurred on AI171—known in the aviation world by its the registration number VT-ANB—was a series of holes in the plane's safety architecture that were the direct result of acts of omission and commission by both Boeing and Air India in order to cut costs. I spoke to nearly thirty pilots, engineers and analysts about the evidence presented and other documents I had received from whistleblowers at Boeing, Air India and the AAIB. Together, the picture they painted was of a disaster that was years in the making. Faults on the plane were visible years before. These compounded on the days leading to the crash and reached a tipping point on that fateful runway.

The experts pointed to a specific chain of events that brought the plane down. *The Caravan* has copies of the Airplane Health Management records of VT-ANB—real-time digital dossiers of maintenance analytics that Boeing’s planes send to the manufacturer and operator. VT-ANB’s AHM records show that on its previous flight, from Delhi to Ahmedabad, both the stabiliser’s position sensor and electrical motor control unit had faulted. These are part of the system that helps control the aircraft’s nose position during flight, the motor moving the horizontal wing on the tail of the plane, and the sensors telling the aircraft computers its exact position. Together, they help keep the aircraft stable during climb, cruise and descent.

The AHM records also demonstrate that all three of the plane’s Flight Control Modules—the aircraft’s “muscle” computers, which take commands from the main flight control computers and physically execute them by moving control surfaces such as the stabiliser, elevators and ailerons—were independently flagging conflict in the stabiliser data. When the entire FCM triplex goes into disagreement on a safety-critical surface such as the horizontal stabiliser, you are no longer looking at a nuisance sensor error. It points to a potential single point of failure in the airplane’s pitch control architecture. Regardless, the AHM records show the stabiliser’s motor and sensor were replaced in Ahmedabad before 12.10 pm, when the maintenance crew released the plane for flight on 12 June.

But fifteen minutes before take-off, at 1.23 pm, the FCMs themselves started faulting. These faults were all being communicated to Air India and Boeing via the plane’s satellite link, called the Aircraft Communications Addressing and Reporting System. An FCM is a highly critical component, and such a fault is called a NO-GO fault, requiring the aircraft to not be cleared for flight. VT-ANB’s ACARS codes, copies of which *The Caravan* has, clearly show that six NO-GO faults existed on the plane, and it was still given clearance to take off.

The codes, according to several engineers I spoke to, suggested that the plane suffered a massive electrical failure shortly into take-off. This was likely because of a failing inverter in the back of the plane, which caused a sustained electrical arc that ran through the 787’s highly centralised wiring.

“The flight computers were already vulnerable to a reboot, given the faults pre-take-off,” a senior Air India engineer told me. “Just think of it like your home computer that will reboot itself automatically if it crashes. And so, these computers just needed a short power glitch to reset them, and instead what they got was a high-voltage inverter arcing. So yes, it would’ve made the flight computers reboot.” The reboot led to flight computers briefly entering “ground-mode,” which, several Air India engineers told me, led FADEC—Full Authority Digital Engine Control, the engine’s computer—to cut off fuel to the engines.

After their failure, the pilots did attempt to relight the engines. The evidence around this pokes major holes in the theory that the captain cut fuel to the engine. The AAIB report, oddly, did not mention exactly when the Ram Air Turbine—a stowed emergency wind turbine that deploys into the airstream during a total loss of power—deployed. It instead included a CCTV image implying the RAT deployed “during the initial climb immediately after lift-off.” Months later, the FIP released imagery that showed the RAT already deployed while the aircraft was still on the runway, suggesting something was already wrong with the plane before take-off.

The AAIB states that the RAT hydraulic pump began supplying power only after both engines’ N2 values—the rotational speed of an engine core—passed below the minimum idle speed at 1.38.47 pm. This would imply that the RAT powered the crew’s relight attempt at the mid-point of the 32-second flight. But RAT can only aid the relight if the aircraft is flying at a minimum of 300 knots, and VT-ANB achieved only 180 knots. Another source of power is the auxiliary power unit, a starter generator at the back of the plane. But this would be unlikely as well, since the report says that the APU’s inlet door was opened only at 1.38.54 pm.

The only other source of power for the aircraft to attempt a relight is the permanent magnet alternator generator, which relies on the smaller fan in each engine that remains spinning for a short while after engine cut-off. “But it can succeed if it is producing at full voltage—that is, five to eight seconds after the engine goes down,” an Air India engineer who worked on 787s, including VT-ANB, told me. “It certainly could not have happened ten

to fourteen seconds later, as the AAIB implies.” The bureau’s timeline for the engine relight, they said, was “electrically impossible.”

The engines could only have relit between 1.38.45 pm and 1.38.50 pm, and not between 1.38.52 pm and 1.38.56 pm, which the AAIB report concludes they did. The AAIB notes that the first engine, “core deceleration stopped, reversed and started to progress to recovery” while “Engine 2 was able to relight.” That behaviour is not instantaneous. The engineer told me it requires a relight sequence lasting several seconds. During those seconds, engine computers must have authority to command ignition and fuel introduction—which means the fuel switches had to be in RUN mode. “The AAIB’s own data would imply the pilots’ hands were nowhere near the fuel switches,” they said.

WHAT IS ASTOUNDING is that the pilot-error narrative has not shifted despite several concerning incidents on 787 Dreamliners since 12 June 2025. Just four days after the AI171 crash, AI315 returned to Hong Kong shortly after take-off, as the pilot suspected a technical issue mid-air. The next month, LATAM Airlines 603 suffered electric problems leading to an uncommanded RAT deployment shortly after take-off. Then, in October, AI117 from Amritsar to Birmingham had an uncommanded RAT deployment minutes before landing. Three months earlier, United Airlines 108 had declared Mayday, after an in-flight engine shutdown shortly after take-off, but was able to safely land. Also in October, AI154 diverted to Dubai en route from Vienna to Delhi after reportedly experiencing autopilot failures.

In November, a Tokyo-bound 787 aborted its take-off. The Tokyo flight had faults in its backstage processors and fault-monitoring system—its general processor modules and central monitoring computing function—as well as in a hydraulic pump. By the end of 2025, the directorate general of civil aviation issued Air India a show-cause notice for allowing a plane to take off despite knowing it had faults. These incidents create precisely the pattern that, aviation safety experts say, should have triggered deeper scrutiny of Air India’s Boeing 787 operations.

Despite not admitting fault, the civil-aviation industry seems to be taking protective measures. Britain has already started scrapping the 787s it purchased in 2013—the year VT-ANB was made. Significantly, Air India grounded three Boeing 787s after the AI171 crash and has not informed the public what issues these planes are facing. The first of these, VT-ANA, was grounded between August and October at Joramco, one of West Asia's largest independent wide-body heavy-maintenance facilities, located in Amman, Jordan. The aviation-safety expert Mark Martin told me that the Dreamliner being parked in Jordan has serious implications, as Air India sends planes there for only long-duration structural inspections, heavy checks and modification work. A second Dreamliner, VT-ANE, was at Etihad Engineering's wide-body Maintenance Repair and Overhaul complex, which specialises in composite structural repair and heavy checks, between July and September. The third has been parked in India at Tata's Mumbai MRO since July, undergoing extended troubleshooting for recurring technical issues.

