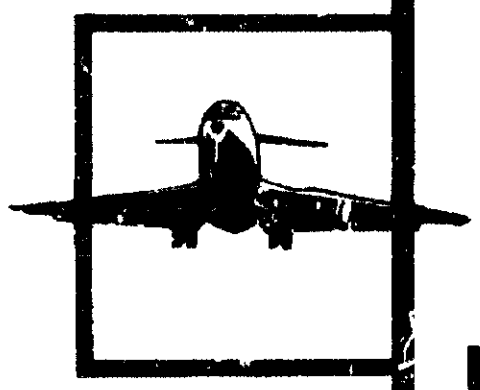

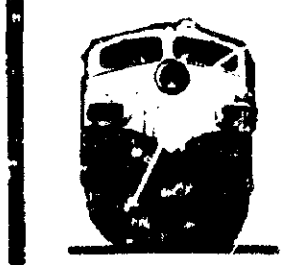

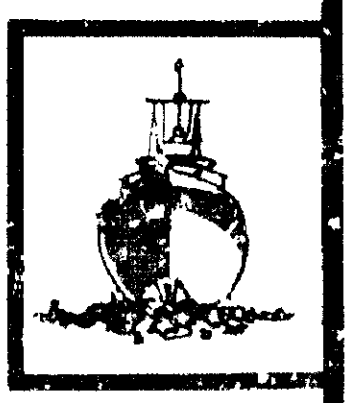

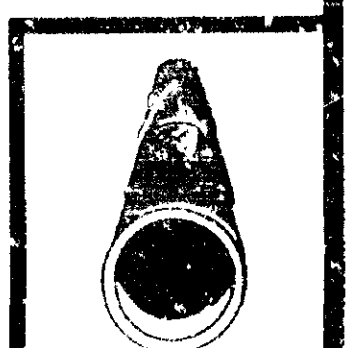

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

ALLEGHENY AIRLINES, INC.
NORD 262, MOHAWK/FRAKES 298, N29824
BENEDUM AIRPORT
CLARKSBURG, WEST VIRGINIA
FEBRUARY 12, 1979

NTSB-AAR-79-12

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16.Abstract

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The official weather at the time of departure was: Sky--partial obscuration 1,000 ft overcast; visibility--5/8 mi in snow; wind--calm; altimeter--29.89 inHg.

The National Transportation Safety Board determines that the probable cause of the accident was the captain's decision to take off with snow on the aircraft's wing and empennage surfaces which resulted in a loss of lateral control and a loss of lift as the aircraft ascended out of ground effect.

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WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

Adopted: August 16, 1979

ALLEGHENY AIRLINES, INC.
NORD 262, MOHAWK/FRAKES 298, N29824
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FEBRUARY 12, 1979

SYNOPSIS

At 1300 e.s.t., on February 12, 1979, a Nord 262, Mohawk/Frakes 298, N29824, operating as Allegheny Flight 561, departed Benedum Airport, Clarksburg, West Virginia, for National Airport, Washington, D.C., with 25 persons on board. The aircraft crashed about 14 sec after liftoff. Two persons were killed and eight persons were seriously injured; the aircraft was destroyed.

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1. FACTUAL INFORMATION

1.1 History of the Flight

On February 12, 1979, Allegheny Airlines Flight 561 (N29824) had originally departed Benedum Airport, Clarksburg, West Virginia, for Morgantown, West Virginia, at 1116, 1/ but the pilot decided not to make an approach at Morgantown because the instrument landing system's (ILS) glide slope was out of service, and the visibility was 1/2 mi. Thereafter the flight returned to Benedum Airport and landed at 1146.

The aircraft was on the ground for about 1 hr 14 min at Benedum Airport. During that time the aircraft was refueled to 3,000 lbs of Jet-A fuel (1,500 lbs in each wing tank), and all surfaces were deiced with a mixure of unheated ethylene glycol and water. Although the Safety Board could not determine the precise time of deicing, the persons

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

involved stated that it was performed between 1220 and 1235. The persons who deiced the plane stated that there was no snow or ice on the aircraft when they finished deicing it.

Flight 561 was rescheduled as a passenger flight from Benedum Airport to National Airport, Washington, D.C. There were 22 passengers and a crew of 3 on board.

Before the captain started the engines for taxiing, the station agent asked him if he wanted the aircraft deiced again, since it was still snowing. The captain declined the offer and about 1257 he taxied the aircraft from the parking ramp. According to the station agent, the aircraft had about 1/4 in. of wet snow on all its horizontal surfaces when it left the parking ramp. He said that some of the snow blew off as the aircraft moved toward the departure runway, but some of the snow appeared to stick to the aircraft's horizontal surfaces.

Twelve of the passengers recalled that shortly after liftoff, the aircraft rolled to the right, back to the left, and back to the right. After the last roll, the right wingtip struck the ground and impact followed shortly thereafter. The aircraft crashed in an inverted position off the right side of the departure end of runway 21.

According to other witnesses, the ground roll appeared normal. The Clarksburg Tower local controller said that he saw Flight 561 taxi to runway 21, and he cleared the flight for takeoff. He saw the aircraft during takeoff until it reached taxiway D, which is about 1,000 ft from the tower, but he did not see the aircraft after that point. He had spoken with the captain by telephone before the takeoff and had given him the 1215 special observation weather. He also radioed the same weather to Flight 561 when it was taxiing for takeoff. He stated that he saw no snow on the aircraft but that moderate snow was falling at the time.

The Clarksburg approach controller said that he saw Flight 561 as it turned to line up for takeoff on runway 21. He watched the aircraft through binoculars and saw nothing abnormal as the takeoff roll began. He thought the aircraft was rotated about 1,900 ft down the runway and the liftoff appeared to him to be normal. He lost sight of the aircraft at 50 ft of altitude because of the poor visibility. He recalled that during Flight 561's takeoff, the runway lights were set at their highest intensity. He also stated that he saw no snow blow off the aircraft during its takeoff roll. Shortly after the aircraft disappeared from his view, he heard the sound of an emergency locator transmitter on 121.5 MHz. He asked the Cleveland Center controller if Flight 561 had established contact with him. Since his reply was negative, the approach controller closed the airport and activated the airport emergency plan.

