

National Transportation Safety Board

Office of Aviation Safety

Washington, DC 20594



DCA24LA330

POWERPLANT

Specialist's Factual Report

January 22, 2026

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A INCIDENT

Location: Kenner, Louisiana
Date: December 20, 2023
Time: 2:14 PM local time
17:14 UTC
Airplane: Southwest Airlines, Boeing 737-8, Registration N8830Q

B SPECIALIST

Specialist Jean-Pierre Scarfo
National Transportation Safety Board
Washington DC

C SUMMARY

On December 20, 2023, about 1414 CST, Southwest Airlines flight 554, a Boeing 737-8, N8830Q, ingested a bird into the no. 1 (left) engine on initial climb out from runway 11 at Louis Armstrong International Airport (MSY), Kenner, Louisiana. The flight returned to MSY and landed on runway 11 about 12 minutes later. There was no damage to the aircraft nor injuries to crew or passengers. SWA 554 was operating under the provisions of Title 14 *Code of Federal Regulations* Part 121 as a scheduled domestic passenger flight. The flight had an intended destination of Tampa International Airport (TPA), Tampa, Florida.

D POWERPLANT SYSTEM DESCRIPTION

The incident airplane was powered by two CFM International LEAP-1B28 turbofan engines (Figure 1). The LEAP-1B28 is a high bypass turbofan engine with a coaxial front fan and three-stage booster driven by a five-stage low-pressure turbine (LPT); a ten-stage high-pressure compressor (HPC) driven by a two-stage high pressure turbine (HPT); a twin annular pre swirl combustor; and a full authority digital engine control (Figure 2). The fan rotates clockwise when viewed aft-looking-forward.



Source: CFM International

Figure 1: LEAP-1B28 turbofan engine

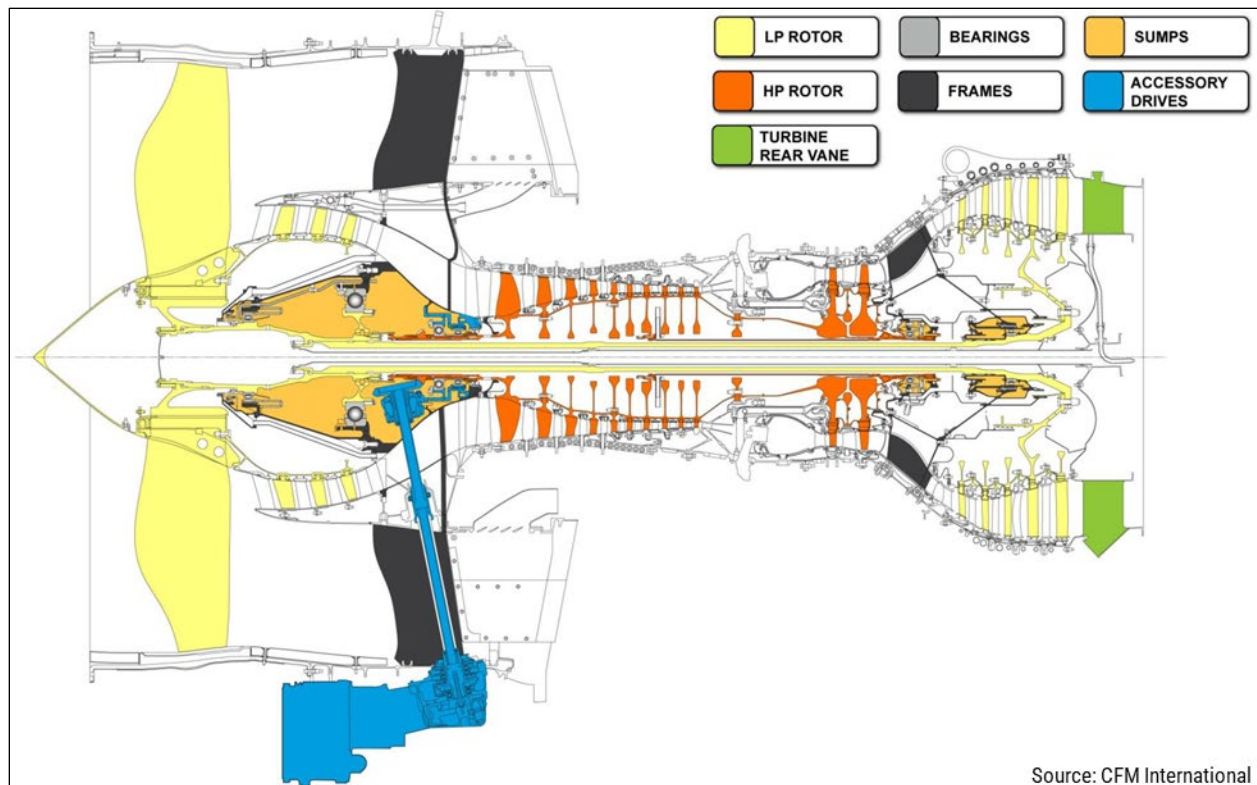


Figure 2: LEAP-1B28 cross-section

According to the Federal Aviation Administration (FAA) Type Certificate Data Sheet E00088EN, Revision 5, dated November 4, 2019, the LEAP-1B28 was certified on May 4, 2016. The engine has a maximum takeoff (5 minutes) at sea level static thrust rating of 29,317 lbs. flat-rated¹ to 86°F (30°C) and a maximum continuous at sea level static thrust rating of 28,690 lbs. flat-rated to 77°F (25°C).

Engine certification basis is as follows:

1. 14 CFR Part 33, effective February 1, 1965, with Amendments 33-1 through 33-33 thereto.
2. 14 CFR Part 34, Amendment 5A, effective October 23, 2013.
3. Emissions: ICAO Annex 16, Vol. II, Amendment 8 (CAEP/8) latest change.
4. Equivalent Level of Safety (ELOS) Findings:
 - LEAP1B-2014-TC-01-P-1 to 14 CFR 33.27(c): High Pressure Shaft Loss-of-Load

¹ Flat-rated to a specific temperature indicates the engine is capable of attaining the rated thrust level up to the specified inlet temperature. Engine ratings for the LEAP-1B are based on calibrated test stand performance under the following conditions: 1) sea level static, standard pressure (14.696 lbs. per square inch absolute (psia), up to the flat rating ambient temperature °F, 2) no customer bleed or customer horsepower extraction, 3) ideal inlet, 100% ram recovery, 4) production aircraft flight cowl-ing, 5) production instrumentation and 6) fuel lower heating value of 18,400 British Thermal Unit (BTU)/lb.

