Docket No. SA-532

Exhibit No. 8-B

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

Powerplant Group Chairman
Factual Report - Certification

(19 Pages)

National Transportation Safety Board
Office of Aviation Safety
Washington, D.C. 20594

May 18, 2009

GROUP CHAIRMAN'S FACTUAL REPORT

POWERPLANT GROUP

DCA09MA026

A. ACCIDENT

Location:	New York, NY
Date:	January 15, 2009
Time:	1527 Eastern Standard Time
Aircraft:	US Airways Airbus A320-214, registration N106US, Flight 1549

B. POWERPLANTS GROUP

Group Chairman:	Harald Reichel National Transportation Safety Board Washington, DC
Member:	Stephen Sheely Federal Aviation Administration Burlington, Massachusetts
Member:	Marc Lever Bureau d'Enquetes et d'Analyses Le Bourget, France
Member:	Leslie McVey CFM International Cincinnati, Ohio

C. SUMMARY

On January 15, 2009 about 1527 Eastern Standard Time, US Airways flight 1549, an Airbus A320-214, registration N106US, suffered bird ingestion into both engines, lost engine thrust, and landed in the Hudson River following take off from New York City's La Guardia Airport (LGA). The scheduled, domestic passenger flight, operated under the provisions of Title 14 CFR Part 121, was en route to Charlotte Douglas International Airport (CLT) in Charlotte, North Carolina. The 150 passengers and 5 crewmembers evacuated the aircraft successfully. One flight attendant and four passengers were seriously injured.

The Airbus A320 involved in the accident was powered by two CFM56-5B4/P engines that were jointly certificated by the US Federal Aviation Administration (FAA) and the European Joint Aviation Authorities (JAA) in 1996.

C.1 CFM56-5B4/P Certification Overview

C.1.1 Joint Certification Concept

CFM International (CFM) is a partnership between General Electric in the USA and Snecma *(Société Nationale d'Etude et de Construction de Moteurs d'Aviation)* of France. CFM is not an acronym; however, the company (CFM) and product line (CFM56) receive their names by a combination of the two parent companies' commercial engine designations: GE's CF6 and Snecma's M56. Because the CFM56-5B4/P engine was jointly designed and manufactured in the USA and Europe, certification was also under a joint agreement and the engine certification process required concurrent issuance of type certificates (TC) by both aviation authorities.

Prior to September 28, 2003 CFM engines, including the CFM56-5B4/P, were certified under a bilateral agreement between the French Direction Generale de L'Aviation Civile (DGAC) in compliance to the Joint Aviation Authorities (JAA) Joint Aviation Regulations – Engines (JAR-E) requirements and the Federal Aviation Administration (FAA) under 14 CFR Part 33 (subsequently referred as solely Part 33). Both FAA and DGAC issued domestic and import TCs (FAA TC No. E37NE & E38NE and DGAC TCs No. M17 & M-IM 28) for the CFM56-5B4/P engine.

Since the specific technical regulations of the two authorities were not harmonized, meaning they had differing certification requirements, CFM was required to use the more stringent certification regulation from each agency's requirement to ensure compliance to both standards.

C.1.2 Joint Aviation Authorities (JAA) & European Civil Aviation Conference (ECAC)

The JAA started as the Joint Airworthiness Authorities in 1970. Originally, its objectives were to produce common airworthiness requirements for large airplanes and for engines in order to meet the needs of European industry and international consortia. After 1987 the JAA influence was extended to operations, maintenance, licensing and certification/design standards for all classes of aircraft and engines.

The JAA was an associated body of the ECAC, representing the civil aviation regulatory authorities of a number of European States who had agreed to co-operate in developing and implementing common safety regulatory standards and procedures. It was not a regulatory body, regulation being achieved through the member country authorities. For European regulation guidance and compliance, CFM International applied to the French DGAC for certification of the CFM56-5B4/P engine.

