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National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: December 11, 1991

In reply refer to: A-91-123 through -128

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

About 0019, Sunday, February 17, 1991, Ryan International Airlines flight 590 (Ryan 590), a DC-9-15, crashed while taking off from Cleveland-Hopkins International Airport (CLE). The flightcrew consisted of two pilots. There were no other crewmembers or passengers on the flight, which was contracted to carry mail for the U.S. Postal Service. Both pilots were fatally injured, and the airplane was destroyed as a result of the accident.[1]

Between 1968 and 1987, there were four accidents involving DC-9 series 10 airplanes in which there was a loss of control shortly after takeoff.[2] In all cases, the investigation showed that the airplanes accelerated normally and reached airspeeds at which they should have been capable of establishing and sustaining a safe climb. Instead, all were observed to enter steep roll attitudes and descend to the ground. Also, in all of these accidents, witnesses reported, and the sounds on the cockpit voice recorders (CVRs) confirmed, that engine compressor surges occurred as the airplanes descended.

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[1] For more detailed information, read Aviation Accident Report--"Ryan International Airlines, DC-9-15, N565PC, Loss of Control on Takeoff, Cleveland-Hopkins International Airport, Ohio, February 17, 1991" (NTSB/AAR-91/09)

[2] Aircraft Accident Report--"Ozark Airlines, Inc., McDonnell Douglas DC-9-15, N974Z, Sioux City Airport, Sioux City, Iowa, December 27, 1968" (NTSB/AAR-70/20); NTSB Field Investigation--"Trans World Airlines, Flight 505, McDonnell Douglas DC-9-10, Newark International Airport, Newark, New Jersey, November 27, 1978;" NTSB Field Investigation--"Airborne Express, Flight 125, McDonnell Douglas DC-9-15, Philadelphia International Airport, Philadelphia, Pennsylvania, February 5, 1985;" and Aircraft Accident Report--"Continental Airlines, Flight 1713, McDonnell Douglas DC-9-14, Stapleton International Airport, Denver, Colorado, November 15, 1987" (NTSB/AAR-88/09)

All of the accidents occurred in weather conditions that were conducive to the accumulation of ice or snow on the fuselage and aerodynamic surfaces. The Safety Board found that the cause of each of these accidents was an attempt to take off with some airfoil contamination that prevented the wings from producing the normal and required amount of lift. The Safety Board is not aware of any similar accidents involving later model DC-9 or MD-80 aircraft.

The accidents since 1968 have motivated the manufacturer to identify the performance penalties associated with wing contamination and issue educational material to operators of Douglas Aircraft Company aircraft regarding this hazard. During the 20-year span, at least 10 technical articles have appeared in magazines or in All Operators Letters that were distributed to the flight training departments of air carriers that were known to be currently operating DC-9 aircraft.

The following paragraphs have been extracted from a technical paper prepared by the Deputy Chief Design Engineer, DC-9 Program. The paper, entitled, "The Effect of Wing Ice Contamination on Essential Flight Characteristics," was presented in 1988 and 1991:

> Contamination of critical aerodynamic surfaces by ice, frost, and/or snow has been identified as the probable cause of a significant number of aircraft accidents. In most cases, the ice contamination has not been large ice accretions on the leading edges or thick layers of adhering snow on the top of the wings. Rather, dangerous reductions in stall margins and handling qualities can occur because of ice-related roughness equivalent to that of medium-grit sandpaper.

In December 1982, following several icing-related takeoff accidents involving transport-category and general aviation airplanes, the FAA provided extensive guidance on wing contamination in its 37-page Advisory Circular (AC) 20-117. In essence, the AC reaffirms the necessity of adherence to the "clean airplane concept" in flight operations. The AC states that the only way to ensure that an airplane is free from surface contaminants is through close visual inspection before it actually takes off. According to the circular, the many variables affecting ice formation (AC 20-117 lists 13 significant ones) preclude a pilot from (a) assuming that his airplane is clean simply because certain precautions have been taken or certain ambient conditions exist, and (b) assuming his airplane is clean simply because he is within a certain arbitrary timeframe between the last inspection of the airplane and takeoff.

Although the Safety Board supports the AC and concurs with the "clean airplane concept," the Safety Board believes strongly that the only way to ensure that the DC-9 series 10 wing is free from critical contamination is to touch it. Ladders or some other suitable equipment would be required to allow crewmembers to reach the wing, which is 7 feet above the ground. Similarly, for night operations, adequate lighting must be provided around the aircraft. Specifying such actions for only the DC-9 series 10 aircraft is not intended to suggest that other aircraft can operate without inspection

for, and removal of, ice contamination; it is rather a reinforcement of the fact that visually imperceptible amounts of ice contamination may result in loss of control on the DC-9 series 10 aircraft.

Much written material has been presented to airline management on the icing problem. There has been general agreement on the accuracy of the data, but no real understanding of the significance of the problem has been evident. Even in cases where the significance is understood, line pilots are apparently not giving the problem the attention that it merits. Accumulations of ice as thin as 0.015 inch on the wings of a DC-9 can reduce the stall angle of attack below stall warning activation. Investigators have found that the vast majority of DC-9 series 10 pilots questioned are either unaware of these facts or lack an appreciation for the criticality of visually imperceptible amounts of wing contamination.

