A-91-45 2296

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: July 3, 1991

In reply refer to: A-91-45 through -48

Honorable James B. Busey
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On May 26, 1991, at about 2317 local time, a Lauda Airlines Boeing 767-300ER, on scheduled flight NG004 from Hong Kong to Vienna, Austria, with an en route stop in Bangkok, Thailand, crashed into mountainous jungle terrain about 94 nautical miles northwest of Bangkok. All 213 passengers and 10 crewmembers on board were fatally injured in the accident.

The positions of the left engine thrust reverser actuators along with data from the electronic engine control (EEC) and the cockpit voice recorder (CVR) indicate that the left engine thrust reverse system deployed while the airplane was at approximately .78 Mach, climbing through 24,700 feet en route to flight level 310. The preliminary evidence suggests that the reverse event was recognized by the flightcrew but that the airplane departed controlled flight, accelerated past the maximum operating velocity, and experienced an in-flight structural breakup. Indications of an in-flight fire prior to the breakup have not been found. However, during the breakup, a large explosion was witnessed, and burning debris fell to the ground.

An investigation of the accident is being conducted by an Investigation Commission of the Government of Thailand, with the participation of the National Transportation Safety Board, representing the United States as the state of airplane manufacture, and the Civil Aviation Administration of Austria, representing the state of registration and the state of the operator, in accordance with the provisions of Annex 13 of the International Civil Aviation Organization. Both the FAA and the Boeing Company are participating in the investigation as part of the U.S. team.

The circumstances that led to the in-flight reverser deployment and the influence that this event had on the ability of the cockpit crew to maintain control of the airplane are not clearly understood at this time. It is hoped that additional evidence may yet be obtained from further examination of the wreckage debris and high speed wind tunnel tests. However, the investigation has raised several issues which the Safety Board believes warrant immediate precautionary measures.

The accident airplane was equipped with Pratt and Whitney PW4000 series engines. The Boeing Airplane Company provides an electro-hydraulic thrust reverse system in these airplanes to redirect engine fan bypass airflow to aid in stopping the airplane on the ground. The thrust reverse system contains logic switching devices that are designed to prevent in-flight deployment caused by a component failure or flightcrew action. These engines also incorporate EEC devices. One function of the EEC is to reduce engine rpm to idle in the event of an inadvertent reverser deployment. Although a reduction in reverse thrust is beneficial, it does not occur immediately because of the time delay while the engine spools down.

The thrust reverse system of the PW4000 series engines installed in Boeing 767 airplanes incorporates a hydraulic isolation valve (HIV) and a directional control valve (DCV) in the engine pylon. An inappropriately positioned HIV is indicated in the cockpit by a reverser isolation valve (REV ISLN) amber caution light on the control pedestal below the throttles. The CVR revealed that the flightcrew observed the "REV ISLN" caution light illuminated about 9 minutes prior to the reverser deployment on the accident airplane and a crewmember observed that the light came on repeatedly.

The flightcrew discussed the Boeing 767 Quick Reference Flight Handbook (QRH) information which states that if this caution light is illuminated, "additional systems failures may cause inflight deployment." The thrust reverse system is designed so that the HIV provides a safeguard against deployment caused by a DCV failure. The system is designed so that the HIV will open to provide pressure to the reverser system in flight to restow the thrust reverser if it is not fully closed. The valve can also open when certain faults exist in the system logic. Because the DCV is downstream of the HIV, a failure of the DCV that would apply hydraulic pressure to the extend side of the reverse actuators would not be apparent until the HIV is opened. The HIV normally opens when the airplane lands and the reverse system is used. A DCV failure might then be apparent when the translating cowl does not stow properly. While information provided by the manufacturer indicates that other Boeing 767 airplanes have experienced "REV ISLN" caution light illuminations during flight, there have been no prior indications of DCV failure or uncommanded thrust reverser extensions.