Air India refused to publicly comment on why these planes were grounded. “All three of these Dreamliners entered service around 2012–13,” a flight engineer at the Mumbai MRO told me. “Typically, the first heavy structural check cycle on a 787 should occur in the twelfth year, and for none of these planes was a check due. Air India is clustering multiple multi-month heavy checks now in 2025, right after AI171. This really doesn't seem to be normal, staggered fleet-maintenance behaviour.” The engineer told me that, for such long periods of downtime, “airlines would be losing money hand over fist.”

Sam Thomas, the president of the India chapter of the Airline Pilots' Association, granted that nothing could be said with certainty. “There's also the possibility that these maintenance checks could be routine, because even if there's a scheduled check, airlines can get a waiver to do it later,” he told me. But for a long-haul subfleet, he said, having three Dreamliners tied up at heavy MRO bases and two more offline at Boeing's factory in Victorville, California, is unusual. Despite the groundings, Air India's former CEO, Campbell Wilson, still maintained in October that “there was

nothing wrong with the aircraft's operations or practices that required changing." Worryingly little is known about what retrofitting is occurring at the Victorville factory. "Boeing did not allow FAA officials in November to inspect these planes at its Victorville factory," a senior analyst at Boeing, who wished to remain anonymous, told me, referring to the US Federal Aviation Administration.



A young Sumeet at flying school in Indira Gandhi Rashtriya Uran Akademi. SPECIAL ARRANGEMENT

Since the civil-aviation world is so deeply intertwined in commercial relationships, it seems unlikely that that very much accountability can be expected in this process. The Tata group, which owns a majority stake in Air India, should have had tough questions for Boeing, but is tied to every step of Boeing's production chain. It manufactures floor beams and aerostructures for the 787, while the joint venture Tata-Boeing Aerospace, in Hyderabad, manufactures fuselages for Boeing's AH-64 Apache attack helicopters. In the West, after a crash like this, it is often the insurer that pushes for a thorough investigation, as they have the most to lose

financially. Air India has a syndicate of direct insurers led by Tata AIG General Insurance. “In such a tightly intertwined ecosystem of governments, airlines and aerospace giants, it becomes dangerously easy for a pilot’s reputation to be sacrificed so that business and a strategic relationship worth billions of dollars can continue,” the senior editor S Raghotham told me.

{TWO}

DESPITE THE POMP of its arrival at Chennai International Airport, in September 2012, with coconut-breaking, pujas and a water cannon salute, Air India’s first 787 Dreamliner landed with the weight of 92 giddy passengers and a nearly decade-old political scandal. The airline, still owned by the union government at the time, had ordered 27 Boeing 787s as part of a much larger aircraft purchase in 2005 and 2006: 68 Boeing aircraft for Air India, and 43 Airbus aircraft for Indian Airlines, a combined 111-plane order that cost Rs 67,000 crore for purchase and leasing. From its earliest days, questions shadowed the acquisition.

Critics argued that the order, the brainchild of the minister of civil aviation at the time, Praful Patel, was not matched by route expansion, revenue planning or the financial strength of the national carrier. Specifications for seats and configuration were changed at the last minute to favour Boeing, which led to an outraged response from Airbus—which often sells cheaper planes than its primary rival, Boeing—and calls for investigations into the deal. Air India, which had recorded comfortable profits in 2003, 2004 and 2005, began moving quickly into the red. The comptroller and auditor general said that the debt-funded acquisition had “contributed predominantly” to Air India’s massive debt, which stood at Rs 38,423 crore by March 2010.

Patel’s other initiative was as much to blame. The 2007 merger between Air India and Indian Airlines proved especially damaging, creating deep organisational dysfunction, labour disputes and mounting debt. By the late 2010s, Air India was surviving largely through repeated taxpayer-funded bailouts. Despite employing experienced pilots and engineers, it struggled

with ageing infrastructure, procurement controversies, maintenance delays and a reputation for poor service reliability.

By 2014, the Central Bureau of Investigation was investigating the Boeing order, prompted by a 2012 case in the Supreme Court by the Centre for Public Interest Litigation, represented by Prashant Bhushan. By 2017 this had grown to four cases. The CBI filed its case closure report in one of the leasing cases, finding no wrongdoing, after the Ajit Pawar faction of the Nationalist Congress Party, of which Patel was part, aligned with the Bharatiya Janata Party's alliance in Maharashtra. Air India continued to struggle financially until its 2022 acquisition by the Tata group, which had founded the company before its nationalisation, in 1953. The conglomerate's attempts to turn Air India around, however, have been mixed, with the airline still posting record losses despite expanding its fleet significantly and refitting its creaky interiors.

Dreamliners had not even entered production at the time of Patel's landmark deal and, over the next half decade, were subject to delays. Boeing's flagship aircraft was already battling technical and certification troubles globally and had suffered repeated setbacks—from design and production problems to concerns around its heavily electrical architecture and lithium-ion battery systems. VT-ANB belonged to this earliest generation of Dreamliners inducted into Air India.



The Air India's Boeing 787 Dreamliner is given a traditional water cannon salute by the fire tenders upon its arrival at in New Delhi in September 2012. Boeing's flagship aircraft was already battling technical and certification troubles globally and had suffered repeated setbacks—from design and production problems to concerns around its heavily electrical architecture and lithium-ion battery systems. PARVEEN NEGI / THE INDIA TODAY GROUP / GETTY IMAGES

“Over the years, we’ve seen some very dangerous EWIS”—electrical wire interconnection system—“practices across multiple Boeing programmes,” Ed Pierson, the executive director of the Foundation for Aviation Safety, told me. “Fatigued employees, skipped installation plans, poor electrical bonding and grounding, improperly installed wire bundles, unqualified staff performing electrical work, rushed functional systems testing, and the removal of long standing quality inspections—all of this can create latent defects in a variety of aircraft systems which can be extremely difficult to troubleshoot. These flaws often produce those frustrating ‘No Fault Found’ or ‘Cannot Duplicate’ maintenance reports.” These were airborne fault warnings and pilot complaints that engineers were unable to reproduce during ground testing, often because intermittent electrical or software glitches can temporarily disappear before troubleshooting begins. “In the military, we used to call them gremlins,” Pierson said.

Pierson and his deputy, Joe Jacobsen, are both Boeing whistleblowers who spoke to the US Senate’s permanent subcommittee on investigations, laying out the disturbing maintenance chronology for VT-ANB. In their

submission, they noted that VT-ANB suffered significant electrical system problems from almost its maiden years in service. As early as 2014, there were issues with the aircraft's fire inverter, which prevents fuel tank explosions by continuously flooding the tanks with nitrogen-enriched air. This was replaced. In January 2022, VT-ANB experienced a major electrical fire in its P100 power distribution panel—one of the central nodes in the 787's highly integrated electrical architecture—stranding it in Frankfurt. The incident was serious enough to require panel replacement, and raised questions about wiring integrity and short-circuiting. In January 2023, when the plane was in Delhi, there was a collapse of its generator and power distribution.

The Caravan has copies of internal correspondence between Boeing and Air India, which show that, in this case and in subsequent ones, Air India followed Boeing's Fault Isolation Manual to the letter. It replaced components and performed wiring integrity checks, documenting every step. Boeing certified each repair as compliant, but these issues kept recurring. The P100 distribution panel alone had to be replaced twice. This is critical because, on VT-ANB's last day, all three of these systems—the power distribution, the generator and the inverter powering the fire inverter—failed simultaneously. What the emails expose is not poor maintenance but a certification infrastructure that treats symptoms while ignoring architecture. Boeing's responses consistently directed Air India towards component-level fixes.