In 2002 the European Parliament and the Council of the European Union (EU) established the European Aviation Safety Agency (EASA), a Europe wide regulatory authority that will eventually absorb all the functions of the JAA in the EASA Members states. Among the functions that have already been transferred are safety and environmental type-certification of aircraft, engines and parts and approval of subsequent design changes. On September 28, 2003 EASA took over responsibility for the airworthiness and environmental certification of all aeronautical products, parts, and appliances designed, manufactured, maintained or used by persons under the regulatory oversight of EU Member States; therefore it now serves as the aviation regulatory agency issuing TCs for all its ratified member states. Since this time, EASA has replaced the original DGAC TCs No. M17 & M-IM 28 with a single EASA TC, No. E.003.

C.2 Bird Strike Certification Requirements

C.2.1 FAA Bird Strike Criteria

The aircraft engine certification process consists of many certification tests or analyses that demonstrate that the engine is compliant with its type certification basis. Due to the number and complexity of the testing required, not all the certification tests are performed at once, but rather are performed in stages until all the FAA and JAA requirements have been satisfied. The engine TCs were issued upon successful completion of all the certification requirements. The bird strike analysis and tests are a small component of the overall engine certification process.

Part 33 regulations contain the airworthiness standards that engines are required to comply with to obtain an FAA TC. Presently the aircraft engine bird strike certification requirements are covered in Part 33 Paragraph 33.76 – titled ‘Bird Ingestion’. At the issuance of this report, the current bird ingestion requirements incorporated all previous amendments up to and including Amendment 33-24.

The CFM56-5B4/P engine was certificated and issued its TC on June 20, 1996. At the time the original CFM56-5B engine was certified in 1993, the bird strike regulations were not a stand-alone requirement but were part of a larger requirement – paragraph 33.77 titled 'Foreign Object Ingestion'. At the time the CFM56-5B4/P engine was certified, Amendment 33-11 was in effect as the basis for compliance.

C.2.2 History of CFR Engine Bird Ingestion Regulation Revisions

CFR regulations are modified from time to time in response to changes in technology, design philosophy, in-service data, or incidents or accidents. The bird ingestion requirements have undergone several changes since 1974 when they were originally introduced. Below is the list of amendments that altered the engine bird ingestion regulations.

- Amendment 33-6, effective on October 31, 1974 introduced paragraph 33.77 that incorporated foreign object ingestion as a certification requirement. Foreign objects were defined as birds, debris, ice and blade fragments.

- Amendment 33-10, effective on March 26, 1984 added details and refined the definition of foreign objects to just water, hail, ice and birds. Debris such as metal and tires was removed. The definition of 'inlet area' was refined and a detail about 'critical locations' in the inlet areas was added. Additionally a requirement for medium bird strike was added, requiring engines to operate after bird ingestion with no more than a 25% loss of thrust for five minutes, demonstrate no hazard[1] to the airplane and cause no change in handling characteristics. The medium bird ingestion criterion for CFM56 sized engines was seven, 1.5-pound birds volleyed[2] into the engine in less than one second. The large bird ingestion criterion was a single 4-pound bird. This is the bird ingestion standard to which the accident engine model was certified.

- Amendment 33-20, effective on December 13, 2000 created a new section 33.76, titled 'Bird Ingestion'. Bird ingestion requirements were expanded significantly over previous amendments in this major revision. The medium bird weight requirement changed from 1.5 pounds to a combination of a 1.5 pound plus a 2.5 pound bird as a function of engine size, with no more than 25% thrust loss for a 20-minute run-on (a 15 minute increase over the previous requirement). The large single bird weight requirement changed from 4 pounds to a variation between 4 pounds, 6 pounds, or 8 pounds depending on engine size. Section 33.77 was dedicated to ice ingestion. The JAA issued a similar rule in the same time period; however these rules were not retroactive. This change was issued in response to Safety Board Recommendation A-76-64 to the FAA in

[1] Engine hazards at that time were defined as fire, uncontained debris, mount failure, and inability to shutdown, as specified in Section 33.75 Safety Analysis.
[2] Volley means shooting the birds into the engine as defined by critical ingestion parameters that include bird speed, critical engine target location, fan speed, and into the engine in a specified time within the normal flight operations up to 1,500 feet above ground level, but not less than V1 minimum for the airplane.

response to a DC-10-30F accident in 1975. Refer to the next section for additional details.

