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National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: March 2, 1994

In reply refer to: A-94-61 through -63

Honorable David R. Hinson
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On February 1, 1994, about 2130 central standard time, American Eagle flight 3641, operating a Saab 340B airplane, reported to air traffic control that power had been lost from both engines. The 4-month-old airplane had departed from Dallas, Texas, and was descending through approximately 9,000 feet, en route to Baton Rouge, Louisiana. The flight made an emergency landing without engine power at False River Airport, New Roads, Louisiana, and came to a rest in a farm field 1,425 feet beyond the end of runway 18. Although the airplane was substantially damaged, the passengers and crew were not hurt.

The flightcrew was interviewed, and the cockpit voice recorder (CVR) and flight data recorder (FDR) were examined to establish the sequence of events that preceded the loss of power from both engines. The CVR revealed that the captain, who was flying, stated his intention to slow the airplane, and about 11 seconds later, a significant increase in background engine noise was noted. Although postaccident external and borescope examination of the engines did not indicate evidence of internal failure, the power turbine assemblies of both engines exhibited extensive and very similar mechanical damage to the turbine and stator assemblies that was typical of turbine overspeed.

The Saab 340B airplane is powered by two General Electric CT7-9B turbopropeller engines, each driving a Hamilton Standard 14RF-19 four-blade, constant speed, full-feathering and full-reversing propeller. The engine consists of a gas generator, compressor, and turbine assembly, driving a free power turbine that is directly coupled to the propeller through a reduction gearbox. Each engine has two primary controls in the cockpit: a power lever and a condition lever. Control cables connect the cockpit control levers with the engine and propeller control units. The CT7-9B engine has a digital engine control unit for overspeed protection and is designed to interrupt fuel flow at 1,573 propeller revolutions per minute (rpm) (25,000 power turbine rpm).

When the power lever is moved forward of the flight idle position, engine power (torque) is increased, although propeller rpm is kept constant by the propeller pitch control unit (PCU). To maintain constant propeller rpm, the PCU adjusts the propeller blade angle to accommodate

the engine power setting. The PCU also supplies propeller overspeed protection to prevent engine damage. When the power lever is forward of the flight idle stop, the flightcrew uses the condition lever to select the propeller speed that the PCU will maintain.

The power lever should never be moved aft of the flight idle stop in flight. Operation below the stop is authorized only for ground operations. When the power lever is moved aft of the flight idle stop, the power lever passes through the ground power range (from high ground power to ground idle), then into reverse pitch. (The travel range aft of the flight idle stop corresponds to propeller operation in the beta range.) An annunciator light for each propeller is located on the instrument panel to alert pilots when the propellers are in the beta range. At ground idle, the propeller blades produce no thrust and little load is imposed on the engine. Within the beta range, the propeller blade angle is proportional to the power lever position, and the propeller PCU is not controlling blade pitch or providing propeller overspeed protection. Thus it is possible when in the beta range for air loads to back-drive the propeller and to overspeed the engine's power turbine.

The CVR did not indicate how or whether the captain reduced power or took other action to slow the airplane. In interviews following the accident, the pilots stated that they did not know why the engines lost power. Both pilots recalled being in moderate "chop" (turbulence) at the time of the event and both remembered hearing the engine speeds increase before power was lost. Neither pilot remembered seeing the power levers aft of the flight idle stop or the illumination of the beta annunciator lights.

The FDR data indicated that before the loss of engine power, the power levers were on the flight idle stop for about 63 seconds. Afterward, the data indicate that the power levers were aft of the flight idle stop for 8 seconds, concluding with 1 second at a position corresponding with a reverse propeller blade angle and 1 second between the flight and ground idle stops. The power levers were subsequently positioned forward of the flight idle stop where they remained until the end of the recording. The data indicated that following the reverse in propeller pitch, the propeller speeds rapidly increased to the FDR maximum limit of 1,500 rpm, after which the engine compressor discharge pressures and engine torque went to zero. A preliminary sound spectral analysis of the CVR indicated that the propeller speeds increased to about 2,000 rpm, which is in the "overspeed" range and above the speed at which the fuel flow to the engine is interrupted.