The control tower chief observed Flight 561 during takeoff. He lost sight of the aircraft when it was at an altitude of about 20 ft above the runway. At that time the aircraft's attitude appeared to be normal.

A pilot in the terminal restaurant said that when the aircraft left the parking ramp, he saw about 1/2 to 1 in. of snow on the wing and tail surfaces of the aircraft. He said that the takeoff appeared normal; but, just before the aircraft disappeared into the overcast, it appeared to pitch up sharply.

Another witness who had experience as a pilot was located on taxiway C about 75 ft from the runway. He thought the aircraft lifted off about 200 to 300 ft past taxiway C. Shortly after liftoff, he saw the right wing of the aircraft dip about 45°, then the left wing dipped about the same amount, and the right wing dipped again before the aircraft disappeared from his view about 100 ft above the runway. Shortly thereafter, he heard two separate and distinct sounds of impact. The witness heard no unusual engine noises from the aircraft.

The aircraft crashed during daylight hours at an elevation of 1,203 ft m.s.l. and at latitude 39°17'44"N and longitude 80°13'44"W, 7.5 nmi east of Clarksburg, West Virginia.

1.2 Injuries to Persons

Injuries	Crew	Passengers	Other
Fatal	1	1	0
Serious	1	7	0
Minor/None	1	14	0

1.3 Damage to Aircraft

The aircraft was destroyed.

1.4 Other Damage

The runway lighting system and associated wiring were damaged.

1.5 Personnel Information

The flightcrew and the flight attendant were properly certificated and qualified for the flight. (See Appendix B.)

1.6 Aircraft Information

N29824 was purchased by Allegheny Airlines on June 2, 1978, and had accumulated 9,140 flight-hours. The aircraft was certificated and equipped in accordance with current Federal aviation regulations and company procedures. (See Appendix C.)

The aircraft's maximum allowable takeoff weight was 23,370 lbs. The takeoff gross weight shown on dispatch documents was 23,368 lbs with a center of gravity (c.g.) of 26.5 percent mean aerodynamic chord (MAC). The c.g. limits for this weight are 20.9 percent MAC forward and 30.0 percent MAC aft. Safety Board calculations confirmed that the takeoff gross weight and c.g. were within limits.

1.7 Meteorological Information

At 0700 on February 12, 1979, the weather over northern West Virginia was characterized by a low pressure area over southern Indiana with a double cold front extending southwest through northwestern Arkansas, and a stationary front extending east-southeast through extreme southern West Virginia and then southeast through the Piedmont area of North Carolina. At 1000 the low had moved east to the border of southern Indiana and Ohio, and the stationary front had begun to move north as a warm front. At 1300, the low had moved into southern Ohio and the warm front had moved across central West Virginia. A high, which had been over the New Jersey coast at 0700, had lost its identity by 1300 and had allowed the low to accelerate its eastward movement.

Throughout the period, the weather in northern West Virginia was characterized by overcast skies, light northerly winds, and light to moderate snow.

The following are the surface observations at Clarksburg, taken by qualified personnel of the Federal Aviation Administration (FAA):

1146 Sky--partial obscuration, estimated 1,000 ft overcast, visibility--1 mi, light snow showers; temperature--29°F; dewpoint--26°F; wind--calm; altimeter--29.94 in.

1215 Sky--partial obscuration, estimated 1,000 ft overcast; visibility--5/8 mi, light snow showers; wind--340° at 1 kn; altimeter--29.91 in.; remarks--snow obscuring 3/10 of sky and braking action fair to poor.

1300 Sky--partial obscuration, estimated 1,000 ft overcast; visibility--3/8 mi, light snow showers; temperature--31°F; dewpoint--28°F; wind--360° at 1 kn; altimeter--29.88 in.; remarks--snow obscuring 3/10 of sky and braking action fair to poor.

Based primarily on observations of visibility, the rates of snowfall at Benedum Airport were computed as follows for the times indicated:

Time	Rate (Ins./hour)
1215	0.50
1230	0.69
1245	0.98
1300	1.25

At 1135, 1235, and 1345 the National Weather Service weather radar at Pittsburg, Pennsylvania, showed Clarksburg in an area 9/10 of which was covered with moderate snow. The top of the observable precipitation was 15,000 ft. No convective activity was observed.

The NWS forecast office at Washington, D.C., issued the following AIRMETS 2/ which were valid at the time of the flight:

AIRMET Bravo 3.

> Flight precautions--Over southern Ohio and southwestern West Virginia for icing. Occasional moderate rime or mixed icing in clouds and in precipitation above the freezing level, spreading eastward over southern West Virginia, western Virginia, and western Maryland during the period. Multiple freezing levels below 4,000 ft.

AIRMET Alfa 2.

> Flight precautions--Over Ohio, adjacent Great Lakes, northern West Virginia, western and central Maryland, District of Columbia, and northern Virginia for IFR conditions. Ceilings frequently below 1,000 ft and visibilities less than 3 mi in snow or mixed precipitation. IFR conditions spreading to eastern Maryland, Delaware, southern Virginia, southern West Virginia, and the mountains of North Carolina during the period.

1.8 Aids to Navigation

The aids to navigation were not factors in the accident.

1.9 Communications

Communications was not a factor in this accident.

2/ In-flight weather advisories which cover moderate icing, moderate turbulence, sustained winds of 30 kns or more within 2,000 ft of the surface and the initial onset of phenomena producing extensive areas of visibilities below 2 mi or ceilings less than 1,000 ft.

1.10 Aerodrome and Ground Facilities

Benedum Airport has two runways--3/21 and 13/31. Runway 3/21 is 5,198 ft long and 150 ft wide; the surface is asphalt/concrete, and the runway is equipped with high intensity runway lights. Runway 21 is equipped with a medium intensity approach lighting system, and runway 3 has no approach lights but has runway end identifier lights and a visual approach slope indicator. Runway 13/31 is 2,500 ft long and 150 ft wide, and it is asphalt/concrete surfaced. Airport elevation is 1,203 ft.

