

CIVIL AERONAUTICS BOARD
ACCIDENT INVESTIGATION REPORTAdopted: February 27, 1951Released: February 28, 1951NORTHWEST AIRLINES, INC., BILLINGS MUNICIPAL AIRPORT, BILLINGS, MONTANA,
SEPTEMBER 4, 1950The Accident

Northwest Airlines' Flight 103, a Martin 202 aircraft, N-93051, crashed during takeoff from the Billings Municipal Airport, Billings, Montana, at 1402^{1/}, September 4, 1950. None of the 15 passengers or crew of three were injured. Aircraft damage was confined to the right wheel assembly, the right wing and engine nacelle, and propeller blades.

History of the Flight

Flight 103 departed on schedule at 0815 September 4, 1950, from Minneapolis, Minnesota, for Seattle, Washington, and intermediate stops. No difficulty was experienced during the first segment of the trip to Billings, Montana, where a routine change of crew was made. The incoming captain reported the aircraft to be mechanically all right for the remainder of the route to Seattle. The new crew, consisting of Captain Ira Bortles, Copilot Brooks Johnson, and Stewardess Adrienne Dietz, taxied out for takeoff to Bozeman, Montana, at 1356.

On board were 15 passengers, 200 gallons of fuel, and 450 pounds of cargo, which resulted in an aircraft weight of 35,269 pounds. This weight was well within the allowable limit of 33,760 pounds, and the

^{1/} All times referred to herein are Mountain Standard and based on the 24-hour clock.

aircraft was properly loaded. There was a clear sky, good visibility, and the temperature was 9 degrees. Copilot Johnson, who was seated on the left or pilot's side of the cockpit, parked the aircraft at the southwest end of Runway 4 where he and Captain Bortles completed the "before takeoff check." During this check both engines operated normally and no trouble was found in the operation of any part of the aircraft. In response to their request the tower cleared the flight for takeoff, reporting the wind to be from the north-northeast at five miles per hour and the altimeter setting to be 29.87.

Throttles were advanced, but before the aircraft had rolled far, blue smoke was noticed between the rudder pedals on the left side of the cockpit. When the aircraft had progressed about 1/3 of the way down the runway, and when it had accelerated to an air speed of approximately 80 miles per hour, a large puff of this blue smoke suddenly filled the cockpit. Accompanying it was a sharp odor of burning. Throttles were retarded and brakes applied to discontinue takeoff. Brakes were effective only momentarily. There was only slight deceleration, and the aircraft continued with speed unchecked toward the end of Runway 4, which is 5,000 feet long.

Runway 4 at Billings has a downhill gradient which increases from 1.9 percent at the approach end to 3.119 percent at the northeast end. It seemed to the crew that because of this down grade the aircraft actually increased in speed after they discontinued takeoff. As soon as it became apparent that brakes were useless, Captain Bortles applied full reverse thrust and instructed Copilot Johnson to steer the aircraft

by the nose wheel control. However, the nose wheel steering control, as were the brakes, was totally ineffective. Both pilots then observed that the hydraulic pressure in the main and emergency systems had dropped to zero. As the aircraft progressed over the runway, it turned slightly to the left and went off the paved area 1,074 feet from the northeast end. Since the ground was hard and dry, no appreciable loss of speed resulted from leaving the paved runway and rolling onto the dirt surface.

By application of reverse thrust the aircraft was slowed to about 15 miles per hour. After that, even reverse thrust seemed to be ineffective. At reduced speed the aircraft continued to roll toward the northeast boundary of the field where the ground level dropped sharply in a bluff. In anticipation of rolling over this bluff, the crew turned off all electrical switches and fuel valves. Before the aircraft reached the bluff, however, it struck a cement culvert and light standard. As a result, the right main landing gear failed to the rear which permitted the right wing to touch ground. This turned the aircraft slightly to the right and brought it to a full stop.

All passengers left the aircraft through the forward cargo door and the emergency exits. The main cabin door and ramp could not be lowered, since the tail section of the aircraft where the ramp is located was resting on the ground. No one received any injuries and there was no fire.

Investigation

The aircraft came to rest 165 feet to the left and abeam of the northeast end of runway 4. The right landing gear was found broken from its fitting and folded rearward into the right flap which was extended in the take-off position. The right wing tip was badly damaged, and the

leading edge of the right wing between the engine nacelle and the wing tip was crushed, however, there was no damage to the wing spars. Both the nose and the left landing gear assemblies remained extended and undamaged. Considerable crushing resulted to the cowling and oil cooler of the right engine. All blades of the propellers were twisted and bent near the tips.