The Foundation for Aviation Safety's submission describes an anomaly in the landing gear, in April 2022, attributed to problems in the plane's central electrical architecture, called the common core system. Instead of isolated, easy-to-blame mechanical snags, the pattern points to recurring issues in the aircraft's core electrical and computing infrastructure—exactly the domains flagged as vulnerable by earlier US FAA directives, by John Barnett, a quality-control manager at Boeing South Carolina, and by independent cybersecurity analyses. Pierson told me that “Boeing and Air India should have treated VT-ANB as a high-risk outlier long before the

crash” and that “the clustering of electrical and CCS issues should have triggered a deep dive into Boeing’s design and quality records.”

These past technical faults also raise troubling questions about the conduct of the AAIB investigation itself, because the preliminary report does not mention them anywhere. There are, fundamentally, only two possibilities. Either the technical history and prior electrical issues involving VT-ANB were new information to investigators, in which case this could be criminal concealment of relevant information by Boeing and Air India. Or, investigators already had access to this information before the preliminary report was released, in which case the AAIB would be culpable for not investigating technical issues, and instead pointing to Sumeet.

FOR MUCH of the twentieth century, Boeing was regarded as the gold standard of aerospace engineering, building its reputation on conservative engineering, rigorous testing and an almost obsessive safety culture. Boeing engineers famously operated on the principle that aircraft should be designed with layers of redundancy and fail-safe protection, because lives depended on it. That culture produced some of aviation’s most celebrated aircraft: the B-17 Flying Fortress, the 707 that launched the jet age, the 747 jumbo jet that transformed global travel and, later, the 777, considered one of the safest and most technically refined aircraft ever built. Inside Boeing, engineers historically held enormous authority, and decisions were driven primarily by technical considerations rather than quarterly earnings.



Boeing's 787 airplanes are assembled at the company's manufacturing plant in Everett, Washington, in May 2008. The 787's earliest production block, nicknamed the "terrible teens," consisted of heavily overweight, out-of-tolerance airframes that sat for years in rework because they did not meet delivery standards. KEVIN P. CASEY / BLOOMBERG / GETTY IMAGES

Many aviation historians and former Boeing employees trace the company's cultural shift to its 1997 merger with McDonnell Douglas. Critics argue that McDonnell Douglas's management philosophy ultimately took over Boeing. The new leadership increasingly prioritised shareholder returns, production targets and cost discipline. Over time, veteran engineers lost influence to finance executives and programme managers. Production was aggressively outsourced, supply chains fragmented and pressure intensified to deliver aircraft faster and cheaper. The consequences soon became painfully visible, particularly in its 787 programme. The aircraft was launched as a technological leap—composite fuselage, electric bleed-less architecture, a globalised supply chain—but it quickly became synonymous with delays, improvisation and patch-up fixes.

The 787's earliest production block, nicknamed the "terrible teens," consisted of heavily overweight, out-of-tolerance airframes that sat for years in rework because they did not meet delivery standards. Barnett told the BBC he could see under-pressure workers were deliberately fitting sub-

standard parts to aircraft on the production line, in some cases pulling them from scrap bins to avoid delays because the plant was strictly driven by schedule and cost. “Boeing quit listening to their employees. So, every time I’d raise my hand and say, ‘Hey, we got a problem here,’ they would attack the messenger and ignore the message,” he said. Barnett submitted all his findings under the FAA’s whistleblowers’ protection programme. Two days into his deposition, he was found dead by a gunshot wound. Law enforcement said that there was no foul play in the death, nonetheless it cast a chilling shadow over other employees considering speaking out.

Barnett documented metal shavings left near critical flight-control wiring, warning that they could chafe through insulation and cause catastrophic failures. FAA spot checks later confirmed shavings where Boeing had assured regulators none existed, forcing retrofits before delivery. These were not isolated incidents. Barnett also described a wider culture inside Boeing’s 787 plant in North Charleston, South Carolina, in which traceability rules were bypassed, workers were under relentless production pressure, and management treated safety concerns as obstacles rather than warnings. The Dreamliner’s electrical system generated its own scandals. In 2013, lithium-ion battery fires grounded the global fleet. Each time, Boeing and the FAA insisted that fixes were in place and that the 787 was safe to fly. Each time, internal whistleblowers painted a much darker picture of systemic shortcuts and unresolved risks.

In 2024, the Boeing engineer Sam Salehpour blew the whistle on flaws in the 787’s fuselage assembly process. He claimed that workers were forcing misaligned composite barrel sections together—at times, physically jumping on them—leaving tiny gaps that were not properly shimmed. Over time, he warned, those gaps could concentrate stress and lead to premature fatigue or structural failure long before the aircraft reached its intended lifespan. Salehpour said he faced retaliation after raising the issue internally, prompting the FAA to open a fresh investigation even as Boeing maintained that the in-service Dreamliner fleet remained safe. By the time AI171 crashed, a pattern was already visible in the public record: a

manufacturer that appeared to treat each controversy as a reputational crisis to contain rather than as a deeper systemic problem to confront.

The most worrying aspect of the 787 programme was that nearly all of its faults were raised by whistleblowers rather than by the FAA, whose role it is to certify the process by which aircraft are made. It was only after two 737 MAX's crashed in 2018 that the reason for the FAA's failures became clear. Boeing had learnt how to work the regulator, rather than fear it. In a 2020 report, the US House of Representatives' committee on transportation and infrastructure found that Boeing repeatedly pushed schedule and cost over safety, while the FAA delegated critical certification work back to the company itself. The software that crashed both Lion Air 610 and Ethiopian 302 was certified by the FAA though they had minimal understanding of it, while Boeing downplayed its training requirements.

"I just Jedi mind-tricked these fools," a Boeing employee boasted in internal communication. "I should be given \$1000 every time I take one of these calls. I save this company a sick amount of \$\$\$\$." He had, he explained, convinced them that all airlines and regulators accept only computer-based training, "to make them feel stupid about trying to require any additional training requirements." It was a glimpse into the culture congressional investigators later exposed: regulators were not always treated as independent checks but as obstacles to be managed, outflanked or, in Boeing's own language, "Jedi mind-tricked." The same report catalogued "undue pressures" on engineers, retaliation against those who raised safety concerns, and a revolving door between Boeing and FAA that eroded the independence of federal oversight.



A person holds a picture of the dead whistleblower John Barnett as Boeing CEO Kelly Ortberg testifies before a Senate Commerce, Science, and Transportation Committee hearing about Boeing's commitment to address safety concerns. KEN CEDENO / REUTERS

In the past decade, aviation crash investigations have followed a striking pattern. It is always easier to blame the pilot, particularly one from the Global South, than the opaque engineering of Boeing. In October 2018, when Lion Air 610 crashed, killing all 189 people onboard, Boeing and parts of the West's aviation establishment quickly pushed the narrative toward pilot error, poor training and Indonesian aviation standards. The life of the pilot, Bhavye Suneja, stopped being dissected and scrutinised five months later, when Ethiopian Airlines 302—the same Boeing 737 MAX model as LA610—crashed, killing 157 more people.

