[4910-13]

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 33

[Docket No. FAA-2018-0568; Notice No. 18-02]

RIN 2120- AK83

Medium Flocking Bird Test at Climb Condition

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Notice of proposed rulemaking (NPRM).

SUMMARY: The FAA proposes the addition of a new test requirement to the airworthiness regulation addressing engine bird ingestion. The current regulation ensures bird ingestion capability of the turbofan engine fan blades, but the existing test conditions do not adequately demonstrate bird ingestion capability of the engine core. This proposed rule would require that, to obtain certification of a turbofan engine, a manufacturer must show that the engine core can continue to operate after ingesting a medium sized bird while operating at a lower fan speed associated with climb or landing. This new requirement would ensure that engines can ingest the largest medium flocking bird required by the existing rule into the engine core at climb or descent conditions.

DATES: Send comments on or before [INSERT DATE 60 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER].

ADDRESSES: Send comments identified by docket number FAA-2018-0568 using any of the following methods:

- Federal eRulemaking Portal: Go to http://www.regulations.gov and follow the online instructions for sending your comments electronically.
- Mail: Send comments to Docket Operations, M-30, U.S. Department of Transportation (DOT), 1200 New Jersey Avenue, SE, Room W12-140, West Building Ground Floor, Washington, DC, 20590-0001.
- Hand Delivery or Courier: Take comments to Docket Operations in Room W12-140 of the West Building Ground Floor at 1200 New Jersey Avenue, SE, Washington, DC, between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays.
- Fax: Fax comments to Docket Operations at 202-493-2251.

Privacy: In accordance with 5 USC 553(c), DOT solicits comments from the public to better inform its rulemaking process. DOT posts these comments, without edit, including any personal information the commenter provides, to www.regulations.gov, as described in the system of records notice (DOT/ALL-14 FDMS), which can be reviewed at www.dot.gov/privacy.

Docket: Background documents or comments received may be read at http://www.regulations.gov at any time. Follow the online instructions for accessing the docket or go to the Docket Operations in Room W12-140 of the West Building Ground Floor at 1200 New Jersey Avenue, SE, Washington, DC, between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays.

FOR FURTHER INFORMATION CONTACT: Alan Strom, Federal Aviation Administration, Engine and Propeller Standards Branch, Aircraft Certification Service, AIR-6A1, 1200 District Avenue, Burlington, Massachusetts, 01803-5213; telephone (781) 238-7143; fax (781) 238-7199; e-mail alan.strom@faa.gov.

SUPPLEMENTARY INFORMATION:

Authority for this Rulemaking

The FAA's authority to issue rules on aviation safety is found in Title 49 of the United States Code. Subtitle I, Section 106 describes the authority of the FAA Administrator. Subtitle VII, Aviation Programs, describes in more detail the scope of the agency's authority.

This rulemaking is issued under the authority described in 49 U.S.C. 44701(a)(1). Under that section, the FAA is charged with, among other things, prescribing minimum safety standards for aircraft engines used in the flight of civil aircraft in air commerce. This proposed rule is within the scope of that authority because it updates existing regulations for certification of aircraft turbofan engines.

I. Overview of Proposed Rule

This proposed rule would create an additional bird ingestion test for turbofan engines. The new requirements would be added to 14 CFR 33.76, which covers engine

testing for bird ingestion. This new test would ensure that engines can ingest the largest medium flocking bird (MFB) required by the existing rule, into the engine core at climb conditions. If the engine design is such that no bird material will be ingested into the engine core[1] during the test at climb conditions, then the proposed rule would require a different test at approach conditions.

The proposed test consists of firing at the engine core one MFB, equivalent to the largest bird currently required by § 33.76(c) for the engine inlet throat area of the engine being tested, using either the following climb or descent testing conditions for an engine:

(1) Testing for bird ingestion on climb. The test bird would be fired at 250-knots, with the mechanical engine fan speed set at the lowest expected speed when climbing through 3,000 feet altitude above ground level (AGL). After bird ingestion, the proposal would require that the engine comply with post-test run-on requirements similar to those in existing § 33.76(d)(5), large flocking bird (LFB) test, except that, depending on the climb thrust of the engine, less than 50 percent takeoff thrust may be allowed during the first minute after bird ingestion.

(2) Testing for bird ingestion on descent. If the applicant determines that no bird mass will enter the core during the test at the 250-knots/climb condition, then the applicant would be required to perform an alternative test to that described in the paragraph (1). For this test, the bird would be fired at 200-knots, with the engine mechanical fan speed set at the lowest fan speed expected when descending through 3,000 feet altitude AGL on approach to landing. Applicants would be required to comply with post-test run-on requirements that are the same as the final six (6) minutes of the

[1] Turbofan engines have fan and core rotors. The fan or low pressure compressor is at the front of the engine. The core consists of additional compressor stages behind the fan.

existing § 33.76(d)(5) post-test run-on requirements for large flocking birds (LFB). This is based on the assumption that the airplane will already be lined up with the runway.

Summary of Costs and Benefits

The FAA estimates the annualized costs of this proposed rule to be $4 million, or $52 million over 27 years (at a seven percent present discount rate).[2] The FAA estimates the annualized benefits of $5 million, or $61 million over 27 years. The following table summarizes the benefits and costs of this proposed rule.

Summary of Benefits and Costs ($Millions)*

Impact	27-Year Total Present Value		Annualized	
	7%	3%	7%	3%
Benefits	$61.0	$100.6	$5.1	$5.5
Costs	$51.5	$71.5	$4.3	$3.9
Net Benefits	$9.4	$29.1	$0.8	$1.6

*Estimates may not total due to rounding. FAA uses discount rates of seven and three percent based on OMB guidance.

