TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB-AAR-75-B	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Aircraft Accident Report - Northwest Airlines, Inc., Boeing 727-251, N274US, near Thiells, New York, December 1, 1974		5. Report Date August 13, 1975
		6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Aviation Safety Washington, D. C. 20594		10. Work Unit No. 1481-A
		11. Contract or Grant No.
		13. Type of Report and Period Covered Aircraft Accident Report December 1, 1974
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20594		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

About 1926 e.s.t. on December 1, 1974, Northwest Airlines Flight 6231, a Boeing 727-251, crashed about 3.2 nmi west of Thiells, New York. The accident occurred about 12 minutes after the flight had departed John F. Kennedy International Airport, Jamaica, New York, and while on a ferry flight to Buffalo, New York. Three crewmembers, the only persons aboard the aircraft, died in the crash. The aircraft was destroyed.

The aircraft stalled at 24,800 feet m.s.l. and entered an uncontrolled spiralling descent into the ground. Throughout the stall and descent, the flightcrew did not recognize the actual condition of the aircraft and did not take the correct measures necessary to return the aircraft to level flight. Near 3,500 feet m.s.l., a large portion of the left horizontal stabilizer separated from the aircraft, which made control of the aircraft impossible.

The National Transportation Safety Board determines that the probable cause of this accident was the loss of control of the aircraft because the flightcrew failed to recognize and correct the aircraft's high-angle-of-attack, low-speed stall and its descending spiral. The stall was precipitated by the flightcrew's improper reaction to erroneous airspeed and Mach indications which had resulted from a blockage of the pitot heads by atmospheric icing. Contrary to standard operational procedures, the flightcrew had not activated the pitot head heaters.

17. Key Words Scheduled air carriers, pitot system errors; atmospheric icing ; stalls; attitude instrument flying.		18. Distribution Statement This document is available through the National Technical Information Service, Springfield, Virginia 22151	
19. Security Classification (of this report) UNCLASSIFIED	20. Security Classification (of this page) UNCLASSIFIED	21. No. of Pages 32	22. Price

NTSB Form 1765.2 (Rev. 9/74)

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File No. 1-0031

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

Adopted August 13, 1975

NORTHWEST AIRLINES, INC.
BOEING 727-251, N274US
NEAR THIELLS, NEW YORK
DECEMBER 1, 1974

SYNOPSIS

About 1926 e.s.t. on December 1, 1974, Northwest Airlines Flight 6231, a Boeing 727-251, crashed about 3.2 nmi west of Thiells, New York. Flight 6231 was a ferry flight to Buffalo, New York. The accident occurred about 12 minutes after the flight had departed John F. Kennedy International Airport, Jamaica, New York. Three crewmembers, the only persons aboard the aircraft, died in the crash. The aircraft was destroyed.

The aircraft stalled at 24,800 feet m.s.l. and entered an uncontrolled, spiralling descent to the ground. Throughout the stall and descent the flightcrew did not recognize the actual condition of the aircraft and did not take the correct measures necessary to return the aircraft to level flight. Near 3,500 feet m.s.l., a large portion of the left horizontal stabilizer separated from the aircraft, which made control of the aircraft impossible.

The National Transportation Safety Board determines that the probable cause of this accident was the loss of control of the aircraft because the flightcrew failed to recognize and correct the aircraft's high-angle-of-attack, low-speed stall and its descending spiral. The stall was precipitated by the flightcrew's improper reaction to erroneous airspeed and Mach indications which had resulted from a blockage of the pitot heads by atmospheric icing. Contrary to standard operational procedures, the flightcrew had not activated the pitot head heaters.

1. INVESTIGATION

1.1 History of Flight

On December 1, 1974, Northwest Airlines, Inc., Flight 6231, a Boeing 727-251, N274US, was a ferry flight from John F. Kennedy International Airport (JFK), Jamaica, New York, to Buffalo, New York. Three crewmembers were the only persons aboard the aircraft.

Flight 6231 departed JFK about 1914 1/ on a standard instrument departure. After takeoff, Kennedy departure control cleared the flight to climb to 14,000 feet. 2/ At 1920:21, New York air route traffic control center (ZNY) assumed radar control of the flight, and at 1921:07, ZNY cleared the flight to climb to flight level 310. 3/

Flight 6231 proceeded without reported difficulty until 1924:42, when a crewmember transmitted, "Mayday, mayday ... " on ZNY frequency. The ZNY controller responded, "... go ahead," and the crewmember said, "Roger, we're out of control, descending through 20,000 feet."

After giving interim altitude clearances, at 1925:21, the ZNY controller asked Flight 6231 what their problem was, and a crewmember responded, "We're descending through 12, we're in a stall." The sound of an active radio transmitter was recorded at 1925:38. There were no further transmissions from Flight 6231.

At 1925:57, Flight 6231 crashed in a forest in the Harriman State Park, about 3.2 nmi west of Thiells, New York. No one witnessed the crash.

The accident occurred during hours of darkness.

The geographic coordinates of the accident site are 41° 12' 53" N. latitude and 74° 5' 40" W. longitude.

1.2 Injuries to Persons

Injuries	Crew	Passengers	Other
Fatal	3	0	0
Nonfatal	0	0	0
None	0	0	

1.4 Damage to Aircraft

The aircraft was destroyed.

1.4 Other Damage

Trees and bushes were either damaged or destroyed.

1.5 Crew Information

The crewmembers were qualified and certificated for the flight. The three crewmembers had off-duty periods of 15 hours 31 minutes during the 24-hour period preceding the flight. (See Appendix B.)

1/ All times herein are eastern standard, based on the 24-hour clock.
2/ All altitudes herein are mean sea level, unless otherwise indicated.
3/ An altitude of 31,000 feet which is maintained with an altimeter setting of 29.92 inches.

In October 1974, the first officer advanced from second officer in B-707 aircraft to first officer in B-727 aircraft; he had flown about 46 hours in the latter capacity.

1.6 Aircraft Information

N274US was owned and operated by Northwest Airlines, Inc. It was certificated and maintained in accordance with Federal Aviation Administration (FAA) regulations and requirements. (See Appendix C.)

N274US was loaded with 48,500 lbs. of Jet A fuel. The gross weight at takeoff was about 147,000 lbs. The weight and center of gravity (c.g.) were within prescribed limits. The aircraft was in compliance with all pertinent airworthiness directives.

In the Boeing 727 aircraft, the pitot-static instruments on the captain's panel, the pitot-static instruments on the first officer's panel, and the pitot-static instrumentation in the flight data recorder (FDR) are connected to separate pitot and static sources. The three pitot systems have no common elements and are completely independent. The three static systems are also independent except for manual selector valves in both the captain's and first officer's systems which provide for selection of the FDR static system as an alternate pressure source if either primary source malfunctions.