The written material, industry presentations, and operator seminars that were offered for more than 20 years should have eliminated any operational problem with icing on the DC-9. However, similar accidents continue to occur. The Safety Board therefore concludes that efforts to educate line pilots of DC-9 series 10 airplanes about this problem have not been adequate. There are many reasons for the inadequacy of these efforts.

The Safety Board is concerned that when aircraft are sold, or when there are changes of pilots and instructors, an opportunity exists for the loss of "corporate memory" of the significance of the icing problem on the DC-9. Although Douglas has issued material and urged that the wing icing problem be incorporated into the airplane flight manuals, it took no positive action to do so. By including the information in the approved Airplane Flight Manual, it would be directly available to the line pilots and would be transferred with the ownership of an aircraft when it is sold to a new operator. Ryan acquired eight DC-9s in 1989 and was unaware of the critical icing information until after the accident. If the information had been contained in the approved Airplane Flight Manual, the subject would have been emphasized in Ryan's initial training of its pilots.

Thus, the Safety Board believes that after four previous accidents, sufficient knowledge has existed within both the FAA and Douglas on the high vulnerability of the DC-9 series 10 to flight control problems in freezing weather conditions, and that this information should have been disseminated in such a manner that it would be available to all pilots of these airplanes. The FAA could have required, and Douglas could have provided, additional information about this problem in the approved Airplane Flight Manual.

Under the circumstances for the takeoff of Ryan 590, it might have been possible to increase the liftoff speed stall margin and establish a climb without stalling by delaying the takeoff rotation, permitting additional acceleration on the runway. However, this procedure would have been improper because the increase in the rotation speed beyond that specified may have infringed upon the safety margin required by the Federal Aviation Regulations (FARs) in case of an engine failure during the takeoff. The rotation speed is currently based upon a minimum field length takeoff for the airplane's

weight; that is, a field length that is sufficient to satisfy the balanced field concept where the accelerate-stop and accelerate-go distances are equal, assuming that an engine failure occurs at the decision speed, and also sufficient to satisfy the posttakeoff climb gradient requirement for obstacle clearance, as specified in the FARs. However, when operating on a runway longer than needed to meet this balanced or minimum field length criteria, a rotation speed higher than that currently specified could be used safely if the flightcrew were given sufficient information in their operating manuals to determine the maximum rotation speed that will still allow the required engine failure safety margins relative to runway length. The Safety Board believes that the FAA should require that this information be included in the manual to provide an additional takeoff safety margin for the DC-9 series 10 airplanes when they are operated from "unbalanced" runways in weather conducive to the formation of wing ice contamination, regardless of the other necessary measures to ensure that the wing is free of such contamination.

Similarly, the Safety Board believes that any operator acquiring a new model airplane in its fleet has an obligation to request from the manufacturer, and any other available sources, information unique to the safe operation of that airplane. If Ryan had fulfilled this obligation it would have become aware of the previous accidents involving wing ice contamination. Then Ryan would have been able to provide the training and guidance to its flightcrews that should have prevented this accident.

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

> Require the inclusion in the DC-9 series 10 Approved Airplane Flight Manual of a caution about the susceptibility of the airplane to flight control problems with minute and marginally detectable amounts of ice on the leading edge and upper surface of the wing. (Class II, Priority Action) (A-91-123)
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> Require in air carrier operations manuals and appropriate airplane flight manuals that flightcrews of DC-9 series 10 airplanes perform a visual and tactile inspection of the wing leading edge and upper surface using necessary equipment prior to departure whenever temperatures below $5^{o}C$ and visible moisture exist or whenever the airplane recently encountered icing conditions. (Class II, Priority Action) (A-91-124)
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> Require Principal Operations Inspectors to review certificate holders operating DC-9 series 10 airplanes to determine the adequacy of flightcrew training programs related to airframe icing conditions. (Class II, Priority Action) (A-91-125)
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> Evaluate the need for actions as described in safety recommendations A-91-123 through A-91-125 for other transport category turbojet airplanes that do not have leading edge devices and are particularly susceptible to flight control problems arising from small amounts of frost, ice or snow on the wings. (Class II, Priority Action) (A-91-126)

Evaluate a procedure to use the maximum rotation speed during takeoff that will retain the presently required end of runway and climb gradient safety margins when operating on runways that exceed the minimum takeoff runway length required; require operators to provide maximum rotation speed information to DC-9 series 10 flightcrews for use in winter operations. (Class II, Priority Action) (A-91-127)

Require air carrier operators, when acquiring a new model aircraft, to formally request from the manufacturer all pertinent information previously disseminated regarding the operation of the particular aircraft type. (Class II, Priority Action) (A-91-128)

In addition, the Safety Board reiterates the following safety recommendation to the Federal Aviation Administration:

Until such time that guidelines for detecting upper wing surface icing can be incorporated into the airplane flight manual, issue an air carrier operations bulletin directing all principal operations inspectors to require that all McDonnell Douglas DC-9-10 series operators anti-ice airplanes with maximum effective strength glycol solution when icing conditions exist. (A-88-134)

This recommendation is now classified "Open-Unacceptable Response."

The Safety Board considers that Safety Recommendation A-91-124, when accomplished, will satisfy the requirements of the following safety recommendation:

Require all DC-9-10 operators to establish detailed procedures for detecting upper wing ice before takeoff. (A-88-136)

This recommendation is now classified "Closed-Unacceptable Action/Superseded."

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

By: James L. Kolstad
Chairman