1.11 Flight Recorders

The aircraft was equipped with a Sundstrand Model FA-542 flight data recorder (FDR), serial No. 1706. The FDR was not required equipment because Allegheny Airlines operated the aircraft under 14 CFR 121, with applicable provisions of Special Federal Aviation Regulations 33 (SFAR 33) which permitted large aircraft with seating capacities of 30 seats or less to be operated without flight or cockpit voice recorders.

The FDR case was intact and was not damaged. All parameters except the vertical acceleration trace were clear and active. The vertical acceleration trace was static and had been static on all recordings on the foil. The airspeed and attitude traces were not accurate because the FDR was located aft of the aft pressure bulkhead near a cabin pressurization relief valve, and the FDR's static pressure source was near the relief valve. This is a known deficiency in FDR's on Nord 262, Mohawk/Frakes 298, aircraft.

Although not required, the aircraft was also equipped with a Sundstrand cockpit voice recorder (CVR), serial No. 1804. The voice tape was in good condition and a complete transcript was prepared. (See Appendix D)

1.12 Wreckage and Impact Information

The aircraft crashed within the airport boundary. Shortly after liftoff, the right wingtip contacted the left side of the runway, 4,398 ft from the takeoff end of the runway, and the outboard portion of the right wing broke off; the wing came to rest 192 ft from the point of first contact. The aircraft fuselage hit the runway in an inverted position, slid down the runway, and came to rest off the right side of the departure end of runway 21, 60 ft from the end of the runway and 137 ft to the right of the runway centerline. There was no fire. (See figure 1 and Appendix E.)

Examination of the aircraft structure disclosed no evidence of preimpact structural damage. Both engines remained with the center section of the wings. The left engine and nacelle remained in place, and the right engine mount separated from the wing. The right engine came to rest adjacent to the center section.

Figure 1. The Nord 262 as it came to rest at the end of runway 21.

The left engine exhaust case was buckled. All power turbine blades broke off and all stator vanes were severely nicked and peened. The fuel valve was open. Although the left propeller remained on the engine, all blades had broken off. Four blades were not recovered.

The right engine compressor case was buckled. There was also slight buckling in its exhaust case. The propeller reduction gearcase and propeller separated from the engine at the rear flange. The second-stage planetary carrier and planetary gears were separated from the gearbox. The right propeller came to rest on the right side of the runway. All blades were intact but were severely bent and twisted. There was no visible damage to the right engine power turbine.

The fuel filters in both wings were clean. There was fuel in the filter bowls and no ice was evident. The right engine fuel valve was open. Both engines and propeller assemblies and associated components were disassembled and inspected; there was no evidence of preexisting operational distress. All damage resulted from impact or wreckage recovery operations.

The landing gears were down and locked, and the wing flaps were fully retracted. The gust lock actuators were fully retracted (unlocked). The fire extinguishers were intact and were fully charged. The electrical power system, hydraulic system, air conditioning system, stall warning system, and pitot static system were examined and tested to the extent possible; no evidence of malfunction or failure existed.

The right aileron was attached to its wing and was not damaged. It was in the faired position and moved freely to its up and down limits. The trim tab was intact and undamaged.

The left aileron was attached to its wing and was not damaged; it was in the faired position but would move only slightly up and down because of control cables binding. One control cable for the left aileron had separated in tensile overload; the other cables were intact but their movements were restricted by extensive fuselage damage just aft of fuselage station (F.S.) 134.

The left and right elevator assemblies and their control cables were intact and were not damaged. The rudder was separated from the vertical stabilizer at its upper hinge point and was bent to the left and slightly aft. The rudder cables were intact.

Within 15 to 20 min after the accident, the chief dispatcher for Aeromech, Inc., inspected runway 21 for marks and debris. He stated that the snow was 1/2 to 3/4 in. deep and that the aircraft's tire tracks in the snow were straight and aligned with the runway until they disappeared at the point of liftoff. He said that the aircraft's electrical power remained on after the accident because the landing light was illuminated.

Beginning about 45 min after the accident, an aircraft mechanic took numerous photographs of the accident scene. These photographs show that the deicer boots on both wings and the horizontal stabilizer were clear of ice and snow. A photograph of the right wing shows an apparent mixture of loose snow and frozen snow on the top surface of the wing. Another photograph shows an area of frozen snow on the top surface of the left horizontal stabilizer; the area covers about 30 percent of the surface excluding the deicer boot. The stabilizer was inverted and was not exposed to snow that fell after the accident. No photographs were taken of the top surface of the left wing because it remained attached to the fuselage and was inverted. However, a photograph of a portion of the trailing edge of the left wing showed a ridge of ice on the top surface of the wing just forward of the leading edge of the outboard portion of the landing flaps. 3/

1.13 Medical and Pathological Information

Postmortem examination of the first officer and the passenger indicated that both died from trauma. The first officer had multiple lacerations, abrasions and contusions of the head and neck, a fractured skull, lacerations of the brain, subdural hematoma, cerebral edema, fractured cervical vertabrae column, lacerations of the aorta, and other

3/ The photographs were not included in the report because the necessary details cannot be reproduced with sufficient clarity. The photographs are a part of the Safety Board's public file on the accident.

injuries. Toxicological examinations of the first officer disclosed no evidence of drugs, alcohol, or elevated levels of carbon monoxide. The passenger had lacerations of the left forehead and temporal region and a fractured skull.

The captain had a fractured skull and a fractured right clavicle. Of the seven severely injured passengers, three had compression fractures of the first lumbar, one had a compression and fracture of the T-12 vertabra, one had a compression of the first lumbar, one had a fractured skull, and one had a closed fracture of the frontal skull bone. Three of these passengers fractured ribs or lower extremities. Five of these passengers were seated in the first three rows of seats. The fourteen passengers who received minor injuries had a variety of lacerations, contusions, and abrasions. The captain was unable to recall any of the events associated with the accident.

1.14 Fire

There was no fire.

1.15 Survival Aspects

The aircraft was configured with 26 passenger seats arranged in 9 rows of dual units on the right side of the cabin and 8 rows of single units on the left side; the seat farthest aft on the left side of the aircraft was the flight attendant's seat. The first row of three seats faced aft; the remainder of the seats faced forward. All seats were equipped with seatbelts with metal connections. The flightcrew's seats and flight attendant's seat were equipped also with double strap, inertia reel, shoulder harnesses.