The first officer's pitot and static systems are connected to a Mach airspeed warning switch. The switch activates a warning horn when it senses a differential pressure which indicates that the aircraft's speed is exceeding V_{mo} or M_{mo}, 4/ depending on the aircraft's altitude. A redundant Mach airspeed warning system is incorporated in the FDR pitot and static systems.

The pitot head for the captain's pitot system is located on the left side of the aircraft's fuselage; the pitot heads for the first officer's system and the FDR system are located on the right side of the fuselage. Each of these heads incorporates a heating element and a small drain hole, for exhausting moisture, aft of the total pressure sensing inlet. The three static systems each have a static port located on either side of the fuselage. The left static port is connected to the right static port to offset sideslip effects by balancing the pressures within the systems. Each of the ports is equipped with a heating element.

In addition to the above systems, two independent pitot-static systems are connected to a mechanism in the aircraft's longitudinal control system. The force which the pilot must exert to move the elevator control surfaces varies as a function of the dynamic pressure measured by these systems. The two pitot heads for these systems are mounted one on each side of the vertical stabilizer, and their design is similar to the other pitot heads.

4/ Maximum operating limit speed or maximum operating limit Mach.

1.7 Meteorological Information

Northwest Airlines' meteorology department supplied the weather information for Flight 6231. This information included a synopsis of surface conditions, terminal forecasts, a tropopause and wind forecast for the 300-millibar level, appropriate surface observations, and turbulence plots. For the period 1700 to 2300, Northwest meteorologists forecasted moderate to heavy snowshowers from Lake Michigan to the Appalachian Mountains and moderate to heavy rainshowers and scattered thunderstorms east of the Appalachians.

Northwest's turbulence plot (TP) No. East 2 was in effect and available to the flightcrew on the day of the accident. TP East 2 was a triangular area defined by lines connecting Pittsburgh, Pennsylvania, New York City, New York, and Richmond, Virginia. Thunderstorm cells with maximum tops to 28,000 feet were located in this area.

SIGMET 5/ Delta 2, issued at 1755 and valid 1755 to 2200, predicted frequent moderate icing in clouds, locally severe in precipitation above the freezing level, which was at the surface in southwestern New York and which sloped to 6,000 feet eastward to the Atlantic coast.

The surface weather observations at Newburgh, New York, about 17 miles north of the accident site, were:

1900 - Estimated ceiling -- 2,500 feet broken, 5,000 feet overcast, visibility -- 12 miles, temperature -- 34°F., dew point -- 22°F., wind -- 070° at 14 kn, gusts -- 24 kn, altimeter setting -- 29.98 in.

2000 - Similar conditions to those reported at 1900 except that very light ice pellets were falling.

Another Northwest flight was on a similar route behind Flight 6231. The captain of that flight stated that he encountered icing and light turbulence in his climb. He was in instrument conditions from 1,500 feet to 23,000 feet, except for a few minutes between cloud layers at an intermediate altitude.

1.8 Aids to Navigation

There were no problems with navigational aids.

1.9 Communications

There were no problems with air-to-ground communications.

5/ A SIGMET is an advisory of weather severe enough to be potentially hazardous to all aircraft. It is broadcast on navigational and voice frequencies and by flight service stations. It is also transmitted on Service-A weather teletype circuits.

1.10 Aerodrome and Ground Facilities

Not applicable.

1.11 Flight Recorders

N274US was equipped with a Fairchild Model 5424 flight data recorder (FDR), serial No. 5146, and a Fairchild A-100 cockpit voice recorder (CVR), serial No. 1640. Both recorders sustained superficial mechanical damage, but the recording tapes were intact and undamaged. All of the FDR traces and the CVR channels were clearly recorded.

The readout of the FDR traces involved 11 minutes 54.6 seconds of flight, beginning 15 seconds before liftoff.

Pertinent portions of the CVR tape were transcribed, beginning with the flightcrew's execution of the pretakeoff checklist and ending with the sounds of impact. The following transcript was made of the flightcrew's activities between 1906:36 and 1906:51:

First Officer: Zero, zero and thirty-one, fifteen, fifteen .... blue.

Second Officer: Bug.

Second Officer: Pitot heat.

First Officer: Off and on.

Captain: One forty-two is the bug.

First Officer: Or ... do you want the engine heat on?

First Officer: Huh!

Sound of five clicks.

Air-to-ground communications, cockpit conversations, and other sounds recorded on the CVR were correlated to the FDR altitude, airspeed, heading, and vertical acceleration traces by matching the radio transmission time indications on both the CVR and FDR.

The FDR to CVR correlation showed that after takeoff, the aircraft climbed to 13,500 feet and remained at that altitude for about 50 seconds, during which time the airspeed 6/ increased from 264 kn to 304 kn. During that 50 seconds, the airspeed trace showed two aberrations in a 27-second period; each aberration was characterized by a sudden reduction in airspeed. These reductions were 40 kn and 140 kn and lasted for 7 and 5 seconds, respectively.

6/ All airspeeds are indicated airspeeds, unless otherwise noted.

The aircraft then began to climb 2,500 feet per minute while maintaining an airspeed of about 305 kn. As the altitude increased above 16,000 feet, the recorded airspeed began to increase. Subsequently, both the rate of climb and the rate of change in airspeed increased. About this same time, the first officer commented, "Do you realize we're going 340 kn and I'm climbing 5,000 feet a minute?"

The flightcrew discussed the implications of the high airspeed and high rate of climb. The second officer commented, "That's because we're light," after which the captain said, "It gives up real fast," and "I wish I had my shoulder harness on, it's going to give up pretty soon." The rate of climb eventually exceeded 6,500 feet per minute.

The sound of an overspeed warning horn was recorded as the altitude reached 23,000 feet. At that time, the recorded airspeed was 405 kn and the following conversation took place:

Captain: "Would you believe that #."

First Officer: "I believe it, I just can't do anything about it."

Captain: "No, just pull her back, let her climb."

This last comment was followed by the sound of a second overspeed warning horn.

The sound of the stall warning stick shaker was recorded intermittently less than 10 seconds after the onset of the overspeed warning. Five seconds later, vertical acceleration reduced to 0.8g, and the altitude leveled at 24,800 feet. The recorded airspeed was 420 kn.

The stall warning began again and continued while the first officer commented, "There's that Mach buffet, 7/ guess we'll have to pull it up." followed by the captain's command, "Pull it up," and the sound of the landing gear warning horn. The FDR readout shows the following:

Two seconds later (about 13 seconds after the aircraft arrived at 24,800 feet), the vertical acceleration trace again declined to 0.8g and the altitude trace began to descend at a rate of 15,000 feet per minute. The airspeed trace decreased simultaneously at a rate of 4 kn per second and the magnetic heading trace changed from 290° to 080° within 10 seconds, which indicated that the aircraft was turning rapidly to the right.

7/ A slight buffet that occurs when an aircraft exceeds its critical Mach number. The buffet is caused by the formation of a shock wave on the airfoil surfaces and a separation of airflow aft of the shock wave. The change from laminar flow to turbulent flow aft of the shock wave causes a high frequency vibration in the control surfaces which is described as "buffet" or "buzz."