- Amendment 33-24, effective on November 16, 2007 revised Section 33.76 by introducing a new class of bird for testing, the large flocking bird whose weight requirement was 4 pounds, 4.5 pounds, and 5.5 pounds depending on engine size, and the run-on test (as a decreasing sliding scale) from 90% maximum takeoff power for 20 minutes after ingestion.[3] This change was issued in response to Safety Board Recommendation A-76-64 to the FAA in response to a DC-10-30F accident in 1975. Refer to the next section for additional details.

C.3 Safety Board Previous Bird Ingestion Recommendations

The Safety Board has investigated a number of bird ingestion-related events, including a rejected takeoff accident involving a DC-10-30F, operated by Overseas National Airways, Inc., that occurred at John F. Kennedy International Airport on November 12, 1975.[4] The accident was caused by the ingestion of several large birds into the No. 3 engine. As a result of the investigation, the Board determined that the bird ingestion certification provision in effect at that time did not provide adequate safeguards against the ingestion potential of future large turbofan engines; therefore, the Safety Board issued Safety Recommendation A-76-064 to the FAA, recommending the following:

> Amend 14 CFR [*Code of Federal Regulations*] 33.77 to increase the maximum number of birds in the various size categories required to be ingested into turbine engines with large inlets. These increased numbers and sizes should be consistent with the birds ingested during service experience of these engines.

Subsequently, the FAA performed a study of bird ingestions that focused on the time period from 1981 to 1983 and issued a report titled *A Study of Bird Ingestions Into Large High Bypass Ratio Turbine Aircraft Engine*s. The study concluded that additional bird ingestion service data was needed to improve the validity of the FAA's database of bird ingestion events. The Safety Board was satisfied with the FAA's work at the time and concurred with the FAA's determination that additional data gathering was needed to make improvements. On July 30, 1986, the Safety Board classified Safety Recommendation A-76-064 "Closed–Acceptable Action." The Board notes that in 2001, the FAA commissioned a study to further collect and analyze data and the results of that study were reported in Report No. DOT/FAA/ARTN03/60, *Study of Bird Ingestions into*

[3] For example, the test requires that for the first 14 minutes of operation after the ingestion, the engine must produce no less that 50% of the maximum takeoff power, but towards the end of the test only between 5 and 10 percent of maximum takeoff power is required.

[4] More information about this accident, DCA76AZ010, can be found on the Safety Board's Web site at <http://www.ntsb.gov>.

Aircraft Turbine Engines (1968 to 1999). The report summarized the historical bird threat and resulting impact to flight safety based on 30 years of bird ingestion data.

The Safety Board reviewed the FAA's Notice of Proposed Rulemaking (NPRM), titled "Airworthiness Standards; Engine Bird Ingestion," which was published in 71 *Federal Register* 41184 on July 20, 2006. The notice proposed amending the aircraft turbine engine type certification standards to reflect recent analysis of the threat flocking birds present to turbine-engine aircraft. In the Safety Board's NPRM response letter to the FAA on September 18, 2006, it was noted that the Safety Board generally supported the NPRM but had concerns about bird size, the thrust rating used for the flocking bird requirement, and the effects of pre-existing damage which were considered vital components of a comprehensive bird ingestion standard.

From 1976 to the present, the Safety Board issued only one recommendation relating to engine bird ingestion certification standards, A-76-64; however, numerous other recommendations were issued relating to airport bird mitigation plans, air traffic control dissemination of bird information, and reporting of bird strike events: A-76-008 to A-76-013, A-76-062, and A-96-038 to A-96-42. The Safety Board also issued safety recommendations, A-76-059 to A-76-061, to address specific deficiencies to engine hardware as a result of a particular investigation. Furthermore, the Safety Board continues to investigate bird ingestion events, such as CHI07LA093[5], that pose a hazard to either the engine or airplane in order to identify potential safety areas.

