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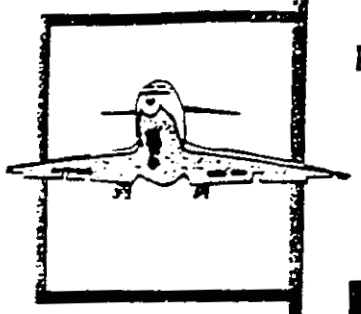

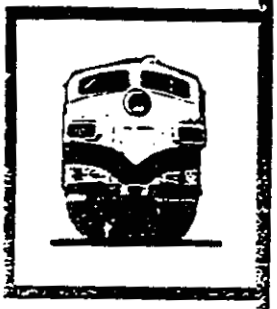

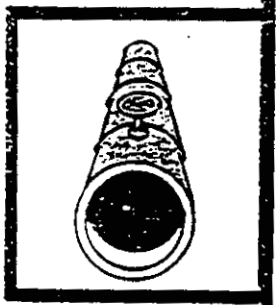

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

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AIRCRAFT ACCIDENT REPORT

MIDWEST EXPRESS AIRLINES, INC.,
DC-9-14, N100ME
GENERAL BILLY MITCHELL FIELD
MILWAUKEE, WISCONSIN
SEPTEMBER 6, 1985

NTSB/AAR-87/01

UNITED STATES GOVERNMENT

TECHNICAL REPORT DOCUMENTATION PAGE

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15. Supplementary Notes		37

16. Abstract

At 1521 c.d.t. on September 6, 1985, Midwest Express Airlines, Inc., Flight 105, a McDonnell-Douglas DC-9-14 airplane, crashed into an open field at the edge of a wooded area about 1,680 feet southwest of the departure end of runway 19R shortly after taking off from General Billy Mitchell Field, Milwaukee, Wisconsin. The weather was clear with visibility 10 miles. During the initial climb, about 450 feet above ground level (a.g.l.), there was a loud noise and a loss of power associated with an uncontained failure of the 9th to 10th stage high pressure compressor spacer of the right engine. Flight 105 continued to climb to about 700 feet a.g.l. and then rolled to the right until the wings were observed in a near vertical, approximately right 90° banked turn. During the roll, the airplane entered an accelerated stall, control was lost, and the airplane crashed. The aircraft was destroyed by impact forces and postcrash fire. The pilot, the first officer, both flight attendants, and all 27 passengers were fatally injured.

The National Transportation Safety Board determines that the probable cause of this accident was the flightcrew's improper use of flight controls in response to the catastrophic failure of the right engine during a critical phase of flight, which led to an accelerated stall and loss of control of the airplane. Contributing to the loss of control was a lack of crew coordination in response to the emergency. The right engine failed from the rupture of the 9th to 10th stage removable sleeve spacer in the high pressure compressor because of the spacer's vulnerability to cracks.

17. Key Words	18. Distribution Statement
removable sleeve spacer; high pressure compressor spacer; improper use of flight controls	This document is available through the National Technical Information Service, Springfield, Virginia, 22161

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The Safety Board further notes that the aviation regulatory authorities of other countries progressive in the aviation field have adopted FDR requirements more stringent than those required or even proposed by the FAA. In fact, the International Civil Aviation Organization (ICAO) has adopted standards which are consistent with Safety Board recommendations. The Safety Board will continue to urge the FAA to expedite the rulemaking actions to upgrade flight recorders on the U.S. airline fleet and to ultimately require that new airplanes be equipped with recorders which met ICAO standards.

Pending further FAA action, Safety Recommendations A-82-64 through -66 have been classified as "Open-Acceptable Action."

3. CONCLUSION

3.1 Findings

1. The flightcrew was medically and operationally qualified and well rested before the flight. There was no indication of chronic or life event stress-related factors which would have affected the performance of either pilot.

2. N100ME was certified, equipped, and maintained in accordance with FAA rules. There were no uncorrected discrepancy reports which involved powerplants or control systems.

3. N100ME was dispatched within the applicable weight and center of gravity limitations.

4. The aircraft performance was normal during the takeoff and initial climb phases of flight until the right engine failed at 450 feet a.g.l. at a speed well in excess of the takeoff safety speed (V2).

5. The right engine failed abruptly and completely due to the uncontained failure of the 9th to 10th stage high pressure compressor spacer.

6. Uncontained pieces of the ruptured spacer did not cause any significant damage to the airplane fuselage, control systems, or the left engine.

7. The right engine failure was precipitated by a fatigue crack in a knife edge of the 9th to 10th stage spacer. The crack had propagated to a length which should have allowed detection on the occasion of the last high pressure compressor overhaul and spacer rework in 1981.