As the aircraft continued to descend, the vertical acceleration trace increased to 1.5g. The aircraft's magnetic heading trace fluctuated, but moved basically to the right. About 10 seconds after the descent began, the "Mayday" was transmitted.

Thirty-three seconds later the crew reported, "We're descending through 12, we're in a stall." About 5 seconds after that transmission, the captain commanded, "Flaps two....," and a sound similar to movement of the flap handle was recorded. There was no apparent change in the rate of descent; however, the vertical acceleration trace increased immediately, with peaks to +3g. The recorded airspeed decreased to zero, and the sound of the stall warning became intermittent.

Five seconds after the captain's command for flaps, the first officer said, "Pull now ... pull, that's it." Ten seconds later, the peak values for vertical acceleration increased to +5g. The rate of descent decreased slightly; however, the altitude continued to decrease to 1,090 feet -- the elevation of the terrain at the accident site. The aircraft had descended from 24,800 feet in 83 seconds.

1.12 Aircraft Wreckage

The aircraft struck the ground in a slightly nosedown and right wingdown attitude in an area where the terrain sloped downward about 10°. The aircraft structure had disintegrated and ruptured and was distorted extensively. There was no evidence of a preexisting malfunction in any of the aircraft's systems.

Except for both elevator tips, the left horizontal stabilizer, and three pieces of light structure from the left stabilizer, the entire aircraft was located within an area 180 feet long and 100 feet wide. The above components were located between 375 feet and 4,200 feet from the main wreckage.

The horizontal stabilizer trim setting was 1.2 units of trim aircraft noseup. The landing gear and spoilers were retracted. The wing trailing edge flaps were extended to the 2° position, and the Nos. 2, 3, 6, and 7 leading edge slats were fully extended, which corresponded to a trailing edge flap selection of 2°.

The No. 1 and No. 3 engines were separated from their respective pylons. The No. 2 engine remained in its mounting in the empennage. The engines exhibited impact damage but little rotational damage. The speed servo cams in all three fuel control units were at or near their high speed detents.

The outboard section of the left horizontal stabilizer had separated between stations 50 and 60. The inboard section remained attached to the

vertical stabilizer. The left elevator between stations 78 and 223 remained attached to the separated section. The right horizontal stabilizer was attached to the vertical stabilizer except for the tip section from station 188 outboard. The right elevator, from station 188 inboard, remained attached to the horizontal stabilizer.

The three attitude indicators were damaged on impact. The indicators showed similar attitude information -- 20° nosedown, with the wings almost level.

The two pitot head heater switches were in the "off" position and the switches' toggle levers were bent aft. The damage to the switch levers and the debris deposited on them was that which would be expected if they had been in the "off" position at impact. A new switch with its toggle lever in the "off" position, when struck with a heavy object, exhibited internal damage similar to the damage found in the internal portions of the right pitot heater switch.

Four of the five pitot head heater circuit breakers were operable and were electrically closed. The auxillary pitot head heater circuit breaker was jammed into its mounting structure, and it was electrically open.

The left elevator pitot head was lying on the frozen ground; when retrieved, at least eight drops of water dripped from the pressure inlet port. After exposure to sunlight, more water drained from the port. The captain's pitot head was retrieved and cleared of frozen mud. The pressure inlet port was filled with dry wood fibers. After exposure to sunlight, wet wood fibers were removed from the interior of the inlet port, and moisture was present on the inner surface of the port. The copilot's pitot head and the auxilary pitot head were crushed and damaged severely; they could not be checked for water content. The right elevator pitot head remained attached to the vertical stabilizer. The head was in good condition and contained no water or ice.

The engine anti-ice switches for the Nos. 1 and 2 engines were in the "open" position. The switch for the No. 3 engine was in the "closed" position and the switch handle was bent aft. Tests of the bulb filaments of the engine anti-ice indicator lights showed that all three lights were on at impact.

1.13 Medical and Pathological Information

The three crewmembers were killed in the crash. Toxicological tests disclosed no evidence of carbon monoxide, hydrogen cyanide, alcohol, or drugs in any of the crewmembers.

1.14 Fire

There was no fire, either during flight or after impact.

1.15 Survival Aspects

The accident was not survivable.

1.16 Tests and Research

1.16.1 Pitot Head Examination and Icing Tests

A metallurgical examination of the separated heater conductor wire in the pitot head from the first officer's pitot system showed that the circumference of the wire was reduced before the wire broke. The metal in the wire had not melted, and there were no signs of electrical current arcing or shorting.

A pitot head of the same type that provided pitot pressure to the first officer's airspeed/Mach indicator was exposed to icing conditions in a wind tunnel. With the pitot heater inoperative, 1 to 2 inches of ice formed over the pressure inlet port. During the exposure, a thin film of water flowed into the pressure port, some of which flowed out of the drain hole.

Blockage of the drain hole by ice seemed to depend on the length of time required for ice to form and block the total pressure inlet port. The longer it took for ice to form and block the total pressure port, the more likely it became that the drain hole would be blocked by ice. Also, the greater the angle between the longitudinal axis of the pitot head and the relative wind, the greater the likelihood that the drain hole would become blocked with ice.

Constant altitude pressure measurements showed that when the total pressure inlet port was blocked by ice and the drain hole remained open, pressure changes occurred that would cause a reduction of indicated airspeed. However, when both the total pressure port and drain hole were blocked, the total pressure remained constant, which would cause indicated airspeed to remain fixed. Also, abrupt and small pressure fluctuations occurred shortly before either the pressure port or drain hole became blocked by ice.

In an effort to reproduce the apparent inconsistencies between the airspeed and altitude values on the FDR traces, tests were conducted with an airspeed indicator and an altimeter connected to vacuum and pressure sources. By altering the vacuum to the altimeter and to the airspeed indicator, the altitude trace could be reproduced. However, following ascent above 16,000 feet, the FDR airspeed and altitude values could be simultaneously duplicated only when the total pressure to the airspeed indicator was fixed at its FDR value for an altimeter reading of about 15,675 feet and an indicated airspeed of about 302 kn.

1.16.2 Aircraft Performance Analysis

Following the accident, the Safety Board requested that the aircraft manufacturer analyze the data from the CVR and FDR to determine: (1) The consistency of these data, particularly the airspeed and altitude values, with the theoretical performance of the aircraft; (2) the significance and possible reason for a simultaneous activation of the overspeed and stall warning systems; and (3) the body attitude of the aircraft during its final ascent and descent. The following are some results of the manufacturer's performance analysis:

The airspeed and altitude values which were recorded were consistent with the aircraft's predicted climb performance until the aircraft reached 16,000 feet. The simultaneous increases in both airspeed and rate of ascent which were recorded thereafter exceeded the theoretical performance capability of a B-727-200 series aircraft of the same weight as N274US. Consequently, the recorded airspeed values were suspected to be erroneous, and it appeared that they varied directly with the change in recorded altitude. The recorded airspeeds correlated within 5 percent with the theoretical airspeeds which would be expected if the pressure measured in the pitot system had remained constant after the aircraft's climb through 16,000 feet.