C.4 High Bypass Aircraft Engine Air Flow Considerations

The high bypass turbofan aircraft engine consists of a ducted fan that is powered by a gas turbine (Figure 1). Part of the airstream from the ducted fan passes through the gas turbine core, providing air to burn fuel to create power. However, most of the airflow bypasses the engine core, and is accelerated by the fan blades and directed through the outer bypass duct, providing most of the thrust for flight. In the large and medium bird ingestion requirement the engine testing is performed at 100% takeoff power.

In the event of a bird strike, the bird can strike any part of the circular open fan area. If the bird enters the inlet near the outer radius (Figure 2), it will most likely strike only the fan blade and then continue along the bypass duct and be ejected at the back of the engine. In this case, the fan blades will exhibit some form of leading edge impact damage and may even bend and fracture, while downstream the passing debris can damage the outer bypass duct and fan outlet guide vanes (OGV), all negatively affecting the production of thrust; typically, the engine will still be able to operate but at a lower thrust level. The large single bird test is intended to test the fan blades, flammable fluid lines and support structure for resistance to impact from a single large bird ingestion. The

[5] This event involved a Boeing 767 that experienced a bird strike on approach causing one of the engines to lose power and leak fuel. No fire resulted and the airplane landed safely without any injuries to the occupants on board. More information about this event, CHI07LA093, can be found on the Safety Board's Web site at <http://www.ntsb.gov>.

bird is fired into the engine fan duct at a relatively large fan radius (between the center of the blade span and the outer blade tip), so that it strikes the fan blades only (Figure 2).

If the bird enters the inlet near a small fan radius (between the center of the blade span and spinner) a portion of it will most likely be ingested by the gas turbine core causing possible damage to the internal components such as the inlet guide vanes, booster vanes and blades, the high-pressure compressor vanes and blades or the combustor. If the damage is sufficient, then the engine may stall or flameout rendering it unable to produce appreciable thrust. The small and medium bird tests are intended to test the fan blades and structure as well as the core machinery for resistance to multiple birds.

C.5 CFM56-5B4/P Certification for Bird Ingestion

C.5.1 Certification Basis for Bird Strike

The original CFM56-5B1, -5B2 and –5B4 aircraft engines were certified in 1993. The basis for certification compliance for the FAA was Part 33.77, Amendment 11 and for the JAA was Joint Aviation Regulations - Engines (JAR-E), change 7 C3-2, paragraph 20.2 for ingestion of large bird. With respect to bird ingestion criteria, Part 33.77, Amendment 33-11 was identical to Amendment 33-10.

C.5.2 CFM56-5B4 Original Bird Ingestion Tests

The following certification tests and reports are germane to the CFM56-5B engine bird ingestion requirements:

CR-731 Medium Bird Ingestion for CFM56-5B1/-5B2/-5B4 - December 15, 1992
CR-732 Large Bird Ingestion for CFM56-5B1/-5B2/-5B4 – August 25, 1992
CR-731A 2.5 lb Birds Ingestion for CFM56-5B1/-5B2/-5B4 – March 10, 1993
CR-731A/P Medium Bird Ingestion CFM56-5B/P/-5B/P2 – June 20, 1996

To comply with the FAA bird ingestion requirements, the CFM56-5B4 engine was subjected to two baseline tests. One demonstrated the medium bird ingestion capability and the other a large bird ingestion capability. A small flocking bird test was not required for the CFM56-5B engine family in accordance with 33.77(e) since the medium birds passed through the IGVs during the medium bird ingestion test. The FAA and DGAC jointly approved all the reports listed above.

Summary results of the two bird tests found:

Medium Bird Test: The medium bird ingestion criterion was seven, 1.5-pound birds in a volley into the engine in less than one second. The birds were aimed at five specific locations in the flow path: the core, a mid-span zone, the outer panel and two intermediate locations. To comply with this section, the engine had to continue to operate

with no more than a 25% loss of thrust for five minutes, demonstrate no hazard to the aircraft and no change in handling characteristics after the birds were ingested. Certification Test Report CR-731 states the engine successfully passed the tests and the FAA and the DGAC jointly approved the report. (See excerpts in Appendix I).

Large Single Bird Test: The large bird ingestion criterion was a single 4-pound bird aimed at the critical fan blade location as defined by the engine manufacturer. The test demonstrated that:

1. The engine did not release hazardous fragments.
2. The fan imbalance was negligible.
3. The large bird ingestion test generated lower loads and fan blade distress than the fan blade-out test[6].