The Saab 340B Aircraft Operations Manual contains a warning that states:

> Do not move the PL [power level] below FLT IDLE [flight idle] when airborne. If PL is moved below FLT IDLE when airborne the propeller will go into low pitch angle, the propeller speed will increase uncontrolled with consequential extremely high drag and uncontrolled flight.

Title 14 Code of Federal Regulations (CFR) Parts 23.1155 and 25.1155 address the potential danger that could result from an inadvertent power lever movement to the beta range.

The Federal regulation governing the design criteria applicable to the Saab 340, 14 CFR Part 25.1155 states:

> **Reverse thrust and propeller pitch settings below the flight regime.**
> For turbine engine installations, each control for reverse thrust and for propeller pitch settings below the flight regime must have means to prevent its inadvertent operation. The means must have a positive lock or stop at the flight idle position and must require a separate and distinct operation by the crew to displace the control from the flight regime (forward thrust regime for turbojet powered airplanes).

The Saab 340B design met regulatory requirements by incorporating spring-loaded latches that were intended to prevent inadvertent movement of the power levers into the beta range, aft of the flight idle stops. To move the power levers aft of the flight idle stops and into the beta range on the Saab 340B airplane, the latches on the power levers must first be lifted about 1/2 inch with two fingers to overcome a combined spring force of about 12 pounds. The tops of the power lever knobs travel about 4 inches from the flight idle stop to the ground idle position. Additionally, a tactile detent is provided to distinguish the threshold between ground idle and reverse pitch.

The power and condition lever control paths of the accident airplane were inspected and found within aircraft maintenance manual rigging tolerances at each end of the control paths. Some cable chafing was found on insulation in the bottom of the fuselage, but the cockpit power lever movements were smooth. The cockpit beta annunciator lights operated properly in postaccident testing.

The Safety Board has investigated other turbopropeller airplane accidents resulting from operation of the propellers in the beta range while in flight. On October 17, 1988, following Construcciones Aeronauticas, S.A. (CASA) C-212 accidents that occurred on March 4, 1987, at Detroit-Wayne County Airport in Romulus, Michigan, and on May 8, 1987, at Mayaguez, Puerto Rico, the Safety Board issued Safety Recommendations A-88-92 through -105 to the Federal Aviation Administration (FAA). The Safety Board found that the CASA C-212 met the provisions of 14 CFR 25.1155. However, it was also found that the beta latch mechanisms in the CASA C-212 were not substantially different than the designs incorporated in other turbopropeller airplanes, and the service history showed that the design was not foolproof. The pilots had to consciously avoid positioning their fingers on the beta latch arms during aft movement of the power levers to the flight idle position to avoid inadvertent movement into the beta range. In fact, the Safety Board observed that in the CASA C-212, movement of the power levers below the flight idle stop and into the beta range was possible in some cases without lifting or touching the beta lockout mechanisms. Safety Recommendations A-88-103 through -105 addressed further means to prevent inadvertent operation of turbopropeller airplanes in the beta range in flight. The recommendations asked the FAA to:

> Require the aircraft evaluation group during the type certification process of turbopropeller airplanes to review carefully the design of propeller pitch controls in order to identify and establish appropriate flightcrew training guidelines and emphasis on the proper use of these controls to prevent inadvertent operation in the beta mode in flight where prohibited by the airplane manufacturer. (A-88-103)
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> Require the principal operations inspectors for operators of turbopropeller airplanes to review carefully flightcrew training programs to verify that appropriate information is provided by the operators on the proper use of propeller pitch controls to prevent inadvertent operation in the beta mode in flight. (A-88-104)
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> Amend Title 14 Code of Federal Regulations 25.1155 and 23.1155 to provide for a positive means to prevent inadvertent operation of the propellers at blade pitch settings below the flight regime in those airplanes where such operation of the propellers is prohibited. (A-88-105)