Cargo bins were located between the cabin area and the cockpit; the bin on the left side of the aircraft was equipped with an external door. The aircraft was configured with four emergency exits, one on each side of the cabin just aft of seat row No. 1, one on the right side of the cabin opposite the rear main entry door, and an overhead hatch for ditching purposes.

Few of the passengers recalled the aircraft's maneuver into the inverted position; the first event they recalled was being suspended upside down by their seatbelts. Those passengers who recalled impact remembered sliding for a short period of time and debris "flying" through the cabin. Before the impact, no one recalled any warning from the cockpit.

After the aircraft came to rest, most of the passengers exited through the right rear emergency exit. However, four passengers in seat-row Nos. 1 through 5 left through an opening in the fuselage, and one passenger in row No. 1 was assisted through the cargo door by rescue

personnel. Most of the passengers stated that they were out of the aircraft by the time rescue personnel arrived. Except for five passengers, all passengers were taken to the terminal building and from there were transported to the hospital. The other five passengers were taken immediately to the the United Hospital Center in Clarksburg. The Safety Board believes that, under the circumstances, the response and actions of crash/fire/rescue personnel was timely and commendable.

The fuselage was intact but had been subjected to extensive impact damage. The forward right side of the fuselage, forward of seatrow No. 3, had been crushed inward about 1 ft. There was a 1-ft separation in the fuselage forward of seatrow No. 2 at the aft end of the forward right exit window. On the left side of the fuselage there was a smaller separation adjacent to seatrow No. 2. These separations occurred in the area just forward of the wings' leading edges.

The forward right primary emergency exit was jammed and could not be opened. The passenger entry door remained intact and attached to the fuselage at its lower hinge points. The door consisted of two parts that opened manually both upward and downward. The top portion of the door had separated from its fuselage attachments. Both sections of the door were found locked and could not be unlocked. The right aft primary emergency exit was found open and the door was on the ground about 7 ft to the rear of the opening. The left forward primary emergency exit was closed and jammed. The left forward cargo door was open and attached to its top hinges. The overhead hatch was found intact and closed. It was later opened without difficulty and was not damaged.

Most of the passenger's seats were intact and were either undamaged or damaged only slightly. One seat was dislodged from its floor and wall retention tracks.

The first officer's sun visor was broken. The ceiling panels and ceiling support structure were also displaced in this area. The first officer's yoke was displaced to the left about 6 ins. by inward displacement of the wall. The outside wall near the first officer's seat was dislodged at the ceiling just aft of his seat. The cockpit escape window at the first officer's side was displaced inward about 3 ins.

The first officer's seat was bent upward and to the right. The left arm rest was broken. His shoulder harness was cut during rescue operations. The captain's seat was removed during the rescue operation; its arm rest padding was broken, and the lap belt and shoulder harness were cut during rescue operations.

At 1301, the Clarksburg tower received the emergency locator signal from Flight 561, and about the same time a lineman from Allegheny told operations personnel that Flight 561 had crashed. At 1302, the tower closed the airport and notified the air rescue team at the airport. At 1305, the rescue team found the aircraft and requested additional help through the control tower. The tower then called the Harrison Fire

and Rescue Squad for additional ambulances. By 1311 three ambulances arrived to take the more seriously injured persons directly to the hospital. At 1312, two ambulances from the United Hospital Center arrived to assist in removing the injured.

For the passengers, the accident was survivable because the decelerative forces did not exceed the tolerable limits of the human body, the occupiable space within the cabin remained relatively intact, the occupant-restraint systems remained intact, and there was no fire. Only one of the four emergency exits was available for passenger use.

The injuries of six of the seven passengers who were seriously injured resulted from their flexing over their seatbelts while they were in the inverted position during impact. This caused serious injury to their lower lumbar regions. The other two serious injuries, including the captain's, were caused by the person's head forcibly contacting aircraft structure that was displaced inward. Many persons incurred minor injuries after the crash when they released their seatbelts and fell downward.

The passenger who died did not have her seatbelt fastened at impact; consequently, she was not restrained and her head hit objects in the aircraft's ceiling structure when the aircraft rolled into the inverted position. The first officer's fatal injuries were caused by the inward displacement of the right frontal area of the cockpit which permitted his head and upper body to hit unyielding objects.

1.16 Tests and Research

Under the direction of the Safety Board, various aircraft components were functionally tested. These components included the gust lock actuators, stall warning system, flight director systems, deicer systems, light bulbs, fuel controls and fuel pumps, autopilot and elevator electric trim servos, propeller governors, ground proximity warning system computer, and a.c. electrical power inverters and transformers. Most of these operated within or close to prescribed specifications. However, some were damaged to the extent that testing was not possible. There was no evidence of stretched filaments in the light bulbs from the pilot's annunciator panel, autofeather panel, and engine start panels, such as would be expected had the bulbs been illuminated at impact.

Although the stall warning system components operated satisfactorily, the system was at a tolerance limit which would have caused activation of the stall warning horn at angles of attack slightly lower than normal. Records indicated that the system was last serviced on July 12, 1978, and no problems were recorded after that date.

Springs in the aileron and elevator/rudder control locking actuators were shorter than prescribed by specifications; however, both actuators functioned normally when installed in another aircraft.

Two seatbelts were tested to determine whether they were fastened at the time of impact. The test showed no evidence of loading sufficient to mark the belt webbing or connections. Both belts were also loaded in tension to the minimum Technical Order standard of 1,500 lbs to test security of the webbing-to-connector bond; the bonds were secure.

A sample of the deicing fluid used to deice the aircraft was tested. The sample consisted of 78 percent ethylene glycol (antifreeze) and 22 percent water which provides protection from freezing at temperatures lower than -50°F.

1.17 Additional Information

1.17.1 Company Directives

According to Allegheny Airlines' flight operations manual, "It is the Captain's responsibility to exercise precaution in taking off under any freezing precipitation conditions. No takeoff should be made when frost, snow, or ice is adhering to wings, flight controls, or propellers."