Certification Test Report CR-732 states the engine successfully passed the tests and the FAA and DGAC jointly approved the report. (See excerpts in Appendix II).

To comply with a new impending rule from the French DGAC (similar to future FAA rule 33.76), additional bird ingestion tests were performed and a report submitted during the initial certification of the CFM56-5B4 engine to comply with a Special Condition imposed by the DGAC.

Special Condition 2.5-pound Bird Test: Several rig and engine tests were conducted with 2.5-pound birds volleyed at critical locations on the fan, spinner, booster IGV's, and combustor and the 20 minute run-on requirements were completed.

Certification Test Report CR-731A states the engine passed all these tests and the FAA and the DGAC jointly approved the report. (See excerpts in Appendix III).

The CFM56-5B4/P engine incorporated high-pressure compressor (HPC) design changes that required a certification test demonstration to qualify the new hardware. A test was performed on February 6, 1996 to certify the new hardware to the medium bird requirement.

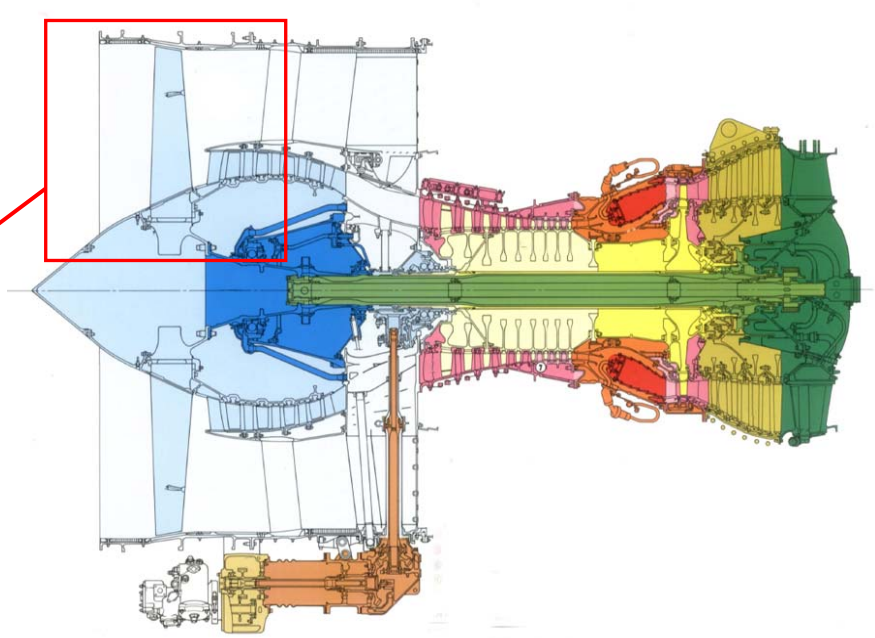
Medium Bird Specific to CFM56-5B4/P: Tests were conducted including a full engine test with two 1.5-pound birds ingested into the core followed by a 20-minute run-on.

Certification Test Report CR-731A/P states the engine passed the tests and the FAA and the DGAC jointly approved the report. (See excerpts in Appendix IV).

[6] The fan blade-out test is part of the Part 33.94 *Blade containment and rotor imbalance test*s that is required for engine certification and is intended to demonstrate the engine's capability of containing engine damage without catching fire and without failure of its mounting attachments.

