CIVIL AERONAUTICS BOARD

# ACCIDENT INVESTIGATION REPORT

Adopted: April 20, 1951 Released: April 23, 1951

## NORTHWEST AIRLINES, INC.,—ALMELUND, MINNESOTA—OCTOBER 13, 1950

### THE ACCIDENT

At approximately 1049*, October 13, 1950, a Martin 202 aircraft NC93037, owned and operated by Northwest Airlines, Inc , crashed at Almelund, Minnesota All of the six occupants received fatal injuries The aircraft was demolished

### HISTORY OF THE FLIGHT

Northwest Airlines' NC93037 departed from the Minneapolis-St Paul International Airport at 0946, October 13, 1950, on a local flight The purpose of the flight was a six-month instrument competency check of Captain John R Galt under the supervision of Captain Ray Render, a company check pilot Also on board and listed as official observers were William H Solomon, CAA air carrier agent, who was sitting on the jump seat between and immediately behind the pilots' seats, and CAA personnel from the Minneapolis Control Tower, E Bergstrom, R Olsen and B. Erickson, who were sitting in the main cabin At the time of takeoff there were 800 gallons of fuel on board which resulted in a total aircraft weight of 32,943 pounds This weight was within the allowable limit of 38,000 pounds and the aircraft was properly loaded. The weather was clear and visibility was unlimited

Following takeoff two simulated ILS (Instrument landing system) approaches were made to the airport and at 1025 the crew radioed the control tower that this phase of the check flight was completed This was the last known contact with the flight After departing the Minneapolis area, the aircraft was first seen near Center City, Minnesota, 43 miles northwest of Minneapolis At this time it was making a steep left turn at an altitude estimated to be between 4,000 and 5,000 feet, and landing gear was down At the completion of this turn a shallow climb was started Throughout these maneuvers the engines sounded as if they were operating in a normal manner The attention of the ground witness was then diverted for a few moments, and when he again saw the aircraft it was in a partially inverted position and starting a steep dive After losing approximately 2,500 feet in the dive, an apprently normal recovery was made to a level flight attitude and the aircraft proceeded in a northeasterly direction Shortly thereafter it was seen to make two or three pitching oscillations about its lateral axis These maneuvers may be described as a series of steps made by the aircraft as it was being lowered abruptly, followed by a recovery to level flight During each oscillation approximately 400 feet in altitude was lost and a noise was heard such as is usually associated with a surge of engine power The aircraft continued on a northeast heading

Two miles south of Almelund, Minnesota, which is 14 miles northeast of Center City, the aircraft was seen to make a shallow right turn of approximately 270° and once more to return to a level attitude heading in a northwesterly direction Throughout the above-mentioned maneuvers the aircraft was gradually losing altitude, and the right propeller was observed to be turning slowly during the latter part of the flight Nearing Almelund, and at an altitude of approximately 500 or 600 feet above the ground, a steep right turn was begun Altitude was lost rapidly and after turning approximately 90°, the aircraft's right wing struck the ground All but one of the six occupants were killed at impact, the injured person died several days later without regaining consciousness. The aircraft was demolished

### THE INVESTIGATION

This contact with the ground was made with the right wing tip and right engine nacelle

*All times referred to herein are Central Standard Time and based on the 24-hour clock

As the right wing progressively disintegrated the aircraft rotated on its nose and the leading edges of the wings, as in a shallow cartwheel, this resulted in the nose of the aircraft turning 90° to the right The aircraft then slid a distance of 378 feet in an easterly direction with its left side facing the line of travel At this time the fuselage was broken and torn into three sections One break occurred immediately forward of the leading edge of the wings and the other just aft of the trailing edge of the wings

The right wing was torn from the aircraft at the fuselage and was demolished The left wing, also severed at the fuselage, was lying adjacent to the main portion of the fuselage in a top surface up position with its leading edge facing west The entire aircraft suffered severe damage It was definitely established that the landing gear was down although not necessarily locked, and that the wing flaps were retracted Investigation did not reveal any evidence of structural failure of the aircraft prior to impact and there was no indication of fire either before or after the crash occurred