1.17.2 Aircraft Performance

According to performance data from the airplane manufacturer, Flight 561's takeoff distance 4/ should have been about 2,900 ft, and its distance to rotation speed should have been about 2,300 ft. These data are based on a pressure altitude of 1,200 ft, an ambient temperature of 31°F, and an aircraft gross weight of 23,350 lbs. Additionally, Flight 561's engine failure recognition speed was 98 kns, its rotation speed was 98 kns, and its initial climb speed at 35 ft a.g.l. was 107 kns.

The aircraft's power-off stall speed without flaps was about 83 kns. With power on, the manufacturer estimated the stall speed between 77 to 79 kns. Stalls are characterized by a nosedown rotation about the aircraft's lateral axis, sometimes accompanied by a roll to the right; however, the roll never exceeds 20° of bank. According to the manufacturer's flight tests, stalls are preceded by buffeting of the empennage, the magnitude of which increases as engine power increases. Buffeting precedes actual stall by 2 to 3 kns. According to the airplane flight manual, the stall warning horn should sound 4 to 8 kns above stall speed.

1.18 New Investigation Techniques

None.

4/ horizontal distance from the takeoff roll to the point where the aircraft reaches an altitude of 35 ft above ground level.

2. ANALYSIS

The flightcrew was properly certificated and trained in accordance with applicable regulations. There was no evidence of preexisting medical or physiological problems that might have affected the flightcrew's performance.

The aircraft was certificated and equipped according to applicable regulations. The gross weight and c.g. were within prescribed limits. The aircraft's structure and components were not factors in this accident. There was no evidence of any failure or malfunction in the aircraft's systems, including the flight control system, the flight instrument system, and powerplants.

Evidence indicates that the takeoff roll was normal and that no problems were encountered until after the aircraft left the runway surface. The aircraft's nose gear left the runway about 2,225 ft from the threshold of runway 21, which compares favorably with the distance predicted by performance data. Also, witness reports indicate that the aircraft's takeoff roll appeared normal.

Based on witness reports and passenger statements, the Safety Board concludes that the flightcrew encountered lateral control problems with the aircraft shortly after it left the runway surface. Further, as a result of the the lateral control problems, the aircraft's right wingtip struck the runway surface with sufficient force to separate a substantial section of the right wing. After the loss of the right wing section, the aircraft continued to roll to the right to the inverted position and crashed.

Examination of the flight control system revealed no discrepancy which could have induced a lateral control problem. Also, there was no evidence that any components of the flight instrument system were faulty. Further, the information conveyed to the pilots by their attitude instruments was accurate. Although the first officer's flight director system could not be tested because of extensive damage, the captain's system functioned properly. CVR conversations indicate that the captain was flying the aircraft and that both flight instrument systems were functioning properly before takeoff. The questionable comment on the CVR, "no horizon," could have been a reference to a problem with an attitude indicating instrument. However, because of the questionable nature of the comment, and because the remark, if accurate, more probably related to the low external visibility situation and the lack of a visual horizon, the Safety Board concludes that the lateral control problem was not related to flight instrumentation. Moreover, since both pilots were experienced, instrument-rated pilots, it is not likely that either would have misread his attitude instrument.

Ice, snow, or frost adheres to an aircraft's wings, control surfaces, and stabilizing surfaces and can cause control problems; 5/ because of such problems, 14 CFR 91.209 prohibits takeoffs in an airplane "...that has...snow or ice adhering to the wings, or stabilizing or control surfaces...or...any frost adhering to the wings, or stabilizing or control surfaces, unless the frost has been polished to make it smooth."

According to a recent review 6/ of the effects of wing surface roughness, frost, snow, or freezing fog adhering to wing surfaces causes a reduction in maximum lift coefficient, a reduction in the angle of attack at which stall occurs, and rapid post stall increases in drag. The above effects are most pronounced when the roughness is on or near the leading edge of the wing. For example, for a given particle size of uniform roughness, the maximum lift coefficient is reduced: (1) 35 percent if the roughness is located within the first 2 percent of the wing chord, (2) 15 percent if the roughness is located aft of the first 10 percent of the wing chord, and (3) about 8 percent if the roughness is located aft of the first 30 percent of the wing chord.

In this accident, evidence indicates conclusively that the aircraft's wings and horizontal stabilizer, including the deicer boots, were partially covered by wet snow or frozen snow when the takeoff roll began. Both the station agent and a local pilot recalled that the aircraft was taxied from the parking ramp with snow on the aircraft's wings and horizontal stabilizer. Also, after the engines were started, the station agent saw some of the snow blowing from the aircraft but recalled that some snow remained on the wings and horizontal stabilizer. Additionally, the photographs taken about 45 min after the accident clearly show frozen snow adhering to a substantial portion of the top surface of the left horizontal stabilizer. Since this surface came to rest in the inverted position, it could not have been exposed to any snow that fell after the accident. Finally, the photographs of the outboard portion of the right wing and the trailing edge of the left wing indicate that similar conditions probably existed on the top surfaces of both wings, excluding the surfaces of the leading edge deicer boots.

After the aircraft was deiced, snow continued to fall at an average rate of about 0.97 in. per hour. Consequently, within a 20-min period, nearly 1/3 in. of snow fell. Since the wind was nearly calm, the snow would not have blown from the aircraft's horizontal surfaces. The deicing fluid, although of substantial strength, apparently drained partially from the surfaces and was diluted by melting snow to the point that it became ineffective. Consequently, before the engines were

5/ H. H. Hurt, Jr., "Aerodynamics for Naval Aviators," NAVWEPS 00-80T-80. U.S. Navy, 1960.

6/ Ralph E. Brumley, "Wing Surface Roughness: Cause and Effect," DC Flight Approach, No. 32 Douglas Aircraft Company, McDonnell Douglas Corporation, January 1979.

started the aircraft's horizontal surfaces were at least partially covered with wet snow. Although after the engines were started, some of the snow exposed to the propellers' slipstreams was probably blown from the inboard surfaces of the wing, snow continued to adhere to sections of the wings outboard of the propeller radius. Moreover, because of the below-freezing ambient temperature and the further reduction in temperature caused by lowered pressure as the air moved over the top surfaces of the wings, the snow froze to the wing surfaces.