II. Background

A. Statement of the Problem

On January 15, 2009, US Airways Flight 1549 ("Flight 1549") took off from La Guardia Airport in New York City. On climb, at approximately 2,800 feet above ground level (AGL) and approximately 230-knots indicated airspeed, the airplane struck a flock of migratory Canada geese. Both engines ingested at least two birds. Both engine cores suffered major damage and total thrust loss.

[2] The FAA uses a 27-year period of analysis since it represents one complete cycle of actions affected by the proposed rule. One life cycle extends through the time required for certification, production of the engines, engine installation, active aircraft service, and retirement of the engines.

Flight 1549 was an Airbus Model A320 airplane. The A320 "family" of airplanes (i.e., Model A318/A319/A320/A321) and the Boeing Model 737 airplanes are among the most frequently used airplanes, transporting a significant number of airline passengers around the world. Most transport airplanes and many business aircraft use turbofan engines that are susceptible to bird ingestion damage which, in some instances, has resulted in greater than 50 percent takeoff thrust loss. In twin-engine airplanes, this amount of thrust loss in both engines can prevent the airplane to climb over obstacles or maintain altitude. This is an unsafe condition because it can prevent continued safe flight and landing.

As a result of the Flight 1549 accident, the FAA began studying how to improve engine durability with respect to core engine bird ingestion.[3] As a result of this tasking, the Aviation Rulemaking Advisory Committee (ARAC) working group produced a report titled, "Turbofan Bird Ingestion Regulation Engine Harmonization Working Group Report", dated February 19, 2015.[4] The ARAC working group report concluded that modern fan blades (such as those on the Flight 1549 airplane engines) have relatively wider fan blade chords (width) than those in service when the current MFB ingestion test (codified in 14 CFR 33.76(c)) was developed and adopted. The ARAC working group report also pointed out that the current MFB ingestion test is conducted with the engine operating at 100 percent takeoff power or thrust. This setting is ideal for testing the fan

[3] The FAA used prior studies to begin the review, such as flocking bird ingestion reports developed as Phase I and II reports for the current rule. The Phase III report, entitled, "Aerospace Industries Association Bird Ingestion Working Group Interim Report – January 2012" was produced after the Flight 1549 event. The Phase III report is the most germane to this proposed rule, as it contains the latest bird ingestion data available through January 2009, including the Flight 1549 accident.

[4] The FAA accepted this report on March 19, 2015. The ARAC working group report included recommendations consistent with this proposed rule. The FAA will file in the docket copies of the referenced reports for this proposed rule.

blades but does not represent the lower fan speeds used during the climb and descent phases of aircraft flight.

When an engine ingests a bird, the amount of bird mass that enters the engine core depends on: (1) the width of the fan blade chord, (2) the airplane's speed, and (3) the rotational speed of the fan blades. The wider the chord of the fan blade and the lower the speed of the airplane, the longer the bird will remain in contact with the fan blade. As airplane speed increases, the bird spends less time on the fan blade. With higher fan speed, the bird will move radially faster away from the core. Thus, the longer the time in contact with the fan blade, from wider blades and lower airspeed, and increased centrifugal forces from a higher fan speed result in the bird being moved further outboard and away from the core. That makes it less likely that bird material will enter the core during the current test compared to the proposed test. Conversely, a lower fan speed and higher airspeed, for a given fan blade width, makes it more likely that the bird material will enter the core.

Currently, the MFB test is conducted using 100 percent power or thrust and 200 knots airspeed, simulating takeoff conditions. Consequently, the current MFB test does not simulate lower fan speed phases of flight (such as climb and descent) during which a bird, if ingested, is more likely to enter the engine core. In addition, the higher airspeed in climb is not covered by the existing test. Therefore, the existing small and medium flocking bird test prescribed in § 33.76(c) do not provide the intended demonstration of core durability against bird ingestion for climb and descent conditions.

B. Related Actions

Before proposing this rule, the FAA reviewed other actions taken by this agency to reduce threats of engine bird ingestion and concluded that these actions would not mitigate the specific risk discussed above. These actions include the following:

(1) Advisory Circular (AC) 150/5200-33B, "Hazardous Wildlife Attractants on or Near Airports" provides guidance on certain land uses that have the potential to attract hazardous wildlife on or near public-use airports.

(2) AC 150/5200-34A, "Construction or Establishment of Landfills Near Public Airports" provides guidance to minimize the impact to air safety when landfills, that often attract birds, are established near public airports.

(3) 14 CFR 139.337, Wildlife hazard management, identifies certified Airport Operator responsibilities with respect to hazardous wildlife issues.

(4) FAA Airport Safety Web site, Wildlife Strike Resources, available at http://www.faa.gov/airports/airport_safety/wildlife/resources/, provides information on wildlife strike prevention, database links, and bird strike/ingestion report forms, for use by airport authorities, airlines, industry, and the public.

Most bird ingestions occur within five miles of an airport, and the ACs discussed above generally only apply within that radius. However, the Flight 1549 accident occurred more than five miles from La Guardia Airport, and the ingested birds were migratory. Therefore, while airport bird mitigation efforts are necessary to reduce engine bird ingestion incidents, these efforts will neither eliminate all flocking bird encounters, nor reduce the chance that such encounters could affect more than one engine on an airplane.

C. National Transportation Safety Board (NTSB) Recommendations

The National Transportation Safety Board (NTSB) has issued two engine-related safety recommendations to the FAA:

(1) A–10–64: Modify the small and medium flocking bird certification test standard to require that the test be conducted using the lowest expected fan speed, instead of 100 percent fan speed, for the minimum climb rate.

(2) A–10–65: During re-evaluation of the current engine bird-ingestion certification regulations by the Bird Ingestion Rulemaking Database working group, specifically re-evaluate the LFB certification test standards to determine if they should:

(a) Apply to engines with an inlet area of less than 2.5 square meters (3,875 square inches).