Both engines and their respective propellers were torn from the nacelles and received major damage

A teardown examination of the left engine failed to reveal any indication of structural failure or operational malfunctioning prior to impact The hydraulic, electrical and mechanical mechanisms of the left propeller also indicated that it was functioning properly prior to impact

The right engine was torn down and examined There was no indication of structural failure However, there were indications that at some time the engine had oversped A functional test was made of the fuel feed valve, using a standard flow bench When the normal pressure of 10 PSI (pounds per square inch) was applied the valve failed to maintain pressure This indicated that the valve was being held off its seat On disassembly a small piece of phenolic resin was found near the valve seat (Phenolic resin had been used to coat the valve at the time of manufacture ) It was determined that this particle of resin was of sufficient size to have caused the valve to stick open if it had lodged in the seat or any other vital place in the valve mechanism A failure of this valve as described would cause an unbalanced pressure condition in the carburetor and this ultimately would result in fuel starvation to the engine, causing complete engine failure

It was determined that the crankshaft of the right engine was rotating in the proper direction at the time of impact and that little, if any, power was being developed

A service bulletin was issued by the engine manufacturer on February 17, 1950, which advised all owners of this model engine that the phenolic coating on the fuel feed valve may be discontinued at overhaul It further stated that any peeling of this coating on the valve due to poor bonding or deterioration may affect fuel valve and fuel slinger operation

The right engine propeller dome was found separated from the hub assembly Number one propeller blade was attached to the hub and was broken off approximately 60 inches inboard from the tip The remaining two blades were not attached to the hub and were found in a damaged condition The number one blade was removed from the hub and examined and it was determined that the blades of this propeller was 7° to 10° in reverse pitch at the time of impact. Examination of the propeller dome disclosed that the stop levers were in the retracted position and that the piston sleeve had moved outboard over the levers to an extent corresponding to the reverse blade angle The feathering pump for this propeller functioned in the required manner when tested

The cover plate of the right propeller governor solenoid valve, which is located in the front of the engine immediately behind the propeller, was damaged This plate was uniformly depressed inward and the depth of the depression at the center of the plate was 072 of an inch The solenoid valve was removed from the governor and functional bench tests revealed that the damaged cover plate held the solenoid valve in a partially energized position In order to check what effect the damaged cover plate would have on the solenoid valve under actual operating conditions, the assembly was removed and installed on the right propeller governor of a like engine on another Martin aircraft After this engine had been run for a few moments, the blades of its propeller moved into the reverse pitch range Without removing the solenoid valve from this installation, the damaged cover plate was removed an a new cover plate was installed, the solenoid valve then functioned in the required manner Other tests were made, the results of which indicated that the cover plate could not have been damaged in this manner prior to takeoff without the crew having been aware of an unusual propeller action The damaged engine and its nacelle were examined and no evidence was found to indicate that the engine, nacelle or solenoid valve had been struck by any object while in flight

In order to determine what might have caused the right propeller to be in reverse pitch at the time of impact,

a study was made of all possible conditions which would permit this to occur This study included a complete analysis of the propeller electrical system Particular emphasis was placed on inadvertent or unwanted reversing as a result of electrical malfunctioning in flight under normal governing conditions, as well as when attempting to feather or unfeather It was found that several situations might occur which would cause the propeller to reverse as a result of such malfunctioning However, the propeller electrical system was so extensively damaged at impact that it was not possible to determine if any of the above-mentioned possibilities occurred

Investigation further revealed that the propeller feathering circuit of the Martin 202 is protected by a thermal overload switch in the feathering pump relay circuit Should a malfunction occur which would permit excessive current to flow through the relay, the thermal overload switch would open and interrupt the flow of current On the pilot's control pedestal are two toggle switches, one for each propeller, known as propeller circuit breaker override switches Their purpose is to permit the pilot to complete the feathering operation should a malfunction to the system exist, as described An extreme emergency must exist, however, since when using the override switch the pilot must accept the risk of a fire due to overheating of the electrical wiring

