

NATIONAL TRANSPORTATION SAFETY BOARD  
WASHINGTON, D.C.

ISSUED: March 25, 1975

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Forwarded to:  
Honorable Alexander P. Butterfield  
Administrator  
Federal Aviation Administration  
Washington, D. C. 20591  
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SAFETY RECOMMENDATION(S)

A-75-22, 23 & 24

On December 4, 1974, the National Transportation Safety Board forwarded to the FAA Safety Recommendations A-74-115 and 116, which dealt with our investigation of the durability of drilled fan blades on CF6 engines. Now that our investigation is completed, there are three other areas which we believe warrant corrective action. These areas are: (1) Engine icing certification tests; (2) extended operation of CF6-50 powered aircraft in moderate icing conditions; and (3) performance degradation of large turbofan engines caused by bird ingestion.

Icing Certification

After the icing-certification test of the CF6-6 conducted in 1969, technical questions were raised about the lack of flight velocity simulation during the test program. Although flight velocity simulation was not possible at Peebles Proving Ground where the tests were made, General Electric Company engineers contended that the engine inlet airflow during the certification test actually produced a more severe engine icing condition than would be encountered in flight. Their contention, however, was disputed by other technical experts who had reviewed the test report. Service experience with the CF6-6 substantiates General Electric's contention.

However, the Safety Board believes that technical disagreements which pertain to vital aircraft systems should be resolved by definitive tests during the experimental phase of certification.

If a manufacturer's test facility is not suitable for icing simulation, the tests should be performed in a facility which can simulate in-flight icing conditions.

#### Prolonged Exposure to Icing

During a General Electric engine icing certification test and during a French A-300B icing test flight, fan blade tips on CF6-50 engines were damaged. The CF6-50 test engine was damaged when 12 lbs. of ice was released. The ice had accumulated on the unheated fan spinner during a hold pattern certification test at the Peebles Proving Ground. The spinner ice accumulated during two previous tests which lasted about 1 hour. These previous tests had been successfully completed in severe icing conditions before the engine was damaged.

Data from the A-300B icing test flight conducted by the French on March 28, 1973, indicate that both engines were damaged after holding for 60 minutes in moderate icing conditions; power was reduced on the left engine for more than 12 minutes while flying out of the icing conditions. After the reduced power operation, a power level of 96 percent fan rpm was achieved with a satisfactory level of vibration for the rest of the flight. French authorities believed that ice shed from the fan spinner was responsible for the damage to five fan blades in the left engine and two fan blades in the right engine; however, they also stated that these icing conditions were substantially more severe than conditions encountered in normal operation. The Safety Board believes that operators of aircraft equipped with CF6-50 engines should be alerted to the possibility of engine damage after prolonged exposure to moderate or severe icing conditions while at a hold pattern power level.

#### Bird Ingestion

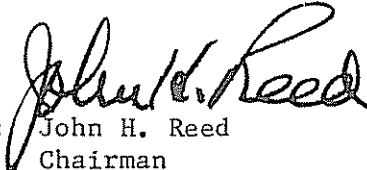
The Safety Board has noted that large turbofan engines have ingested greater numbers of birds and heavier birds than required for engine certification by Federal Aviation Regulations. These ingestions have not caused accidents, but engines have been damaged severely. Bird ingestion by more than one engine on a wide-bodied, multi-engine aircraft has been reported five times; in a foreign incident, one engine of a DC-10 was shut down and another limited to 76 percent fan rpm after encountering birds on takeoff. Although bird encounters have caused hazardous flight conditions, little knowledge of the effects of such encounters is available. Without accurate quantitative data regarding bird ingestion and resultant engine performance degradation, current bird ingestion criteria for large turbofan engines cannot be assessed. Therefore, the Safety Board believes that quantitative information about large turbofan engine performance after bird ingestion should be obtained and used to evaluate the adequacy of current bird-ingestion certification standards for these engines.

In view of the above, the National Transportation Safety Board recommends that the Federal Aviation Administration:

1. Require that certification demonstration of engine anti-icing provisions be performed in a test facility which can aerodynamically simulate in-flight icing conditions.
2. Warn all operators of aircraft equipped with CF6-50 engines that engine damage could result when ice is shed from the fan spinner after prolonged exposure to moderate or severe icing conditions at a hold pattern power setting.
3. Gather accurate engine performance information from selected in-service cases of bird ingestion by large turbofan engines which resulted in engine shutdown, serious thrust loss, or excessive vibration. This information, in combination with the most recent ornithological data and advances in engine technology, should be used to evaluate the adequacy of bird ingestion criteria for large turbofan engines.

Our Bureau of Aviation Safety staff is available for consultation if desired.

REED, Chairman, McADAMS, THAYER, and BURGESS, Members, concurred in the above recommendations. HALEY, Member, did not participate.

  
By: John H. Reed  
Chairman