No evidence of braking action was found in the examination of the tire tread marks, either on the runway or dirt surface, nor was evidence of fire found in the aircraft. However, considerable hydraulic fluid was found in the nose wheel compartment, and this was traced to a separation of the tubing from the reducer fitting in the hydraulic line from the emergency accumulator to the emergency pressure gauge in the cockpit.

In the Martin 202 the emergency accumulator is charged from the same line which supplies the main accumulator. The two accumulators are separated by a check valve which prevents the fluid from returning from the emergency system. The fitting which failed in this case was located in the line between the emergency accumulator and the emergency power brake valve. When the failure occurred fluid from the main accumulator flowed through the check valve into the emergency accumulator and from there out of the open line where the fitting was located. As a result, all pressure was lost from both accumulators, and neither the brakes nor the hydraulic nose-wheel steering mechanism could be actuated.

Northwest's maintenance manual includes detailed instructions for the installation of the type fitting involved, the trade name of which is "ermcto." Briefly, these instructions provide for tightening of the parts so as to collapse a metal sleeve around the end of the tube or line to be joined. When the work is properly done the sleeve actually cuts

into the tubing and, in effect, becomes a part of it. Instructions then require that the fitting be disassembled so as to determine whether or not the sleeve has cut into the tubing. Examination of the failed fitting in this case showed that the sleeve had not cut into the tubing. As a result, the necessary holding power of the fitting was never obtained when it was installed.

In October of 1949, Northwest Airlines experienced a similar failure. In this case an "Ermeto" fitting, located at the same position as the one which failed at Billings, separated while the aircraft was in flight from Minneapolis to Chicago. The result was the same. All hydraulic pressure was lost from both the main and the emergency accumulators. This incident, which occurred almost one year before the Billings' accident, demonstrated that one single failure could result in the loss of both the main and emergency brake systems^{2/}

Following the Chicago incident, the Administrator, Region I, notified the Glenn L. Martin Company of this condition in the model 202 hydraulic system. To correct the defect the manufacturer, on February 21, 1950, issued Service Bulletin No. 105. This bulletin described the installation of a hydraulic "fuse" in the line between the main and the emergency

^{2/} Section 4b.337 of the Civil Air Regulations provide:

". . . (2) The brake system shall be so designed and constructed that in the event of a single failure in any connection or transmitting element in the brake system (excluding the operating pedal or handle), or the loss of any single source of hydraulic or other brake operating energy supply, it shall be possible to bring the airplane to rest under conditions specified in 4b.122. . . ."

accumulators. The fuse was, in effect, a spring-loaded valve designed to prevent a substantial flow of fluid from the main accumulator to the emergency accumulator.

Service Bulletin 105 was considered satisfactory by the Civil Aeronautics Administration; however, Northwest Airlines did not believe that the fuse gave complete protection since it required a substantial flow of fluid to actuate the fuse, and consequently did not protect against small leakage in the system. According to tests of the fuse made by Northwest Airlines, a quarter of a gallon per minute could pass through it without causing it to close. The company, in turn, suggested that a manual shut-off valve be installed to separate the two systems.

The modification incorporating the shut-off valve was to be the subject of Martin's Service Bulletin 107. This bulletin was never issued for the reason that the substantiating test data required by the Administrator was not furnished by the manufacturer and the Administrator did not issue an airworthiness directive requiring Northwest to install the fuse described in Service Bulletin 105.

Tests were made by the Glenn L. Martin Company to determine the effectiveness of reverse thrust in stopping the aircraft. The tests showed that on a level runway and with calm wind conditions, the aircraft could be brought to a complete stop from a rolling speed of 50 miles per hour in 1,750 feet if the throttles were placed in the first detent of the reverse thrust throttle quadrant. This would be using approximately 750 brake horsepower per engine. Tests conducted by the Martin Company further showed that at high speeds reverse thrust was as effective as wheel brakes in reducing the speed of an aircraft, but that at low speeds

wheel brakes were much more effective.

Tests were also conducted by Northwest Airlines at the time the reverse thrust feature was added to the 202's. It was found that the airplanes could be brought to a full stop without brakes by use of reverse thrust. These tests were conducted on a level runway at the Minneapolis and St. Paul airports.

Analysis

It is apparent from the facts described above that this accident occurred as a result of an improperly installed "Emeto" fitting. Because the fitting was not properly installed, it separated, and the separation permitted all pressure in the main and the emergency hydraulic systems to escape. Without hydraulic pressure, the aircraft could not be stopped by brakes, nor could it be steered. The only means of control that remained was reverse thrust.