Rather than sending the black box to be studied in the United States, as is often done, Ethiopian investigators flew them to be studied by French experts. Their findings clearly showed that proprietary Boeing automation software to stabilise the plane had repeatedly forced the nose of the aircraft down because of faulty sensor data. The pilots had fought desperately to regain control, but Boeing's software and lack of redundancies for sensor

malfunctions had led to the disaster. After the crash, all 387 Boeing 737 MAXs were then grounded for more than a year, costing the airline \$20 billion in fines, compensation and legal fees—and about three times that in cancelled orders. If Boeing has learnt anything since, it is that bad media perception of the cause of a crash can be a very costly affair.

Formally, the AAIB is the lead investigator in the AI171 crash. But, in practice, the analysis of the black box is not just a mechanical download. The data has to be decoded, matched to Boeing's parameter maps, interpreted against the company's system logic and then argued over by investigation groups. The AAIB used the US National Transportation Safety Board's help to retrieve and analyse black-box data. Instead of ring-fencing the recorders from interested parties, as the Ethiopian government did, it has repeatedly relied on the US system for analysis and interpretation. That gives Boeing and US regulators enormous room to influence the frame: which data points matter, which anomalies are treated as noise, which failure paths are considered plausible, and which are ruled out.

This is not paranoia. In the 737 MAX crashes, Boeing's design assumptions escaped proper FAA scrutiny and the US Congress later found deep failures at both Boeing and the FAA. In 2024, the NTSB itself sanctioned Boeing for violating investigation rules in the Alaska Airlines MAX 9 case by disclosing non-public information and speculating on cause. So, the issue is not whether Boeing can "change" black box data. The issue is whether Boeing and its regulator should be allowed so close to the interpretation of data in a crash where the company's own aircraft architecture is under question.

Boeing and the US regulators have certainly been monitoring the AI171 investigation closely since the day of the crash. The AAIB's preliminary report says, "A team led by the NTSB Accredited Representative comprising of representatives from Boeing, GE and FAA arrived at Ahmedabad on 15.06.2025 and participated in the Investigation." However, a member of the management team at Lloyds—the British bank is part of Air India's reinsurance syndicate—told me that Lloyds representatives, along with a

“go-team” from Boeing and General Electric, had already visited the site two days earlier.



Candles burn before a flower adorned memorial arch erected at the site of the Ethiopian Airlines Flight ET302 crash in March 2019, in Ejere, Ethiopia. French investigators found that proprietary Boeing automation software to stabilise the plane had repeatedly forced the nose of the aircraft down because of faulty sensor data. JEMAL COUNTESS / GETTY IMAGES

This is a question that came up in parliament too. Six months after the crash, Manish Tewari of the Congress party raised a series of pointed questions in the Lok Sabha, including “whether the Government would furnish the chain of custody, access protocols and current status of the Flight Data Recorder (FDR) and Cockpit Voice Recorder (CVR) and the procedure followed during their transfer, examination and evaluation by domestic and foreign investigators.” He also asked whether the government intended to conduct an independent, time-bound review of the investigation process to eliminate conflicts of interest, uphold global aviation safety standards, restore public confidence and ensure

transparency. The ministry of civil aviation simply replied that other states “may” participate and noted the rules under which the AAIB is allowed to investigate the crash. Tewari told me it was “effectively a non-answer ... that sidestepped the core questions being asked.” Boeing, Air India and the AAIB did not respond to a detailed questionnaire from *The Caravan*.

HOURS BEFORE THE CRASH, Akash Vatsa was exasperated. He was flying in VT-ANB on its previous flight from Delhi to Ahmedabad, and nothing seemed to be working on the aircraft. “This AC is not working at all, as usual the TV screens are not working, neither this button to call the cabin crew—nothing is working, nothing, not even the light is working,” he said in a video he took as the plane waited for permission to take off from Delhi. “This is why Air India is considered one of the worst airlines in the world,” he added, panning around to show other passengers use the in-flight magazines to fan themselves in the gruelling June heat. When Vatsa uploaded the video after the crash, viewers mocked him, calling him a fussy traveller who did not understand how aircraft systems worked. Perhaps unknowingly, he was documenting the first public evidence of a deep electrical failure spreading through VT-ANB’s core.

On the 787, the in-flight entertainment, cabin-climate control and crew communication panels are not isolated luxuries—they share both power and data on the aircraft’s core network. The same core network connects dozens of flight-critical systems, including the pathways to the FADEC and the flight computers. Boeing describes the Dreamliner as offering “advanced aerodynamics, more efficient engines and more electric systems.” The common core system is one of its biggest selling points. The CCS is an integrated, modular network that ties together functions that earlier jets handled with more discrete, independent systems. The goal of the system was evidently to cut costs. A December 2013 technical bulletin by Boeing notes that the 787 “differs from the traditional aircraft system, where each individual system requires its own dedicated communications route ... the 787 architecture reduces the amount of wiring, hardware and overall weight of the airplane.” This reduced weight means lower production costs for Boeing, and lower fuel costs for the 787’s operators.

But that integration comes at a cost. In 2019, the security firm IOActive warned that the 787's core network architecture exhibited insufficient redundancy and inadequate segmentation, raising concerns that failures in one domain could propagate in ways the original certification had not fully anticipated. Boeing publicly responded to IOActive by arguing that its systems had sufficient redundancy. However, the company's internal documents, copies of which are with *The Caravan*, show that Boeing was well aware that they were lying. An internal document, dated 3 December 2013, reads, "the failure of one component in the common core system can lead to the failure of multiple systems."

Three days before the crash, according to the AAIB preliminary report, maintenance staff logged that the plane's core network was degrading. But this was a serious issue that Air India could have easily underestimated. In its operations notes to airlines, Boeing minimised the damage an inoperative core network could do, only mentioning that it tied non-flight critical systems. Maintenance marked the core network as "medium-risk"—issues that the airline can take a few days to fix. However, the core network connected dozens of flight-critical systems alongside as many mundane functionalities, such as the plane's air conditioning.

Alongside the degraded core network, the AAIB report notes, the aircraft was already reporting cabin- and cargo-related faults in the weeks prior to the crash, all signalling stress with the same electrical ancestry. I was informed about this by an Air India engineer who had serviced the plane a few months before the crash. They were wracked with guilt when I spoke to them, having self-isolated for a month, repeatedly watching images and videos of the crash on repeat. "It's like background music, the crash," the engineer said. "It's always at the back of my mind, the rhythm to my day at the site. I kept thinking what I could have done differently." But it was not any one part's maintenance alone that caused the crash. "If Boeing or the airlines gave engineers more authority, leeway and time when it came to dealing with faults, it's possible the root cause could have been identified," they said.

The AAIB reports that it had marked the plane's data network or core network as CAT C MEL, or a "medium risk" entity, and the fire-inerter fault as CAT A MEL, or "high risk." The urgency to deal with each of these differs. Boeing assesses the operational risk of a component failure and proposes dispatch conditions and repair timelines, which are approved by regulators such as the FAA and the DGCA, which largely apes all of the FAA's guidelines. In practice, airlines do not always wait until the final deadline to fix an issue, instead fixing them based on a range of factors such as the availability of spare parts, engineering manpower and aircraft routing. But "high-risk faults need to be fixed immediately, making it extremely odd that the AAIB says the airline had nine more days to fix the fire inerter. "What does the AAIB report mean by saying the MEL is valid for the next ten days?" CS Randhawa, the president of the Federation of Indian Pilots, asked me. "If it was invoked on June 10, it should have been fixed by June 11, as it's high-risk. How did they give it so much time?"