(b) Include an engine core ingestion requirement.

If re-evaluation determines the need for these requirements, incorporate them into 14 CFR 33.76(d) and require that newly certificated engines be designed and tested to these requirements.

The ARAC working group addressed both NTSB safety recommendations. In response to NTSB safety recommendation A-10-64, the ARAC working group recommended the test in this proposed rule. The ARAC working group found that its recommendation would also address the intent of NTSB safety recommendation A-10-65, since the kinetic energy of the bird in the proposed rule is of the same magnitude as a LFB test.

III. Discussion of the Proposal

A. Hazard Identification

There are two types of engine bird ingestion hazards related to turbofan-powered aircraft: single- and multiple-engine bird ingestion. This proposed rule addresses the multiple-engine bird ingestion hazard, which can happen concurrently or sequentially, during the same flight.

Multiple-engine bird ingestion occurs when the airplane flies through a bird flock that spans the distance between the engines. This can cause engine damage that prevents thrust production, which can then force an off-airport landing. The ARAC working group found that the existing rules and controls are not sufficient to address the threat from multi-engine core ingestion events.[5]

B. Safety Risk Analysis

The ARAC working group conducted a risk analysis to evaluate the bird ingestion threat using criteria that included (a) bird size class, (b) engine inlet size class, (c) phase of flight, and (d) recorded events with evidence of engine core flow path bird ingestion. The analysis included (a) the overall bird ingestion rate per flight, (b) rate of multi-engine ingestions per flight, (c) rate of power loss resulting in available power below 50 percent of takeoff per flight, and (d) the percent of events during each flight phase. Results from these analyses were used to determine:

(1) If the civil air transport fleet is currently meeting its safety goal.

(2) If engines in certain inlet size groups are performing worse than others.

[5] The existing controls to prevent these hazards include airport mitigation strategies (previously mentioned), and regulatory controls that include 14 CFR: (a) Part 25 installation requirements, concerning uncontained engine debris (e.g., § 25.903(d)(1)) and minimizing hazards to the airplane from foreseeable engine malfunctions (such as §§ 25.901(c) and 25.1309); (b) Section 33.76 certification test requirements; and (c) Part 33 requirements (such as §§ 33.19 and 33.94 containment requirements, § 33.17 fire protection requirements, etc.).

(3) If evidence of engine core ingestion indicates a greater chance of engine power loss (post-event power available less than 50 percent of takeoff thrust).

(4) Which flight phase poses the highest threat to engines designed under existing regulations.

The ARAC working group also analyzed the bird ingestion threat from (a) engine damage, and (b) engine failure to produce thrust due to stall, surge, etc. Thrust loss from bird damage generally refers to damage or failure of engine internal static and rotating parts. Damage that causes any of these hazards and those listed in § 33.75 (except complete inability to shut down the engine), would result in the pilot reducing thrust to idle, or shutting down the engine. Therefore, damage that causes any of the hazards listed in § 33.75(g)(2)[6] was considered to have the same effect as internal damage to static and rotating engine parts.

The ARAC working group considered two engine performance conditions after bird ingestion, namely, less than 50 percent and more than 50 percent takeoff thrust available. Less than 50 percent takeoff thrust available is a hazard, since it could prevent the airplane from climbing at a safe rate to avoid obstacles, or maintain altitude. More than 50 percent takeoff thrust available was not considered a hazard, as the airplane could still climb at a safe rate to avoid obstacles, or maintain altitude. Based on bird ingestion data from the Phase I through Phase III reports, the ARAC working group found it is extremely improbable that an airplane with more than two engines would have power loss greater than 50 percent of takeoff thrust on three or more engines.

[6] The hazards are: (1) Non-containment of high-energy debris; (2) concentration of toxic products in the engine bleed air intended for the cabin sufficient to incapacitate crew or passengers; (3) significant thrust in the opposite direction to that commanded by the pilot; (4) uncontrolled fire; (5) failure of the engine mount system leading to inadvertent engine separation; (6) release of the propeller by the engine, if applicable; and (7) complete inability to shut the engine down.

Since a surge or stall could occur upon bird ingestion, the ARAC working group assessed whether engine surge or stall, without significant physical damage to the engine's rotating parts, would prevent continued safe flight and landing. Based on its review of in-service incidents, the ARAC working group determined that surge and stall are transitory events unlikely to cause an accident, since engine power can be recovered when the ingested material is cleared.

Modern fan blades have relatively wider fan blade chords than those in service when the small and medium flocking bird core test in § 33.76(c) was developed. At takeoff, the fan speed is higher and the airspeed is lower than during climb. Therefore, the existing MFB core test of § 33.76(c), does not provide the intended demonstration of core durability against bird ingestion for climb and descent conditions. In contrast to other phases of flight, takeoff conditions (which are simulated under the current MFB test) are more likely to move bird material away from the core section and into the fan flow path than climb and descent conditions (which are not simulated under the current MFB test). Testing the engine at the bird speed and fan speed representative of the airplane climb condition is more likely to result in significant bird material entering the engine core during the engine test. If the engine is designed so that no bird material enters the core during climb, then a test at the bird speed and fan speed associated with approach (lower bird speed but significantly lower fan speed) is another way to ensure significant bird material enters the core.

The FAA agrees with the ARAC working group conclusion that, for modern engine designs, the existing § 33.76(c) small and medium flocking bird test does not demonstrate engine core flow robustness against bird ingestion as intended.

C. Alternatives

The ARAC working group determined there were six (6) MFB test options, as follows:

(1) Conduct the existing test; then add a new and separate core test using a single bird at climb conditions.

(2) Conduct the existing test, but leave out the core bird test described in § 33.76(c)(2)[7], add a new and separate core test using a single bird at climb conditions.

