Birdstrike and runway overrun, Northwest Airlines, Inc., Boeing 747-151, N602US, Miami, Florida, December 15, 1972

Micro-summary: **On takeoff, this Boeing 747 hit a flock of sea gulls. On the subsequent return to the airport, it overran the runway.**

Event Date: **1972-12-15 at 1714 EST**

Investigative Body: **National Transportation Safety Board (NTSB), USA**

Investigative Body's Web Site: **http://www.ntsb.gov/**

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File No. 1-0037

AIRCRAFT ACCIDENT REPORT

NORTHWEST AIRLINES, INC.

Boeing 747-151, N602US

Miami, Florida

December 15, 1972

Adopted: May 30, 1973

NATIONAL TRANSPORTATION SAFETY BOARD
Washington, D.C. 20591
REPORT NUMBER: NTSB-AAR-73-13

NORTHWEST AIRLINES, INC.
BOEING 747-151, N602US
MIAMI, FLORIDA
DECEMBER 15, 1972

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NORTHWEST AIRLINES, INC.
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SYNOPSIS

A Northwest Airlines B-747, operating as Flight 723, ran off the end of Runway 27L while landing at Miami International Airport, Miami, Florida, on December 15, 1972, at 1714 eastern standard time. There were 149 passengers and 11 crewmembers aboard; no one was seriously injured. The nose landing gear collapsed, which resulted in substantial damage to the aircraft structure in that area.

During takeoff from Runway 27R a few minutes earlier, the aircraft had collided with a flock of sea gulls. The crew had shut down the No. 4 engine, which was believed to have been causing vibration, and then had requested clearance to return to Miami.

The local weather at the time of the accident was 1,300 feet broken, 3,000 feet overcast, visibility 2 1/2 miles, wind 130° at 9 knots. A thunderstorm was southwest of the airport and moving eastward.

The National Transportation Safety Board determines that the probable cause of this accident was the ineffective braking capability of the aircraft on the wet runway because of the low coefficient of friction of the new runway surface, and insufficient engine reverse thrust to decelerate the aircraft. The combined effects of the lack of the No. 4 engine reverse thrust and malfunction of the No. 3 engine reverser resulted in a directional control problem and restricted the use of Nos. 1 and 2 engine reversers.

In view of the potential hazard involved in overrun accidents, the Board recommends that the Federal Aviation Administration expedite its research program to determine the friction characteristics of wet runways, not only for its effect on the landing certification requirements for aircraft, but also for the certification of runway surfaces under the new Airport Certification Regulations.

On April 10, 1973, Runways 9R/27L and 9L/27R were grooved to increase the coefficient of friction and improve the wet-runway landing conditions.

INVESTIGATION

A Northwest Airlines B-747, N602US, Flight 723, was cleared for takeoff at 1655 1/ and, while rotating, encountered a flock of sea gulls. The crew heard a noise that sounded like a bird strike on the right side of the aircraft; they detected an aircraft vibration at the same time. The second officer reported that the No. 4 engine turbine section vibration meter indicated maximum deflection. All other engine instruments were normal. The captain retarded the No. 4 thrust lever and shut down the No. 4 engine. The aircraft vibration then ceased.

At 1658, the crew advised departure control that they had struck birds on takeoff and would return for a landing at Miami. The flight was routinely vectored and cleared for an Instrument Landing System (ILS) approach to Runway 27L, at which time it was approximately 11 miles outside the outer marker.

At 1711:55, the tower controller reported radar contact at the outer marker and advised the crew that the wind was 120° at 10 knots. Flight 723 acknowledged this transmission and confirmed the clearance to land on Runway 27L. Subsequently the tower advised other flights on the same frequency that the wind was 160° at 10 knots and that operations would be shifted in configuration to the east. Approximately 1 minute later, Flight 723 reported, "723 is going off the end."

According to the flightcrew, an ILS approach was flown in a normal manner, in light rain, for a short period of time. Below 1,000 feet, and with the runway in sight, the flight made the approach clear of clouds and rain. With flaps set at 25°, the aircraft used a computed V_{TH} 2/ speed of 140 knots for the approach and landing. All crewmembers stated that the touchdown was made at the "normal point": 140 knots.

The captain stated that at touchdown, brakes were applied and engine reverse was attempted on the Nos. 1, 2, and 3 engines; but, the No. 3 reverser lever failed to go beyond the interlock position. At this time, according to the captain, the Nos. 1 and 2 engines were reversing, but yawing of the aircraft precluded the use of these engines to any extent. The aircraft was hydroplaning, and groundspeed was not being reduced sufficiently, despite full braking and continual attempts to accomplish full reversing.