- LEAP1B-2014-TC-01-P-2 to 14 CFR 33.77: Foreign object Ingestion – Ice
 - LEAP1B-2014-TC-01-P-3 to 14 CFR 33.83: Vibration Test
5. Special Conditions:
 - Fan Blade Special Condition No. 33-017-SC
 6. Exemptions: None

Engine production basis is as follows:

1. Production Certificate No. 108 for engines produced in the United States by General Electric (GE) Aerospace under license from CFM, S.A.
2. Production Certification No. FR.21G.0007 dated December 17, 2009, for engines produced in France by Safran under license from CFM, S.A.

CFM International is a partnership between GE Aerospace of the USA and Safran Aircraft Engines (formerly Snecma) of France. CFM is not an acronym. Snecma changed its name to Safran Aircraft Engines, a subsidiary of the Safran Group, in May 2016. Safran Aircraft Engines is responsible for the fan and LPT modules while GE Aerospace is responsible for the HPC, combustor, and HPT.

The fan and booster module is shown in Figure 3 below and consists of the following:

1. A fan case and fan frame module that together enclose the fan and booster module
2. A forward acoustic shroud and six aft acoustic segments for noise reduction, and an abradable seal that provides a wear surface between the fan blade tips and the fan case
3. A fan frame module that includes 38 outlet guide vanes (OGV), OGV struts, fan frame strut panels, shroud segments, and OGV platforms
4. A front spinner cone, located forward of the platform front shroud, that provides an aerodynamic, smooth surface to direct airflow into the fan stage
5. A platform front shroud located between the front spinner cone and the fan blades provides an aerodynamic, smooth surface for the airflow, receives the fan blade balance weights, and holds the fan blade platforms in place
6. 18 solid, wide-chord, 3-dimensionally shaped composite fan blades with a titanium leading edge located between the platform front shroud and the splitter fairing
7. Fan blade platforms located between the fan blades to provide a smooth aerodynamic surface
8. A splitter fairing located behind the fan blades to separate the primary and secondary airflows
9. A fan disk attached to the booster spool to retain the fan blades
10. A three-stage booster spool

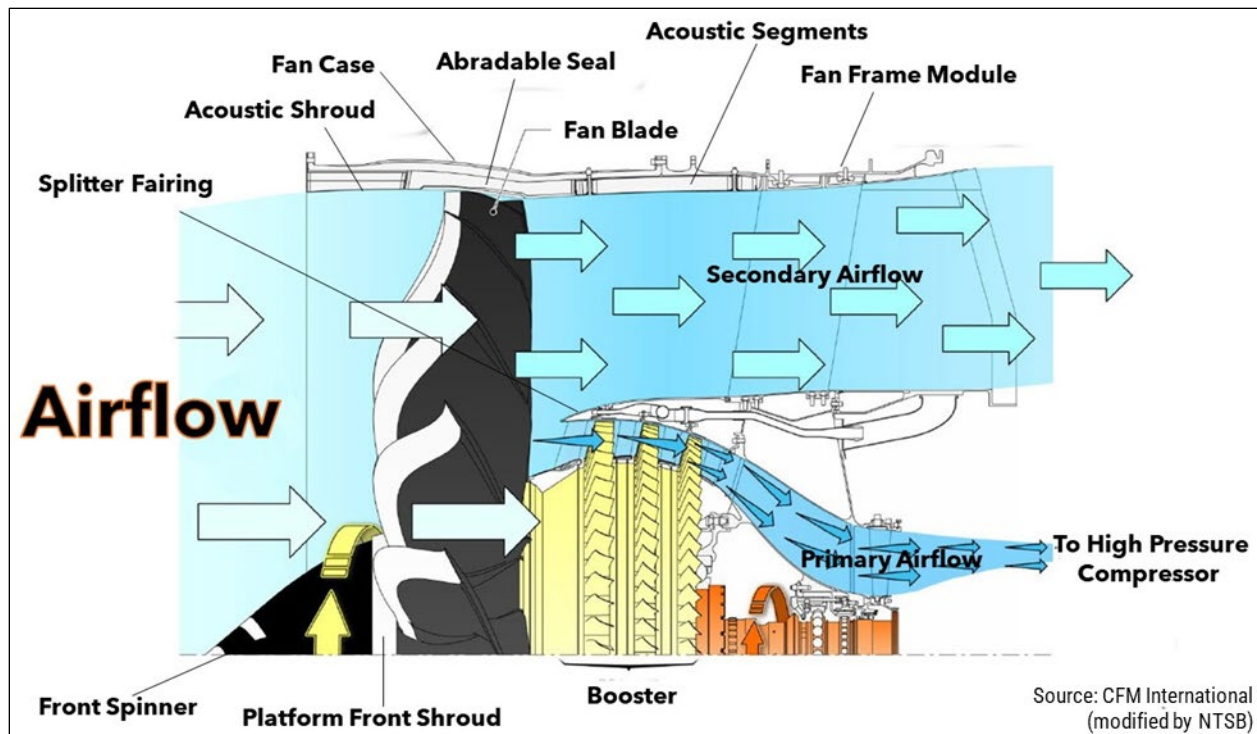


Figure 3: Fan and booster section

The two engine rotors are supported by five bearings. The low-pressure rotor is supported by two roller bearings (No. 1 at the front and No. 5 at the rear) and one ball bearing (No. 2). The high-pressure rotor is supported in the front by one roller bearing and one ball bearing (No. 3) and in the rear by one roller bearing (No. 4).

The No. 1 roller bearing, No. 2 ball bearing, and No. 3 ball and roller bearings are inside sump A. The No. 4 roller bearing is inside sump B, between the hub of the turbine center frame and the rear shaft of the HPT. The No. 5 roller bearing is inside sump C, between the No. 5 bearing support and the shaft of the LPT. Sumps B and C are located inside the turbine center frame.