(3) Conduct the existing test without the existing core bird test; change the engine and bird speed conditions to match airplane climb conditions, and then fire the final bird.

(4) Conduct the existing test using the existing core bird test; change the engine and bird speed conditions to match airplane climb conditions, and then fire the final bird.

(5) Combine a new MFB engine core bird test with the existing LFB test. Fire an additional, MFB at the engine core, at least one minute after the LFB, but before the run-on portion of the test (for reference, the LFB is fired at 50 percent blade radius or higher, well outside the core).

(6) Make no changes to the existing MFB regulation.

The ARAC working group concluded that a modified Option 1 is necessary. The working group rejected options that would have eliminated the current core bird testing requirements set forth in § 33.76(c)(2) once the new test is in place. The working group determined that the current requirements are still needed to test the ability of the engine fan blades to withstand impact with a bird at the higher speeds present during takeoff. Because the new test proposed in this rule uses lower fan speed and higher bird speed

[7] The MFB test defined in § 33.76(c)(2) requires that largest of the birds fired at the engine must be aimed at the engine core primary flow path.

than those specified in the current core bird testing requirements, it would be able to measure the ability of the engine core to withstand impact of bird mass that passes through the engine fan blades during the climb and descent phases of flight. However, the new test would not ascertain whether the engine fan blades could safely withstand a higher-kinetic-energy impact with a bird during the takeoff phase of flight while operating at 100 percent takeoff power or thrust (which is measured by the current testing).

The FAA notes, however, that some aircraft are designed to operate such that their engine power during takeoff is nearly identical to their engine power during the climb and descent phases of flight. Because the takeoff and post-takeoff conditions for this group of engines are so similar, requiring an additional test that mimics post-takeoff conditions would be needlessly repetitive for these engines, as the current testing already measures bird ingestion during takeoff conditions. Accordingly, this proposed rule would allow the new test to be combined with the existing test, if the climb fan rotor speed of the engine being tested is within 1 percent of the first fan stage rotor speed at 100 percent takeoff thrust or power.

The new test would ensure that the core flow path of future engines remains sufficiently robust to maintain the civil fleet catastrophic hazard rate objective from bird ingestion. The ARAC working group chose this option since the other options did not address the safety risk, because they introduce unnecessary program test risk with no additional safety benefit.

Because the Flight 1549 accident involved the ingestion of two birds into each engine, the FAA also considered requiring that, as part of the new test proposed in this

rule, an engine must be capable of sustaining an ingestion of two MFBs into the engine core. However, the FAA rejected this approach as needlessly burdensome, because the simultaneous ingestion of two MFBs into the cores of multiple engines is an extremely rare event.

D. New Bird Ingestion Test

Under this proposed rule, § 33.76 would be amended to require turbofan engine manufacturers to demonstrate compliance with an additional bird ingestion test. The new test would require firing the largest MFB required by § 33.76 (Table 2) at the engine core, at one of the following two conditions:

The first test condition is at a speed of 250-knots, with the engine fan set at the speed associated with the lowest expected climb setting for the engine while the airplane is climbing through 3,000 feet above ground level. The post-test run-on requirements would remain the same as the existing § 33.76(d)(5). Because the climb setting may be significantly less than takeoff thrust, less than 50 percent takeoff thrust would be allowed up to one minute after bird ingestion. After one minute, the engine would be required to demonstrate at least 50 percent takeoff thrust. The FAA notes that current MFB testing, which simulates takeoff conditions, does not allow a reduction below 50 percent takeoff thrust. If this condition is present for only one minute during one of the post-takeoff phases of flight, it would not result in an unsafe condition because a pilot would have more time to respond to this issue without hazard. Requiring the engine to operate satisfactorily for one minute without throttle movement will ensure that the engine will not stall or shut down in the time it takes the pilot to understand that the engine has ingested a bird.

The proposed requirements of the first condition above are intended to simulate the worst threat to the engine core in expected operating conditions. The maximum airspeed allowed below 10,000 feet is 250-knots indicated airspeed. Higher airspeed corresponds to less time for a bird to be in contact with the fan blades, reducing the likelihood that the bird would be centrifuged (moved radially outward) away from the core. Thus a test where the bird is fired at a higher speed is more likely to result in the bird going into the core as intended. The altitude, 3,000 feet AGL, was chosen for two reasons: (1) 91 percent of bird ingestion events occur at or below 3,000 feet AGL and (2) during typical takeoff and climb profiles, engine speeds are increased and the aircraft climbs quickly after reaching 3,000 feet AGL. The post-test run-on requirements for the climb point would be the same as the existing LFB test (§ 33.76(d)(5)). The LFB post-test run-on requirements were chosen because the major threat to the engine core happens away from the airport when the airplane is well above the ground.

The second test condition, should the applicant determine that no bird mass will enter the core during the test at the climb condition, must be successfully conducted at a speed of 200-knots indicated airspeed, with the engine fan set at the lowest expected mechanical fan speed while the airplane is descending through 3,000 feet AGL on approach to landing. The post-test run-on requirements would consist of the final seven minutes of the existing LFB 20-minute post-ingestion run-on requirement (§ 33.76(d)(5)) based on the assumption that the airplane would already be lined up with the runway during this phase of descent.

The conditions for the approach test point are based on a typical aircraft approach profile. The post-test run-on requirements for the approach test point were selected based

on the airplane approach being lined up with the runway and ready for landing. In addition, the possibility of having a multi-engine power loss (more than 50 percent loss per engine) on approach, combined with another simultaneous event that could prevent a safe landing, is considered extremely improbable. Finally, the approach test point would be run only if the engine has been designed to centrifuge all bird material away from the core of the engine during the takeoff and climb phases of flight. This test point would reduce the total risk of power loss from engine core bird ingestion.