After it was released from maintenance, fifteen minutes before take-off, the aircraft's ACARS logs started streaming fault after fault. At 1.23 pm, six sets of NO-GO warnings were sent. The ACARS told everyone in the loop that AI171's left and right bus power control units—the computers that act as traffic controllers for electrical power—had entered fault mode, unable to keep the left and right 115-volt AC buses, or electrical junction points, in sync. It gave this warning three times. The aircraft's two main power highways were falling out of phase, a condition that can cause surges, flickers or even short-circuits across systems. Next, all three FCMs began reporting operational errors, before two general processor modules, which perform calculations and control power supply, faulted. Taken together, AI171 was not dealing with a single fault but a systemwide degradation. All the holes in the Swiss cheese were aligning. Even one NO-GO fault should have been enough to disallow the plane from being cleared for take-off. There were six.

How was an aircraft in such disrepair allowed to fly? Before a flight departs, multiple layers of clearance are involved. Engineers must certify that the aircraft is airworthy or legally dispatchable under the MELs. Pilots then

review the aircraft technical log, onboard warnings, weather, fuel, flight controls and take-off performance before accepting the aircraft for flight. Finally, air traffic control issues the actual take-off clearance for the runway. But the faults on AI171 slipped through the cracks, because the fault-monitoring mechanism also likely stopped working at the same time as flight-critical issues were surfacing.

Three days earlier, the aircraft's core network was marked as an active fault. Once it starts degrading, this core network can also impact the Airplane Condition Monitoring Function, the Central Maintenance Computing Function and the pilots' Electronic Flight Bags—all of which report faults in the plane to the cockpit. An internal maintenance note of Boeing, a copy of which *The Caravan* has, itself notes that an inoperative core network could impair the ACARS transmission of faults to the cockpit tablets or EFBs. When maintenance signed off, it did not have NO-GO faults. When Sumeet and his co-pilot, Clive Kunder, checked in the cockpit, the NO-GO items likely never appeared.

Because of the architecture of the ACARS system, Air India's operations centre in Gurugram and Boeing's data monitoring hub in Belleville, Illinois, were getting second-by-second updates on the faults of VT-ANB. "Air India's operations control centre, under their live maintenance control department, are in charge of giving the call backs to pilots of flights that they have found faults in," S Sen, an Air India pilot, told me. "This can happen as we're taxiing, when we're at the holding point before take-off or even after we have taken off. Then they will ask us to circle around and land at the departure airport itself. I have worked with other airlines and they have the same system too, every operator does." When I asked him if it is a frequent occurrence, he said it was not because most faults would be found at the maintenance stage itself, and the flight would not be cleared for take-off. "But in a carrier that has about eight hundred aircrafts, it would happen about once a month." Other pilots I spoke to reported the same procedure of monitoring by the operator and call backs to the pilot.

Other companies involved in the plane's architecture, such as the engine manufacturer, would often get live updates too. An engineer from Safran

Electronics, which is the creator of the 787's FADEC, told me that the aircraft "also had live Engine Health Monitoring from its engines going to GE. For instance, if they see an issue with the engine, the plane can be at the holding point and still be called back." But Air India, General Electric and Boeing did nothing to stop AI171's take-off. This means that even if Sumeet had a death wish—a narrative for which the AAIB, Boeing and Air India have not produced a shred of evidence—the crash would still be criminal negligence on the part of all three companies.

The aircraft was cleared for take-off at 1.25 pm. At 1.38 pm, it started to roll and lifted off. The sheer negligence on Air India's part became clearer later. At 1.50 pm, a full eleven minutes after the crash, an operator from Air India's Gurugram operation centre sent the crashed plane a message asking, "DEAR CAPT CFRM ALL OPS NORMAL."

{THREE}

MARK MARTIN WAS 16 years old when his father was blamed for a crash. His father was a helicopter pilot in the Indian Air Force and was out on deputation with the DGCA, in 1987. The DGCA lacks manpower and expertise and often takes in pilots from the IAF and even commercial airlines. "For the DGCA, he was flying a Hiller UH12 near a remote village in Kerala," Martin told me. "At five hundred feet, the engines suddenly went dead. Given how little time he had, he attempted landing at a relatively open spot and crashed into a hut nearby. Nobody was in it, and nobody got hurt except my father, who was injured from head to toe. I remember being in the hospital when I heard that the AAIB had said the crash was caused by my father." He said AAIB officials had announced that, at that altitude, the right thing to do would have been to attempt a relight of the engine rather than attempting a landing.

By 2012, Martin was a pilot on business jets. He told me that year, the DGCA analysed several crashes and released a directive saying that, in such a situation, the pilot should not attempt a relight and should instead land. "I took a printout of that directive to my father's grave and laid it there," Martin told me. "I returned home after that, had three shots of whiskey in

his honour and said, ‘Finally, we’re right. The bastards are wrong.’” The moment pushed him to be an airplane crash investigator.

Piloting has never been simple. It requires an enormous store of memorised procedure and error responses, most of which must be executed in high-stress environments, with little margin for error. A mistake can cost a lot of lives and a lot of money. On the face of it, being a pilot appears to be a flashy and well-paid job. But when things go wrong, the industry’s financial incentive is to blame the cockpit rather than the machine design. As the commercial pilot Balraj Bhullar put it, “In the aviation world, Rachel, if someone is alive, hang him. If someone is dead, blame him.” Whatever you prepare for, whatever fail-safes exist on a plane, there could always come a time when every single one of those Swiss cheese holes align. All you have is protocol and knowledge fighting a ghost in a machine.

“A clean take-off roll on a 787 should take only between forty and forty-two seconds,” Amit Singh, one of Pushkaraj’s co-petitioners, told me. AI171 took a full 62 seconds, nearly double the time it was actually airborne. Normally, as the plane’s nose begins rising at about three degrees per second, lift increases, drag rises sharply, and the aircraft naturally stops accelerating the way it did on the runway. But AI171 did the opposite. It shot up. This was a fact that Simon Hradecky, an electronics engineer and editor at *Aviation Herald*, kept returning to in our conversations. He pointed out that, according to the AAIB report, the aircraft had been accelerating at nearly four knots a second immediately after take-off, compared to 2.6 knots a second on the ground. It was a telltale fingerprint that something was holding the jet back on the ground.

The explanation for the loss of speed on the runway seemingly lies in an ACARS code the plane had beamed out at 1.38 pm, the minute it was about to take off. This code indicates that there was a problem with the locking sensors of the thrust reversers, the devices that tell the FADEC whether the engine’s rear doors are properly sealed for forward thrust. If the thrust reverser doors are not fully sealed, hot exhaust air could leak forward into the engine’s intake, disrupting smooth airflow and causing the engine to lose power or stall. To ward against this, the FADEC limits thrust.

Soon after the plane was airborne, a rapidly growing number of ACARS codes began beaming out strings of faults codes, indicating that major systems, including flight control computers, were going down, taking dozens of subsystems and sensors in their wake. Multiple engineers and pilots told me that so many different systems failing at once points to a cascading electrical failure.