E POWERPLANT LOAD REDUCTION DEVICE DESCRIPTION

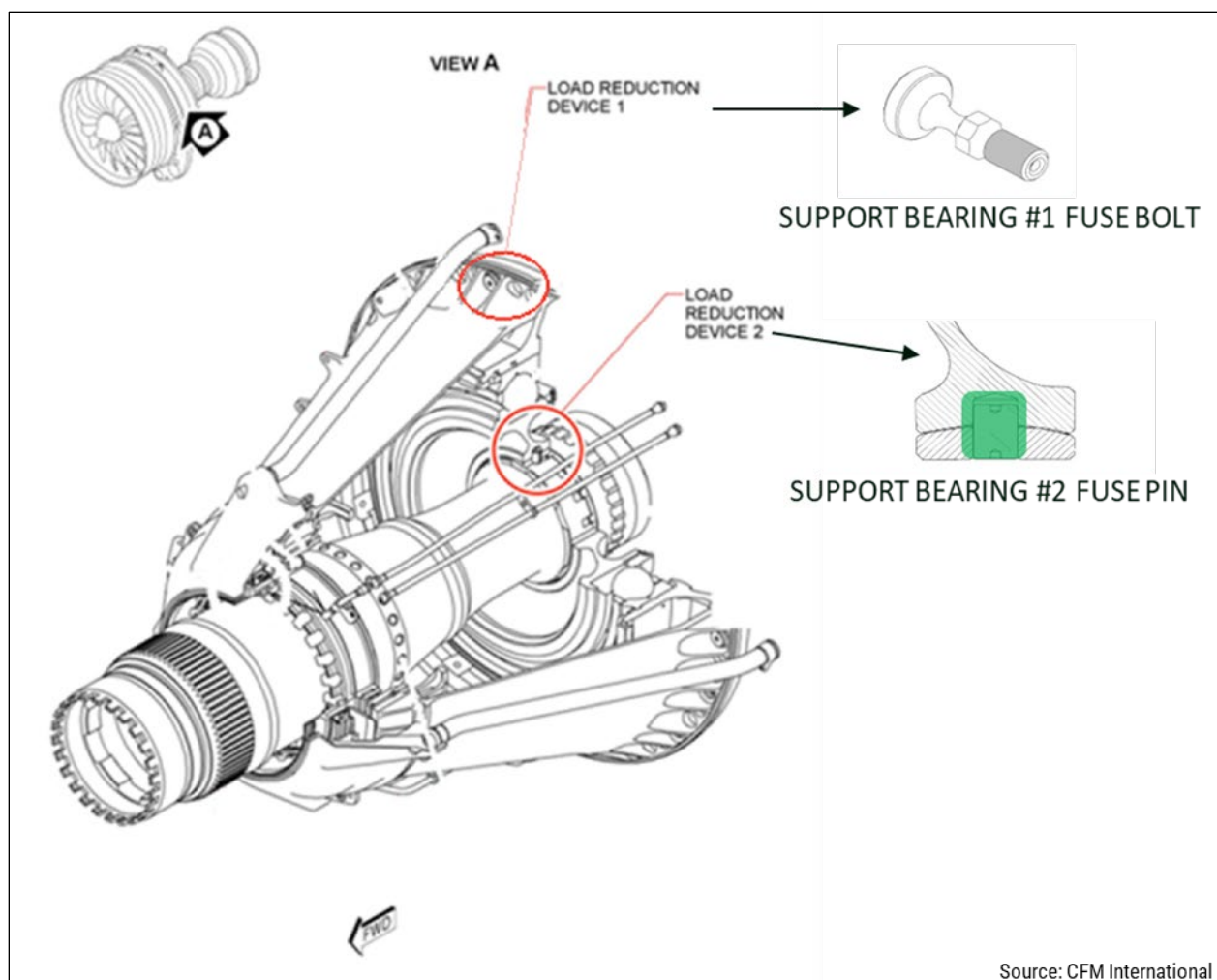
The LEAP-1B engine has a load reduction device (LRD), which is a passive system designed to reduce aircraft and engine loads in the event of a significant fan imbalance.

LRDs are a common feature of engines with wide-chord fan blades. While specifics vary according to engine design, the intent is the same. When the fan is significantly damaged, the LRD reduces stiffness of the fan rotor support, thus reducing the severity of the vibration transmitted to the engine and into the airframe. LRDs are design features that activate only in the event of significant imbalance and do not require any pilot intervention.

The No. 2 bearing housing bolts directly to the fan hub frame. The No. 1 bearing housing is bolted through holes in the No. 2 bearing housing to the fan hub frame by 23 shear bolts. The intent of the shear bolts is to decouple the No. 1 bearing from the engine structure during high fan imbalance events, allowing the No. 1 bearing support to move freely relative to fan frame and the No. 2 bearing housing support which remains attached to the fan frame. This enables safe continued flight during the post-event windmilling phase as the damaged fan slows or stops (Figure 4).

Fracture of the No. 1 bearing shear bolts prevents the No. 1 roller bearing from providing radial support for the fan rotor. Shear pins in the No. 2 bearing spherical joint shear, preventing overturning moment from transferring into the No. 1 bearing support while still allowing transfer of radial and axial load.

Fan case-to-fan blade tip gap is increased to avoid "hard" radial rubbing normally encountered during significant fan imbalance. Larger tip gap is achieved by using abradable material to increase the distance between the fan case base material and the blade tips. Disconnecting the No. 1 bearing radial load path and the No. 2 bearing moment load path and reducing the rub load into the fan case allows the fan to spin nearly about its new center of gravity, thereby reducing loads transmitted to the rest of the engine and airframe.



F NO. 1 ENGINE EXAM, SERIAL NUMBER 60A887

Engine exam information was provided by CFM. The NTSB did not participate or provide input.

The incident engine was a CFM LEAP-1B, engine serial number 60A887. The engine was shipped to the Safran facility in Villaroche, France for disassembly and examination. Bird feathers and bird remains (snarge) have proteins that fluoresce/glow under ultraviolet light. Black light inspection found organic debris on all fan blades. Bird remains were collected and sent to the Museum National D'Histoire Naturelle in Paris, France who identified them as a female bald eagle (*Haliaeetus leucocephalus*). According to the United States Fish and Wildlife website, female bald eagle weights typically range from 10.2 - 14 lbs.

Significant damage was found to the fan module. The front spinner and platform front shroud were present. All 18 fan blades were present except for the No. 4 fan blade which was fractured at the blade platform. All remaining fan blades exhibited a combination of leading edge and blade tip damage and blade tip material loss. The fan case abradable seal was heavily worn and missing 360° around the circumference almost down to the case material (Figure 5).