A number of incidents have occurred where after a landing had been accomplished and the pilot was attempting to move the propeller from the reverse to the positive thrust position, the feathering pump continued to operate As this pump was not designed for continuous operation, in these instances the pump motor was damaged Because of this, Northwest Airlines, Inc made a modification to the circuit of the override switch A new circuit was added which did not destroy the function of the original circuit but which did provide a means of shutting off a runaway feathering pump by use of the signal switch The new circuit further allowed the pilot to unfeather a propeller should an open circuit occur in the blade signal circuit which would normally prevent this operation To accomplish this latter function of the override switch it is necessary for the pilot to hold the feathering button in the "unfeather" position while simultaneously actuating the override switch The switches are held in the closed or "on" position until the propeller blades move out of the feathered position and normal windmilling occurs, this permits the propeller governor to resume control Should the switches be actuated beyond this point, the blades would continue to move into the reverse pitch range

Consideration was given to the possibility that the pilot, while being checked, intentionally placed the propeller in reverse thrust by means of manual manipulation of the controls This was discarded since both pilots were highly skilled in their profession and since such a maneuver would not be a part of a pilot's competency check because of the danger involved

CAA Agent Solomon, riding as an observer and sitting on the jump seat, was a large man who weighed approximately 200 pounds Due to the close proximity of the jump seat to the pilot's control pedestal, on which are located pertinent propeller controls, for example, the propeller circuit breaker override switches, it would have been possible for a person sitting on this seat with an unfastened or loosely fastened safety belt to have been thrown forward against the pedestal This could have occurred during any violent maneuver or unusual attitude of the aircraft such as the aircraft's position at the start of the dive, as described It was determined that Agent Solomon's safety belt was buckled at the time of impact and the left side attach fitting was broken

On this flight Captain Galt, who was being checked, was seated in the left or captain's seat It is normal procedure on flights of this character for the window area around the person being checked to be covered to prevent that person from having visual reference to any objects outside of the pilot's cockpit This is done in some instances throughout the entire check flight or a major portion of it The hood (as the cover is commonly called) to be used on this flight was made of a brittle material and was divided into four sections After the accident it was found in the cockpit, completely shattered except for the left window panel section Because of this it was impossible to determine if the hood was installed at the time of impact It was

estimated that, if necessary, the hood could be removed in 10 to 15 seconds

An examination of the aircraft's records indicated that the aircraft was in an airworthy condition at the time of departure of the flight and that it had been properly maintained

As a part of the investigation it was learned that during a manufacturer's test flight of a Martin 202, with a Martin factory pilot at the controls, a propeller inadvertently reversed in flight The purpose of this flight, which departed from Martin Airport, Baltimore, Maryland, was to test the minimum control speed of the aircraft with the aircraft loaded to the maximum gross weight of 43,000 pounds and the maximum rearward center of gravity of 37 percent A study was made of this case and the pilot was questioned to determine the flight characteristics of the aircraft under such a condition When this test was made an aluminum propeller which had been previously installed for another test was on the right engine and a hollow steel propeller of similar make was on the left engine Because the aluminum propeller, in this instance, was not equipped with a reversing mechanism, a jumper wire was installed to ground in the junction box to permit the propeller to be brought out of the feathered position once it was feathered In error a similar installation was made to the circuit of the steel propeller However, since the left or steel propeller was equipped with reversing mechanism the normal moving of the feathering control to the unfeather position would permit the propeller blades to rotate beyond the low pitch stops into the reverse range