8. None of the airplane flight control systems were disabled.

9. The cause of the left engine power loss, which occurred beginning about 1.5 seconds after the right engine failed, was not determined.

10. The left engine experienced a compressor stall in the last seconds of the flight after control had been lost and the airplane was descending toward the ground in an unusual attitude.

11. The loss of left engine power was not significant with respect to the loss of control of the airplane.

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12. The captain initially responded correctly with deflection of the rudder pedal to the left to compensate for the loss of right engine thrust and by lowering the nose of the aircraft; however, he appeared to be unaware of the exact nature of the emergency.

13. The crew response to the right engine failure was not coordinated.

14. Neither pilot verbally identified the emergency condition or made the emergency callouts required by FAA-approved Midwest Express procedures.

15. The rudder was incorrectly deflected to the right 4 to 5 seconds after the right engine failure.

16. An accelerated stall and loss of control occurred 10 seconds after the failure of the right engine.

17. Forward visual cues (outside the cockpit) were not available to the crew at the time that the right engine failed. Peripheral visual cues were available.

18. The visual flight simulator, which was used by the crewmembers in training, did not provide onset yaw and longitudinal acceleration cues, peripheral visual cues, or aural cues which were available to the crew in the airplane. 37

19. The captain and first officer misinterpreted the inside visual cues which were presented in the airplane.

20. The differences in visual motion and aural cues presented in the visual flight simulator and in the airplane may have limited the ability of the flightcrew to recognize and react appropriately to the emergency.

21. Failure to recognize the nature of the emergency and improper operation of flight controls precipitated the loss of control.

22. The DC-9-14 does not require unusual pilot skill or strength to maintain continued flight following an engine failure on takeoff.

23. Both crewmembers were relatively inexperienced in DC-9 flight operations.

24. The FAA Principal Operations Inspector who was responsible for oversight of Midwest Express was inexperienced in FAR 121 turbojet air carrier operations.

25. A "silent cockpit" philosophy was suggested by Midwest Express in response to certain emergency situations, although the concept was not approved by the FAA and was in conflict with approved emergency procedures.

26. FAA surveillance of Air Carrier Engine Service (AeroThrust) was deficient in the 2-year period which preceded the overhaul of the 9-10 spacer.

27. The accident was nonsurvivable because the impact forces exceeded the limitations of human tolerance.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the flightcrew's improper use of flight controls in response to the catastrophic failure of the right engine during a critical phase of flight, which led to an accelerated stall and loss of control of the airplane. Contributing to the loss of control was a lack of crew coordination in response to the emergency. The right engine failed from the rupture of the 9th to 10th stage removable sleeve spacer in the high pressure compressor because of the spacer's vulnerability to cracks.

4. RECOMMENDATIONS

On November 8, 1985, the Safety Board recommended that the Federal Aviation Administration:

A-85-120

Issue an Airworthiness Directive (AD) to require the installation of the one-piece, integral sleeve spacer at all six locations in the high-pressure compressor rotor of Pratt & Whitney JT8D-series engines not so equipped. The installation should be made as soon as practical but no later than the next opportunity wherein the engine is available in the maintenance facility where a partial or complete disassembly of the compressor can be accomplished.

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A-85-121

Notify appropriate foreign civil aviation authorities and foreign operators of airplanes equipped with Pratt & Whitney JT8D-series engines of the failures associated with the removable sleeve spacers installed in the high-pressure compressor rotor and of the actions which should be taken to minimize or eliminate the failures.

On April 7, 1986, the Safety Board recommended that the Federal Aviation Administration:

A-86-28

Issue a Telegraphic Airworthiness Directive and amend the airworthiness directive proposed in the Notice of Proposed Rulemaking published at 51 FR 37, Docket No. 85-ANA-46, to require that the one-time, on-wing eddy current inspection specified in the proposed airworthiness directive be repeated at 1,000-cycle intervals until stage 7-8, 8-9, and 9-10 removable sleeve spacers between the high-pressure compressor are replaced with integral sleeve spacers.