Additional bird ingestion testing at the 200-knot approach condition would ensure that, if the engine is designed to centrifuge all bird material away from the core flow path at takeoff and climb conditions (which is beneficial), then engine core capability to ingest bird material would still be tested. This is because an engine that centrifuges bird material away from the core at the 250-knot climb condition may not be able to centrifuge away the same amount of bird material at the lower (200-knot) speed approach condition.

The FAA notes that this proposed rule may result in the engine manufacturer having to run an additional bird ingestion test. If the manufacturer discovers during the 250-knot climb test that no bird material enters the engine core, then it is required to run the 200-knot approach test. However, the FAA anticipates the two-test scenario is unlikely, because manufacturers would evaluate the design of its engine prior to engine bird ingestion testing. Thus, a manufacturer would be able to determine, prior to commencing certification testing, whether their engine will centrifuge all bird material away from the core. Based on this determination, the manufacturer would select the appropriate bird ingestion test (either the 250-knot climb or 200-knot approach test) proposed in this rule.

The European Aviation Safety Agency (EASA) has notified the FAA that it intends to incorporate requirements similar to those proposed here into its engine bird ingestion rule, CS-E 800. Incorporating the proposed test conditions into § 33.76 would harmonize FAA requirements with EASA requirements and ensure that applicants would only need to comply with one set of regulations. Furthermore, incorporating these changes would prevent confusion within the FAA and EASA when validating engines developed under each other's regulations.

With respect to the NTSB's recommendation to apply the LFB requirement to engines with inlet areas less than 2.5 square meters (3,875 square inches), the evidence from the Flight 1549 accident did not indicate a deficiency in current bird ingestion requirements for the fan blades. The Phase II report supports the FAA's conclusion that for engines with inlets of less than 2.5 square meters (3,875 square inches), a LFB test requirement is not necessary to meet the safety objective of preventing catastrophic effects from fan blade failure, for engines of that size.

The FAA also considered whether to increase the required size of the bird aimed at the core during the MFB test as recommended by the NTSB. The FAA evaluated the relative effects of ingesting a MFB at the new proposed climb condition, against a LFB at the take-off condition in the current regulation (§ 33.76(d)). The LFB condition resulted in a smaller mass fraction of the bird entering the core (0.39 versus 0.52 at the MFB condition). However, in terms of mass, a LFB fired into the core resulted in a 20 percent higher total mass into the core than the MFB. The FAA determined that the difference in impact energy delivered to the core inlet was insignificant between the LFB and MFB ingestion conditions (± 2 percent). This is a result of the slower aircraft and engine fan

rotor speed associated with the LFB ingestion criteria. For this reason, this proposed rule would not change the current LFB requirement (§ 33.76(d)).

IV. Regulatory Notices and Analyses

A. Regulatory Evaluation

Changes to Federal regulations must undergo several economic analyses. First, Executive Order 12866 and Executive Order 13563 direct that each Federal agency shall propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs. Second, the Regulatory Flexibility Act of 1980 (Public Law 96-354) requires agencies to analyze the economic impact of regulatory changes on small entities. Third, the Trade Agreements Act (Public Law 96-39) prohibits agencies from setting standards that create unnecessary obstacles to the foreign commerce of the United States. In developing U.S. standards, this Trade Act requires agencies to consider international standards and, where appropriate, that they be the basis of U.S. standards. Fourth, the Unfunded Mandates Reform Act of 1995 (Public Law 104-4) requires agencies to prepare a written assessment of the costs, benefits, and other effects of proposed or final rules that include a Federal mandate likely to result in the expenditure by State, local, or tribal governments, in the aggregate, or by the private sector, of $100 million or more annually (adjusted for inflation with base year of 1995; current value is $155 million). This portion of the preamble summarizes the FAA's analysis of the economic impacts of this proposed rule. The FAA suggest readers seeking greater detail read the full regulatory evaluation, a copy of which the FAA placed in the docket for this rulemaking.

In conducting these analyses, the FAA has determined that this proposed rule: (1) has benefits that justify its costs, (2) is not an economically "significant regulatory action" as defined in section 3(f) of Executive Order 12866, (3) is "non-significant" as defined in DOT's Regulatory Policies and Procedures; (4) would not have a significant economic impact on a substantial number of small entities; (5) would not create unnecessary obstacles to the foreign commerce of the United States; and (6) would not impose an unfunded mandate on state, local, or tribal governments, or on the private sector by exceeding the threshold identified above. These analyses are summarized below.

i. Total Benefits and Costs of this Rule

The FAA proposes the addition of a new test requirement to the engine bird ingestion airworthiness regulation. This new requirement would ensure that engines can ingest the medium flocking birds into the engine core at climb conditions. The ingestion of small and medium size birds can cause thrust loss from core engine bird ingestion if enough bird mass enters the engine core, which in turn can cause accidents or costly flight diversions. This proposed rule would add to the certification requirements of turbine engines a requirement that manufacturers must show that their engine cores can continue to operate after ingesting a medium sized bird while operating at a lower fan speed associated with climb out or landing. Engine manufacturers have the capability of producing such engines.

The FAA estimates the annualized cost of the proposed rule to be $4 million, or $52 million over 27 years (discounted at 7%).[8] The FAA estimates annualized benefits of $5 million, or $61 million over 27 years. The following table summarizes the benefits and costs of this proposed rule.

Summary of Benefits and Costs ($Millions)*

Impact	27-Year Total Present Value		Annualized	
	7%	3%	7%	3%
Benefits	$61.0	$100.6	$5.1	$5.5
Costs	$51.5	$71.5	$4.3	$3.9
Net Benefits	$9.4	$29.1	$0.8	$1.6

*Estimates may not total due to rounding. The FAA uses discount rates of seven and three percent based on OMB guidance.

