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National Transportation Safety Board

Washington, D. C. 20594

Safety Recommendation LOG 2099

Date: October 17, 1988

In reply refer to: A-88-92 through -105

Honorable T. Allan McArtor
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On March 4, 1987, Fischer Bros. Aviation, Inc., doing business as Northwest Airlink, flight 2268, a Construcciones Aeronauticas, S.A. (CASA) C-212-CC, N160FB, crashed just inside the threshold of runway 21R at the Detroit Metropolitan Wayne County Airport in Romulus, Michigan. Nine of the 19 persons on board were killed. The airplane was destroyed by impact forces and postcrash fire.[1]

On May 8, 1987, Executive Air Charter, Inc., doing business as American Eagle, flight 5452, a CASA C-212-CC, crashed short of runway 9 while on a visual approach to the airport at Mayaguez, Puerto Rico, in visual meteorological conditions. Both crewmembers were killed and the four passengers sustained minor injuries. The airplane was destroyed by impact forces and postcrash fire.[2]

An examination of the interior configuration of the C-212 showed areas of noncompliance with Title 14 Code of Federal Regulations Part 25. In the Fischer Bros. accident airplane, a flight attendant's retractable seat was installed on the left side of the forward cabin bulkhead, adjacent to the left forward Type II emergency exit. In the extended position, the seat blocked passage to the exit. The seat was found retracted, but it was not equipped with an automatic folding mechanism feature. The seat was designed and certified by the airplane manufacturer, but there was no data plate visible on the seat frame. The Federal Aviation Administration (FAA) issued Airworthiness Directive (AD) 87-05-07, effective March 25, 1987, requiring installation of an automatic retract mechanism in the seat in accordance with the manufacturer's Service Bulletin (SB) 212-25-32 of October 23, 1985. Further, the folding flight attendant seat would have obstructed the pathway to the

[1]For more detailed information, read Aircraft Accident Report--*Fischer Bros. Aviation, Inc., dba Northwest Airlink, Flight 2268 Construcciones Aeronauticas, S.A. (CASA) C-212-CC, N160FB, Detroit Metropolitan Wayne County Airport, Romulus, Michigan, March 4, 1987* (NTSB/AAR-88/08).
[2]For more detailed information, read Aircraft Accident Report--*Executive Air Charter, Inc., dba American Eagle, Flight 5452, Construcciones Aeronauticas, S.A. (CASA) C-212-CC, N432CA, Mayaguez, Puerto Rico, May 8, 1987* (NTSB/AAR-88/07).

left front emergency exit had it not been retracted. Had the airplane not come to rest inverted, the seat may have remained extended as a result of impact forces.

The flight attendant's jumpseat in the accident airplane in the Executive Air accident remained in place, but was found extended for use instead of retracted because the inboard spring retainer bar had separated from the seat. All of the 19 passenger seats, manufactured to Technical Standard Order C39A, remained attached to the cabin floor. Passenger seats 7B and 7C were installed adjacent to a Type III emergency exit. In this location, the armrests protruded into the pathway of the exit, as did the seatbacks.

The National Transportation Safety Board examined another Fischer Bros. C-212-CC and compared some of the installations with Federal regulations. The Board examined the boarding stairs that were hinged at the floor just inside the left main cabin entry door. When they were folded with the door closed, the stairs obstructed the view and operation of the door handle. The Fischer Bros. accident airplane contained the same installation which was approved by the FAA under a supplemental type certificate (STC) obtained by the carrier. Although surviving passengers did not remark about having difficulty with the main cabin entry door stairs, the door opened during the impact sequence, and the stairs apparently did not obstruct the passengers' evacuation. However, since the stairs were found to also obstruct the view and use of the door handle, the Safety Board believes that the stairs could present a problem in an evacuation. Therefore, the Board encourages the FAA to review this installation.