Figure 5: Fan blade and fan case damage

The LRD was found activated. All 23 No. 1 bearing support shear bolts were found fractured (Figure 6) and all the No. 2 bearing support fuse pins were activated. This softened the load path to the engine structure, as designed, reducing the severity of the vibration transmitted into the airframe. Evidence of oil leakage was found inside the booster cavity and 4:00 o'clock position on the right side of the environmental control system (ECS) cavity (Figure 7). According to CFM, the condition of the remaining engine modules (booster, compressor, turbines) was consistent with damage from a very large bird strike and subsequent LRD activation.



Figure 6: Fractured No. 1 bearing housing support shear bolts

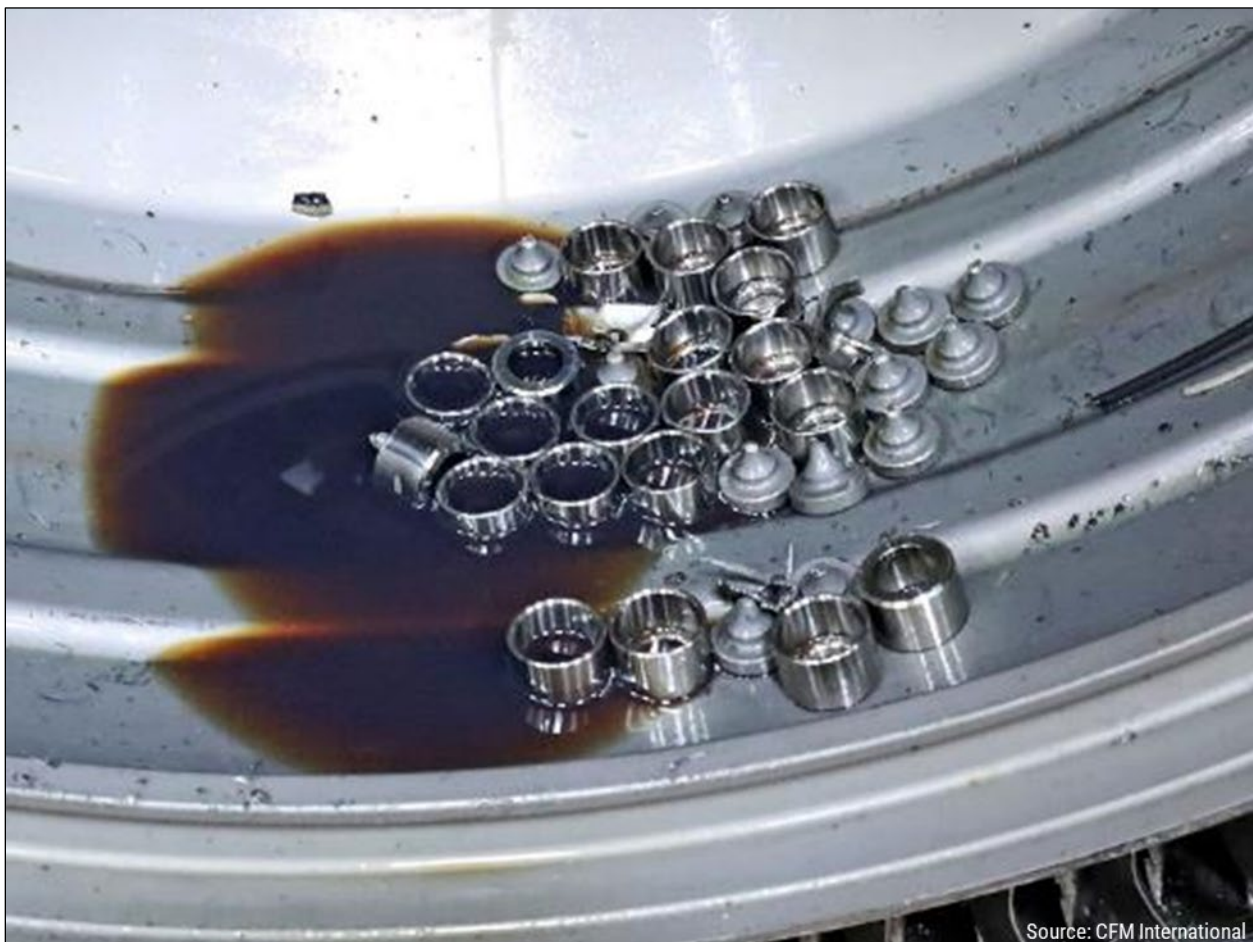


Figure 7: Oil and sheared No. 1 bearing housing support bolts in booster cavity

An approximate 15 mm (0.6 inch) gap was measured between the Nos. 1 and 2 bearing support module rear flange and No. 2 bearing outer support (Figure 8). The No. 1 bearing oil tubes were found bent and disconnected.