As a result of its investigation, the Safety Board recommended that the Federal Aviation Administration:

Issue an air carrier operations bulletin directing Principal Operations Inspectors to review their respective air carrier's flightcrew training programs to ensure the existence of new coordination procedures that,

notwithstanding a policy endorsing nonessential conversation during an emergency condition, require any crewmember who observes a potential or actual emergency situation to verbally call it to the captain's attention. (Class II, Priority Action) (A-87-8)

Issue an air carrier operations bulletin directing Principal Operations Inspectors to review their respective air carrier's simulator training programs to verify that engine failures in the posttakeoff climb are frequently given with particular emphasis on the use of engine and flight instruments as the primary source of information for airplane control and on the need for deliberate actions based upon flight and engine instrument analysis rather than hasty action based upon kinesthetic cues. (Class II, Priority Action) (A-87-9)

Require Principal Operations Inspectors of 14 CFR 121 certificate holders to have training and experience commensurate with the air carrier involved, including a comparable type rating (e.g., turbojet powered transport category) in the category and class of aircraft to be used by the certificate holder. (Class II, Priority Action) (A-87-10)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

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/s/ JIM BURNETT
Chairman

/s/ PATRICIA A. GOLDMAN
Vice Chairman

/s/ JOHN K. LAUBER
Member

/s/ JOSEPH T. NALL
Member

Jim Burnett, Chairman, filed the following dissenting statement regarding probable cause and contributing factors:

The probable cause of the accident was the catastrophic failure of a high pressure compressor spacer in the right engine during a critical phase of flight, together with the flightcrew's improper use of the flight controls that resulted in an accelerated stall and loss of control of the airplane.

Contributing to the cause of the accident was a training program which inadequately prepared the flightcrew to diagnose and respond to an engine-out situation in the climb-out phase of flight, a lack of crew coordination in response to the emergency, and the inadequate inspection of the compressor spacer at the engine repair facility.

/s/ JIM BURNETT
Chairman

February 3, 1987

By contrast, the captain of flight 105 had been employed by Midwest Express for 12 months and had 600 hours of turbojet experience as a DC-9 first officer (no flight engineer experience) at the time of his captain upgrade. He had no turbojet or sweptwing airplane experience before being hired by Midwest Express. The first officer of flight 105 had previous turbojet experience in the U.S. Air Force before his Midwest Express employment. He was upgraded to DC-9 captain with only 500 hours experience in the airplane.

Both flightcrew members received training that was in accordance with FAA regulations. The first officer, who had received DC-9 instruction from USAir as well as Republic Airlines, was described by instructors of both carriers, independently of each other, as an excellent pilot. Republic Airlines' officials were pleased with the attitude of Midwest Express in that it willingly encouraged Republic to provide all the training Republic believed necessary, within reason, to train its pilots to proficiency.

The Safety Board concludes that the training that the crew received met all applicable standards. Training to proficiency, a practice used by Midwest Express, is a sound educational practice used in many professions. However, the Board is concerned about Midwest Express utilizing a "silent cockpit" philosophy which was not outlined in its approved training and operations manuals and which is contrary to other procedures which are published in approved manuals. The Safety Board believes this conflict may have resulted in less crew communication and coordination than otherwise might have been demonstated. 37

The Safety Board is aware that pilots with substantial experience in multiengine airplanes usually have received considerable training in engine-out emergencies and have had opportunities to practice appropriate emergency responses during initial and recurrent training. Several pilots confirmed these facts in their testimony at the public hearing on this accident and stated that a pilot's reaction, in applying proper rudder pedal forces in response to an engine-out emergency, can become reflexive because of that training and previous pilot experience.

Also, the Safety Board is aware that pilots have occasionally misidentified a failed engine in previous accidents and incidents and have erroneously shut down still operative engines. In the course of this investigation, the Safety Board learned of several simulated engine failure incidents in which pilots responded initially with deflection of the incorrect rudder pedal in the DC-9 airplane. A Douglas test pilot, who had flight instructor experience in the DC-9, testified to a personal experience where a pilot who was receiving DC-9 instruction commanded rudder deflection in the wrong direction in response to a simulated engine failure. An FAA DC-9 instructor, with extensive training experience, testified that about 1 of every 50 of his students, each of whom held an airline transport pilot certificate, had attempted to deflect the wrong rudder pedal during simulated engine failures on takeoff. The Safety Board attempted to identify other DC-9 engine failure incidents which occurred after takeoff, while at low altitude, and found that such incidents have been infrequent in this critical flight regime.

The Safety Board also found that the majority of engine-out training provided to Midwest Express pilots in the takeoff regime occurred near V1 when the simulated airplane's pitch attitude was low, which provided outside visual references, including a runway centerline which were not available to the pilots of flight 105. There was very little exposure in training to the potential errors which might occur in response to an engine failure after gear retraction in the climb phase when the airplane's pitch attitude is near 12° nose up. In this accident, with only a clear blue sky visible through the windshield, the flightcrew would not have had the outside visual references that were