On July 27, 1989, Safety Recommendation A-88-104 was classified "Closed--Acceptable Action," after the FAA issued Air Carrier Operations Bulletin (ACOB) 89-1, "Inadvertent Operations in Beta Mode/Turbopropeller Airplanes." The ACOB requested that principal operations inspectors review turbopropeller airplane operators' flightcrew training programs to ensure that appropriate information was provided to prevent inadvertent operation in the beta mode in flight. Safety Recommendation A-88-103 was subsequently classified "Closed--Acceptable Action," when the FAA advised the Safety Board that ACOB 89-1 had been provided to aircraft evaluation groups and that the groups were requested to carefully review the design of propeller pitch controls during the type certification process of turbopropeller airplanes. The FAA responded to Safety Recommendation A-88-105 on May 1, 1990, stating that an FAA Inter-Directorate Propeller Installation Review Team had completed a review of current turbopropeller installations with respect to the means of controlling propeller blade pitch. The team had determined that changes to 14 CFR Parts 23 and 25 were not necessary, providing the propeller control levers and control systems were designed to comply with 14 CFR 23.1155 or 25.1155. The FAA concluded, however, that in view of recent accidents and continuing issues related to the beta mode, it was considering the possible need for regulatory changes or the issuance of advisory materials. Safety Recommendation A-88-105 was therefore classified "Open--Acceptable Response." The Safety Board has not received any subsequent updates from the FAA regarding the regulatory changes considered above.

Following another CASA C-212 accident on December 1, 1989, at the Patuxent River Naval Air Station, Maryland, the FAA issued airworthiness directive (AD) 90-04-11, effective February 26, 1990, to require revision of the CASA C-212 flight manuals to state:

> Do not retard the power lever of an operating engine aft of FLIGHT IDLE while airborne. WARNING: An immediate out-of-control situation may develop from which recovery cannot be accomplished.

Subsequent to its investigation of the December 1, 1989, accident, the Board's concern that Federal regulations and previously approved airplane certifications had not provided adequate protection against inadvertent or intentional operation of the beta range in flight was heightened. In a December 19, 1990, safety recommendation letter to the FAA, the Safety Board stated, "If in-flight use of the beta mode is not to be permitted, then a more positive means of locking out beta mode use must be required on all turbopropeller airplanes." To address the inadequacy, the Safety Board reiterated Safety Recommendation A-88-105 and issued the following additional safety recommendations to the FAA:

> Issue an Airworthiness Directive applicable to the CASA C-212, to require the design and installation of a system that provides a positive means of preventing the power levers from being placed below the flight idle position while the airplane is airborne. (A-90-181)
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> Conduct a directed safety investigation of all Garrett TPE-331 engine powered turbopropeller airplanes. This investigation should evaluate the potential for in-flight use of the beta mode, and the effects of incorrectly adjusting the blade pitch angle of the propeller during maintenance activities and, following the directed safety investigation, take appropriate action to preclude in-flight beta operation on airplanes not approved for such operation. (A-90-182)

On April 22, 1991, in response to Safety Recommendation A-90-182, the FAA re-advised the Safety Board of its issuance of ACOB 89-1 and stated that it had requested that its aircraft certification offices review airplane flight manuals (AFMs) and applicable service histories for all small/commuter-category turbopropeller-powered airplanes to determine whether the beta range could be used safely in flight. Changes would be required to the AFMs if warranted by the FAA review. The FAA again advised the Safety Board that it was considering a revision to 14 CFR Part 23 to preclude the in-flight use of beta, unless approved for in-flight use. The recommendation status was classified "Open--Acceptable Response," pending further response. However, the FAA has not subsequently updated the Safety Board on these proposed actions.

On May 7, 1991, Safety Recommendation A-90-181 was classified "Closed--Acceptable Action," after the FAA issued AD 91-03-10. The AD required modification of the CASA C-212 propeller speed and pitch control system to prevent movement of the propellers into reverse blade angles and adjustment of the propeller pitch settings below the flight regime while in flight. This AD superseded AD 90-04-11.