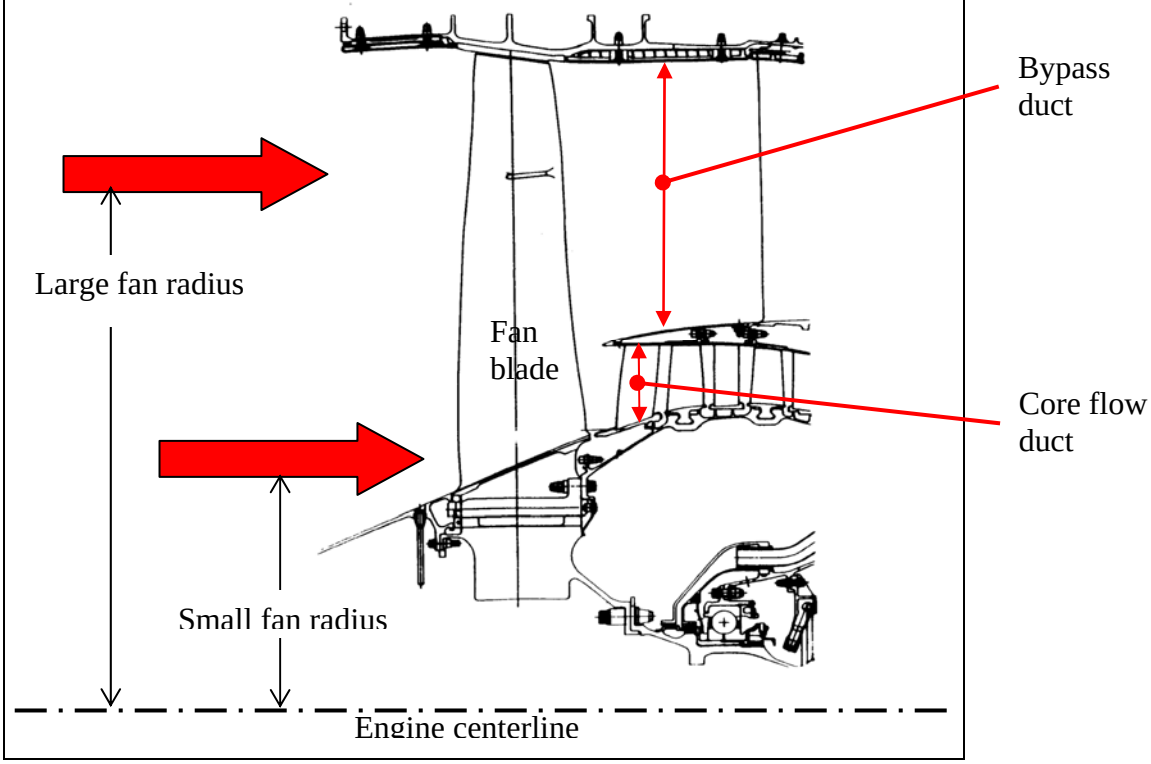
Harald Reichel
Aerospace Engineer – Powerplants

Figure 1 – Typical high bypass turbofan airplane engine



See Close-up
(Figure 2)

Figure 2 – Close-up of inlet area



APPENDIX I

CR-731

(Note: This CFM certification report summary has had certain limited portions redacted because they include CFM's proprietary information)

1.0 SUMMARY

1.1 OBJECTIVE

The purpose of this report is to compile and document information which demonstrates that the CPM56-5B1/-5B2/-5B4 engine is In compliance with FAR Part 33, Amendment 11 and JAR-E, Change 7, in its ability to show the required degree of tolerance to the ingestion of medium birds.

In particular, this report summarizes the testing performed to allow compliance with FAR Paragraph 33.77 and JAR-E Section C3-2 paragraph 1.5.1 and Section C3-4 Paragraph 20.3.

1.2 CONCLUSIONS

The engine has demonstrated its ability to ingest 7 medium birds in a volley within less than one second with a sustained thrust toss of less than 25%.

Operation for 5 minutes following stabilization and the post-test hardware condition show all components to have the capability of further operation without risk of Imminent hazard to the aircraft, without exceeding engine limitations, and with no change in handling characteristics.

1.3 RECOMMENDATION

CFM International recommends that the test results described herein be accepted as satisfactory evidence that the CFM56-5B1/-5B2/-5B4 engine has complied with the requirements of FAR 33 Amendment 11 and JAR-E Change 7 for medium birds and small birds ingestion.

1.4 SIGNIFICANT RESULTS AND OBSERVATIONS

1.4.1 Seven sea gulls, each weighing at least 1 1/2 lb. (680 g), were fired in a volley at selected targets in the engine inlet with the engine at takeoff power.

