

Log 2370



National Transportation Safety Board

Washington, D.C. 20594
Safety Recommendation

Date: June 11, 1992

In reply refer to: A-92-49

Honorable Barry L. Harris
Acting Administrator
Federal Aviation Administration
Washington, D.C. 20591

On July 11, 1991, about 12:58 Universal Coordinated Time, Delta Air Lines flight 29, N177DN, a Boeing 767-332ER, powered by two Pratt & Whitney PW-4060 turbofan engines, aborted takeoff at Shannon, Ireland. Flight 29 was a regularly scheduled passenger flight from Shannon, Ireland, to Atlanta, Georgia. Aboard the airplane were 128 passengers and a crew of 13. There were no injuries.

During the takeoff ground roll, the flightcrew noticed two birds on the runway that took flight as the aircraft bore down on them. Shortly thereafter, and about the time that the airplane reached V1 speed (takeoff decision speed) of 144 knots, the flightcrew heard one of two "bangs" accompanied by the airplane momentarily yawing to the right. The captain suspected a tire failure and aborted the takeoff. Reverse thrust was initially selected on both engines. However, when the first officer observed a rapid rise in the No. 2 engine exhaust gas temperature and an increase in vibration, he terminated the use of reverse thrust. During the rollout, the captain requested that the No. 2 engine be shut down. The airplane was stopped 1,500 to 2,000 feet short of the end of the runway. The aircraft rescue and fire fighting (ARFF) trucks responded to the scene. No fire was noted, but the ARFF personnel reported damage to the No. 2 engine, including holes in the engine cowling. After the tires and brakes had cooled sufficiently, the airplane returned to the gate area where the passengers deplaned normally.

The accident was investigated by the Government of Ireland, and through its Accredited Representative, the Safety Board has monitored the investigation.

Subsequent inspection of the No. 2 engine revealed that one fan blade had separated inboard of the mid-span shroud and had broken into three relatively large pieces and a number of smaller ones. All the remaining fan blades were badly gouged, the inside surface of the inlet cowl surface was extensively torn, and much of the acoustic liner was missing. The largest airfoil section of the failed blade was lodged tangentially in the inlet cowl near the 12 o'clock position, and the blade section containing the midspan shroud appears to have exited downward through the cowl at the 8 o'clock position. The third section of the failed blade was protruding through the inlet cowl. The root end and platform of the failed blade was still attached to the fan hub. The fracture surface appeared consistent with an overload failure and showed no indications of high-cycle fatigue.

Vestigial remains of bird feathers were recovered from the engine on the fan stator and thrust reverser blocker door arms. Additional remains were found on the runway and were identified as the remains of a wood pigeon (*Columba Polumbus*) that weighed about 18 ounces.

Inspection of the broken fan blade revealed soft body damage¹ in an area 2 to 3 inches below the midspan shroud. Examination of the fracture surface disclosed a preexisting nick, approximately 0.018 inch deep, on the leading edge of the fan blade at the bottom of the soft body deformation where the transverse fracture originated. The impact force of the ingested bird is believed to have caused the fan blade outer panel to twist and bend rearward, resulting in a tearing action that originated from the preexisting leading edge damage. After the tearing action began, the normal loads on the blade caused it to continue tearing until failure occurred.

The engine certification requirements relevant to bird ingestion contained in 14 Code of Federal Regulations (CFR) Section 33.77 specify that:

- (a) the ingestion of a 4-pound bird under the prescribed test conditions of speed and engine power may not cause the engine to burst, catch fire, generate loads greater than the ultimate strength of the mounting installation or lose the capability to shut down.

¹Soft body ingestion is distinguished by relatively smooth bend deformation on the leading edges of one or more fan blades in the opposite direction from fan rotation. This larger area of smooth deformation results from blade impact with a compliant mass rather than a rigid object.

(b) the ingestion of a number of 3-ounce or 1.5-pound birds under the prescribed conditions of speed, power and quantity may not cause more than a 25 percent sustained loss of engine thrust, require the engine to be shut down in less than 5 minutes, or result in a potentially hazardous condition.

The investigation found that the amount of damage to the fan blade by the ingestion of an 18-ounce bird was considerably greater than would have been expected under the certification criteria. However, the certification criteria did not consider the presence of nicks or preexisting damage that could reduce the resistance of the blade to foreign object impact.

Delta maintenance personnel reported that the fan blades had been inspected on the morning of the accident and that no discrepancies were noted. They further reported that they would not necessarily expect a nick of this size to be noticed or reported during a daily line inspection. They stated that such damage is normal and can be found on nearly every blade in the airplane fleet. The maintenance manual for the PW-4000 series engines states that in accomplishing a fluorescent penetrant inspection of the fan rotor blades, cracks are not permitted if they are larger than the repair limits. The repair limit for the area where the nick was found is 0.250 inch.

The final report by the Government of Ireland provided the following recommendation:

It is recommended that the state of manufacturer of the engine/airframe review this incident in relation to certification criteria for the engine type and engine installation concerned, regarding bird ingestion tolerance and engine debris containment, to determine if any regulatory or development action is required.


In its reply to this recommendation, the Federal Aviation Administration (FAA) stated in its letter of March 30, 1992, that it was currently addressing a continued airworthiness concern rather than a certification issue. Toward this goal, it had initiated a reexamination of the effectiveness of the existing inspection procedures, in terms of clarity, content, and frequency. Pending completion of this effort, the FAA plans to require that existing inspection instruction be revised accordingly.

The Safety Board believes that this accident clearly demonstrates that current certification requirements do not address the environment found in normal operations. Nicks or imperfections in the leading edge of turbine engine fan blades are accepted in daily operations, and, in fact, tolerances are provided for acceptable damage. The Safety Board is concerned that the current engine foreign object ingestion certification requirements do not take into account blade imperfections that are normally found in service. By not considering normal service damage, the certification criteria do not provide the level of flight safety that is assumed when foreign object ingestion tests are conducted on a new engine.

As a result of its investigation of this accident, the National Transportation Safety Board recommends that the Federal Aviation Administration:

Modify the certification requirements for turbine engines (14 CFR Section 33.77) to require that foreign object ingestion requirements consider the adverse effects of preexisting service-acceptable blade damage, such as nicks, scrapes and gouges, that can occur during normal operation and that may be present during revenue service. (Class II, Priority Action) (A-92-49)

Acting Chairman COUGHLIN, and Members LAUBER, HART, HAMMERSCHMIDT, and KOLSTAD concurred in this recommendation.


By: Susan M. Coughlin
Acting Chairman