The Safety Board also found that the clearance between the left front passenger seat and the galley/electronics bulkhead was 28 inches, whereas 14 CFR 25.785(c) prescribes that the seat's neutral reference point should have been 35 inches from the compartment to provide injury-free head clearance in the event of a minor crash. This deficiency indicated that the FAA's STC had been granted without careful consideration of all the applicable regulations that enhance occupant safety, protection, and survival. The galley/electronics compartment was also approved under an STC. Further, the armrest of passenger seat 8-C extended into the projected opening of the Type III emergency exit at the aft right side of the airplane. Title 14 CFR 25.813(c)(1) requires that openings be free of protrusions.

The Safety Board noted that, according to those who had flown with the captain in the Fischer Bros. accident, he did not use the shoulder harness. This fact was also reported about the captain in an accident involving another CASA C-212-CC, flown by the captain in the Executive Air accident about 2 months later. Both pilots were small. The captain in the Fischer Bros. accident was 5 feet 5 inches and weighed 140 pounds, and the captain in the Executive Air accident was 5 feet 4 inches and weighed 155 pounds. Since the shoulder harness restricted movement and did not always retract properly, the Safety Board believes the harness probably would have been more of a nuisance for these two captains than for larger pilots. However, it was noted that other pilots also had difficulty with the harness. It could not be determined from the physical evidence if the first officer in the Fischer Bros. accident used his shoulder harness. The 2-inch contusion on his right temple could have been the result of a flailing-type injury that probably would not occur with a securely fastened shoulder harness and lapbelt. There was no evidence that the first officer in the Executive Air accident had used his shoulder harness. Consequently, the Safety Board believes that the pilots' failure to use the shoulder harness in the CASA C-212, especially smaller pilots, have been more widespread than reported. Therefore, the Safety Board believes the FAA should inspect the harness installation

in the C-212 to verify that it conforms with accepted anthropomorphic criteria of intended users. The Safety Board believes that features which restrict movement and render a shoulder harness uncomfortable will tend to discourage its use. These features should be eliminated since appropriate use of the harness prevents certain types of injuries.

Seat cushion fire blocking is a method used to encapsulate cushions inside a fire resistant material to delay the decomposition, outgassing, and combustion of cushion material, thereby extending the critical time available for airplane occupants to escape. The fire-blocking requirements became effective under 14 CFR 25.853(c), 121.312(b), and 135.169(a) on November 26, 1984, with a 3-year period for compliance. In the Fischer Bros. accident, fire-blocking materials had not been installed on the seat cushions, and the seat cushions in the rear of the cabin were completely consumed by the fire and released large amounts of toxic fumes and smoke into the entire cabin. Although it is not possible to conclude precisely how effective fire-blocking material may have been in reducing toxic fumes and smoke in this accident, research has demonstrated that fire-blocking materials that meet FAA requirements increase the time available for occupants to escape before the seat cushions begin to outgas toxic fumes and begin to burn and produce dense smoke. Nonetheless, the Safety Board believes that fire-blocking material might have been a benefit in this accident and that lives might have been saved had it been installed.

The Safety Board noted that there are no comparable regulations to require fire-blocking material for commuter-type airplanes that are certificated under 14 CFR Part 21 and Special Federal Aviation Regulations (SFAR) No. 41 or for the new commuter airplane category in 14 CFR Part 23. For example, commuter airplanes that operate under 14 CFR Part 135 are not required to have fire-blocking material unless it is required by the airworthiness rules under which the airplane is type certificated. Fischer Bros. operated both 14 CFR Part 21 and SFAR No. 41 airplanes (the 19-passenger Dornier 228) as well as airplanes certificated under 14 CFR Part 25 (22-passenger CASA C-212-CC). Fire-blocking material would have been required on the CASA after November 26, 1987, but not on the Dornier 228.

The Fischer Bros. accident is an example of a commuter airplane accident in which fire-blocking material would have provided protection during a fire. The Safety Board believes that the FAA should require fire-blocking material on all commuter airplanes to provide comparable levels of fire protection to passengers and crew on board these airplanes when operated by commercial air carriers.