Furthermore, this proposed rule would address two engine-related safety recommendations that the National Transportation Safety Board (NTSB) issued to the FAA: (1) A–10–64 and (2) A–10–65.

ii. Who is Potentially Affected by this Rule?

Aircraft operators and engine manufacturers.

iii. Assumptions

- The analysis is conducted in constant dollars with 2016 as the base year.
- Present value estimate follows OMB guidance of a 7 percent and a 3 percent discount rate.
- The analysis period is 27 years with 10 years of new engine certificates.
- Based on the actual production numbers of a common airline engine, it is estimated that about 220 engines are produced per year per certification.

[8] The FAA uses a 27-year period of analysis since it represents one complete cycle of actions affected by the proposed rule. One life cycle extends through the time required for certification, production of the engines, engine installation, active aircraft service, and retirement of the engines.

- The FAA estimates that the average life of an engine is 27,500 cycles (flights) and that engines fly on average 1,748 flights per year. Therefore, the estimated average service life of an engine is about 16 years.
- The FAA estimates the average fuel consumption will increase by $750 per year per aircraft.

B. Regulatory Flexibility Determination

The Regulatory Flexibility Act of 1980 (RFA) establishes "as a principle of regulatory issuance that agencies shall endeavor, consistent with the objective of the rule and of applicable statutes, to fit regulatory and informational requirements to the scale of the business, organizations, and governmental jurisdictions subject to regulation." To achieve that principle, the RFA requires agencies to solicit and consider flexible regulatory proposals and to explain the rationale for their actions. The RFA covers a wide range of small entities, including small businesses, not-for-profit organizations, and small governmental jurisdictions.

Agencies must perform a review to determine whether a proposed or final rule would have a significant economic impact on a substantial number of small entities. If the agency determines that it would, the agency must prepare a regulatory flexibility analysis as described in the Act. Two groups would be affected by this rule: aircraft operators and engine manufacturers.

The FAA believes that this proposed rule would not have a significant economic impact on small aircraft operators. Affected operators would incur higher fuel burn costs due to increase in engine weight (heavier blading/components) and resultant consequent increase in total aircraft weight. The FAA estimates fuel burn costs of $750 per year per

aircraft, which would not result in a significant economic impact for small aircraft operators.

Similarly, the FAA believes that this proposed rule would not have a significant economic impact on engine manufacturers. The FAA identified one out of five engine manufacturers that meets the Small Business Administration definition of a small entity. The annual revenue estimate for this manufacturer is about $75 million.[9] The FAA then compared that manufacturer's revenue with its annualized compliance cost. The FAA expects that the manufacturer's projected annualized cost of complying with this rule would be 0.7 percent of its annual revenue[10], which is not a significant economic impact.

If an agency determines that a rulemaking will not result in a significant economic impact on a substantial number of small entities, the head of the agency may so certify under section 605(b) of the RFA. Therefore, as provided in section 605(b), the head of the FAA certifies that this rulemaking will not result in a significant economic impact on a substantial number of small entities.

C. International Trade Impact Assessment

The Trade Agreements Act of 1979 (Public Law 96-39), as amended by the Uruguay Round Agreements Act (Public Law 103-465), prohibits Federal agencies from establishing standards or engaging in related activities that create unnecessary obstacles to the foreign commerce of the United States. Pursuant to these Acts, the establishment of standards is not considered an unnecessary obstacle to the foreign commerce of the United States, so long as the standard has a legitimate domestic objective, such the protection of safety, and does not operate in a manner that excludes imports that meet this

[9] Source: http://www.manta.com.
[10] Ratio= annualized cost/annual revenue = $557,459/$74,800,000 = 0.7 percent.

objective. The statute also requires consideration of international standards and, where appropriate, that they be the basis for U.S. standards. The FAA has assessed the potential effect of this proposed rule and determined that it has legitimate domestic safety objectives and would harmonize with forthcoming EASA standards. Accordingly, this proposed rule is in compliance with the Trade Agreements Act.

D. Unfunded Mandates Assessment

Title II of the Unfunded Mandates Reform Act of 1995 (Public Law 104-4) requires each Federal agency to prepare a written statement assessing the effects of any Federal mandate in a proposed or final agency rule that may result in an expenditure of $100 million or more (in 1995 dollars) in any one year by State, local, and tribal governments, in the aggregate, or by the private sector; such a mandate is deemed to be a "significant regulatory action." The FAA currently uses an inflation-adjusted value of $155 million in lieu of $100 million. This proposed rule does not contain such a mandate; therefore, the requirements of Title II of the Act do not apply.

E. Paperwork Reduction Act

The Paperwork Reduction Act of 1995 (44 U.S.C. 3507(d)) requires that the FAA consider the impact of paperwork and other information collection burdens imposed on the public. According to the 1995 amendments to the Paperwork Reduction Act (5 CFR 1320.8(b)(2)(vi)), an agency may not collect or sponsor the collection of information, nor may it impose an information collection requirement unless it displays a currently valid Office of Management and Budget (OMB) control number.

The FAA has determined that there would be no new requirement for information collection associated with this proposed rule.

F. International Compatibility

In keeping with U.S. obligations under the Convention on International Civil Aviation, it is FAA policy to conform to International Civil Aviation Organization (ICAO) Standards and Recommended Practices to the maximum extent practicable. The FAA has determined that there are no ICAO Standards and Recommended Practices that correspond to these proposed regulations. The proposed regulation is harmonized with changes the European Aviation Safety Agency (EASA) plans to make to its certification specifications.

G. Environmental Analysis

FAA Order 1050.1F identifies FAA actions that are categorically excluded from preparation of an environmental assessment or environmental impact statement under the National Environmental Policy Act in the absence of extraordinary circumstances. The FAA has determined this rulemaking action qualifies for the categorical exclusion identified in paragraph 5-6.6(f) and involves no extraordinary circumstances.