The indicated airspeed of the aircraft when the stick shaker was first activated was calculated to be 165 kn as compared to the 412 kn recorded by the FDR. The decrease in airspeed from 305 kn to 165 kn as the aircraft climbed from 16,000 feet to 24,000 feet (within 116 seconds) is within the aircraft's theoretical climb power performance. The aircraft's pitch attitude would have been about 30° noseup as stick shaker speed was approached. The stall warning stick shaker is activated by angle of attack instrumentation which is completely independent of, and therefore not affected by errors in, the aircraft's airspeed measuring systems.

Vertical acceleration reduced slightly as the aircraft leveled at 24,800 feet probably because the pilot relaxed the back pressure being applied to the control column. The stick shaker ceased momentarily; however, the aircraft continued to decelerate because of the drag induced by the high body attitude, and the stick shaker reactivated. Boeing personnel interpreted the sound of the landing gear warning horn on the CVR to indicate that the thrust levers had been retarded to idle. The second reduction in vertical acceleration -- to 0.8g which was coincident with a sudden descent and a rapid magnetic heading change -- was probably caused by an aerodynamic stall with a probable loss of lateral control.

Theoretical relationships of angle of attack, velocity, and drag were compared to the recorded rate of descent and load factor to determine the attitude of the aircraft after the stall. The comparison showed that the aircraft attained an angle of attack of 22°, or greater, during the

descent. Transient nosedown attitudes of more than 60° would have been required to achieve the measured descent rate with an angle of attack of 22°. The variations in load factors, which averaged about +1.5g, were attributed to variations in the aircraft's angle of bank.

The aircraft was probably exceeding 230 kn, with a nosedown attitude of about 50° as it descended below 11,000 feet, when the flaps were extended to 2°. The momentary cessation of the stick shaker indicated that the angle of attack had been reduced to less than 13°. The increase in vertical acceleration to 2.5g was attributed to the aircraft's being in a tight nosedown spiral with a bank angle between 70° and 80°.

With a normally operating elevator feel system, and a stabilizer trim setting of 1.2 units aircraft noseup, the pilot would have to exert a pull force of between 45 and 50 lbs. to achieve a 2.5g load factor at 5,000 feet and 250 kn. If, however, the elevator pitot system was blocked so that the system sensed a zero indicated airspeed, a pull force of less than 30 lbs. would have produced the same load factor. After the aircraft had descended through 5,000 feet, the load factor reached peak values of +5g.

The manufacturer's engineers stated that the aircraft's structural limits would have been exceeded at high angles of sideslip and load factors approaching +5g. They stated that a consequent failure of the elevator assemblies could have produced an aerodynamic flutter which could have, in turn, caused the elevator spar to fail and the left horizontal stabilizer to separate. With the aircraft at a stall angle of attack when the horizontal stabilizer separated, an uncontrollable noseup pitching moment would have been produced, which could have resulted in an angle of attack of 40° or more.

1.17 Other Information

1.17.1 Pretakeoff Checklist

Northwest Airlines' operational procedures require that the flightcrew make a pretakeoff check of certain items. The second officer is required to read the checklist items, and the first officer must check the items and respond to the second officer's challenge. Included on the checklist are:

Second Officer	First Officer
Flaps	15, 15 (25,25) Blue
Marked Bug_____K	(C, FO) Numbers Set
Ice Protection	OFF (ON)
Pitot Heat	ON
Pressurization	(C, FO) Zero, _____o, Normal Flags

Company pilots stated that the checklist is used only to check that the required action has already been performed; it is not used as a list of items to be accomplished. With regard to the activation of pitot head heaters, it was the first officer's duty to turn the two switches to the "on" position shortly after the engines had been started and to check the ammeter readings on the various heaters to confirm their proper operation. After checking these items, he was supposed to leave the pitot heater switches on and to check that they were on during the pretakeoff check.

1.17.2 Airspeed Measuring System

When an aircraft moves through an air mass, pressure is created ahead of the aircraft, which adds to the existing static pressure within the air mass. The added pressure, dynamic pressure, is directly proportional to the velocity of the aircraft. When a symmetrically shaped object, such as a pitot head, is placed into the moving airstream, the flow of air will separate around the nose of the object so that the local velocity at the nose is zero. At the zero velocity point, the airstream dynamic pressure is converted into an increase in the local static pressure. Thus, the pressure measured at the nose of the object is called total pressure, and it is equal to the sum of the dynamic pressure and the ambient static pressure.

In an aircraft airspeed measuring system, the total pressure is measured by the pitot head and is transmitted through the pitot system plumbing to one side of a differential pressure measuring instrument (airspeed indicator). The ambient static pressure is measured at static ports which are mounted in an area that is not significantly influenced by the moving airstream. The static pressure measured at these ports is transmitted to the opposite side of the differential pressure measuring instrument. In effect, the differential pressure instrument (whether it be an airspeed indicator gage, a flight data recorder pressure transmitter, or a component within an air data computer) subtracts the ambient static pressure measured by the static system from the total pressure measured by the pitot system. The resultant dynamic pressure is a direct measurement of indicated airspeed.

Since the ambient static pressure is a component part of total pressure, any change in static pressure would normally result in an equal change in both the pitot and static pressure systems. Therefore, a change in ambient static pressure, such as that encountered during a change in altitude, would normally have no effect on airspeed measurement. Only a change in dynamic pressure produced by a change in the aircraft's velocity would cause a change in the indicated airspeed. If, however, only one side of the airspeed indicator sensed a change in the ambient static pressure, an erroneous change in indicated airspeed would result, even though the actual dynamic pressure remained unchanged. Such a condition would occur if either the pitot or static system was blocked or was otherwise rendered insensitive to external pressure changes.

In the event of a blocked pitot or static system, the direction of the indicated airspeed error would depend on which of the systems was blocked and the direction of change in the ambient static pressure. Under conditions where the pressure in the static system increases with respect to the pressure in the pitot system, the indicated airspeed will read low erroneously. For the opposite condition, where the pressure in the static system decreases with respect to the pressure in the pitot system, the indicated airspeed will read high erroneously. The latter would exist if the pitot head was blocked so that a constant pressure was trapped in the pitot system while the aircraft was ascending. This is because the static system pressure would decrease and the resultant differential pressure would appear as an increase in dynamic pressure.

Indicated airspeed error may also occur when the pitot system becomes insensitive to changes in total pressure in such a manner that the system vents to an ambient static pressure source. The pressure measured by the pitot system will equalize with the pressure in the static system, and the dynamic pressure (indicated airspeed) will decrease to zero. The vent source in a pitot head which can produce this kind of error is the moisture drain hole which is located downstream from a blocked total pressure sensing inlet.