The Hartzell Service Center overhauled the propellers installed on the Fischer Bros. accident airplane under an exchange program. During the overhaul, the feathering spring assemblies were pre-assembled in a separate area, according to personnel involved, and then were verbally identified and given to a stockroom attendant who placed them in a specifically designated storage bin. When the feathering spring assemblies were ordered for the propellers, the stockroom attendant provided the incorrect assemblies with the single feathering spring instead of the double feathering spring. The stockroom attendant's actions reportedly were based on memory and previous experience with CASA C-212-CB propeller installation requirements. The feathering spring assemblies were not identified by an assembly part number. Based on the assembler's previous experience with the aluminum blade propeller configuration, he installed the incorrect assemblies and erroneously checked off the Assembly Inspection Check-Off record, Form No. 1237, as being the correct assembly.

The propellers were subsequently inspected by a Hartzell Service Center employee who is an FAA-certified inspector. The feathering spring assembly is one of the few parts that cannot be inspected after the propeller is assembled. The inspector was not required to verify that correct parts were being installed during the assembly process.

As a result of these mistakes, Hartzell Propeller issued an instruction on January 19, 1988, establishing new procedures to use during propeller assembly. The stockroom attendant and the assembler are now required to verify from the propeller assembly print that the correct parts are being supplied and installed. A feathering spring parts card will be used to document the parts listed for installation, and it will be attached to the Final Inspection Record.

According to Hartzell Service Center representatives, the FAA visits their facility about three times each year. The inspector(s) examine documentation and review overhaul procedures and manuals. The representatives reported that the FAA also inspects to ensure that the various new and overhauled parts are correctly segregated.

Regarding the maintenance department's actions in the Executive Air accident, the Safety Board believes that there was a failure to troubleshoot the pilot-reported discrepancies correctly. This poor performance led to unnecessary and time-consuming maintenance tasks that aggravated the carrier's maintenance difficulties.

The setting of the C-212's flight idle blade angle and corresponding fuel flow adjustments can be tedious and time consuming. However, their proper settings are critical to the proper handling and landing characteristics of the airplane. The evidence indicates that the Executive Air's maintenance personnel were inclined to take the most expedient means to correct an engine rigging problem by simply adjusting the beta tube a couple of turns in a quick trial-and-error approach to correct the discrepancies. The determination of the airplane's flight idle blade angle is a manufacturer design and is evaluated from a performance and safety standpoint in the type certification process by the regulatory authority. Proper maintenance of this flight characteristic is critical to the airplane and should not have been taken lightly as shown by this accident. Therefore, the Safety Board concludes that the management and supervision of the maintenance personnel were deficient.

In addition, during its investigation, the Safety Board found it difficult to verify when scheduled maintenance actions had been taken and when final inspections of the maintenance had been performed without extensive interviews of the maintenance personnel involved because of poor maintenance recordkeeping. This situation came to light when it was learned during interviews that the accident airplane had been released for flight during the day when the scheduled inspection interval was incomplete. Although performing a particular scheduled inspection in intervals is a common maintenance practice under a continuous airworthiness inspection program, it was not possible to determine from the records what date the required inspection items were inspected before the airplane was released for flight each day. This type of recordkeeping should not have been acceptable to the FAA flight standards district office (FSDO) responsible for issuing the carrier's operating certificate. In fact, the FAA FSDO questioned if the carrier's maintenance program permitted this type of maintenance activity. Additionally, though this kind of maintenance practice is acceptable, the Safety Board believes it can lead to

difficulties without the proper controls in place, such as adequate staffing, supervision, and a sound system of recordkeeping.

The history of the type certification of the CASA C-212 raises some doubt about the FAA's management of bilateral type certification projects. It appears that more FAA resources are devoted to foreign-manufactured aircraft of greater complexity than to aircraft in the commuter air carrier class. However, given the growth of the U.S. commuter airline industry with its demand for suitable aircraft and the efforts of foreign manufacturers to fulfill this demand, the Safety Board believes that such aircraft must be given the evaluation scrutiny they deserve. The Board recognized the FAA had made changes and improvements in its engineering and operations organizations to provide better monitoring and followup on foreign type certification projects. However, several noncompliance problems remained unresolved after the FAA's changes and improvements had been put into place.