Regarding the rollout, the first officer stated, "During reversing operation, green lights for 1 and 3 (reversers) came on but No. 3 reversing ineffective. No. 2 turbine section reversing had been previously blocked out. Full braking and amount of reversing available for directional control failed to stop aircraft."

1/ All times herein are eastern standard, based on the 24-hour clock.

2/ Speed at Threshold.

The aircraft continued to roll past the end of the runway and came to a stop at a point 611 feet beyond the load-bearing runway surface and 78 feet to the left of the extended runway centerline. The site where the aircraft came to a stop is a sodded area within the airport boundary.

Crash/rescue personnel and emergency equipment alerted by the tower responded and followed the flight down the runway after the landing. They were in position next to the aircraft shortly after it had come to a stop. All occupants were evacuated successfully via the emergency slides approximately 1 minute after the first exit door was opened.

Witnesses at various vantage points along the runway indicated that the aircraft landed approximately 2,475 feet from the threshold. One witness reported that the quantity of water, smoke, and mist that sprayed about was enough to conceal almost all the lower fuselage of the aircraft from view. The witnesses reported sporadic heavy rainshowers in the airport area before the time of the accident.

Other than reverted rubber near the end of Runway 27L, no evidence of tire debris was found. Scrub marks 3/ from the right body trucks were found 3,950 feet from the end of the runway (5,400 feet from the threshold). They extended, intermittently, to 2,890 feet from the end of the runway; thereafter, they were continuous. Scrub marks from the left wing trucks began 2,890 feet from the end and changed to intermittent black rubber marks, beginning 1,490 feet from, and continuing to, the end of the runway. Scrub marks from the left body and right wing trucks began 2,890 feet from the end of the runway but were intermittent for only 1,600 feet; after that, they were continuous. All main landing gear tire tracks were made prominent by the displacement of the loose gravel. The initial scrub marks were on the runway centerline. At 2,890 feet from the end of the runway the marks began a gradual arc to the left which ceased 1,890 feet from the end. The aircraft nose landing gear ran off the end of the overrun 37 feet to the left of the centerline.

The aircraft nose landing gear struck a concrete slab which had been a foundation for a building. The nose landing gear collapsed rearward damaging the lower fuselage and nose wheel well structure as well as distorting the cabin flooring. Since the accident, the hazard created by the concrete slab has been eliminated by compacting and grading of the land area beyond the end of the runway.

3/ The term "scrub" marks as used in this report refers to marks of the tire footprint found on the runway, which marks are lighter in color than the surrounding surface. They are created by the release of water under pressure and the attendant heat from the tire footprint. The degree of definition of the scrub mark is dependent upon other factors such as gross weight, speed, and the degree of friction and heat created by tire skid. Scrub marks are commonly associated with viscous hydroplaning, whereas such marks are not present during dynamic hydroplaning.

Examination of the Nos. 1, 2, and 4 engines showed no evidence of damage or of debris that suggested a bird strike.

Visual inspection of the No. 3 engine showed that the fan blades were extensively damaged and that numerous holes were punctured in the cowl adjacent to and forward of the fan. No visible damage was found in the compressor and turbine areas. The fan guide vanes were damaged slightly by the impact. Bird feathers and remains were found impinged on the outer shroud of the fan section and on the leading edges of the fan reverser door struts between the 4 and 6 o'clock positions, viewed from the rear.

The Nos. 1 and 9 main landing gear tires had a "flat" spot worn into their points of rupture. No other unusual marks were found on these tires. All other main tires were inflated with approximately 200 to 225 pounds pressure.

All but one main gear tire had tread depths from 1/16 to 11/16 inches remaining; the No. 11 tire was worn smooth.

During the functional testing of the aircraft systems, the thrust lever for the No. 3 engine could not be advanced. The thrust lever-sequencing actuator was found locked. When the lever was released manually, the malfunction could not be duplicated. The actuator was replaced, however, for precautionary reasons.

The detailed examination and functional testing of the No. 4 engine revealed no discrepancy other than instability of the turbine Airborne Vibration Monitor (AVM) during the engine runup. The No. 4 turbine AVM pickup accelerometer connector was found to have a broken wire.

All brake assemblies functioned normally during testing, and brake wear was found within serviceable limits.

All antiskid transducers were tested for functional operation, and no discrepancies were found. Bench tests of the antiskid control box revealed a discrepancy in the Nos. 8, 15, and 16 wheel circuits when the control was in either the normal or the reserve position. No evidence of the discrepancy was noted in the normal position after the control box was reinstalled and checked in the aircraft. The aircraft antiskid control box check revealed a malfunction of the No. 1 wheel in the normal system which would signal a brake release when braking was in effect. This malfunction, however, could not be related to a "brakes locked" condition, like that found in wheels Nos. 1 and 9.

Operational testing of the spoiler system, in both the "armed" and "unarmed" positions, showed no evidence of a malfunction. Similarly, the leading flaps were found to function normally.