In addition to the known accidents involving the CASA C-212, the Safety Board became aware of eight accidents and incidents involving Embraer EMB-120 airplanes that were also attributed to in-flight operation of the propellers in the beta range. As a result of those accidents and incidents, the FAA issued ADs T88-16-51 and 88-16-51R1, which addressed changes to EMB-120 operational procedures. The FAA also issued AD 90-14-09, which required the installation of lockout devices in the EMB-120 to prevent power lever movement into the beta range.

After the FAA issued AD 90-14-09, the Safety Board investigated a July 21, 1992, incident at Denver Colorado, in which an EMB-120 experienced propeller overspeeds in both engines, although a flight idle lockout system was installed as per AD 90-14-09. The pilot said that he had been resting his hand on the power levers while descending in turbulence. Investigators found that the incident airplane's circuit breakers for the lockout system would occasionally trip when the power levers were pulled aft to the flight idle stops. After the circuit breakers were reset, the system functioned satisfactorily. Following the incident, AD T92-16-51 was issued to require daily visual inspections of the flight idle solenoid circuit breakers, as well as functional tests.

Although ADs have been issued to reduce the likelihood of inadvertent power lever movements into the beta range in flight in the CASA C-212 and EMB-120 airplanes, no such action has been taken to address the Saab 340. The Safety Board believes that the accidents and incidents cited above illustrate an urgent need not only to prevent inadvertent selection of the beta mode in flight, but also to preclude the possibility of that selection in any turbopropeller airplane in which use of the beta mode is not authorized in flight. The FAA should issue an AD, applicable to the Saab 340, similar to those applicable to the CASA C-212 and Embraer EMB-120, to prevent either inadvertent or intentional selection of the beta mode in flight. The AD should require installation of a system that prevents the power levers from moving aft of the flight idle stops while airborne, regardless of pilot manipulation of any detent or trigger mechanism provided to meet current regulations. Saab personnel have reported that the company has already developed and flight-tested power lever beta lockout components for the Saab 340. Until the system is installed, placards should be installed in the Saab 340 airplanes to warn pilots not to move the power levers into the beta range while in flight.

As a result of the investigation into the Saab 340 accident of February 1, 1994, and the other accidents, incidents, and the safety recommendation history cited above, the Safety Board believes that unless turbopropeller airplanes are certificated for beta selection in flight, regulatory action should be taken to preclude the possibility of that selection. Since Safety Recommendations A-88-105 and A-90-182 are still open, but do not adequately reflect the Safety Board's current concerns, they are now reclassified "Closed--Superseded."

Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

> Issue an airworthiness directive applicable to Saab 340 airplanes that would require installation of a system that prevents the power levers from moving aft of the flight idle stops into the beta range in flight regardless of pilot action. Until the system is installed, cockpit placards should be installed in Saab 340 airplanes to warn pilots not to move the power levers into the beta range while in flight. (Class I, Urgent Action) (A-94-61)
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> Revise Title 14 Code of Federal Regulations Parts 25.1155 and 23.1155 to require a positive means to prevent operation of the propeller in the beta mode while in

flight, unless the airplane is certificated for such use. (Class II, Priority Action) (A-94-62)

Review all other turbopropeller airplane designs to determine whether in-flight engine operation in the beta range should be prohibited. Issue appropriate airworthiness directives applicable to those airplanes to install a system to prevent movement of power levers into the beta range, and require appropriate warnings in airplane operating manuals and on cockpit placards to warn pilots not to move power levers into the beta range in flight, unless the airplane is certificated for such use. (Class II, Priority Action) (A-94-63)

Chairman VOGT, Vice Chairman COUGHLIN, and Members LAUBER, HAMMERSCHMIDT, and HALL concurred in these recommendations.

By: Carl W. Vogt
Chairman