Conventional aircraft are generally designed so that the wings will begin to stall at the root section first. This permits the ailerons, which are outboard on the wings, to remain effective at high angles of attack and provides favorable stall warning characteristics from the buffet on the empennage. 7/ The Nord 262's design is not unusual in this respect, and stall tests show that the aircraft has good lateral control authority throughout entry to a stall and through the initial stages of a stall.

The Safety Board concludes that because of the snow that had adhered to the outboard surfaces of the wings of Flight 561, the normal stall characteristics of the wings were reversed. Consequently, the ailerons became at least partially ineffective before the wings lost enough lift to prevent the aircraft from climbing. Although ground effect probably provided added lift and reduced drag, once the aircraft had ascended to 70 ft above the runway, the increased angle of attack needed to maintain the required lift coefficient as the aircraft climbed out of ground effect, placed at least the outboard portion of the wings in a stall condition. This reduced lift and diminished aileron effectiveness. The aircraft then entered successive rolls to the right, left, and right as the pilot attempted to compensate for the loss of aileron authority.

Since a banked attitude decreases the vertical component of lift, increases in either angle of attack or airspeed, or both, are needed to maintain level or climbing flight when the aircraft rolls into a bank. In this case, when the aircraft entered successive rolls, airspeed probably could not be increased because power was at maximum for takeoff and further increases in the angle of attack aggravated the stall condition. Consequently, the aircraft lost altitude during the rolling maneuvers and crashed. The loss of lateral control, therefore, was the primary impediment to the pilot's capability to maintain flight. The Safety Board believes that the stall warning horn never sounded, which indicates that the stall occurred at an angle of attack below that for which a stall would normally be expected and even below the threshold for stall warning. Snow or frost on an airfoil will produce such a change in the aerodynamic characteristics of the airfoil.

7/ Ibid.

Since the captain of Flight 561 could not recall any of the events associated with the accident, the Safety Board was not able to determine why he decided to take off with snow on the aircraft's wings, in spite of the station agent's advice that the aircraft's wings and horizontal stabilizer were covered with snow. The Safety Board believes that the captain may not have been completely aware of the condition of the wings because they are on top of the aircraft's fuselage, about 12 ft above ground level. However, the captain should have considered the rate of snowfall which increased significantly during the 20- to 30-min period before takeoff. Further, after receiving the information from the station agent, the captain may have thought that any accumulation of snow on the wings' surfaces was either insignificant or would be blown from the wings while taxiing. In this respect, he might also have been misled by the condition of the deicer boots, which were essentially clean. In any event, the captain did not take the proper precautions to insure compliance with company directives and Federal aviation regulations. Consequently, the Safety Board concludes that the captain's decision to take off without insuring that all snow had been removed from the aircraft's control and lifting surfaces was the cause of the accident.

The accident again illustrates that in order to insure the level of safe operation desired from a professional pilot, he must take the proper measures to insure that wings, stabilizing surfaces, and control surfaces are clean and free of ice, snow, or frost before he attempts a takeoff. Further, any doubts about the matter must be resolved by visual inspection--if necessary, immediately before the takeoff is begun.

3. CONCLUSIONS

3.1 Findings

1. The flightcrew was properly certificated and was qualified for the flight.

2. The aircraft was airworthy, and it was certificated and maintained in accordance with existing regulations and approved procedures.

3. There was no evidence of a failure or malfunction of any of the aircraft's structure or systems, including flight control sytems, flight instrument systems, and powerplants.

4. The aircraft had been deiced 20 to 30 min before takeoff; however, about 1/4 in. of wet snow had accumulated on the top of the wings and horizontal stabilizer before the captain taxied the aircraft for takeoff.

5. The captain of Flight 561 did not insure that the aircraft's wings, stabilizing surfaces, and control surfaces were clean and free of snow before he began the takeoff roll.

6. Flight 561's takeoff roll was normal and it conformed to predicted performance values.

7. Shortly after liftoff, the aircraft became laterally unstable; it rolled to the right, then to the left, back to the right, and its right wing struck the runway.

8. The snow adhering to the outboard sections of the wing probably caused those sections to stall prematurely.

9. The stalling of the outboard sections of the wings caused a loss of lift and significantly reduced the effectiveness of the ailerons, which resulted in lateral control problems and lateral instability.

10. The lateral oscillation of the aircraft further decreased lift and caused the aircraft to lose altitude and crash.

11. The accident was survivable for the passengers.

12. One passenger was fatally injured because her seatbelt was not fastened.

13. The accident was marginally survivable for the flightcrew because the cockpit structure was crushed inward, which reduced the occupiable space, particularly for the first officer.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the captain's decision to take off with snow on the aircraft's wing and empennage surfaces which resulted in a loss of lateral control and a loss of lift as the aircraft ascended out of ground effect.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JAMES B. KING
Chairman

/s/ ELWOOD T. DRIVER
Vice Chairman

/s/ PATRICIA A. GOLDMAN
Member

/s/ G. H. PATRICK URSLEY
Member

FRANCIS H. McADAMS, Member, did not participate.

August 6, 1979

5. APPENDIXES

APPENDIX A

Investigation and Depositions

1. Investigation

At 1312 e.d.t. on February 12, 1979, the National Transportation Safety Board was notified of the accident by the FAA Communications Center in Washington, D.C. An investigative team was formed immediately. However, because of severe weather conditions over the entire northeastern section of the United States, the team's departure was delayed until 0700 e.d.t. on February 13, 1979. The team arrived at the accident site about 1200 on February 13, 1979.

Investigative groups were established for operations/witnesses/air traffic control, human factors, structures, systems, powerplants, weather, and aircraft records. Representatives of the Federal Aviation Administration, Allegheny Airlines, Pratt & Whitney Aircraft Group of United Technologies, Air Line Pilots Association, International Association of Machinists, Association of Flight Attendants, Professional Air Traffic Controllers Organization, and the Hartzell Propeller Company participated in the investigation.

2. Depositions

The deposition of a ground observer was taken on February 16, 1979, at Clarksburg, West Virginia. No public hearing was held.

APPENDIX B

Personnel Information

Captain Robert Everly

Captain Robert Everly, 30, was employed by Allegheny Airlines on January 30, 1978. At the time of the accident he held Airline Transport Pilot Certificate No. 495489866, first issued on December 15, 1977, with commercial pilot and single-engine land ratings. He also held type ratings in the DC-9 and Nord 262 aircraft.