H. Regulations Affecting Intrastate Aviation in Alaska

Section 1205 of the FAA Reauthorization Act of 1996 (110 Stat. 3213) requires the FAA, when modifying its regulations in a manner affecting intrastate aviation in Alaska, to consider the extent to which Alaska is not served by transportation modes other than aviation, and to establish appropriate regulatory distinctions. The FAA has determined that this rule would not affect intrastate aviation in Alaska.

V. Executive Order Determinations

A. Executive Order 13132, Federalism

The FAA has analyzed this proposed rule under the principals and criteria of Executive Order 13132, Federalism. The agency has determined that this action would not have a substantial direct effect on the States, or the relationship between the Federal Government and the States, or on the distribution of power and responsibilities among the various levels of government, and, therefore, would not have federalism implications.

B. Executive Order 13211, Regulations that Significantly Affect Energy Supply, Distribution, or Use

The FAA analyzed this proposed rule under Executive Order 13211, Actions Concerning Regulations that Significantly Affect Energy Supply, Distribution, or Use (May 18, 2001). The FAA has determined that it would not be a "significant energy action" under the executive order and would not be likely to have a significant adverse effect on the supply, distribution, or use of energy.

C. Executive Order 13609, International Cooperation

Executive Order 13609, Promoting International Regulatory Cooperation, (77 FR 26413, May 4, 2012) promotes international regulatory cooperation to meet shared challenges involving health, safety, labor, security, environmental, and other issues and reduce, eliminate, or prevent unnecessary differences in regulatory requirements. The FAA has analyzed this action under the policy and agency responsibilities of Executive Order 13609, Promoting International Regulatory Cooperation. The FAA has determined that this action would eliminate differences between U.S. aviation standards and those of

other civil aviation authorities, by ensuring that § 33.76 remains harmonized with EASA CS-E 800.

D. Executive Order 13771, Reducing Regulation and Controlling Regulatory Costs

Executive Order 13771 titled "Reducing Regulation and Controlling Regulatory Costs," directs that, unless prohibited by law, whenever an executive department or agency publicly proposes for notice and comment or otherwise promulgates a new regulation, it shall identify at least two existing regulations to be repealed. In addition, any new incremental costs associated with new regulations shall, to the extent permitted by law, be offset by the elimination of existing costs. Only those rules deemed significant under section 3(f) of Executive Order 12866, "Regulatory Planning and Review," are subject to these requirements.

This proposed rule is not expected to be an EO 13771 regulatory action because this proposed rule is not significant under EO 12866.

VI. Additional Information

A. Comments Invited

The FAA invites interested persons to participate in this rulemaking by submitting written comments, data, or views. The agency also invites comments relating to the economic, environmental, energy, or federalism impacts that might result from adopting the proposals in this document. The most helpful comments reference a specific portion of the proposal, explain the reason for any recommended change, and include supporting data. To ensure the docket does not contain duplicate comments, commenters should send only one copy of written comments, or if comments are filed electronically, commenters

should submit only one time. Commenters must identify the docket or notice number of this rulemaking.

The FAA will file in the docket all comments received, as well as a report summarizing each substantive public contact with FAA personnel concerning this proposed rule. Before acting on this action, the FAA will consider all comments it receives on or before the closing date for comments. The FAA will consider comments filed after the comment period has closed if it is possible to do so without incurring expense or delay. The agency may change this proposal in light of the comments it receives.

Proprietary or Confidential Business Information: Commenters should not file proprietary or confidential business information in the docket. Such information must be sent or delivered directly to the person identified in the FOR FURTHER INFORMATION CONTACT section of this document, and marked as proprietary or confidential. If submitting information on a disk or CD ROM, mark the outside of the disk or CD ROM, and identify electronically within the disk or CD ROM the specific information that is proprietary or confidential.

Under 14 CFR 11.35(b), if the FAA is aware of proprietary information filed with a comment, the agency does not place it in the docket. It is held in a separate file to which the public does not have access, and the FAA places a note in the docket that it has received it. If the FAA receives a request to examine or copy this information, it treats it as any other request under the Freedom of Information Act (5 U.S.C. 552). The FAA process such a request under Department of Transportation procedures found in 49 CFR part 7.

B. Availability of Rulemaking Documents

An electronic copy of rulemaking documents may be obtained from the Internet by

1. Searching the Federal eRulemaking Portal (http://www.regulations.gov);
2. Visiting the FAA's Regulations and Policies web page at http://www.faa.gov/regulations_policies or
3. Accessing the Government Printing Office's web page at http://www.access.gpo.fdsys/.

Copies may also be obtained by sending a request to the Federal Aviation Administration, Office of Rulemaking, ARM-1, 800 Independence Avenue SW., Washington, DC 20591, or by calling (202) 267-9680. Commenters must identify the docket or notice number of this rulemaking.

All documents the FAA considered in developing this proposed rule, including economic analyses and technical reports, may be accessed from the Internet through the Federal eRulemaking Portal referenced in item (1) above.

List of Subjects in 14 CFR Part 33

Bird ingestion.

The Proposed Amendment

In consideration of the foregoing, the Federal Aviation Administration proposes to amend chapter I of title 14, Code of Federal Regulations as follows:

PART 33 - AIRWORTHINESS STANDARDS: AIRCRAFT ENGINES

1. The authority citation for part 33 continues to read as follows:

Authority: 49 U.S.C. 106(g), 40113, 44701, 44702, 44704.

2. Amend § 33.76 by revising paragraph (a)(1) and adding paragraph (e) to read as follows:

§ 33.76 Bird ingestion.