1.4.2 The throttle was not touched after the shot. Engine speed after the shot was unchanged.

1.4.3 No engine ratings or limitations were exceeded during test.

1.4.4 Engine operation and subsequent inspection indicate that there was no damage which affected the engine ability to continue to run and to provide at least 75 of the initial takeoff thrust.

1.4.5 Fan blade permanent deformation resulting from the bird ingestion was acceptable. There were 13 blades with deformation.

1.4.6 There was evidence of bird ingestion into the booster and core. Bird material was found on the booster and was seen In the HP compressor by horoscope inspection.

1.4.7 There was no damage to the booster. HP compressor (except for a few minor nicks and dents on a few stage 3 blades), combustor, HP turbine or IP turbine by horoscope inspection.

APPENDIX II

CR-732

(Note: This CFM certification report summary has had certain limited portions redacted because they include CFM's proprietary information)

FOREWORD

This report is submitted as proof of compliance with FAR 33.77 (a), Amendment 11 and JAR-E, change 7 C3-2, paragraph 1-5-2 and C3-4 paragraph 20.2, for ingestion of large bird, and to request formal type certification of the CFM56-5B1/-5B2/-5B4 engine to the requirements of these regulations.

1. SUMMARY

1.1. Objectives

The purpose of this report is to compile and document information which demonstrates that the CFM56-5B1/-5B2/-5B4 turbofan engine is in partial compliance with FAR Part 33, Amendment 11 and JAR-E, change 7, in its ability to show the necessary degree of tolerance to the ingestion of one large bird.

In particular, the report summarizes the large bird ingestion test to show partial compliance with FAR 33.77 (a) and JAR-E C3-2, paragraph 1.5.2 and paragraph 20.2.

1.2. Conclusion

The large bird ingestion test has shown the ability of the CFM56-5B1/-5B2/-5B4 engine to meet the evidence of partial compliance :

- no hazardous fragments,

- negligible fan unbalance and as a result, absence of excessive loads in engine structure and accessories which could cause either mounting failure or fire.

- the large bird ingestion test generated lower dynamic loads and fan blade distress than those experienced in fan blade containment tests;

1.3. Recommendations

CFM International recommends that the test results described herein be accepted as satisfactory evidence that the CFM56-5B1/-5B2/-5B4 engine has partially complied with the requirements of FAR, Part 33, Amendment 11 and JAR-E, change 7 for the ingestion of one large bird.

The complementary engine test which will demonstrate that large bird ingestion does not hazard the engine and provide substantiation for mount integrity, fire safety and shutdown capability is the fan containment engine test.

2.4. Test requirements

a) bird weight:

one bird of 1814 grams (4 Ibs) minimum

b) bird strike target:

Target corresponds to the most critical area for bird impact.

c) bird velocity:

- lift off speed of a typical aircraft with the engine operating at take off rating

d) Fan speed:

CFM56-5B1/-5B2/-5B4 engine take off rating.

2.5. Test description and chronology of events

The test was conducted on March 9 & 10, 1992 with appropriate STPA witnessing.

2.6 Analysis of results

There was no damage, which restricted the fan rotor ability to continue to run.

APPENDIX III

CR-731A

(Note: This CFM certification report summary has had certain limited portions redacted because they include CFM's proprietary information)

1.0 SUMMARY

1.1 OBJECTIVE

The purpose of this report is to compile and document the component and engine tests which demonstrate that the CFM56-5B1/-5B2/-5B4 engine is in compliance with FAR Part 33 Amendment 11, JAR-E Change 7 and DGAC CFM56-5B1/-5B2/-5B4 Special Condition #1, in its ability to show the required degree of tolerance to the ingestion of 2.5 lb birds.

1.2 CONCLUSION

Tests were conducted to demonstrate the capability of the CFM56-5B1/-5B2/-5B4 engine to ingest 2.5 lb birds:

1.2.1 Fan Rotor

A 2.52 Ib (1144 grams) seagull was ingested into the fan rotor. The bird was fired at the critical fan rotor target. The engine was operated for 20 minutes to demonstrate the capability for further operation. There was no risk of imminent hazard to the aircraft, no engine limitations were exceeded, and there was no change in engine handling characteristics.