During his flying career, Captain Everly had accumulated 4,028:32 hrs of flight-time, 528:32 of which were in the Nord 262 aircraft. His first-class medical certificate had no restrictions and was dated July 25, 1978. According to company records he had completed and passed a first-class medical examination on January 23, 1979.

First Officer David C. Baltes

First Officer David C. Baltes, 29, was employed by Allegheny Airlines on March 20, 1978. He held Airline Transport Pilot Certificate No. 1879631, first issued on July 19, 1976, with airplane multiengine land and airplane single-engine land ratings. He held type ratings in Lear Jet and Nord 262 aircraft.

During his flying career, First Officer Baltes had accumulated approximately 7,474:19 flight-hrs, 474.19 of which were in Nord 262 aircraft. His first-class medical certificate had no restrictions and was dated March 13, 1978.

Flight Attendant Deborah Freeland

Flight Attendant Deborah Freeland, 25, was employed by Allegheny Airlines on September 26, 1977. Her last proficiency check was completed on May 24, 1978, and her last recurrent training was completed on September 27, 1978.

APPENDIX C

Aircraft Information

The aircraft, U.S. Registry N29824, originally a Nord 262, serial No. 48, was manufactured by Aerospatiale in July 1968; it was acquired by Allegheny Airlines on June 2, 1978.

The aircraft was modified in 1978 by Frakes Aviation, Cleburne, Texas, in accordance with supplemental type certificate Nos. SA 2369SW and SA 2367SW. These modifications included installation of Pratt & Whitney PT-6 engines, re-design of the interior, installation of a lavatory, and installation of flight data and cockpit voice recorders. The aircraft was then re-designated a Mohawk/Frakes M298.

The aircraft was equipped with two Pratt & Whitney PT6A-45 turbine engines and Hartzell HC-5E MP-3 propellers.

The operating times and serial Nos. for the engines and propellers were:

	Position	Serial No.	Total Time	Installation Date
Engines	No. 1	84039	1,729:00	Nov. 2, 1978
	No. 2	84040	1,269:00	June 3, 1978
Propellers	No. 1	EV-40	927:00	July 31, 1978
	No. 2	EV-83	1,007:00	July 31, 1978

The aircraft had accumulated a total of 9,140.54 hours, including 53.39 hours since the last C-3 maintenance check, which was accomplished on February 1, 1979. The last through-service check was accomplished on February 11, 1976.

APPENDIX D

TRANSCRIPT OF A SUNDSTRAND COCKPIT VOICE RECORDER REMOVED FROM THE ALLEGHENY NORD WHICH WAS INVOLVED IN AN ACCIDENT AT CLARKSBURG, WEST VIRGINIA, ON FEBRUARY 12, 1979

LEGEND

CAM	Cockpit area microphone voice or sound source
RDO	Radio transmission from accident aircraft
-1	Voice identified as Captain
-2	Voice identified as First Officer
-3	Voice identified as Stewardess
-?	Voice unidentified
TWR	Clarksburg Tower
M-3	Mobile three
M-4	Mobile four
*	Unintelligible word
#	Nonpertinent word
%	Break in continuity
( )	Questionable text
(( ))	Editorial insertion
---	Pause

Note: Times are expressed in elapsed time from an arbitrary zero.

INTRA-COCKPIT

TIME & SOURCE	CONTENT
%	
CAM	((Sound similar to windshield wiper coming on))
CAM-1	(Lights)
CAM-2	Get it
CAM-1	Yeah, two one
CAM-2	Yeah
CAM-3	Do you want tea?
CAM-2	Ah yes, please
CAM-1	That sheet you gave me, was that the tare sheet *
CAM-2	Think so
CAM-3	That's it right there

AIR-GROUND COMMUNICATIONS

TIME & SOURCE	CONTENT
16:14 TWR	Allegheny five sixty one via the center taxiway, taxi in position, hold runway two one, you will be following a snowplow to the end of two one
16:21 RDO-2	Roger
16:28 TWR	Clarksburg weather remains previously advised, sky partially obscured
TWR	One thousand overcast, visibility five eights and snow, winds are calm
TWR	The altimeter two niner --- niner check that two nine eight nine, clearance when you're ready
16:46 RDO-2	Okay, go ahead

INTRA-COCKPIT		AIR GROUND COMMUNICATIONS	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
		16:47 TWR	Allegheny five sixty one is cleared to the Washington National Airport via victor one sixty six Kessel as filed, maintain one one thousand squawk five seven seven one, you'll be Cleveland Center one two four point six
CAM	((Sound of squeal))		
	Flight tests indicated that sound and similar sounds recorded on the CVR were caused by the application of wheel brakes.	17:00 RDO-2	Okay, cleared to Washington one sixty six Kessel as filed eleven thousand
		RDO-2	Five seven seven one, twenty four six
		17:07 TWR	Five sixty one roger, and, ah, that's all correct, and Cleveland Center does have your request for higher
		17:12 RDO-2	Roger and we cleared on the runway yet?
		17:14 TWR	Affirmative, taxi into position and hold, the snow removal will be clearing momentarily
		17:19 RDO-2	Okay

INTRA-COCKPIT		AIR-GROUND COMMUNICATIONS	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
		17:27 M4	Four Clear
		17:29 TWR	Mobile four if you like, you can just make a one eighty hold short of the runway until this departure
		17:34 M4	Okay
		17:36 TWR	Mobile three, you may drive on the center taxiway, hold short of runway two one
CAM-2	Max, ninety eight and one oh seven		
CAM-2	Flight indicators		
CAM-2	Shoulder harness on the right		
		17:41 M3	Mobile three
CAM-1	On the left		
CAM-2	Takeoff data posted		
17:42 CAM-2	Flight instruments on the right	17:42 TWR	Okay
CAM-1	On the left		
CAM-2	Trim tabs		
CAM-1	Set		