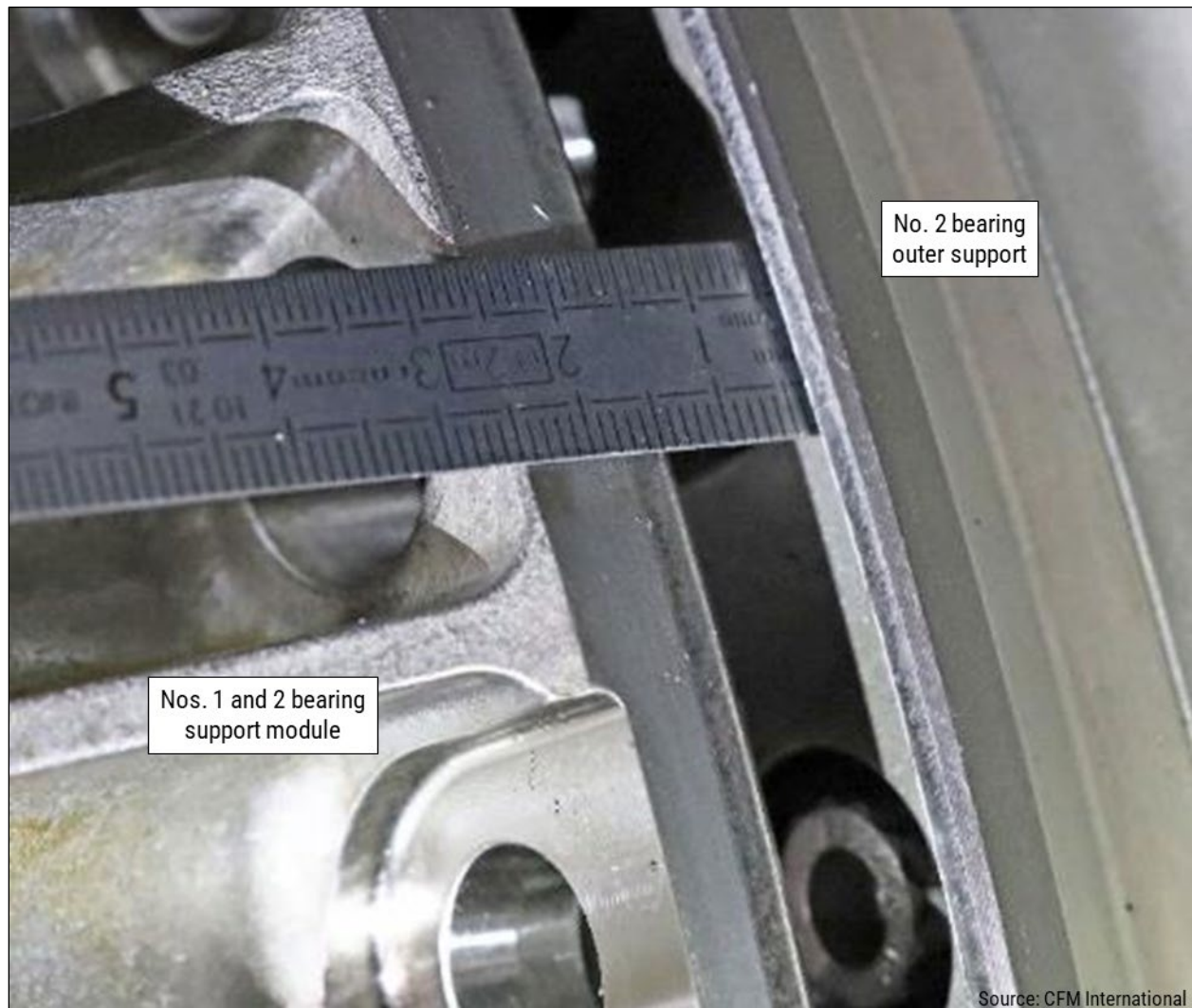


Figure 8: Gap between Nos. 1 and 2 bearing support module rear flange

G AIRPLANE ENVIRONMENTAL CONTROL SYSTEM DESCRIPTION

The ECS controls outside air flow for airplane pressurization and ventilation, and cabin temperature for the flight compartment and passenger cabin. The ECS also filters and recirculates cabin air for ventilation. A simplified schematic of the ECS is shown in Figure 9 and Figure 10 below.