Based on the information we currently have—from ACARS codes, leaked documents I accessed from Air India, the AAIB and Boeing, as well as the expertise of the nearly thirty pilots, aircraft engineers and Boeing analysts and subcontractors I spoke to—the aircraft suffered a massive electrical failure shortly into take-off. Two days before the crash, maintenance engineers had marked the fire inerter as a high-risk fault. Along the same electrical line, called R2, as the inerter lay several other components that were faulting, such as the cabin air compressor, whose faults were already visible from the fluctuating air-conditioning in the previous flight, and the stabiliser's motor and sensors that had been replaced in Ahmedabad.

In the tail section of the plane, near the inerter and the compressor, is an aft zonal dryer, a small unit that removes moisture from the ventilation air around them. “The aft zonal dryer itself was removed in later 787s around 2018,” Mike Andrews, the lawyer representing the families of more than 120 victims, told me. “We don't know what problems existed with it that it was replaced with other systems. But older models like VT-ANB still had the dryer. Water intrusion and water leaks into the front and aft electronic bays has been a repeated problem with 787s.”

On VT-ANB, an ACARS code shows that, fifteen minutes before take-off, the aft zonal dryer was likely failing. If the dryer was malfunctioning, there would be a buildup of moisture in the aft bay, with high condensation risk on the wiring and high-voltage inverters, raising the risk of short circuits or even an arc. In fact, that very day, another Air India 787, departing from Vienna, had been grounded by an Austrian engineer because its electronic bays got flooded with water. But unlike the flight in Vienna, VT-ANB's fault-monitoring mechanism was also faulting, indicating that the severity of the rising temperatures in the aft electronics bay could have gone

undetected. Additionally, the plane's left and right bus power control units were already slipping out of phase, one of the NO-GO faults that the companies had overlooked.

If the BPCUs are also faulting, power quality can swing violently, and protection may not isolate the inverter when it should. As heat built up, it is likely the inverter reached its thermal and dielectric threshold limits—meaning, its cooling and insulation could no longer contain the voltage. “When that happens, the inverter will discharge through nearby wiring harnesses a sustained electrical arc—a plasma-level short that can melt metal and vaporise insulation,” a senior Air India flight engineer, who did not want to be named, told me. This explosive electric charge is likely the “loud boom in the back” that the sole survivor heard.

Take-off is always one of the most electrically demanding phases of flight—all four power channels, BPCUs and hydraulic pumps draw maximum load as the plane transitions from ground to airborne mode. It is in this phase that any latent faults or improper wiring can surface and cause unintended consequences.

The trigger for the electrical arc was probably the demand placed on the system when the landing gear was commanded up. On successful climb, Clive would have commanded the wheels “UP” a second before and Sumeet would have executed his command as the pilot monitoring. The gear would have started retracting, then stopped milliseconds later. The hydraulic right pump—which supplies pressurised fluid that powers critical aircraft systems such as flight controls, brakes, landing gear and steering—had already faulted before take-off. Sitting on R2, the electrical arc would have hit it too. The AAIB report only notes that the landing gear itself was physically down, but does not share black box data on whether it had stopped its retraction.



Relatives of first officer Clive Kunder pay their last respect to his mortal remains during a funeral at Mumbai on 19 June 2025. ANSHUMAN POYREKAR / HT PHOTO

The flight engineer told me that the maintenance engineer on the previous flight had already warned about the possibility of this high-voltage inverter arcing, and on the crash flight it did—sending sharp voltage spikes surging back through the airplane’s 28-volt and 115-volt power buses, rippling through the core network. “This indicates a cascading electrical failure,” they told me. Four ACARS codes corroborate this, suggesting the arc passed through the R2 line, hitting the forward and aft electronics bays. These codes suggest that the arc cooked the wiring of the emergency distress beacon and crippled the auxiliary power unit—a starter generator for the plane’s massive turbofan engines in an emergency. The AAIB report documents the results to the components nearby. “The Emergency Locator Transmitter (ELT) was not activated during this event” ... the (aft) EAFR had impact and thermal damages to the housing. The wires were protruding from the housing and the connectors were burnt.”

The most dangerous of these failures is the auxiliary power unit, because it meant that AI171’s emergency power source failed before its engines did, a

possibility that Boeing had not designed to prevent. The AAIB report seems to argue against this possibility, stating, “the APU was inspected and found intact ... APU inlet door began opening at 08:08:54 UTC”—that is, 15 seconds after liftoff. But the Air India engineer who had maintained the plane three months before, and had seen its electrical degradation, told me that the “APU inlet door opening was probably a result of the prior electrical disturbance on the plane; that same disturbance that resulted in the deployment of the RAT”—the ram air turbine, which is the plane’s other reserve of power.

The final effect of the electrical arc was likely the rebooting of all three of AI171’s flight-control computers. The possibility of something like this occurring was already flagged by the FAA as early as 2016. The FAA had found that if a 787’s flight-control modules are continuously powered for 22 days, all three would simultaneously reboot mid-air. To ward against this, it recommended a 21-day power recycle for the FCMs, and, similarly, a 51-day power recycle for the common core system to clear up any software corruption, stale data accumulation or latent logic faults building up. Air India did not respond when I asked whether such a recycle had been done on AI171.

But, even if a recycle had been done, the FCM almost certainly rebooted because of the electrical arc. The danger of such a reboot is that, for a few moments, the logic deep inside the computers would have silently flipped to its failsafe “ground mode,” before it started up, analysed and flipped back to “air mode.” Immediately, every flight parameter on the plane—weight-on-wheels, thrust reversers, flaps, spoilers, landing gear, stabiliser trim—would have gone to their fail-safe mode, which would be “on ground.”

“The spoilers”—the flat panels on the top surface of an aircraft’s wings —“will likely deploy if the plane goes to ground mode in air,” Singh told me. This makes sense when on ground, because drag is created and airflow disrupted, allowing the aircraft to slow down safely and stay on the runway. In the air, this can make the plane stall. The thrust reversers, already faulted, would go from “stowed” to “idle reverse.” This means the engines directing airflow backwards would redirect airflow in the opposite direction

to have a gentle braking effect, like on a landing plane. Both the spoilers and thrust reversers would have led to an immediate loss of lift and forward thrust. As with the landing gear, the AAIB report only describes the final physical position of thrust reverser and does not mention the spoilers. “The digital capture for the very systems that determine ‘air’ versus ‘ground,’ for whether there was a stall, for whether the fly-by-wire automated jet went into manual mode—are all conspicuously absent from the report,” an engineer at Emerson Electric, a Boeing subcontractor, told me.

All of these errors would have hit the cockpit immediately after take-off. The amber coloured “master caution” light, the aircraft’s general warning alert for significant system problems would have suddenly lit up. Then, on the flight warning display, if the fault-monitoring system was working, the ACARS codes suggest amber messages would have started queuing faster than any human eye could read: “ELEC SYS,” “BUS ISLN,” “GEN OFF BUS,” “RAT DEPLOYED,” “SPOILERS,” “STAB TRIM.” And then the loss of flight-critical data: “AIR DATA SYS,” “ALT DISAGREE,” “MACH DISAGREE,” “CAS DISAGREE,” “CABIN ALT AUTO,” “PACK,” “ZONE TEMP,” “DATA COM,” “BAT DISCH.” Then whole sections of the cockpit display would have frozen on their last readings as the computing and power backbone feeding the warning display collapsed—a sudden, systemwide blackout, like a stroke cutting off blood flow to the brain. The cockpit lights would have flickered.