1.17.3 B-727 Stall Characteristics

During its type certification process, the B-727-200 series aircraft demonstrated stall characteristics which met the requirements of the Civil Air Regulations, parts 4b. 160-162. The significant requirements defined therein are: (1) That, at an angle of attack measurably greater than that of maximum lift, the inherent flight characteristics give a clear indication to the pilot that the aircraft is stalled -- typical indications are a nosedown pitch or a roll which cannot be readily arrested; (2) that recovery from the stall can be effected by normal recovery techniques starting as soon as the aircraft is stalled; (3) that there is no abnormal noseup pitching and that the longitudinal control force be positive, up to an including the stall; (4) that a safe recovery from a stall can be effected with the critical engine inoperative; and (5) that a clear and distinctive stall warning be apparent to the pilot at an airspeed at least 7 percent above the stalling airspeed.

The certification stall tests, conducted with the aircraft in all operating configurations and with the most adverse weight and c.g. conditions, demonstrated that as the aircraft was slowed and its wing angle of attack was increased, the buffet produced by airflow separation from the wing provided a natural warning of impending stall. With the landing flaps extended, however, the airspeed margin provided by the buffet warning was considered to be insufficient. Consequently, a stick shaker system was installed to provide an artificial warning for all configurations.

In the clean configuration, 8/ the stick shaker activated when the angle of attack reached 13°. When the aircraft was slowed further, natural buffeting occurred at an angle of attack between 16° and 18°. The buffet was described as "quite heavy" when the speed was reduced to within 2 to 3 kn of the speed associated with maximum lift. When the angle of attack for maximum lift (about 22°) was reached, there was a tendency for the nose to drop if the pilot relaxed pressure on the control column. Also, lateral stability was reduced noticeably, which increased the pilot's workload in maintaining wings-level flight.

During certification flight tests, the angle of attack was increased to 25°, after which recovery was effected by relaxing the pull force on the control column. With the use of engine thrust during recovery, the altitude lost was restricted to about 2,000 feet.

Up to the onset of stall buffet, the longitudinal control forces needed to effect stall entry increased as the angle of attack increased. At higher angles of attack, up to and beyond the angle for maximum lift, the pull force required to maintain a noseup pitching moment decreased. The forces did not reverse, however, and, with normal trim, a reduction in pull force resulted in a decreased angle of attack.

The B-727 longitudinal control system is capable of developing the noseup pitching moments needed to obtain angles of attack much higher than those associated with stall. For an aircraft having the same weight, c.g. location, and stabilizer trim setting as N274US, the manufacturer's analysis showed that an angle of attack of approximately 37° could be attained if a continuous pull force was exerted to hold the control column aft.

Like other aircraft which have horizontal stabilizers located near or on top of their vertical stabilizers, the B-727 does pass through a range of high angles of attack where longitudinal instability occurs. This instability causes the aircraft, when no control force is applied, to pitch to even higher angles of attack. Longitudinal instability is caused by degraded horizontal stabilizer effectiveness when the aircraft's attitude is such that the horizontal stabilizer is enveloped by the low-energy turbulent air in the wake from the wings. When these high angles of attack are reached, a push force on the control column is required to reduce the angle of attack. For a B-727 with an aft c.g. location and stabilizer trim in the cruise range, wind tunnel data show that a nosedown pitching moment will decrease the angle of attack and stall recovery can be attained by applying push forces to the control column.

A stick pusher is a device which will apply a force to move the control column forward when the angle of attack for maximum lift is exceeded. The usefulness of a stick pusher is controversial since it can effect primary control of the aircraft. However, a stick pusher is required on B-727 and other aircraft registered by the United Kingdom. That stick pusher is designed so that its action can be overpowered by a pull force of about 80 lbs. on the pilot's control column.

8/ Without landing gear, flaps, or spoilers extended.

2. ANALYSIS AND CONCLUSIONS

2.1 Analysis

The aircraft was certificated, equipped, and maintained in accordance with regulations and approved procedures. The aircraft weighed substantially less than its authorized maximum weight for takeoff.

Although the speed servo cams in all three engine fuel controllers were positioned for high engine revolutions per minute, the engines were producing very little thrust at impact as evidenced by the absence of significant rotational damage to the engines. Probably, the throttles had been advanced shortly before impact, but there was either insufficient time for the engines to accelerate, or acceleration was limited because airflow into the engine inlets had been distorted by the extreme angle of attack and probable sideslip.

The flightcrew was properly certificated and each crewmember had received the training and off-duty time prescribed by regulations. There was no evidence of medical or physiological problems that might have affected their performance.

The conversations recorded on the CVR revealed that, following ascent above 13,500 feet, the flightcrew became concerned and puzzled by the apparent performance of the aircraft because of the indicated airspeed and the indicated rate of ascent. The FDR airspeed and altitude traces provided investigators an insight regarding these conversations. The airspeed trace increased rapidly after the aircraft ascended above 16,000 feet while the rate of climb continued to increase and eventually reached a peak value of 6,500 feet per minute. The Boeing Company's analysis of the airspeed and rates of climb values that registered above 16,000 feet showed that these values were incompatible with the aircraft's performance capabilities.

Analysis showed that there was a direct relationship between the airspeed and altitude values. This relationship was based on the assumptions that (1) the total pressure measured by the FDR pitot system remained constant after the aircraft ascended above 16,000 feet, and (2) the pressure measured by the FDR static system varied according to the recorded altitude values. These assumptions were substantiated by the tests which determined that the FDR airspeed and altitude traces could be reproduced only if the total pressure to the airspeed indicator was held constant during ascent above 16,000 feet.

Although the pitot systems for the captain's and first officer's airspeed Mach indicators and the FDR airspeed instrumentation are three separate and completely independent systems, it is reasonable to conclude that all three systems were sensing nearly identical and erroneous total pressures. This can be concluded because the flightcrew made no reference to

any difference between the airspeed readings on the captain's and first officer's indicators, and the first officer's reference to "...going 340 kn ..." corresponded closely to the airspeed value recorded on the FDR at that time. Additionally, the near simultaneous activation of the overspeed warning systems tends to prove that the first officer's airspeed was close to the value recorded on the FDR when the aircraft neared its peak altitude.

The erroneously high airspeed indications were caused by a complete and nearly simultaneous blockage of all three pitot pressure systems. Moreover, since the only common elements among the systems were the design features of the pitot heads and the environment to which they were exposed, the Safety Board concludes that the pitot heads were blocked by ice which formed around the heads and closed the drain holes and the pressure inlet ports. The conclusion is supported by the airspeed aberrations that were recorded while the aircraft was flying level at 13,500 feet and by the moisture which was found in the pitot heads when they were recovered and examined. Additionally, it is known that icing conditions existed in the area through which Flight 6231 was flying, and it is unlikely that any other type of blockage or malfunction would simultaneously affect the three independent systems.