1.2.2 Booster Assembly

A 2.55 Ib (1156 grams) seagull was fired into a fan rotor and booster assembly. The bird was fired at the booster IGV. There was no effect on thrust. The engine was operated for 20 minutes to demonstrate the capability for further operation. There was no risk of imminent hazard to the aircraft, no engine limitations were exceeded, and there was no change in handling characteristics.

1.2.3 Spinner

Two 2.5 Ib seagulls were fired at the type design spinner. There was no damage to the type design spinner components.

1.2.4 HP Compressor

A test was conducted in which three 2.5 Ib seagulls were fired into a CFM56-5 engine at takeoff power. One of these birds entered the HP compressor. There was no compressor damage except for a minor leading edge tip curl on two stage 1 blades, which would have no significant effect on engine thrust or operability.

1.2.5 Combustor

Combustor dome damage from bird strikes occasionally has been seen in CFM56 engines. This damage has never resulted in an unscheduled engine removal. Such damage, if any, has been discovered during engine overhaul.

1.3 RECOMMENDATION

CFM International recommends that the test results described herein be accepted as satisfactory evidence that the CFM56-5B1/-5B2/-5B4 engine has complied with the requirements of FAR 33 Amendment 11 and JAR-E Change 7 and DGAC Special Condition #1 for the ingestion of 2.5 Ib birds.

APPENDIX IV

CR-731A/P
Medium Bird

(Note: This CFM certification report summary has had certain limited portions redacted because they include CFM's proprietary information)

1.0 SUMMARY

1.1 OBJECTIVE

The purpose of this report is to compile and document information which demonstrates that the CFM56-5B/P (2P) engine models are in compliance with FAR 33 amendment 11 paragraph 77 (b), JAR-E-540 (b) change 7, JAR-E-800 (c) change 7, NPA-E-12, and DGAC Special Conditions for medium bird ingestion.

In particular, this report summarizes the testing performed to show compliance with FAR Paragraph 33.77 (b), JAR-E-540 and JAR-E-800 in accordance with the CFM56-5B/P (2P) Compliance Check List Item Number 1202.

This report summarizes the CFM56-5B/P (2P) Medium Bird Certification test, test results and findings.

1.2 CONCLUSIONS

The engine demonstrated its ability to ingest two medium birds, into the core, in a volley within less than one second with a thrust loss of less than 25%.

Following engine stabilization after the bird strike, operation for the 20 minute run-on showed that all components have the capability of further operation without hazard to the aircraft, without exceeding engine limitations, and with no change in handling characteristics.

1.3 RECOMMENDATION

CFM International recommends that the test results described herein be accepted as satisfactory evidence that the CFM56-5B/P (2P) engine has complied with the requirements of FAR 33 Amendment 11, JAR-E change 7 for medium birds and small birds ingestion.

1.4 SIGNIFICANT RESULTS AND OBSERVATIONS

1.4.2 Two sea gulls, each weighing at least 1 1/2 lb. (680 g), were fired in a volley with the engine at takeoff power.

1.4.3 The throttle was not touched during the strike and stabilization at takeoff. No thrust loss was evident from this two bird ingestion into the core.

1.4.4 Engine operation during the 20 minute run-on and subsequent hardware inspection indicate that there was no damage which affected the engine ability to continue to operate, including transients, and provide at least 75% of the initial takeoff thrust.

1.4.5 No engine ratings or limitations were exceeded during the test.

1.4.7 Five consecutive fan booster IGV's and five consecutive IGV's showed deformation.

1.4.10 The stage 4 booster vane inner shroud showed moderate inboard deflection.

1.4.11 The HP turbine nozzles showed leading and trailing edge burning. There was no further damage to the combustor, HP and LP turbines.

1.4.12 There was evidence of bird ingestion into the booster and core. Bird material was found on fan blade roots as well as on booster IGV's.

1.4.13 There was a moderate booster blade tip rub with some minor tip curl, nicks and dents on a few blades. There was a light tip rub on the HP compressor blades with some minor tip curl, nicks and dents on a few stages of blades.