(a) * * *

(1) Except as specified in paragraph (d) or (e) 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.

* * * * *

(e) Core engine flocking bird test. Except as provided in paragraph (e)(4) of this section, for turbofan engines, an engine test must be performed in accordance with either paragraph (e)(1) or (2) of this section. The test specified in paragraph (e)(2) may be used to satisfy this requirement only if testing or validated analysis shows that no bird material will be ingested into the engine core during the test under the conditions specified in paragraph (e)(1).

(1) 250-knot climb core engine flocking bird test:

(i) Test requirements are as follows:

(A) Before ingestion, the engine must be stabilized at the mechanical rotor speed of the first exposed fan stage or stages that, on a standard day, produces the lowest expected power or thrust required during climb through 3,000 feet above ground level.

(B) Bird weight must be the largest specified in Table 2 of this section for the engine inlet area.

(C) Ingestion must be at 250-knots bird speed.

(D) The bird must be aimed at the first exposed rotating fan stage or stages, at the blade airfoil height, as measured at the leading edge that will result in maximum bird material ingestion into the engine core.

(ii) Ingestion of a flocking bird into the engine core under the conditions prescribed in paragraph (e)(1)(i) of this section must not cause any of the following:

(A) Sustained power or thrust reduction to less than 50 percent maximum rated takeoff power or thrust during the run-on segment specified under paragraph (e)(1)(iii)(B) of this section, that cannot be restored only by movement of the power lever.

(B) Sustained power or thrust reduction to less than flight idle power or thrust during the run-on segment specified under paragraph (e)(1)(iii)(B) of this section.

(C) Engine shutdown during the required run-on demonstration specified in paragraph (e)(1)(iii) of this section.

(D) Conditions specified in §33.75(g)(2).

(iii) The following test schedule must be used (power lever movement between conditions must occur within 10 seconds or less, unless otherwise noted):

Note to paragraph (e)(1)(iii) introductory text: Durations specified are times at the defined conditions.

(A) Ingestion.

(B) Followed by 1 minute without power lever movement.

(C) Followed by power lever movement to increase power or thrust to not less than 50 percent maximum rated takeoff power or thrust, if the initial bird ingestion resulted in a reduction in power or thrust below that level.

(D) Followed by 13 minutes at not less than 50 percent maximum rated takeoff power or thrust. Power lever movement in this condition is unlimited.

(E) Followed by 2 minutes at 30-35 percent maximum rated takeoff power or thrust. Power lever movement in this condition is limited to 10 seconds or less.

(F) Followed by 1 minute with power or thrust increased from that set in paragraph (e)(1)(iii)(E) of this section, by 5-10 percent maximum rated takeoff power or thrust.

(G) Followed by 2 minutes with power or thrust reduced from that set in paragraph (e)(1)(iii)(F) of this section, by 5-10 percent maximum rated takeoff power or thrust.

(H) Followed by 1 minute minimum at ground idle.

(I) Followed by engine shutdown.

(2) 200-knot approach flocking bird core engine test (performed only if test or analysis shows no bird material will be ingested into the core during the test at the conditions of paragraph (e)(1) of this section):

(i) Test requirements are as follows:

(A) Before ingestion, the engine must be stabilized at the mechanical rotor speed of the first exposed fan stage or stages when on a standard day the engine thrust is set at approach idle thrust when descending 3,000 feet above ground level.

(B) Bird mass and weight must be the largest specified in Table 2 of this section for the engine inlet area.

(C) Ingestion must be 200-knot bird speed.

(D) Bird must be aimed at the first exposed rotating fan stage or stages, at the blade airfoil height measured at the leading edge that will result in maximum bird material ingestion into the engine core.

(ii) Ingestion of a flocking bird into the engine core under the conditions prescribed in paragraph (e)(2)(i) of this section may not cause any of the following:

(A) Power or thrust reduction to less than flight idle power or thrust during the run-on segment specified under paragraph (e)(2)(iii)(B) of this section.

(B) Engine shutdown during the required run-on demonstration specified in paragraph (e)(2)(iii) of this section.

(C) Conditions specified in §33.75(g)(2).

(iii) The following test schedule must be used (power lever movement between conditions must occur within 10 seconds or less, unless otherwise noted):

Note to paragraph (e)(2)(iii) introductory text: Durations specified are times at the defined conditions.

(A) Ingestion.

(B) Followed by 1 minute without power lever movement.

(C) Followed by 2 minutes at 30-35 percent maximum rated takeoff power or thrust.

(D) Followed by 1 minute with power or thrust increased from that set in paragraph (e)(2)(iii)(C) of this section, by 5-10 percent maximum rated takeoff power or thrust.

(E) Followed by 2 minutes with power or thrust reduced from that set in paragraph (e)(2)(iii)(D) of this section, by 5-10 percent maximum rated takeoff power or thrust.

(F) Followed by 1-minute minimum at ground idle.

(G) Followed by engine shutdown.

(3) Applicants must show that an unsafe condition will not result if any engine operating limit is exceeded during the run-on period.

(4) The core engine flocking bird test of this paragraph (e) may be combined with the MFB test of paragraph (c) of this section, if the climb fan rotor speed calculated in paragraph (e)(1) of this section is within 1 percent of the first fan stage rotor speed required by paragraph (c)(1) of this section. As used in this paragraph (e)(4), "combined" means that, instead of separately conducting the tests specified in paragraphs (c) and (e) of this section, the test conducted under paragraph (c) of this section satisfies the requirements of this section if the bird aimed at the core of the engine meets the bird ingestion speed criteria of either:

(i) Paragraph (e)(1)(i)(C) of this section; or

(ii) Paragraph (e)(2)(i)(C) of this section if testing or validated analysis shows that no bird material will be ingested into the engine core during the test.

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David W. Hempe,

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