When the pilot attempted to unfeather the left propeller, he advanced the mixture control and held the feathering button in the unfeathered position until the propeller rotated at approximately 500 RPM The engine, however, did not start The pilot, thinking that the propeller was returning to feather again, momentarily held the feathering button out At this time the propeller surged slightly in RPM and apparently went a few degrees in reverse thrust and began to windmill backward slowly Although the pilot was not certain that the propeller was windmilling in backward rotation, he immediately pushed the feathering button to the feather position, however, no propeller action resulted The propeller continued to windmill intermittently throughout the remainder of the flight Power could not be increased and at times, when the drag became heavier due to the windmilling propeller, it was necessary to dive the aircraft to gain enough airspeed to maintain control The altitude lost could not be regained When the propeller was inadvertently reversed the aircraft was flying at an altitude of 3,500 feet and an airspeed of approximately 130 miles per hour By using 12 1/2 degrees of wing flaps and METO (maximum except takeoff) power on the right engine the pilot was able to maintain an altitude of 1,500 feet and 120 miles per hour airspeed Directional control could be maintained only by using full aileron and a large amount of rudder control There was considerable rudder buffeting throughout this portion of the flight The pilot considered that control of the aircraft was sufficiently marginal to make an immediate forced landing on a nearby small sod airport advisable, and he did so rather than continue the flight 15 miles over water to the Martin Airport

Another propeller reversal occurrence on a similar Martin 202 aircraft was disclosed as a part of the investigation In this instance the reversal occurred when the aircraft was on the ground and the pilot was performing the pre-flight check prior to takeoff As a part of the check, the pilot depressed the feathering button to check the feathering mechanism, at which time a rapid increase of RPM occurred, resulting in an overspeed condition, and the propeller moved into the reverse thrust position Power was immediately retarded After the pilot determined that the propeller was in the reverse position he moved the throttle rearward over the detent and into the reverse quadrant to a position corresponding to that of the angle of the propeller blades Then, by moving the throttle to the forward thrust quadrant, the propeller responded to the movement of the controls and returned to forward thrust The pilot made several additional attempts to check the feathering action of the propeller, and in each instance the propeller reversed, it was necessary to utilize the same procedure to return it to forward thrust position After corrective action was taken the condition did not recur However, at a later date, and as a result of the subject accident, further study and analysis of the incident

was made It was concluded that the corrective action taken was inconsequential in correcting the malfunction, and that the cause had been an intermittent electrical short in the junction box which is located at Station 225 in the nose-wheel well

## ANALYSIS

It is reasonable to assume that the aircraft inadvertently entered the dive since such a maneuver is not included in the instrument check Also it can be assumed that when this occurred Captain Galt was flying the aircraft while under the hood because the character of the check flight was such that most maneuvers are normally performed in this manner Although it was established that prior to impact the right propeller was in the reverse thrust position, it is not known how or at what point in the flight this occurred For example, it could have occurred before the dive and have been partially, if not wholly, responsible for the dive, or it may have happened at any time after recovery from the dive was accomplished Further, the crew may not have re realized that the right propeller hau reversed in flight In any event it is apparent that from this point on the crew was unable to maintain control of the aircraft

What caused the propeller to reverse could not definitely be determined As previously stated, it could have been caused in several ways, such as combinations of malfunctions in the electrical circuit Or, if the propeller had previously been feathered, and in the confusion an attempt was made by both pilots to unfeather it quickly the feathering control may have been held in the unfeathering position and the circuit breaker override switch actuated at the same time

The Martin factory pilot who had a similar experience stated that it was some time after the propeller reversed during his flight before he realized that it actually had reversed He also said that the controllability of the aircraft was extremely marginal throughout the remainder of the flight, so much so in fact that when the drag became heavier he had to dive the aircraft to increase air speed to maintain control This loss of altitude could never be regained In reviewing these known facts it would appear that there was a decided similarity between the two flights However, in the Martin factory test flight the cause of the propeller reversal is known

Because of the danger involved a test flight was not made to simulate these conditions, however, extensive flight tests were made with the right propeller windmilling slowly, in forward thrust against the low pitch stops These tests were conducted with various configurations of landing gear and flaps up and down to determine the effects of drag on the aircraft These tests further substantiated the marginal controllability of the aircraft under these conditions

Although it was found that the fuel feed valve malfunctioned when tested, which may have been because of the loose particle of phenolic resin lodging under the valve seat or some other vital place, it is not known if this occurred during flight or at the time of impact It is known, however, that if it occurred during flight the engine would have stopped because of fuel starvation