INTRA-COCKPIT

TIME & SOURCE	CONTENT
17:52 CAM-1	Flaps are up
CAM-2	Okay, flaps are up autofeather
CAM-2	Water met
CAM-1	Not required
CAM-2	Engine bleed air
CAM-2	PY's are on, props are on
CAM-2	Windshield is on
CAM-2	Pitot heaters are on
CAM-1	Yes
18:00 CAM-2	Flight recorders
CAM-1	Both on
CAM	((Click))
18:05 CAM	((Sound similar to windshield wipers coming on))

AIR-GROUND COMMUNICATIONS

TIME & SOURCE	CONTENT
17:44 TWR	Allegheny five sixty one cleared for takeoff
17:46 RDO-2	Five sixty one cleared to go roger
17:52 TWR	Allegheny five sixty one when airborne contact Cleveland center one two four point six, have a nice day

INTRA-COCKPIT		AIR-GROUND COMMUNICATIONS	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
18:10			
CAM-2	On the top		
CAM	((Sound of click))		
18:14			
CAM-2	Props to go		
18:15			
CAM-1	Three (green)/(dings)		
18:43			
CAM	((Sound similar to windshield wipers coming on))		
18:46			
CAM	((Sound of squeal))		
CAM-1	Props are up (condition levers)		
CAM-1	All set		
CAM-2	Okay, checklist complete		
18:54			
CAM-1	(Really)		
		18:56	
		RDO-2	And five sixty one is rolling on two one
		19:01	
		TWR	Allegheny five sixty one, contact Cleveland Center one two four point six when airborne

INTRA-COCKPIT

TIME & SOURCE	CONTENT
CAM	((Sound of increasing power))
CAM	((Sound similar to windshield wipers coming on))
CAM	((Sound of prop noise))
19:16 CAM-2	Props stabilized on the right
19:19 CAM-1	Power on the left
19:23 CAM-1	Two blue
19:25 CAM-2	Sixty knots
19:35 CAM-2	One and R
19:39 CAM	((Sound of small squeal))
19:42 CAM-?	(No horizon)
19:45 CAM	((Sound of squeal))

AIR-GROUND COMMUNICATIONS

TIME & SOURCE	CONTENT
19:07 RDO-2	Twenty four six when airborne roger we'll see you

APPENDIX D

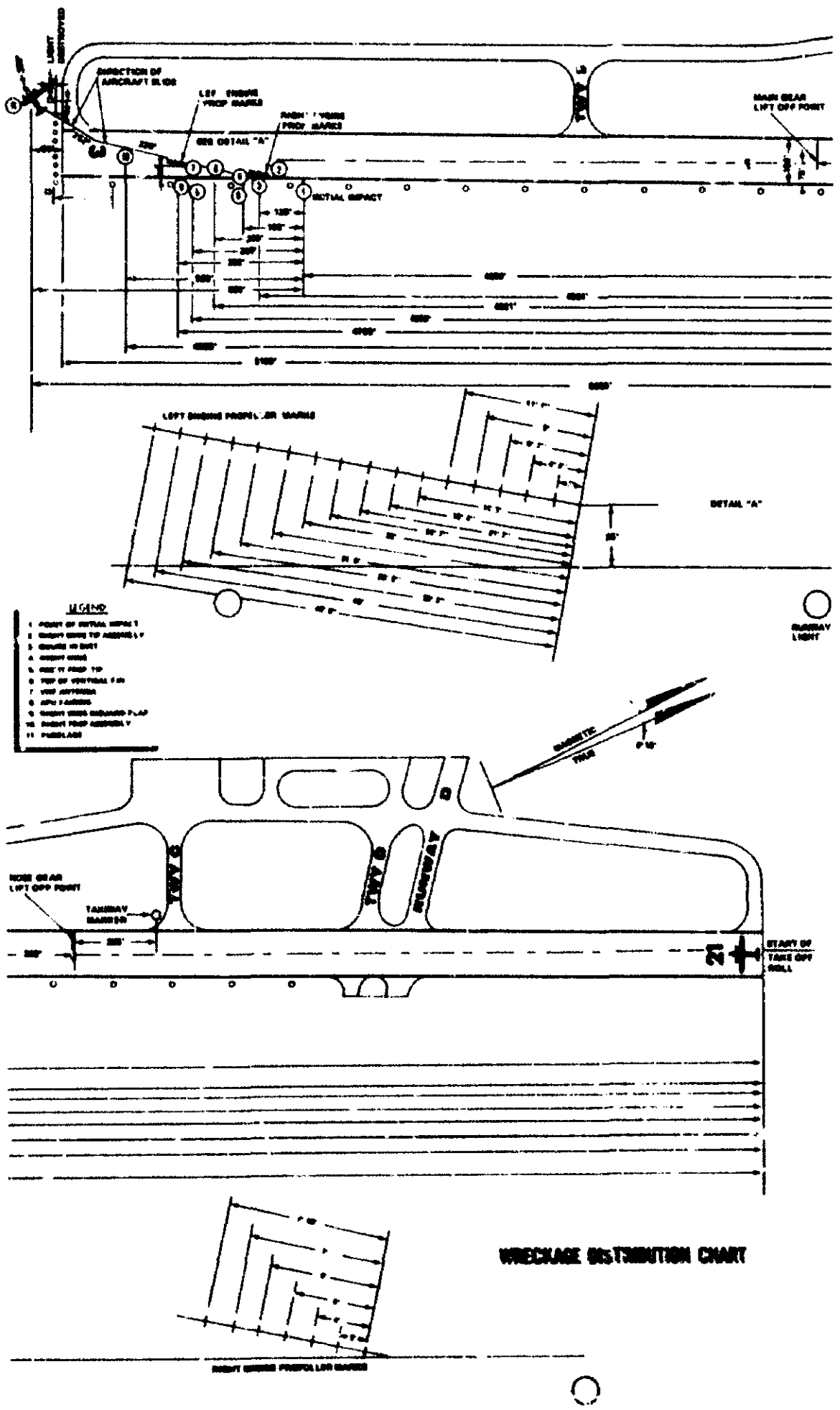
INTRA-COCKPIT

TIME & SOURCE	CONTENT
19:47 CAM-1	# what (you) doing
CAM-?	*
19:49 CAM	((Sound of impact))

AIR-GROUND COMMUNICATIONS

TIME & SOURCE	CONTENT

APPENDIX E



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