The formation of ice on the pitot heads should have been prevented by electrical heating elements which are activated by the pitot heater switches located in the cockpit. The Safety Board concludes that the heating elements were never activated because the pitot heater switches were not in the "on" position during the flight. This conclusion is substantiated by the position and condition of the switches in the wreckage, the internal damage to the right switch, and the lack of evidence that electrical current was present in the heater circuit to the pitot head in the first officer's pitot system at the time of impact.

The Safety Board was unable to determine why the pitot head heater switches were not placed in the "on" position before departure. It is clear that the flightcrew performed the pretakeoff checks required by Northwest's operational procedures. However, the proper checklist sequence was not followed, and it is possible that the first officer positioned the switches improperly because of an omission in the sequence and his inexperience as a B-727 copilot.

While reading the checklist, the second officer called "bug" and, before receiving a response from either the captain or first officer, he omitted the "ice protection" call and called "pitot heat." The first officer apparently responded to both the omitted call and the "pitot heat" call by saying, "off and on," but following the captain's response to the "bug" call, the first officer asked whether the engine heat was needed. The captain may or may not have responded with a nod or hand signal, but the sound of five clicks was recorded and the first officer returned to the task of setting his airspeed bug.

The five clicks may have been the movement of the pitot heater switches to the "off" position and the movement of the engine anti-ice switches to the "on" position -- a reversal of their normal positions. This assumption is supported by the position of the engine anti-ice and pitot heater switches in the wreckage, the condition of the lights associated with the engine anti-ice switches, and the lack of any reference during the flight to the need for engine anti-ice.

Because of the flightcrew's comments concerning aircraft performance and the absence of comments about possible instrument error or airspeed system icing, the Safety Board concludes that the flightcrew attributed the high airspeed and the high rate of climb to the aircraft's relatively low gross weight and to an encounter with unusual weather, which included strong updrafts. The flightcrew's analysis of the situation must have been strongly influenced by these factors and by the fact that both airspeed instruments were indicating essentially the same values. However, the aircraft's attitude as it neared the top of its ascent should have warned them that the aircraft's performance was abnormal because its nearly 30° noseup attitude was about 25° higher than the normal climb attitude, and at such a high noseup attitude it would have been impossible for the airspeed to continue to increase even if influenced by extreme updrafts. Because the use of attitude references is a fundamental of instrument flying, which is stressed in Northwest's flightcrew training program, the Safety Board concludes that the flightcrew improperly relied on airspeed indications as a means of determining aircraft performance.

Although the activation of the overspeed warning systems probably reinforced the flightcrew's belief that they were taking appropriate action, the operation of the stall warning stick shaker should have alerted them that the aircraft actually was approaching a stall. The first officer apparently misinterpreted the control column vibration produced by the stick shaker as Mach buffet because when the stick shaker began, he commented, "... there's that Mach buffet." The captain apparently agreed with this interpretation because he then commanded, "Pull it up." The almost simultaneous activation of the stall and the overspeed warning systems undoubtedly created some confusion; however, the differences between stall buffet and Mach buffet are substantial and the former should have been easily recognized. Again, though, it appears that the flightcrew relied almost exclusively on the airspeed indicators and their related warning systems to assess the aircraft's performance.

Even after the stall, as manifested by the rapid heading change (banked attitude) and the sudden descent, the flightcrew failed to recognize the problem for a number of seconds. They continued to exert back pressure on the control column which kept the aircraft at a high angle of attack. They probably were having difficulty with lateral control, and the aircraft entered into a spiralling descent to the right, during which the actual airspeed of the aircraft began to increase rapidly.

The erroneous airspeed indications, the steep nosedown attitude, and the proprioceptive sensations associated with the positive vertical acceleration forces undoubtedly contributed to confusion which prevented the flightcrew from recognizing the true condition of the aircraft. Additionally, it is probable that the nosedown and banked attitudes of the aircraft were so steep that the horizon references in the attitude instruments were nearly hidden. This would have made the lateral attitude of the aircraft difficult to determine. However, had the pilots concentrated more on the attitude indicators, and particularly the position of the "sky pointers", 9/ they probably could have returned the aircraft to level flight had they taken appropriate corrective action within 30 to 40 seconds after the stall.

Probably because of the low airspeed indications, the captain decided that the aircraft was in a stall. He transmitted: "We're descending through 12, we're in a stall," and he called for the flaps to be extended to 2° -- a proper step in the stall recovery procedure. However, the actual indicated airspeed at that time was probably in excess of 230 kn and increasing rapidly; consequently, although the stick shaker ceased operation momentarily, the extension of the flaps had little favorable effect.

Even after the pilots decided that the aircraft was stalled, the Safety Board believes that they continued to react primarily to the high rate of descent indications and proprioceptive sensations because they continued to exert a pull force on the control column. This is substantiated by the increasing vertical acceleration forces as the descent continued. However, because the wings were not leveled first, the aircraft continued to descend rapidly in a spiralling, accelerated stall.

Since the pitot heads for the elevator feel system were probably blocked by ice, the force required of the pilots to move the elevators would have been increased while the aircraft was above 16,000 feet. However, when the aircraft descended below that altitude, the force required would have been diminished. As the descent continued below 5,000 feet, the actual indicated airspeed probably exceeded 350 kn while the airspeed sensed by the elevator feel system was probably near zero. Consequently, conditions were created in which high vertical acceleration forces could be produced with relative ease. As evidenced by the FDR acceleration trace, high vertical acceleration forces were produced below 5,400 feet.

As the aircraft continued its descent through 3,500 feet, the high vertical acceleration forces induced were sufficient to cause the failure of the left horizontal stabilizer. Thereafter, the aircraft probably rolled to a near wings-level attitude, pitched up to an extremely high angle of attack, and continued to descend in an uncontrollable stall to the ground.

9/ A triangular index which is positioned above the movable horizon and which moves in the opposite direction from the aircraft's banked attitude to indicate the number of degrees of bank.

During the Safety Board's investigation, incidents involving possible pitot-static system icing were reviewed. Although none of these incidents resulted in a catastrophic accident, it became clear that pitot or static system icing during flight can and does occur. Also, the resultant effects on pressure-operated flight instruments can produce at least momentary confusion among the crewmembers.

While all of the flightcrews involved in these incidents reverted to attitude flying until the cause of the icing could be eliminated or instrument flight could be terminated, it was apparent from these incidents that some pilots who understood the basic principles of airspeed measurement failed to analyze the possible results of a blockage of the pitot or static systems. The pilots often failed to determine the proper reasons for an increasing airspeed indication; they attributtd such indications to unusual weather phenomena.

