



demonstration enhancing aircraft safety through successful simulation of an aircraft air-turn back and missed approach following an ingestion event.

2. For the PW535A engine with a maximum inlet throat area of 400 in<sup>2</sup>, the proposed medium bird test procedure in the NPRM would require ingestion of two 1.0 lb. birds, with the engine sustaining a post ingestion thrust level greater than 75-percent of pre-ingestion thrust and completion of a 20 minute operability demonstration.

3. The PW535A engine was subjected to ingestion of two 1.0 lb. birds and successfully demonstrated more than 75 percent of the pre-test thrust level, the 20 minute operability test and other post-test requirements in compliance with the proposed medium bird test requirements in this petition. The compliance has been documented in PWC Engineering Report No. 3648, submitted to, and approved by, Transport Canada.

4. The petitioner states that the results of compliance with the proposed standards are that the engine will enable an aircraft to successfully complete a flight following a medium bird ingestion, and a normal approach and landing or a missed approach. Designing for compliance with the proposed standards may also mean that a more optimum fan design can be utilized, resulting in lower fuel consumption and reduced environmental impact.

5. The petitioner requests to demonstrate compliance with the small and medium bird ingestion standards using the proposed procedures found in a NPRM to part 33, published in the Federal Register on December 11, 1998 (Docket Number FAA-1998-4815, 63 FR 68635), in lieu of the existing § 33.77(b).

6. The proposed procedures in the NPRM, applicable to small and medium bird tests, are described as follows:

(a) General. Compliance with paragraphs (b) of this section shall be in accordance with the following:

(1) All ingestion tests shall 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 area as used in this section to determine the bird quantity and weights will be established by the applicant and identified as a limitation on the inlet throat area in the installation instructions required under § 33.5.

(3) The impact to the front of the engine from the single largest medium bird which can enter the inlet must be evaluated. It must be shown that the associated components when struck under the conditions prescribed in paragraph (b) of this section, as applicable, will not affect the engine to the extent that it cannot comply with the requirements of paragraphs (b)(5) 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 paragraph (b) 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) Small and medium birds. 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 affects 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 1. 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 1, 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) 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.

(4) 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.

(5) 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 subparagraphs (b) (6);

(iii) The engine to catch fire, release hazardous fragments through the engine casing, generate loads greater than those ultimate loads specified under § 33.23(a), or lose the ability to be shut down.

(iv) Unacceptable deterioration of engine handling characteristics.

(6) 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. The durations specified are times at the defined conditions with the power lever being moved between each condition in less than 10 seconds.

(7) If any engine operating limit(s) is exceeded during the initial 2 minutes without power lever movement, as provided by subparagraph (b)(6)(ii) of this section, then it shall be established that the limit exceedence will not result in an unsafe condition.

Table 1

## Medium Flocking Bird Weight &amp; Quantity Requirements

Engine Inlet Area (A) Square-meters (square-inches)	Bird Quantity	Bird Weight kg. (lb.)
0.05 (77.5) > A	None	-----
.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)

Note: Table 1 has been abbreviated to include only the inlet area range relevant to the PW535A series engines

The FAA's analysis/summary is as follows:

The FAA has reviewed the PWC petition and has determined that a grant of the requested exemption is appropriate and justified.

The basis for granting the exemption is that the proposed rule (63 FR 68635, published in the Federal Register on 12/11/98) represents acceptable standards for aircraft engines, and the FAA has not received any specific negative comments on the reduction in test bird weight from 1.5 pounds (the existing rule) to 1.0 pound (as prescribed in the above proposed rule) for the medium bird test requirements for engines of this size. Notwithstanding this Grant of Exemption, the FAA will continue to monitor the service performance of products certificated to these currently proposed bird ingestion standards. If it is determined that a related unsafe condition exists on a product certificated to these proposed bird ingestion standards, the FAA may require design changes under 14 CFR 21.99 and 14 CFR part 39.

In consideration of the foregoing, I find that a grant of exemption would be in the public interest and would not have an adverse effect on safety. Therefore, pursuant to the authority contained in 49 U.S.C. §§ 40113 and 44701, formerly §§ 313(a) and 601(c) of the Federal Aviation Act of 1958, as amended, delegated to me by the Administrator (14 CFR § 11.53), PWC is hereby

granted an exemption from § 33.77(b) to the extent necessary to allow PWC to demonstrate compliance with the medium bird engine test in the NPRM, for the issuance of a type certificate.

The FAA has determined that good cause exists for not following the publication and comment procedures of 14 CFR § 11.27(c) of the Federal Aviation Regulations. In making this request PWC has shown that delay in acting on the petition that would result from publication, would cause PWC to delay shipment of engines to the aircraft manufacturer, which in turn would cause delay in delivery of aircraft to operators. Delay would therefore, be detrimental to PWC.

Issued in Burlington, Massachusetts, on November 16, 1999.

A handwritten signature in black ink, appearing to read "D A Downey". The signature is written in a cursive, somewhat stylized font.

David A. Downey  
Assistant Manager, Engine And Propeller Directorate  
Aircraft Certification Service