The pertinent, official weather observation at Miami International Airport was, in part:

> 1710, Special, ceiling estimated 1,300 feet broken, 8,000 feet overcast, visibility 2-1/2 miles, thunderstorm, heavy rainshowers, wind 130° at 9 knots, altimeter setting 29.98 inches, thunderstorm southwest moving east, occasional lightning cloud to ground.

The record of surface weather observations showed the following: 0.42-inch of rainfall from 1600 to 1700 and 0.17-inch from 1700 to 1800; light rainshowers began at 1602 and ended at 1630; heavy rainshowers began at 1707 and ended at 1728: very light rainshowers began at 1728 and ended at 1817; thunderstorm began at 1653 and ended at 1836. The National Weather Service rainfall recording devices at Miami International Airport are located 2,000 feet northwest of the threshold of Runway 27L.

Runway 27L at Miami International Airport is 9,350 feet long and 150 feet wide. The runway has an asphaltic (bituminous and crushed lime rock mixture) surface with no gradient. The crown of the runway is graded 1 percent for 28 feet from the centerline, 1.5 percent for the next 14 feet, and 2 percent for the remaining 33 feet to the edge of runway. After being resurfaced, the runway was opened to traffic on November 7, 1972. The runway is served by an ILS; the 2.9° glide slope intercept point is located 1,250 feet from the runway threshold.

All of the tower and approach facilities and navigational aids were operational at the time of the accident. The Federal Aviation Administration (FAA) flight-tested the ILS after the accident and found that it met specifications .

The actual landing weight of Flight 723 was 507,776 pounds, and the V_{TH} reference speed was 140 KIAS. According to the Approved Airplane Flight Manual, the runway length required for landing in wet conditions is 8,250 feet with 25° flaps, 3-knot tailwind component 4/, and operative spoilers and antiskid devices. Any use of reverse thrust would reduce this stopping distance. The maximum allowable landing weight was 546,000 pounds.

The flight recorder readout reveals that touchdown occurred at a peak value of + 2.66 g at 145 knots. At a point 45 seconds later, the vertical acceleration trace shows the beginning of an excursion to 2.25 g at 70 knots and the beginning of a rapid deceleration of the airspeed trace to zero.

4/ The tailwind component is based on wind of 160° at 10 knots.

At the request of the National Transportation Safety Board a joint FAA and National Aeronautics and Space Administration (NASA) program was established to gather data on wet runway friction coefficients at Miami International Airport. On March 14 and 15, 1973, the NASA diagonal-braked vehicle was used to measure the slipperiness of Runways 9R/27L and 9L/27R with varying depths of water on the runway surfaces. The surface water depths in these tests were varied from 0.01 to 0.04 inches, approximating conditions of steady, light rain. The stopping distance ratio (SDR) derived from the normalized test readings of the segmented test runs disclosed an average ratio of 3.22 for Runway 9R/27L and 2.32 for 9L/27R. The SDR based on the wet runway landing requirements, specified in section 121.195 of the Federal Aviation Regulations, is 1.92.

ANALYSIS

Several factors combined to prevent the crew from successfully stopping the aircraft short of running off the runway. One factor was the ingestion of birds by the No. 3 engine on takeoff, which caused damage to the engine fan blades. The result was a reduction in power during climbout and later during cruise, accompanied by aircraft vibration. Reduced vibration in the damaged No. 3 engine coincided with the detection by the crew of excessive vibration in the malfunctioning No. 4 turbine AVM system. The flightcrew would logically assume that the excessive vibration indicated on the AVM resulted from the bird strike.

Another factor was the lack of capability to decelerate after the aircraft touched down at a point approximately 2,475 feet from the runway threshold. The lack of decelerating forces is evident in the analysis of the velocity/time trace in the flight data recorder readout. The flight recorder data, based on 145 knots, showed that the aircraft decelerated approximately 2.7 ft./sec.^{2} for 34.8 seconds after the moment of touchdown. This rate is characteristic of a free rolling airplane configured for a landing. The aircraft continued to decelerate at this rate to a point approximately 1,400 feet from the end of the runway overrun area. From this point to the end of the overrun, the deceleration forces showed a marked increase. From this data it is evident that although some braking action was available in the area of the scrub marks which began 3,950 feet from the end of the runway, there was little change in the decelerative forces affecting the velocity of the airplane until the final moments of rollout.