Reverse thrust served as a secondary safety device, though the aircraft was not completely stopped until it struck the cement culvert and the light standard. By this means the crew was able to decelerate the aircraft from 80 to approximately 15 miles per hour, and they might have stopped it completely if it had not been for the downhill gradient of the runway. A more positive determination in this respect is not possible, since the available test information, referred to above, does not take into account such variables as runway gradient and aircraft weight.

Underlying the immediate cause of this accident, the separation of the hydraulic fitting, is the fact that this accident should not have occurred if the requirement of Section 4b.237 of the Civil Air Regulations had been satisfied. As previously stated, this regulation provides in effect that a brake system be designed so that the aircraft can be stopped even though

there is a single failure, such as occurred in this case. Compliance with this regulation was required before the Martin 202 was certificated. After the similar failure on the flight to Chicago, which was almost a year before this accident, the government, the manufacturer, and the operator were fully aware that the design of the Martin 202 hydraulic system did not satisfy the regulation inasmuch as ~~the separation~~ the separation of the fitting that occurred on that flight resulted in a loss of pressure in both the main and emergency hydraulic systems the same as it did at the time of this accident. Accordingly, it is concluded that the failure of the manufacturer to comply with Section 4b.337, the failure of the government to require compliance at the time of certification, and the lack of positive corrective action required by the government, all were contributing factors.

One month after this accident occurred, the Administrator of Civil Aeronautics required by an airworthiness directive that the hydraulic fuses be installed as described in the Glenn L. Martin Service Bulletin 105.

Findings

On the basis of all available evidence, the Board finds that:

1. The carrier and the crew were properly certificated.
2. The aircraft was not properly certificated in that Section 4b.337 of the Civil Air Regulations was not complied with.
3. An "Ermeto" reducer fitting in the hydraulic line between the emergency accumulator and the emergency accumulator gauge was not properly installed, and, as a result, it separated. This separation resulted in the loss of pressure in both the main and emergency hydraulic systems.
4. Although a similar failure occurred one year prior to the time of this accident, no positive corrective action was taken by either the government, the manufacturer or the operator.

5. Reverse thrust was a substantial safety factor in this accident in that it permitted the deceleration of the aircraft from 80 to 15 miles per hour.

Probable Cause

The Board determines that the probable cause of this accident was the failure of an "Ermeto" hydraulic fitting due to improper installation.

BY THE CIVIL AERONAUTICS BOARD.

/s/ D. W. RENTZEL

/s/ JOSH LEE

/s/ HAROLD A. JONES

Oswald Ryan, Vice Chairman, and Joseph P. Adams, Member of the Board, did not participate in the adoption of this report.

S U P P L E M E N T A L D A T A

Investigation and Hearing

The Civil Aeronautics Board was notified of this accident through the CAA Communications Station at the Seattle-Tacoma Airport at 1530, September 4, 1950. An investigation was initiated immediately in accordance with provisions 702 (a)(2) of the Civil Aeronautics Act of 1938, as amended. A public hearing was held as a part of this investigation in Seattle, Washington, September 27, 1950.

Air Carrier

Northwest Airlines, Inc., is a Minnesota corporation with its principal place of business at 1335 University Avenue, St. Paul, Minnesota. The company is engaged in transportation by air of persons, property and mail under certificates of public convenience and necessity issued by the Civil Aeronautics Board and operates in accordance with an air carrier operating certificate issued by the Administrator of Civil Aeronautics. These certificates authorize and describe the route which was being flown at the time of this accident.

Flight Personnel

The captain, Ira Bortles, age 41, was employed by Northwest Airlines July 7, 1939. He had served as a pilot in command since April 9, 1942. Captain Bortles had a total of 7,896 hours, of which 604 were in the Martin 202. He held a valid airline transport pilot rating. He completed a first class CAA physical examination on July 14, 1950, his last 6 months instrument flight check May 1, 1950, and his annual line check February 9, 1950.

The copilot, Brooks Johnson, age 30, was employed by Northwest Airlines July 7, 1942. He had a total of 4,576 hours, of which 161 were in the Martin 202. He held a valid airline transport pilot rating. He passed his first class CAA physical examination on July 13, 1950.

Both pilots were fully qualified to fly the Martin 202.

The Aircraft

N-93051 was a Martin 202 manufactured by the Glenn L. Martin Company, Baltimore, Maryland. The "Ermeto" fitting which was the subject of failure in this case was manufactured by the Weatherhead Company of Cleveland, Ohio, and the fuse which was described in the Martin Service Bulletin 105 is manufactured by Simmonds Aerocessories, Inc., Tarrytown, N. Y.

An examination of all of the historical, maintenance, and inspection records of N-93051 disclosed no item which had any particular significance to this accident.