Since ground witnesses stated that the right propeller was windmilling slowly throughout the latter portion of the flight, and since it is known that this engine could have malfunctioned because of fuel starvation, it is reasonable to conclude that the fuel feed valve may have malfunctioned during flight If this occurred, the normal piloting procedure would be to feather this engine's propeller If, while attempting to feather the propeller, an intermittent short occurred in the propeller system, as previously described, the propeller would have moved into the reverse thrust position If an actual engine failure did not occur as described, the character of the flight was such that an attempt to feather may have been made as part of the pilot's check on single-engine procedure

## FINDINGS

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

1 The carrier, the crew, and the aircraft were properly certificated

2 The fuel feed valve of the right engine malfunctioned when tested

3 The right propeller was found in 7° to 10° of reverse thrust

4. A review of the evidence of a similar occurrence indicated that with a propeller in the reverse thrust position the aircraft would assume dangerous flight characteristics

5 The fact that the aircraft's wing flaps were retracted may have contributed to the uncontrollability of the aircraft at speeds below 140 miles per hour.

**PROBABLE CAUSE**

The Board determines that the probable cause of this accident was the unwanted reversal of the right propeller during flight, as a result of which the crew was unable to maintain control of the aircraft.

BY THE CIVIL AERONAUTICS BOARD.

*/s/ D. W. RENTZEL*
*/s/ OSWALD RYAN*
*/s/ JOSH LEE*
*/s/ JOSEPH P. ADAMS*
*/s/ CHAN GURNEY*

# Supplemental Data

## INVESTIGATION AND HEARING

The Civil Aeronautics Board received notification of the accident at 1210, October 13, 1950, from the CAA's District Office at Minneapolis, Minnesota, and immediately initiated an investigation in accordance with the provisions of Section 702 (a)(2) of the Civil Aeronautics Act of 1938, as amended As part of the investigation a public hearing was held at Minneapolis, Minnesota, on November 7 and 8, 1950

## AIR CARRIER

Northwest Airlines, Inc , is a Minnesota corporation having its principal place of business at 1885 University Avenue, St Paul, Minnesota The company is engaged in the transportation by air of persons, property and mail, and holds a certificate of public convenience and necessity issued by the Civil Aeronautics Board which authorizes it, among other things, to operate between New York, N Y , and Seattle, Washington, via various other intermediate points The carrier also holds an air carrier operating certificate issued by the Administrator of Civil Aeronautics

## FLIGHT PERSONNEL

J. R Galt, age 38, the captain who was being checked, was employed by Northwest Airlines Inc , December 5, 1939 He checked out on Martin 202 type aircraft October 22, 1947, and had a total of 769 flying hours on these aircraft. He was the holder of a valid airman certificate with an airline transport rating and both single and multi-engine ratings 110 to 7,200 horsepower He had logged a total of 9,800 flying hours He had completed a first class CAA physical examination May 18, 1950, and had satisfactorily completed a six-month instrument flight check April 6, 1950 He also had satisfactorily completed an annual line check on January 23, 1950

R F Render, age 38, the check pilot, and also a captain, was employed by Northwest Airlines, Inc , on January 2, 1942 He held a valid airman certificate with an airline transport rating and single and multi-engine land and sea ratings 0 to 7,200 horsepower He had been checked out on Martin 202 type aircraft December 1, 1949, and had logged a total of 8,228 flying hours of which 368 were on Martin 202 type aircraft His last CAA first class physical examination was completed August 25, 1950 He had successfully completed his last six-month instrument flight check on May 27, 1950, and his last line check on April 18, 1950

## AIRCRAFT

The aircraft, a Martin Model 202, was owned and operated by Northwest Airlines, Inc., It was manufactured April 5, 1947, and was purchased by Northwest Airlines, Inc , August 2, 1947 It had been flown a total of 5,289 hours and 1,360 hours since last overhaul It was equipped with two Pratt and Whitney R-2800-CA-18 engines and Hamilton Standard Hydromatic propellers