Although unusual weather phenomena such as mountain waves, extreme turbulence, and vertical wind shear can produce significant airspeed deviations, these phenomena usually are of short duration and cause erratic or abruptly changing airspeed indications rather steadily increasing, steadily decreasing, or fixed airspeed indications. Also, the aircraft's attitude during encounters with these phenomena is important in determining airspeed trends and possible sources of error. Consequently, the Safety Board believes that potential pitot-static system problems and attitude flying as a temporary remedy for these problems should be reemphasized in instrument flying training programs, and the Safety Board has made a recommendation to this effect to the Administrator, Federal Aviation Administration.

2.2 Conclusions

(a) Findings

1. All members of the flightcrew were properly certificated and were qualified for their respective duties.

2. The aircraft had been properly maintained and was airworthy for the flight; its gross weight and c.g. were within the prescribed limits.

3. There was no evidence of a system malfunction or failure or of a structural defect in the aircraft.

4. The flightcrew had adequate weather information for the flight.

5. The FDR vertical acceleration trace indicates that only light turbulence was encountered.

6. The weather conditions encountered during the flight were conducive to the formation of moderate airframe ice.

7. The aircraft accumulated sufficient ice during its flight to block completely the drain holes and total pressure inlet ports of the pitot heads; the static ports were not affected by the ice.

8. The pitot heads became blocked at an altitude of about 16,000 feet.

9. The ice formed on the pitot heads because the pitot head heater switches had not been turned on before Flight 6231 departed JFK.

10. The complete blockage of the pitot heads caused the cockpit airspeed indicators to read erroneously high as the aircraft climbed above 16,000 feet and the static pressure decreased.

11. The flightcrew reacted to the high airspeed indications by increasing the noseup attitude of the aircraft which increased the rate of climb. While this caused the indicated airspeed to increase more rapidly because the static pressure decreased more rapidly with the increased rate of climb, the actual airspeed was decreasing.

12. The airspeed overspeed warning and stall warning stick shaker operated simultaneously because of the blocked pitot heads and the high noseup attitude of the aircraft.

13. The flightcrew misconstrued the operation of the stall warning stick shaker as Mach buffet.

14. The flightcrew continued to increase the noseup attitude of the aircraft following the operation of the stall warning stick shaker.

15. The aircraft stalled at an altitude of 24,800 feet while in a noseup attitude of about 30°.

16. Following the stall, the aircraft entered into a right spiralling dive at a high rate of descent. Throughout the descent, the flightcrew reacted primarily to airspeed and rate of descent indications instead of attitude indications, and thus failed to initiate proper recovery techniques and procedures.

17. In an effort to recover the aircraft from a high rate of descent, the flightcrew exerted excessive pull forces on the control columns which induced high vertical acceleration forces and caused the left horizontal stabilizer to fail.

(b) Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the loss of control of the aircraft because the flightcrew failed to recognize and correct the aircraft's high-angle-of-attack, low-speed stall and its descending spiral. The stall was precipated by the flightcrew's improper reaction to erroneous airspeed and Mach indications which had resulted from a blockage of the pitot heads by atmospheric icing. Contrary to standard operational procedures, the flightcrew had not activated the pitot head heaters.

3. RECOMMENDATIONS

As a result of this accident, three recommendations were made to the Administrator, Federal Aviation Administration. (See Appendix D.)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ FRANCIS H. McADAMS
Member

/s/ LOUIS M. THAYER
Member

/s/ ISABEL A. BURGESS
Member

John H. Reed, Chairman, and William R. Haley, Member, did not participate in the adoption of this report.

August 13, 1975

APPENDIX A

Investigation and Hearing

1. Investigation

The National Transportation Safety Board was notified of the accident about 1935 on December 1, 1974. The Safety Board immediately dispatched an investigative team to the scene. The following morning the team established investigative groups for operations/witnesses, air traffic control, weather, structures, powerplants, systems, flight data recorder, maintenance records, and cockpit voice recorder.

Parties to the investigation were: The Federal Aviation Administration, Northwest Airlines, Inc., The Boeing Company, Air Line Pilots Association, International Association of Machinists and Aerospace Workers, and the Pratt and Whitney Division of the United Aircraft Corporation.

2. Hearing

A public hearing was held at Bear Mountain, New York, on February 12 and 13, 1975. All of the parties to the investigation except the Pratt and Whitney Aircraft Division were parties to the hearing.

APPENDIX B

Aircrew Information

Captain John B. Lagorio

Captain Lagorio, 35, was employed by Northwest Airlines on January 17, 1966. He held Airline Transport Pilot certificate No. 1496609 with airplane multiengine and single-engine land ratings, commercial privileges and a type rating in the B-727. He held Flight Engineer certificate No. 1682555 and a valid first-class medical certificate which was issued with no limitations on August 22, 1974.

Captain Lagorio had accumulated about 7,434 flight-hours, of which about 1,973 were in the B-727. In the 30-, 60-, and 90-day periods preceding the accident, he flew about 58, 122, and 185 hours, respectively, all in the B-727.

Captain Lagorio was advanced from first officer to captain on August 5, 1969. He completed his last general refresher training on January 15, 1974, and his last B-727 refresher training on November 15, 1974. He passed a proficiency flight check in the B-727 simulator on November 15, 1974.

First Officer Walter A. Zadra

First Officer Zadra, 32, was employed by Northwest Airlines on January 8, 1968. He held Commercial Pilot certificate No. 1624729 with airplane multiengine and single-engine land ratings, and an instrument rating. He held Flight Engineer certificate No. 1834609 and a valid first-class medical certificate which was issued with no limitations on July 9, 1974.

First Officer Zadra had flown about 1,550 hours as a pilot or first officer and about 3,152 hours as a second officer (flight engineer) of which about 1,244 hours were in the B-727. He upgraded from second officer in B-707 aircraft to first officer in B-727 aircraft on October 16, 1974, and he had flown about 46 hours in the latter capacity. In the 30-, 60-, and 90-days periods preceding the accident, he flew, respectively, about 46 hours as first officer in the B-727 and 23 and 76 hours as second officer in the B-707.

First Officer Zadra completed general refresher training on January 7, 1974, and he passed a first officer proficiency check in the B-727 on October 16, 1974.

Second Officer James F. Cox

Second Officer Cox, 33, was employed by Northwest Airlines on February 2, 1969. He held Commercial Pilot certificate No. 1643627 with multiengine land and instrument ratings. He held Flight Engineer (turbojet powered) certificate No. 1920999 and a first-class medical certificate which was issued with no limitations on March 1, 1974.

Second Officer Cox had acquired about 1,938 hours of flying time as a second officer with Northwest Airlines, including about 1,611 hours in B-727 aircraft. In the 30-, 60-, and 90-day periods preceding the accident, he flew about 45, 113 and 180 hours, respectively, all in B-727 aircraft.

Second Officer Cox completed general refresher training on January 10, 1974, and he passed a second officer proficiency check on April 10, 1974.

APPENDIX C

Aircraft Information

N274US was manufactured by The Boeing Company on December 2, 1969, and it was assigned serial No. 20295. It had accumulated about 10,289 hours of time in service.