Accordingly, questions remain about management capabilities and about the availability and allocation of resources devoted to such projects by the FAA. Since the demands of the U.S. aircraft industry occupy the majority of FAA's type certification and continuous airworthiness attention, the increase in foreign aircraft certification activity appears to have placed a less manageable burden on FAA resources. The Safety Board is aware that as a result of the CASA C-212-CC accidents in Romulus and Mayaguez and some other occurrences, the FAA has conducted an in-house review of its bilateral certification program. However, a report on the review has not yet been made available to the Safety Board. Further, the Safety Board has not been made aware of any corrective actions taken as a result of the in-house review. Therefore, the Safety Board believes that the FAA should complete its report on the bilateral certification review and make it available as soon as possible along with any corrective actions taken or contemplated.

Correlation of the accident site terrain features, impact marks, airplane geometry, and damage to the right wing tip indicated that the Executive Air accident airplane was in a right bank of 30° or greater and that its flightpath angle was 5° or greater when it struck the ground 643 feet short of the runway threshold and 86 feet below a normal 3°-approach path. The Safety Board believes the evidence confirms that the pilot flew an unstabilized approach at a steep angle and at a fairly high rate of descent. This resulted in the airplane sinking below the normal approach path requiring the pilot to arrest the rate of descent at the last minute. In fact, a witness reported that the nose of the airplane rose up quickly, and the airplane then rolled to the right when he observed it coming toward him. This suggests the pilot may have suddenly increased the pitch attitude to arrest the rate of descent and attempted to extend the approach path or that he attempted to make a go-around before lateral and directional control was lost. The evidence further suggests that the loss of control could have been the result of a stall.

The indication of a stall resulting from the unstabilized approach and the nature of the stall warning of the C-212-CC brought into question the adequacy of aerodynamic buffeting as a stall warning. The C-212 was originally determined to have adequate inherent aerodynamic buffeting to provide warning of an impending stall, and it was not required to be equipped with a stall warning device. Later subjective evaluations by the FAA reversed the original determination. In both evaluations, only straight and turning flight were required to be evaluated. The warning margins assume a "normal" deceleration rate and nearly constant 1.0 G maneuver to provide a timely, early warning of an approaching stall. However, stalls may result from more severe deceleration rates or more abrupt maneuvers,

and airplane vibrations and atmospheric turbulence may mask the inherent aerodynamic buffeting cues. Therefore, the warning time can be significantly reduced or masked depending on the particular maneuver and other environmental conditions.

The Safety Board is concerned that the absence of a stall warning device compromises safety in 14 CFR Parts 121 and 135 passenger-carrying operations by placing too much reliance on a subjectively approved "inherent" buffeting stall warning feature that may be less noticeable during an emergency or in the presence of atmospheric turbulence. Therefore, the Safety Board believes that the FAA should reevaluate the stall warning certification criteria for airplanes used in Parts 135 and 121 air carrier operations with a view toward requiring stall warning devices on these airplanes.

The Safety Board believes that the evidence shows that the pilot of the Fischer Bros. accident airplane flew an unstabilized visual approach and that he used the beta mode in flight to decelerate the airplane rapidly. This technique was not authorized by Fischer Bros. Factors that the Safety Board believes would have led the captain to use the negative thrust available in the beta mode on this approach were the speed of the airplane, the shortened base leg approach, the location of another aircraft that was departing, his tendency to use this technique occasionally to make short field landings, and possibly his desire to make up for the delay in the arrival time. Also, since the airspeed was high, the captain did not have the benefit of the increased drag that the flaps could have provided because the speed was above that which would allow use of the maximum extension of the flaps (135 KIAS). Another factor which could have influenced the pilot to use the beta mode was the higher-than-normal flight idle fuel flow settings.