The hydraulic thrust reverse actuators from the left engine of the accident airplane were found in the deployed position and no pre-existing faults were evident. Hydraulic power for the actuators can come only through the DCV located in the pylon, which is a high vibration environment. The left engine DCV has not been found and thus could not be examined for malfunction. It was located in the pylon near the point where the pylon separated from the airplane. However, a failure mode and effects analysis for the thrust reverser system has revealed failure modes in the DCV that could cause an uncommanded reverser deployment after an opening of the HIV. After reviewing HIV/DCV failure modes, the Safety Board believes that the FAA should conduct a certification review of the PW4000 series equipped Boeing 767 airplane thrust reverse system.

The Safety Board has been provided with data from Boeing indicating that flight control has been demonstrated on the Boeing 767 with one engine in the reverse idle position at 200 knots IAS; however, the Board has been informed that such testing has not been performed at higher speeds or at higher engine thrust levels. The Safety Board is concerned about the potential severity of airframe buffeting, aerodynamic lift loss, and subsequent yawing and rolling forces which may occur at the airspeed and engine thrust levels that existed when the reverser deployed in the accident flight.

The Safety Board is also concerned that Boeing 767 flightcrew emergency procedures may not provide appropriate and timely guidance to avoid loss of flight path control in the event that the reversers deploy in flight. Pending completion of actions taken to assure acceptable reliability of the thrust reverse system, the Safety Board believes that flight crew procedures in response to a "REV ISLN" light while airborne should include actions to attain appropriate combinations of altitude, airspeed, and thrust settings which will minimize control difficulties in the event of subsequent reverser deployment. Furthermore, consideration should be given to the development of emergency procedures which would include pulling the fire handle in the event that the reverser does deploy. This would immediately remove fuel, and hydraulic and electrical power to the affected engine. The Safety Board also believes that flightcrews should be forewarned that an in-flight deployment of a thrust reverser may result in significant airplane buffeting, yawing, and rolling forces.

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

Conduct a certification review of the PW4000 engine equipped Boeing 767 airplane thrust reverser systems to evaluate electrical and mechanical anomalies and failure modes that can allow directional control valve pressure to be applied to the reverser EXTEND port. The certification review should include subjecting the valve to the engine's vibration spectrum concurrent with introduction of intermittent pressure spikes to the valve pressure port. The certification review should also determine the adequacy of the thrust reverser system safeguards when the hydraulic isolation valve is open to prevent uncommanded thrust reverser extensions. (Class I, Urgent Action) (A-91-45)

Amend the Boeing 767 Flight Operations Manual on aircraft powered by the PW4000 series engine to include in the section, "Reverser Isolation Caution Light," a warning that in-flight reverser deployment may result in severe airframe buffeting, yawing, and rolling forces. (Class I, Urgent Action) (A-91-46)

Pending completion of a certification review of the thrust reverser system, establish operational procedures to be followed upon illumination of the Reverse Isolation Caution Light (REV ISLN) that will enhance the controllability of the PW4000 powered Boeing 767 should a secondary failure result in the in-flight deployment of a thrust reverser. Actions should be taken to achieve an appropriate

combination of airspeed, altitude and thrust settings that will minimize control difficulties in the event that the reverser subsequently deploys. Also consider the inclusion of a procedure to pull the fire handle if this occurs. In lieu of implementation of revised operational procedures, operators may be directed to deactivate thrust reversers until the certification review is completed and the reliability of the system can be adequately assured. (Class I, Urgent Action) (A-91-47)

Examine the certification basis of other model airplanes equipped with electrically or electro hydraulically actuated thrust reverse systems for appropriate safeguards to prevent inflight deployment of reversers and ensure that operating procedures are provided to enhance aircraft control in the event an of inadvertent in-flight reverser deployment. (Class II, Priority Action) (A-91-48)

KOLSTAD, Chairman, COUGHLIN, Vice Chairman, LAUBER, HART, and HAMMERSCHMIDT, Members, concurred in these recommendations.

By: James L. Kolstad
Chairman