N274US was powered by three Pratt and Whitney JT8D-7 engines. Pertinent engine data are as follows:

Position	Serial No.	Total Time	Time Since Heavy Maintenance
1	649153	18,641 hours	3,044 hours
2	654070	14,818 hours	2,234 hours
3	648988	17,612 hours	1,193 hours

All of the required maintenance inspections and checks on the aircraft had been performed in accordance with Northwest Airlines approved directives.

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

APPENDIX D

ISSUED: March 20, 1975

Forwarded to:
Honorable Alexander P. Butterfield
Administrator
Federal Aviation Administration
Washington, D. C. 20591

SAFETY RECOMMENDATION(S)

A-75-25 thru -27

The National Transportation Safety Board is investigating the Northwest Airlines, Inc., Boeing 727, N274US, aircraft crash which occurred near Thielle, New York, on December 1, 1974. The Board's continuing investigation has revealed that ice blocked the pitot heads.

A preliminary review of the evidence in this accident suggests the possibility that the crew concentrated on air data instrumentation to the exclusion of aircraft attitude indications. The timely use of the attitude information may have prevented the stall and subsequent crash.

About 5 minutes before the rapid descent, the flight data recorder (FDR) recorded aberrations in the airspeed trace. These aberrations were caused by the closure of the ram air inlet and the drain hole of the pitot mast. These aberrations were verified by wind-tunnel icing tests of a pitot mast and pneumatic tests of an altimeter and airspeed system. These tests produced airspeed/altitude traces similar to those recorded on the FDR.

The Safety Board is aware of other incidents in which an aircraft encountered difficulties while flying in freezing precipitation because of a lack of pitot heat. In these incidents, the flightcrews recognized the problem and took corrective action.

Evidence in this case indicates that the pitot heater control switches were not on, although the heaters were capable of operation. The aircraft had been flying in clouds and freezing temperatures.

Recently, one air carrier reported that it is operating its pitot heater system continuously and the failure rate is minimal, i.e., one element failure per aircraft per year. Several other air carriers are actively considering the institution of a similar procedure, and they believe there would be no adverse affect on the life of the pitot heater elements.

APPENDIX D

Honorable Alexander P. Butterfield - 2 -

The National Transportation Safety Board believes that corrective action is necessary and recommends that the Federal Aviation Administration:

1. Issue an Operations Bulletin to all air carrier and general aviation inspectors to stress the need for pilots to use attitude information when questionable information is presented on instruments that are dependent on the air data system. The information in this Bulletin should be disseminated to all operators for incorporation into their operations procedures and training programs. (Class 1)

2. Issue an Airworthiness Directive to require that a warning system be installed on transport category aircraft which will indicate, by way of a warning light, when the flight instrument pitot heating system is not operating. The warning light should operate directly from the heater electrical current. (Class 2)

3. Amend the applicable Federal Air Regulations to require the pitot heating system to be on any time electrical power is applied to an aircraft. This should also be incorporated in the operator's operations manual. (Class 2)

Our staff is available to assist your personnel in this matter, if desired.

REED, Chairman, McADAMS, THAYER, BURGESS, AND HALEY, Members, concurred in the above recommendations.

By: John H. Reed
Chairman

APPENDIX D

THE SECRETARY OF TRANSPORTATION
WASHINGTON, D.C. 20590

March 13, 1975

Honorable John H. Reed
Chairman, National Transportation
Safety Board
800 Independence Avenue, S.W.
Washington, D. C. 20591

Dear Mr. Chairman:

This is to acknowledge receipt of your letter of March 12 enclosing a copy of a safety recommendation to the Federal Aviation Administrator concerning the Board's investigation of the Northwest Airlines, Inc., Boeing 727, N274US, aircraft crash which occurred near Thielle, New York, on December 1, 1974.

The recommendations are receiving attention by the Department's Assistant Secretary for Environment, Safety and Consumer Affairs, as well as other appropriate Departmental officials.

Sincerely,

William T. Coleman, Jr.

William T. Coleman, Jr.

APPENDIX D

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

WASHINGTON, D.C. 20590

OFFICE OF
THE ADMINISTRATOR

MAY 27 1975

Notation 1481

Honorable John H. Reed
Chairman, National Transportation Safety Board
800 Independence Avenue, S. W.
Washington, D. C. 20594

Dear Mr. Chairman:

This is in response to your letter of March 12 which transmitted NTSB Safety Recommendations A-75-25 thru 27.

Recommendation No. 1.

Issue an Operations Bulletin to all air carrier and general aviation inspectors to stress the need for pilots to use attitude information when questionable information is presented on instruments that are dependent on the air data system. The information in this Bulletin should be disseminated to all operators for incorporation into their operations procedures and training programs. (Class 1)

Comment.

Air Carrier Operations Alert Bulletin 75-3 dated February 13 covers this subject. A Part 135, Air Taxi Bulletin, is being prepared. We are also considering the issuance of an advisory circular on the subject.

Recommendation No. 2.

Issue an Airworthiness Directive to require that a warning system be installed on transport category aircraft which will indicate, by way of a warning light, when the flight instrument pitot heating system is not operating. The warning light should operate directly from the heater electrical current. (Class 2)

Comment.

We do not concur in this recommendation. Some current aircraft have cycling types of pitot heaters. These cycle on and off as controlled by thermostats or timers. Warning lights would flash on and off with

the cycling. We consider this as distracting and possibly detrimental to safety. Other aircraft in which the pitot heat is controlled directly by a simple on-off switch could be modified by adding a power relay and warning light. We do not consider this necessary or desirable. Operation of pitot heat is on cockpit checklists and is well covered in operations manuals and crew training. In addition, the effectiveness of additional warning lights among the many warning lights presently installed in the cockpit is of doubtful value.

Recommendation No. 3.

Amend the applicable Federal Air Regulations to require the pitot heating system to be on any time electrical power is applied to an aircraft. This should also be incorporated in the operator's operations manual. (Class 2)

Comment.

This recommendation is considered to apply to all types of aircraft in service and to future designs. We propose to delete from consideration those aircraft which are limited to VFR flight only since they are not required to have any deicing capabilities.

Retrofit on existing aircraft presents many problems and we do not consider the recommendation practical for general adoption. Some cyclic installations will not tolerate continuous heat and would have to be completely replaced. Continuous heat would be unsafe in many circumstances such as extended parking with electrical power on. As you mentioned, reliability would be reduced leading to more frequent unsafe conditions in flight. We do not consider retrofit of existing aircraft practical or feasible.

For new designs the recommendation may be feasible because the installations can be safe and reliable by design of interfacing electrical power systems, positioning of pitot tubes, and construction of pitot tubes. A regulatory project leading to a Notice of Proposed Rule Making and subsequently a rule requiring an appropriately designed pitot heating system is being established.

Sincerely,

James E. Dow

James E. Dow
Acting Administrator