Two seconds later, Sumeet and Clive would have heard the sound that pilots reserve for their nightmares: the sound of the left engine spooling down and, before the plane could yaw with the asymmetric thrust, the right engine winding down as well.

WHAT DID THE FADEC really do in AI171’s last moments? According to Boeing’s training manual for the 787, the company, designed protection circuit and software logic called the thrust control malfunction accommodation to prevent dangerous thrust. In the critical take-off phase, when both engines are at full power and the aircraft is still on the ground, there is almost no room or time to correct an error, before the plane hits the airport perimeter wall, nearby buildings or planes. When it comes to the

question of how much engine power to command, it is not the pilots but the FADEC that calls the shots. The FADEC continuously compares the pilot's commanded thrust with the engine's actual output, and calculates whether the thrust is accelerating or decelerating as expected. If the system detects that the thrust is contradictory to commands, then the TCMA informs the FADEC of a thrust control malfunction and automatically shuts off fuel to the engine.



Families of the victims of Lion Air flight JT 610, visit an operations centre to look for personal items of their relatives, at the Tanjung Priok port in Jakarta, Indonesia, in October 2018. The plane crashed because of the same automation software that crashed Ethiopian Airlines 302. ULET IFANSASTI / GETTY IMAGES

As per the TCMA's patent document and Boeing's literature, five parameters need to all be true for a TCMA event: the aircraft is on the ground, its speed is less than 200 knots, the altitude is less than 17,500 feet, thrust levers or thrust reverser levers are in "idle," and the engine fan speed is more than the TCMA threshold. At 1.38.44 pm, all these would have been seen as true. The airplane read "on ground," airspeed was less than 200 knots, altitude was low and the fan speed was likely high, given take-off thrust. The preliminary report itself notes that "EAFR data revealed that

the thrust levers remained forward (takeoff thrust) until the impact.”

Additionally, the whole series of ACARS codes accessed and sent to Boeing were topped off with “EM12R0,” an indicator of airspeed data disagreement. The senior Air India engineer told me that on an average day, with eleven hundred Dreamliners in the sky, nearly eighty to a hundred can fly with this code meaning no harm, as it simply indicates that one of the channels for airspeed calculation disagreed with another. But, on AI171, it would have proved disastrous, since the FCM reboot would have sent the thrust reversers to idle—triggering TCMA and resulting in the fuel cutoff.

But the AAIB report fights shy of telling us when this fuel cutoff exactly happened. It notes that the aircraft “achieved the maximum recorded airspeed of 180 Knots IAS at about 8:08:42 UTC (1:38:42 IST) and immediately thereafter, the Engine 1 and Engine 2 fuel cutoff switches transitioned from RUN to CUTOFF position.” But this explanation defies logic. Newton’s first law tells us that an object in motion will continue in motion unless acted upon by an external force, just like a car would not stop the minute you switch off the ignition but would coast along unless someone or something brakes it. “With both engines still at takeoff thrust at 1:38:42 pm the aircraft would accelerate further for about a second even if at that very point both fuel switches were selected to CUTOFF and the engines begin to run down,” Hradecky, the *Aviation Herald* editor, told me.

The preliminary report would make readers assume that there was a fuel cut off, then both engines went to minimum idle, then fuel switches were moved back to “RUN” and then relight attempts started. But the AAIB carefully stays away from giving precise timestamps for fuel cut-off and when the engines went below minimum idle, instead clubbing it with other events that have a timestamp.

The AAIB report also has a few puzzling lines. “When fuel control switches are moved from CUTOFF to RUN while the aircraft is inflight, each engine’s full authority dual engine control (FADEC) automatically manages a relight and thrust recovery sequence of ignition and fuel introduction,” it notes. But the report itself does not mention whether the FADEC did attempt a relight. “It does sound as if the AAIB report is referencing how

the FADEC procedure should work rather than explaining exactly what did happen on 171,” Mike Andrews, the lawyer, told me. “This underscores the need for an independent evaluation of the actual FDR and any ACARS data to understand what was actually occurring with the automated systems.”

The truly horrifying thing I discovered in this investigation, though, is that the AAIB wrote those lines on the FADEC likely to mislead its readers that a relight had happened because the pilots recycled the fuel switches. Instead, the FADEC would have prevented a relight attempt, even if ordered by the cockpit, because the aviation industry increasingly values automation for these processes. FADEC could have also refused Clive’s desperate attempts to recycle switches at 1.38.52 pm and 1.38.56 pm, because it had nowhere to draw power from. “The industry is designing systems with the goal of protecting the engines or saving money,” the former senior analyst at Boeing told me. “It’s a good sell to airlines if you can tell them, ‘We can have your engines running for longer, reducing your maintenance costs.’” Engines are expensive. A single GE Aerospace engine for the Dreamliner typically costs between \$25 million and \$30 million. With two engines per aircraft, the upfront investment exceeds \$60 million and roughly accounts for about a fifth of the value of the whole aircraft. But that same cost-cutting can lead to a computer disobeying the pilot, even in an emergency.

This design philosophy of protecting the engines at all costs, is a world apart from older jets—in which pilots had full control of their planes and could even burn their engines if needed, to keep the aircraft flying. Take the example of the United Airlines Flight 232 in 1989. One of its engines failed, it lost all hydraulics, and the aircraft became effectively unflyable by conventional means: no ailerons, no elevators, no rudder. The crew did something that in a modern FADEC-restricted environment would simply be impossible. They flew the jet entirely through asymmetric engine thrust—pushing one engine harder, pulling another back—manually modulating raw power to force the aircraft to turn, climb and descend. They knew this could overheat or overstress the engines, and potentially destroy them. But that was not the priority. Pilot authority overrode engine preservation.

Nearly half the passengers survived. Similarly, on Polish Airlines Flight 16 in 2011, pilots used very aggressive thrust changes to stabilise pitch and keep aerodynamic control during approach. The objective was to save 231 lives, not to preserve turbofan hardware so it could have a longer maintenance cycle. The engines were sacrificed. Everyone lived.

With no altitude, no thrust, no starter power, 16 seconds after take-off, Sumeet and Clive would have known the plane could not be saved. They still did their best. One took over controls, while the other attempted a relight. They called out Mayday at 1.39.05 pm and likely never even received the “Pull up, Pull up” terrain warnings. Against the deafening silence of blacked-out systems, the only sounds they would have heard were passenger screams and the ATC’s responses, as the ground closed in on them.



Romin Vahora (left), a lab technician at Ahmedabad Civil Hospital, poses with his brother Parvez Vahora's family outside Ahmedabad airport before the Air India 171 crash. Parvez (33), his daughter Zuveriya (3 years), and their 50-year-old aunt were among those killed when the Boeing 787

“I WILL NEVER FORGET that day until I die,” Romin Vahora, a lab technician at the Ahmedabad Civil Hospital, told me. The hospital is housed in the same campus as BJ Medical College, which AI171 crashed into. Just hours earlier, he had been at the airport, seeing off his brother Parvez, his aunt Yasmin and Parvez’s three-year-old daughter, Zuveriya. He was on duty during the crash as bodies began piling into the hospital, and he was called to sign onto the panchnamas—witness documents—of the cadavers, all the time worrying if his family had survived.