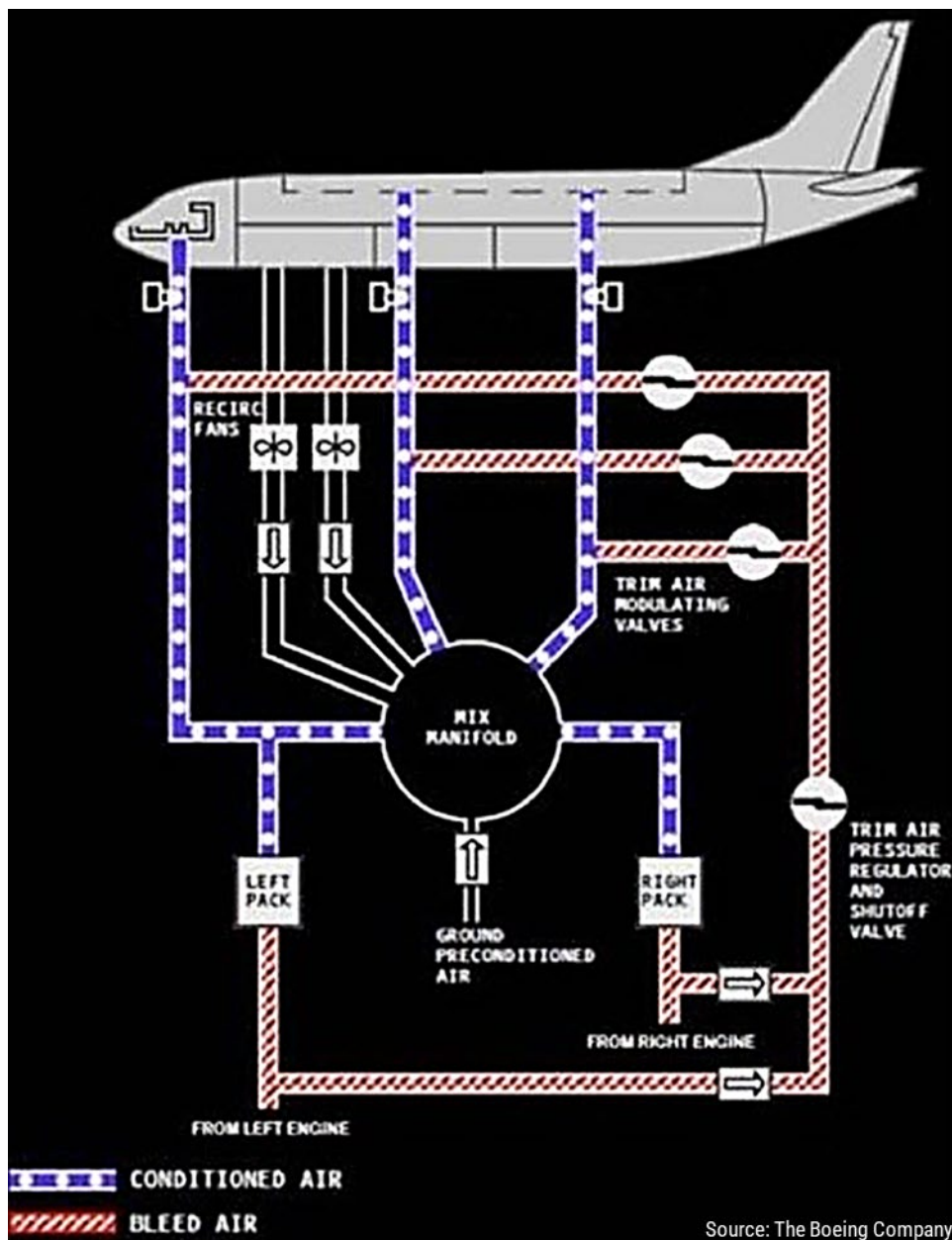


Figure 9: Air distribution system

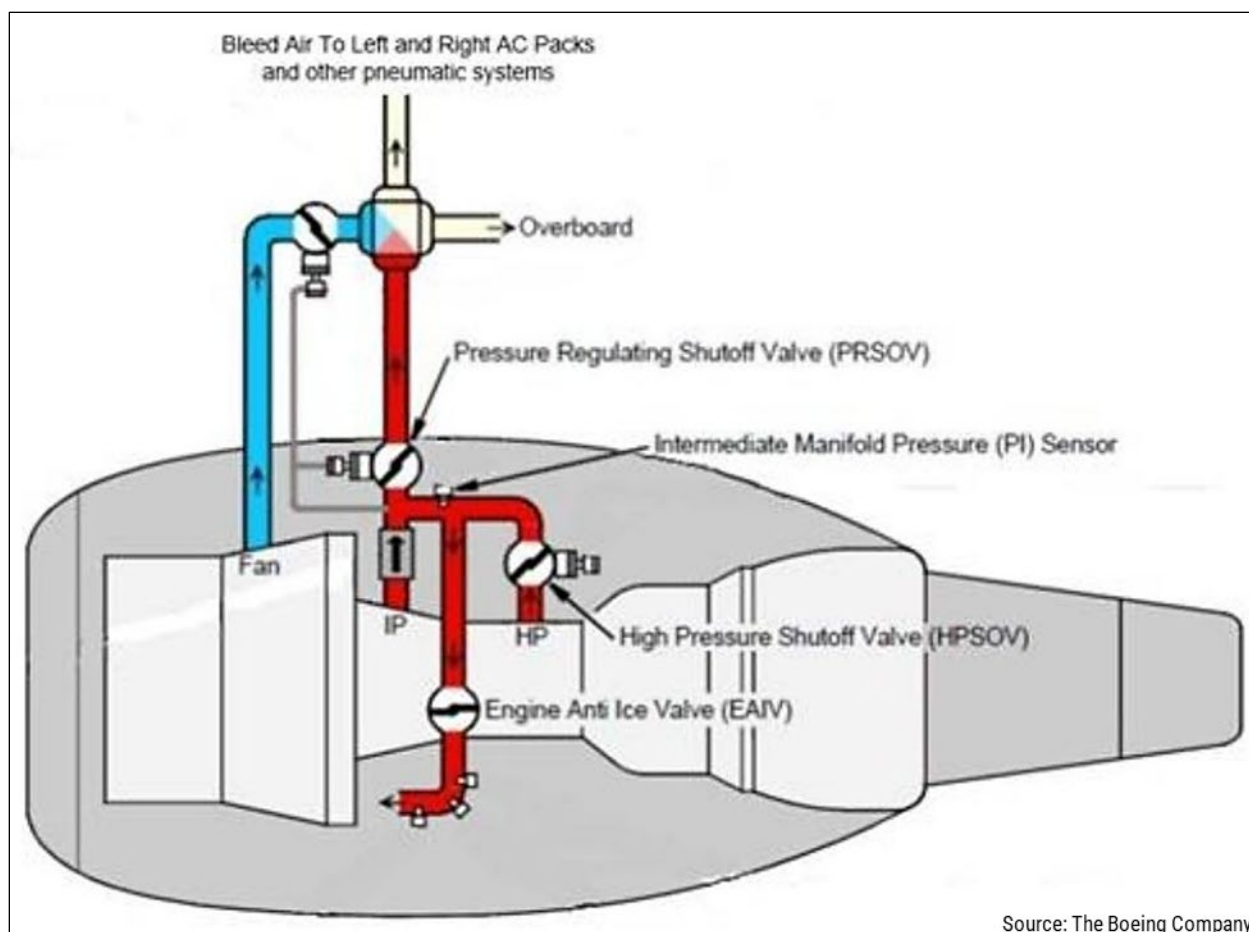


Figure 10: Engine bleed air system

1.0 Engine and Pack Flow Control

A pressure regulating shutoff valve is installed on each engine to control engine bleed air supply to the airplane. A bleed air isolation valve divides the pneumatic manifold system into left and right sides. The normal position of this valve is closed. The No. 1 engine pneumatic bleed air is normally supplied through the left pack and the No. 2 engine pneumatic bleed air is normally supplied through the right pack. In single bleed conditions, the isolation valve opens to provide airflow to both the left and right sides from a single bleed.

A pack flow control and shutoff valve upstream of each pack controls the quantity of outside air that flows into the airplane, which is determined by the number of seats in the airplane. The quantity of outside air necessary for ventilation is more than what is required for pressurization. Usually, the left and right flow control systems provide equal quantities of outside air.

2.0 Pack Cooling System

Left and right pack systems control the temperature of outside air before it flows into the air distribution system. System temperature control is typically dictated by the zone (flight deck, forward, or aft) requiring the most cooling and trim air is used to achieve the desired temperature in each zone. During failure conditions (such as trim valves failing full open), the system will prioritize the flight deck.

3.0 Air Distribution System

The air distribution system distributes outside air mixed with filtered, recirculated air. Left and right recirculation fans with high efficiency particulate air (HEPA) filters recirculate approximately 50% of the cabin air for ventilation purposes. Air constantly flows in and out of the cabin and continuously exits the airplane through an outflow valve in the aft section of the airplane.

H BIRD INGESTION REQUIREMENTS AND TESTING

1.0 Current FAA Bird Ingestion Standards

Airworthiness standards for aircraft engines are in Title 14 *Code of Federal Regulations* Part 33 and bird ingestion standards are in Subpart E - Design and Construction; Turbine Aircraft Engines, Section 33.76 Bird Ingestion. Section 33.76 Amendment (Amdt.) 33-33² was published October 17, 2007, effective November 17, 2007. The CFM LEAP-1B28 was certificated to this bird ingestion standard.

The latest amendment to Section 33.76 is Amdt. 33-36 published April 4, 2023, effective June 5, 2023. This amendment included a new medium flocking bird test at climb condition. The new test requirements ensure that turbofan engines can ingest the largest medium flocking bird into the engine core during climb or approach conditions. The event engine was certified prior to Amdt. 33-36, thus did not require the new medium flocking bird test at climb condition. The remaining bird ingestion requirements did not change and were used to certify the event engine.