Witness statements also support the conclusion that the captain selected the beta mode in flight. Some witnesses, both in the airplane and on the ground, reported hearing unusual engines sounds immediately before control of the airplane was lost. Many of the witnesses reported that the airplane appeared high on final approach, and some stated that it also appeared to level off on short final. Subsequently, some witnesses observed the airplane make a slight right bank before it banked sharply to the left. The right and left banking could have occurred when the captain encountered lateral and directional control problems from asymmetric power between the engines which can easily occur when operating in the beta mode because of differences in power lever (PL) rigging and fuel control unit operation or because of differing propeller recovery rates when the PLs are returned to the flight idle gate. The Safety Board noted that the accident airplane had a difference in PL "stagger," which could have contributed to the asymmetric condition. Furthermore, the Safety Board believes that the absence of the complete feathering spring assemblies in the propellers could have delayed the ability of the propellers to achieve increased blade angles following operation below the flight idle regime.

Moving the PLs behind the flight idle stop and into the beta mode would have produced significant deceleration, propeller cyclic noise, stickfree nosedown pitch (which is correctable), and potentially high rates of descent. The CASA approved flight manual (AFM) contained this warning, "Power lever must not be retarded aft of F.I. [flight idle] when in flight. Excessive drag may result." However, the Safety Board noted that the design of the beta latch mechanism on the PLs permits use of the beta mode in flight. Therefore, based on the foregoing circumstances, the Safety Board believes the captain placed the PLs into the beta mode to slow the airplane rapidly while continuing the descent to land. This produced a significant

asymmetric power condition and control difficulty from which the pilot could not recover given the low altitude of the event.

The Safety Board considered two other factors which could have contributed to the loss of control: a stall or a malfunction in the flap system. The FAA flight test pilots and other pilots who flew the C-212 noted that the natural aerodynamic warning of a stall in the airplane was insufficient. What little inherent warning existed could have been masked by noises and vibrations generated during operation in the beta mode. Furthermore, the flaps were extended only 25 percent at ground impact instead of the normal 37.5 percent used for landing. Therefore, the Safety Board concludes that the evidence demonstrates that the high rate of deceleration associated with the use of the beta mode in flight was the predominant cause in the loss of control.

The Safety Board also recognized that inadvertent selection of the beta mode in flight is possible based on its examination of the beta latch mechanism in the C-212 and the views expressed by some pilots. However, line pilot opinions varied on this question, and the operational history of the airplane revealed that this was a remote occurrence. The design of the beta latch mechanism in the C-212 is not unlike the designs incorporated in other turbopropeller airplanes. Federal regulation governing the design criteria, 14 CFR 25.1155, states:

> 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.

Although the rule requires that inadvertent operation of the propeller pitch control below the flight regime be prevented, the rule relies on a positive lock or stop plus a separate and distinct operation. However, the rule is subjective because it is dependent on the degree of separate and distinct movement that prevents its inadvertent operation. Further, the rule does not provide for a positive means of preventing the in-flight selection of propeller pitch settings below the flight regime of propeller operation when such settings are prohibited by the FAA-AFM.

The Safety Board's evaluation of the beta latch mechanism on the C-212 in conjunction with the service history of the airplane indicates that the design meets the provisions of the current rule, but it is not foolproof. That is, if the pilot is not aware and conscious of how easy it is to retract the beta latch mechansim (arm and finger movements must be coordinated to prevent retraction of the beta latch arm) during movement of the PLs, inadvertent retraction of the latch arm could occur concurrently with movement of the PLs toward the flight idle position. Consequently, pilots must consciously avoid positioning their fingers on the beta latch arms during aft movement of the PLs to the flight idle position; otherwise, inadvertent movement of the PLs into the beta mode is possible.

For those airplanes certificated under the current rule, if in-flight selection of propeller pitch below the flight regime is prohibited, the Safety Board believes that provisions for certain operational reinforcements should have been an integral part of the type certification process. For instance, proper operation of the beta latch mechanism, proper use of the PLs to avoid making a mistake in selecting the beta mode in flight, and the use of crew coordination as a backup against making such a mistake should be items emphasized in training. Certainly, caution against using

the beta mode in flight and the hazards associated with it should be emphasized to instill an awareness of the danger and the proper discipline in using the PLs and to foster the proper habit-pattern development. The air carrier in this case was responsible for ensuring that its pilots adhere to the limitations in the airplane as outlined in the AFM. Any deviations from those limitations, particularly in a critical flight regime, should not have been tolerated. The fact that one of the carrier's pilots attempted, with passengers on board, to find out how the airplane would react in flight while in the beta mode may be an indication that these operational reinforcements were not emphasized.