He shuddered while recounting the sights he saw. He had seen a woman who had been six months pregnant, her stomach split open with the foetus visible. He kept searching through the bodies brought in and, at one point, he found a child with her head separated from her body. The child was about Zuveriya’s age. He went closer to look at the disembodied head. “It wasn’t her, and I felt such a flood of relief then,” Romin told me. “Then I felt so terrible for that relief. Even if it is not my niece, that was someone else’s child.”

When his family were identified, they were handed over to Romin in a sealed casket. “They refused to let me open my brother’s casket, so I argued with them,” he told me. “They told me, ‘We are stopping you because the body is not in a condition to be seen.’ So I said, ‘Whatever it is, that is my problem, not yours. I will open the body—do whatever you can.’” He opened it and found his brother’s body.

Others have not been as lucky. Sagar Patel, a British resident, told me that the loss of his mother, 62-year-old Hasumatiben Patel, hit him the hardest when he saw his two-year-old daughter wandering around the house, “searching and asking for her gran.” She had been the heart of the house, he said. Sagar had just finished performing the last rites for Hasumatiben when he read reports that British coroners had found parts of other people’s bodies in the remains returned to the families of some aircraft victims. “It derailed me,” Sagar said. “Who had I buried? What is my mother? Where is my mother?” He told me he got no closure for her death.

After the crash, Air India agreed to pay Rs 25 lakh each to the victims' families, the minimum legal liability under the Montreal Convention. I had been following the story closely since the day of the crash, and the families I spoke to said that Air India representatives had asked them all to sign release forms, waiving their right to sue the company, in order to get the compensation. In December, the release forms mentioned that they could not sue Boeing, GE, GE Aerospace, Safran and Safran Electronics. Late that month, I reported that experts I spoke to suggested the flight control computers on the plane likely restarted because of the electrical arc. From the next month, the release form for the victims' families seems to conspicuously state that the families could not even sue Honeywell, which manufactures the FCCs. Ajay Parmar, a 28-year-old gardener at the hospital, suffered thirty-percent burns on his hands, face and feet, and no longer has a job—by the time he returned after recovery, the college had hired another gardener. For many families like his, surviving precarious financial situations, there would not have been a second thought about signing the indemnity and collecting compensation.

Meanwhile, Air India has made its largest purchase of jets ever: a whopping 585 jets, 250 of which are from Boeing. It is a high-flying time for Indian aviation. With an overcrowded and underfunded railway system creaking from railway accidents, and the declining cost of flying over the past decade, more Indians are flying than ever before. "India is now one of the world's fastest-growing aviation markets and is expected to have a fleet of more than two thousand aircrafts in the coming years, making it too important a market for Boeing and Airbus to ignore," Raghotham told me. If so many more Indians will be flying, their safety can only be ensured if there is strict regulatory oversight and clear moves are made to disallow commercial interests from influencing investigations when something does go wrong.

Honest answers are the least the families of the victims deserve. Romin told me that, when he was scrambling around the charred bodies, searching for his relatives, he saw them bring in the body of Sumeet. The captain was still vaguely recognisable, and he had gone down holding onto the yoke of the

plane, not letting go even when all hope had been lost. His body was brought to the hospital with him still holding onto it.



Air India sets up Centres for Friends and Relatives Assistance at Mumbai airports to support families and loved ones of passengers on flight AI171. SATISH BATE / HT PHOTO

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RACHEL CHITRA is an investigative and financial journalist who has worked with outlets including Reuters, Forbes and The Times of India. On the Air India crash, she's published a four-part investigative series for The Federal and detailed analyses for Frontline.

Air India

Boeing

Ministry of Civil Aviation

Pilot was clutching controls: Witness reveals morgue horror after Air India crash

Romin Vohra, who lost three family members in the Air India crash last June, told the Daily Mail that he witnessed scenes inside the hospital morgue that he "can never unsee".

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Captain Sumeet Sabharwal was the pilot in command of the ill-fated Air India flight.

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India Today News Desk

New Delhi, UPDATED: May 18, 2026 08:13 IST

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A man who gained access to the morgue where victims of the fiery Air India AI-171 crash were kept has revealed he witnessed scenes he "can never unsee", including the body of the plane's captain still clutching the aircraft's steering column.

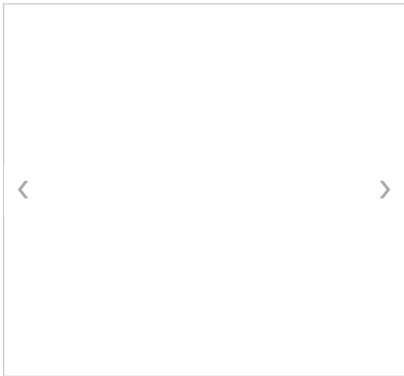
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Among those killed were Romin Vohra’s aunt Yashmin, his brother Parvez, who worked for Amazon in London, and his three-year-old niece.

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Speaking to the Daily Mail, Vohra said he managed to gain entry into the mortuary because he had worked as a pathology lab assistant at Ahmedabad Civil Hospital during the Covid-19 pandemic and still knew people there. He hoped to identify the remains of his relatives.

Instead, he walked into a vision straight out of hell.

According to Vohra, many of the bodies had been laid side by side on the floor. He recalled seeing severed heads and limbs, a charred mother with her child still in her arms, and the skull of a little girl that he desperately tried to match with a photograph of his niece.

But one image, he said, stood apart from the rest.

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Vohra claimed he saw the body of Captain Sumeet Sabharwal, the pilot in command of the ill-fated flight, placed separately in a corner of the mortuary.

"He was still in a sitting position," Vohra told the Mail. "His back was burnt, but the front of his body was absolutely perfect."

He said the captain's white uniform shirt, complete with four gold stripes on the shoulders, dark tie and trousers, appeared intact. Even his shoes were still on.

What shocked him most, however, was what Sabharwal was allegedly still holding.

Vohra claimed the pilot remained clutching the aircraft's double-handled yoke -- the steering column used to control the plane -- which may have broken off during impact or while rescuers removed him from the cockpit.

The Mail reported that a doctor who was purportedly present in the mortuary also backed Vohra's account.

If accurate, aviation experts said the detail could support the argument that Captain Sabharwal was trying to save the aircraft until the final seconds.

In its preliminary report released on July 12 last year, the Aircraft Accident Investigation Bureau said the [fuel supply to both engines was cut off within one second](#) of each other shortly after takeoff, leading to confusion inside the cockpit.

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The report mentioned cockpit voice recordings in which one pilot asked, "Why did you cut off?" while the other replied, "I didn't."

The exchange triggered speculation that [pilot error may have contributed to the crash](#).

Captain Sabharwal's family and pilot bodies, however, have strongly objected to the preliminary findings. His [88-year-old father, Pushkaraj Sabharwal](#), along with the Federation of Indian Pilots, approached the Supreme Court alleging the report was "profoundly flawed" and unfairly focused on pilots who were no longer alive to defend themselves.

The Supreme Court also described such a narrative as "unfortunate".

Civil Aviation Minister [Ram Mohan Naidu has since urged people not to jump to conclusions](#), insisting there has been no manipulation in the investigation and asking the public to wait for the final report, which is expected next month.

- Ends

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