Bird ingestion test requirements are divided into three categories - large single bird, small and medium flocking birds, and large flocking birds³. Requirements for bird weight and number of birds are dictated by the size of the engine inlet throat area. For this discussion, only requirements for large single bird and small and medium flocking birds will be addressed. This includes:

1. Part 33.76 section (a) general requirements
2. Part 33.76 section (b) large single bird requirements
3. Part 33.76 section (c) small and medium flocking bird only

² Amdt. 33-23 amended the aircraft turbine engine type certification standard to better address the threat flocking birds present to turbine engine aircraft. [Doc. No. FAA-1998-4815, 65 FR 55854, Sept. 14, 2000, as amended by Amdt. 33-20, 68 FR 75391, Dec. 31, 2003; Amdt. 33-24, 72 FR 50868, Sept. 4, 2007; Amdt. 33-23, 72 FR 58974, Oct. 17, 2007]

³ The large flocking bird test was not applicable because the inlet throat area for the LEAP-1B is less than the required 2.50 m² / 3,875 in².

1.1 § 33.76 Bird ingestion

- (a) **General.** Compliance with paragraphs (b), (c), and (d) of this section shall be in accordance with the following:
- (1) Except as specified in paragraph (d) of this section, all ingestion tests must be conducted with the engine stabilized at no less than 100-percent takeoff power or thrust, for test day ambient conditions prior to the ingestion. In addition, the demonstration of compliance must account for engine operation at sea level takeoff conditions on the hottest day that a minimum engine can achieve maximum rated takeoff thrust or power.
 - (2) The engine inlet throat area as used in this section to determine the bird quantity and weights will be established by the applicant and identified as a limitation in the installation instructions required under § 33.5.
 - (3) The impact to the front of the engine from the large single bird, the single largest medium bird which can enter the inlet, and the large flocking bird must be evaluated. Applicants must show that the associated components when struck under the conditions prescribed in paragraphs (b), (c) or (d) of this section, as applicable, will not affect the engine to the extent that the engine cannot comply with the requirements of paragraphs (b)(3), (c)(6) and (d)(4) of this section.
 - (4) For an engine that incorporates an inlet protection device, compliance with this section shall be established with the device functioning. The engine approval will be endorsed to show that compliance with the requirements has been established with the device functioning.
 - (5) Objects that are accepted by the Administrator may be substituted for birds when conducting the bird ingestion tests required by paragraphs (b), (c) and (d) of this section.
 - (6) If compliance with the requirements of this section is not established, the engine type certification documentation will show that the engine shall be limited to aircraft installations in which it is shown that a bird cannot strike the engine, or be ingested into the engine, or adversely restrict airflow into the engine.
- (b) **Large single bird.** Compliance with the large bird ingestion requirements shall be in accordance with the following:
- (1) The large bird ingestion test shall be conducted using one bird of a weight determined from Table 1 aimed at the most critical exposed location on the first stage rotor blades and ingested at a bird speed of 200-knots for engines to be installed on airplanes, or the maximum airspeed for normal rotorcraft flight operations for engines to be installed on rotorcraft.
 - (2) Power lever movement is not permitted within 15 seconds following ingestion of the large bird.

- (3) Ingestion of a single large bird tested under the conditions prescribed in this section may not result in any condition described in § 33.75(g)(2)⁴ of this part.
- (4) Compliance with the large bird ingestion requirements of this paragraph may be shown by demonstrating that the requirements of § 33.94(a)⁵ constitute a more severe demonstration of blade containment and rotor unbalance than the requirements of this paragraph.

Table 1: § 33.76 – Large Bird Weight Requirements

Engine Inlet Throat Area (m ² /in ²)	Bird Mass and Weight (kg/lbs)
1.35 (2,092) > A	1.85 (4.07) minimum, unless a smaller bird is determined to be a more severe demonstration.
1.35 (2,092) ≤ A < 3.90 (6,045) [†]	2.75 (6.05)
3.90 (6,045) ≤ A	3.65 (8.03)

⁴ § 33.75 Safety Analysis

- (g) Unless otherwise approved by the FAA and stated in the safety analysis, for compliance with part 33, the following failure definitions apply to the engine:
 - (2) The following effects will be regarded as hazardous engine effects:
 - (i) Non-containment of high-energy debris
 - (ii) Concentration of toxic products in the engine bleed air intended for the cabin sufficient to incapacitate crew or passengers
 - (iii) Significant thrust in the opposite direction to that commanded by the pilot
 - (iv) Uncontrolled fire
 - (v) Failure of the engine mount system leading to inadvertent engine separation
 - (vi) Release of the propeller by the engine, if applicable
 - (vii) Complete inability to shut the engine down.

⁵ § 33.94 Blade containment and rotor unbalance tests

- (a) Except as provided in paragraph (b) of this section, it must be demonstrated by engine tests that the engine is capable of containing damage without catching fire and without failure of its mounting attachments when operated for at least 15 seconds, unless the resulting engine damage induces a self shutdown, after each of the following events
 - (1) Failure of the most critical compressor or fan blade while operating at maximum permissible rpm. The blade failure must occur at the outermost retention groove or, for integrally-bladed rotor discs, at least 80 percent of the blade must fail
 - (2) Failure of the most critical turbine blade while operating at maximum permissible rpm. The blade failure must occur at the outermost retention groove or, for integrally-bladed rotor discs, at least 80 percent of the blade must fail. The most critical turbine blade must be determined by considering turbine blade weight and the strength of the adjacent turbine case at case temperatures and pressures associated with operation at maximum permissible rpm.

[†] LEAP-1B requirement.