With regard to the future application of 14 CFR 25.1155 (and 14 CFR 23.1155), the Safety Board believes that from a human engineering perspective, a means to prevent inadvertent operation of a critical control should be positive or foolproof. That is, the designer should provide either a separate control that requires a deliberate act on the part of the pilot to select, under certain conditions, a function that is prohibited or an interlock mechanism that will automatically prevent the selection of a prohibited function except when the correct conditions have been established. Therefore, in airplanes where selection of propeller pitch settings below the flight regime of propeller operation is to be prohibited, the Safety Board believes that a positive means to prevent this from happening, such as incorporating an additional control or an air-ground interlock mechanism that prevents removal of the flight low pitch stops during flight should be required. Consequently, the Safety Board believes that 14 CFR 25.1155 (and 14 CFR 23.1155) should be revised accordingly.

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

> Correct any deficiencies in compliance with Title 14 Code of Federal Regulations 25.813 regarding the installation of passenger seats adjacent to Type II and III exits in CASA C-212 airplanes with 19 seats or less. (Class II, Priority Action) (A-88-92)
>
> Remedy the deficiencies in compliance with Title 14 Code of Federal Regulations 25.809, .811, and .813 of the supplemental type certificate for the CASA C-212-CC main door regarding accessibility to door controls during emergency conditions. (Class II, Priority Action) (A-88-93)
>
> Require in accordance with Title 14 Code of Federal Regulations 25.785(c) adequate head clearance between passenger seats and bulkheads/partitions installed in CASA C-212 airplanes. (Class II, Priority Action) (A-88-94)
>
> Inspect flightcrew restraints in CASA C-212 airplanes to verify the adequacy of operation, convenience, and comfort based on anthropomorphic criteria, and take appropriate remedial action. (Class II, Priority Action) (A-88-95)

Require fire-blocking materials on all passenger and crew seats on Title 14 Code of Federal Regulations Part 21, Special Federal Aviation Regulations No. 41, and 14 Code of Federal Regulations Part 23 commuter category airplanes that are operated under Title 14 Code of Federal Regulations Part 135. (Class II, Priority Action) (A-88-96)

Conduct a special surveillance inspection of approved Hartzell Propeller overhaul facilities and of other propeller manufacturer overhaul facilities as service difficulty historical data and experience dictate to determine that the proper quality control organization and procedures are in place and are being followed. (Class II, Priority Action) (A-88-97)

Alert all principal operations and maintenance inspectors to emphasize in their surveillance of operators of turbopropeller airplanes the need to adhere to prescribed manufacturer instructions in maintaining flight idle blade angles and to emphasize to operators the criticalness of maintaining them properly. (Class II, Priority Action) (A-88-98)

Reissue to operations and maintenance inspectors Federal Aviation Administration Notice N8320.301 of September 17, 1984, prompted by Safety Board Recommendation A-84-15. (Class II, Priority Action) (A-88-99)

Complete as soon as possible and make the findings available to the Safety Board the report on the in-house review of the bilateral aircraft type certification program and the corrective actions taken or contemplated as a result of the review. (Class II, Priority Action) (A-88-100)

Amend Title 14 Code of Federal Regulations 23.207 and 25.207 to require a stall warning device and eliminate the use of "inherent aerodynamic qualities" (aerodynamic buffeting) as a stall warning. (Class II, Priority Action) (A-88-101)

Amend Title 14 Code of Federal Regulations Parts 121 and 135 to require a stall warning device on those airplanes that currently use "inherent aerodynamic qualities" (aerodynamic buffeting) as a stall warning. (Class II, Priority Action) (A-88-102)

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. (Class II, Priority Action) (A-88-103)

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. (Class II, Priority Action) (A-88-104)

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. (Class II, Priority Action) (A-88-105)

KOLSTAD, Acting Chairman, and BURNETT, LAUBER, NALL, and DICKINSON, Members, concurred in these recommendations.

By: James L. Kolstad
Acting Chairman