The diagonal-braked vehicle tests conducted with water depths from .01 to .04 inches on Runway 9R/27L showed an overall wet stopping distance ratio of 3.22. When applied to the certificated dry braking distance of the aircraft (approximately 2,700 feet), the 3.22 ratio indicates a

required braking distance of 8,694 feet, if engine reverse thrust is not used. Obviously, the aircraft could not have been stopped on the runway under these conditions, unless the aircraft had landed within the first 656 feet of the runway or had used engine reverse thrust. However, the No. 4 engine was shut down, the No. 3 engine reverser malfunctioned, and problems with directional control of the aircraft hindered the crew from using a sufficient amount of reverse thrust in the Nos. 1 and 2 engines.

The correlation between the flight recorder data, the touchdown point, and the scrub marks found on the runway indicates dynamic hydroplaning by the aircraft for approximately 3,000 feet during initial ground roll. The scrub marks on the runway also show that viscous hydroplaning in varying degrees occurred until the aircraft reached a point approximately 1,400 feet from the end of the overrun, where some effective braking did occur.

Except for the malfunction of the No. 3 engine reverser and the failure of the Nos. 1 and 9 tires, no other malfunction or failure was found that could have adversely affected the stopping distance of the aircraft.

PROBABLE CAUSE

The National Transportation Safety Board determines that the probable cause of this accident was the ineffective braking capability of the aircraft on the wet runway because of the low coefficient of friction of the new runway surface, and insufficient engine reverse thrust to decelerate the aircraft. The combined effects of the lack of the No. 4 engine reverse thrust and malfunction of the No. 3 engine reverser resulted in a directional control problem and restricted the use of Nos. 1 and 2 engine reversers.

RECOMMENDATIONS

In view of the potential hazard involved in overrun accidents, the Board recommends that:

> The Federal Aviation Administration expedite its research program to determine the friction characteristics of wet runways, not only for its effect on the landing certification requirements for aircraft, but also for the certification of runway surfaces under the new Airport Certification Regulations. (Recommendation No. A-73-49.)

As a result of the test conducted for the Board by NASA and the FAA, the Dade County Port Authority decided to groove Runway 9L/27R and Runway 9R/27L. The Airport Authority petitioned the FAA for financial assistance and received a grant for matching funds under the Airport Development Aid Program. The 44-day grooving operation commenced on April 10, 1973.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JOHN H. REED
Chairman

/s/ LOUIS M. THAYER
Member

/s/ ISABEL A. BURGESS
Member

/s/ WILLIAM R. HALEY
Member

Francis H. McAdams, Member, was not present and did not participate in the adoption of this report.

May 30, 1973.

CREW INFORMATION

Captain William F. Burnett, aged 57, held Airline Transport Pilot Certificate No. 84985-41 and was type rated in the Boeing 747. At the time of the accident, he had accumulated a total of 23,774 hours, of which 825 hours were in the Boeing 747. His initial checkout in the Boeing 747 was accomplished in February 1971. His last proficiency check and recurrent ground training in the Boeing 747 were satisfactorily completed in October 1972. He possessed a current first-class medical certificate, dated July 1972, with a limitation to wear correcting eyeglasses.

First Officer Harry L. Camm, aged 48, held Commercial Pilot Certificate No. 1022006 and was type rated in the Boeing 747. At the time of the accident, he had accumulated a total of 4,934 hours, of which 1,478 hours were in the Boeing 747. His initial checkout in the Boeing 747 was in May 1970, and his most recent proficiency check and recurrent ground training in the aircraft were satisfactorily accomplished in May and October 1972. He possessed a first-class medical certificate with no limitations.

Second Officer Rodney D. Hold, aged 36, held Airline Transport Pilot Certificate No. 1453408 and Flight Engineer Certificate No. 1710962 for turbojet-powered aircraft after having completed his checkout as flight engineer in the Boeing 747 in February 1972. He had accumulated a total of 6,044 hours pilot time and 1,567 hours as flight engineer, of which 457 hours were in the Boeing 747. His most recent recurrent ground training was satisfactorily completed in October 1972. He possessed a first-class medical certificate, dated April 1972, with no limitations.

All crewmembers had been off duty approximately 14 hours during the 24-hour period preceding the flight.

AIRCRAFT INFORMATION

Make and Model	:	Boeing 747-151
Registration No.	:	N602US
Serial No.	:	19779
Date of Manufacture	:	May 11, 1970
Total Flying Hours	:	6,605:41
Since Last Major Inspection	:	668:01
Since Last Line Inspection	:	65:00
Engines	:	Pratt & Whitney, JT9D-3A

No.	Serial No.	Total Time	Date of Manufacture
1	P662678B	3,403:44	10-8-70
2	P662952B	4,299:43	5-15-71
3	P662963B	4,301:04	5-15-71
4	P662645B	5,482:29	9-17-70

A review of the aircraft records for the 21-day period preceding the accident revealed no evidence of discrepancies with regard to the braking, antiskid, or spoiler systems of the aircraft. A carryover item in the aircraft log indicated that the No. 2 engine turbine reverser was locked out.