- (c) **Small and medium flocking bird.** Compliance with the small and medium bird ingestion requirements shall be in accordance with the following:
- (1) Analysis or component test, or both, acceptable to the Administrator, shall be conducted to determine the critical ingestion parameters affecting power loss and damage. Critical ingestion parameters shall include, but are not limited to, the effects of bird speed, critical target location, and first stage rotor speed. The critical bird ingestion speed should reflect the most critical condition within the range of airspeeds used for normal flight operations up to 1,500 feet above ground level, but not less than V_1 minimum for airplanes.
 - (2) Medium bird engine tests shall be conducted so as to simulate a flock encounter, and will use the bird weights and quantities specified in Table 2. When only one bird is specified, that bird will be aimed at the engine core primary flow path; the other critical locations on the engine face area must be addressed, as necessary, by appropriate tests or analysis, or both. When two or more birds are specified in Table 2, the largest of those birds must be aimed at the engine core primary flow path, and a second bird must be aimed at the most critical exposed location on the first stage rotor blades. Any remaining birds must be evenly distributed over the engine face area.
 - (3) In addition, except for rotorcraft engines, it must also be substantiated by appropriate tests or analysis or both, that when the full fan assembly is subjected to the ingestion of the quantity and weights of bird from Table 3, aimed at the fan assembly's most critical location outboard of the primary core flowpath, and in accordance with the applicable test conditions of this paragraph, that the engine can comply with the acceptance criteria of this paragraph.
 - (4) A small bird ingestion test is not required if the prescribed number of medium birds pass into the engine rotor blades during the medium bird test.
 - (5) Small bird ingestion tests shall be conducted so as to simulate a flock encounter using one 85-gram (0.187 lb.) bird for each 0.032 square-meter (49.6 square-inches) of inlet area, or fraction thereof, up to a maximum of 16 birds. The birds will be aimed so as to account for any critical exposed locations on the first stage rotor blades, with any remaining birds evenly distributed over the engine face area.
 - (6) Ingestion of small and medium birds tested under the conditions prescribed in this paragraph may not cause any of the following:
 - (i) More than a sustained 25-percent power or thrust loss;
 - (ii) The engine to be shut down during the required run-on demonstration prescribed in paragraphs (c)(7) or (c)(8) of this section;
 - (iii) The conditions defined in paragraph (b)(3) of this section.
 - (iv) Unacceptable deterioration of engine handling characteristics.
 - (7) Except for rotorcraft engines, the following test schedule shall be used:

- (i) Ingestion so as to simulate a flock encounter, with approximately 1 second elapsed time from the moment of the first bird ingestion to the last.
 - (ii) Followed by 2 minutes without power lever movement after the ingestion.
 - (iii) Followed by 3 minutes at 75-percent of the test condition.
 - (iv) Followed by 6 minutes at 60-percent of the test condition.
 - (v) Followed by 6 minutes at 40-percent of the test condition.
 - (vi) Followed by 1 minute at approach idle.
 - (vii) Followed by 2 minutes at 75-percent of the test condition.
 - (viii) Followed by stabilizing at idle and engine shut down.
 - (ix) The durations specified are times at the defined conditions with the power being changed between each condition in less than 10 seconds.
- (8) For rotorcraft engines, the following test schedule shall be used:
- (i) Ingestion so as to simulate a flock encounter within approximately 1 second elapsed time between the first ingestion and the last.
 - (ii) Followed by 3 minutes at 75-percent of the test condition.
 - (iii) Followed by 90 seconds at descent flight idle.
 - (iv) Followed by 30 seconds at 75-percent of the test condition.
 - (v) Followed by stabilizing at idle and engine shut down.
 - (vi) The durations specified are times at the defined conditions with the power being changed between each condition in less than 10 seconds.
- (9) Engines intended for use in multi-engine rotorcraft are not required to comply with the medium bird ingestion portion of this section, providing that the appropriate type certificate documentation is so endorsed.
- (10) If any engine operating limit(s) is exceeded during the initial 2 minutes without power lever movement, as provided by paragraph (c)(7)(ii) of this section, then it shall be established that the limit exceedance will not result in an unsafe condition.

Table 2: § 33.76 – Medium Flocking Bird Weight and Quantity Requirements

Engine Inlet Throat Area (m ² /in ²)	Bird Quantity	Bird Mass and Weight (kg/lbs)
0.05 (77.5) > A	none	
0.05 (77.5) ≤ A < 0.10 (155)	1	0.35 (0.77)
0.10 (155) ≤ A < 0.20 (310)	1	0.45 (0.99)
0.20 (310) ≤ A < 0.40 (620)	2	0.45 (0.99)
0.40 (620) ≤ A < 0.60 (930)	2	0.70 (1.54)
0.60 (930) ≤ A < 1.00 (1,550)	3	0.70 (1.54)
1.00 (1,550) ≤ A < 1.35 (2,092)	4	0.70 (1.54)
1.35 (2,092) ≤ A < 1.70 (2,635)	1	1.15 (2.53)
	plus 3	0.70 (1.54)
1.70 (2,635) ≤ A < 2.10 (3,255)	1	1.15 (2.53)
	plus 4	0.70 (1.54)
2.10 (3,255) ≤ A < 2.50 (3,875) [†]	1	1.15 (2.53)
	plus 5	0.70 (1.54)
2.50 (3,875) ≤ A < 3.90 (6,045)	1	1.15 (2.53)
	plus 6	0.70 (1.54)
3.90 (6,045) ≤ A < 4.50 (6,975)	3	1.15 (2.53)
4.50 (6,975) ≤ A	4	1.15 (2.53)

Table 3: § 33.76 – Additional Integrity Assessment

Engine Inlet Throat Area (m ² /in ²)	Bird Quantity	Bird Mass and Weight (kg/lbs)
1.35 (2,092) > A	none	
1.35 (2,092) ≤ A < 2.90 (4,495) [†]	1	1.15 (2.53)
2.90 (4,495) ≤ A < 3.90 (6,045)	2	1.15 (2.53)
3.90 (6,045) ≤ A	1	1.15 (2.53)
	plus 6	0.70 (1.54)

[†] LEAP-1B requirement.

2.0 LEAP-1B Bird Ingestion Test Results

The LEAP-1B was subjected to three bird ingestion certification tests. The large bird test was conducted at the Safran Aircraft engine facility in Villaroche France in September 2015 (test 1). The medium flocking bird (test 2) and medium bird additional integrity assessment (test 3) tests were conducted at the GE Aerospace test facility in Peebles, Ohio, USA in January 2016.

The medium flocking bird certification and medium bird additional integrity assessment tests were full engine tests. No fan blade airfoils liberated or fractured and damage was primarily cracks, disbonding, and deformation of the fan blade airfoil leading edges. The medium flocking bird and medium bird additional integrity assessment certification tests were deemed satisfactory.

The large single bird test was conducted on a test rig consisting of a set of fan blades and a fan case. Two fan blades fractured about mid-span during the test and the fan case had two corresponding impacts. The fan case did not exhibit any breaches or pass-through penetration, but the abradable seal was totally consumed (worn away and missing). Fan imbalance was less than what was observed in the fan-blade-out certification test and the large single bird certification test was deemed satisfactory. Fan blades that were fractured mid-span during this test had cracks and disbonding on the suction side of the blades at the transition radius between the airfoil and platform. The LPT shaft was not installed during this test since the test's primary purpose was to validate fan blade and case capabilities and fan blade retention. The Nos. 1 and 2 bearing support module was also not installed so no information about LRD function is available from this test.

Submitted by:

Jean-Pierre Scarfo
Powerplant Lead