

U.S. DEPARTMENT OF COMMERCE
National Technical Information Service
NTISUB/D/104-005

Aircraft Accident Report - Alaska Aeronautical
Industries, inc., DeHavilland DHC-6-200, N563MA,
Near Iliamna, Alaska, September 6, 1977

U.S. National Transportation Safety Board, Washington, D.C.

4 May 78

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB-AAR-78-5		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle Aircraft Accident Report - Alaska Aeronautical Industries, Inc., DeHavilland DHC-6-200, N563MA, Near Iliamna, Alaska, September 6, 1977				5. Report Date May 4, 1978	
				6. Performing Organization Code	
7. Author(s)				8. Performing Organization Report No.	
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Accident Investigation Washington, D.C. 20594				10. Work Unit No. 2202B	
				11. Contract or Grant No.	
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20594				13. Type of Report and Period Covered Aircraft Accident Report September 6, 1977	
				14. Sponsoring Agency Code	
15. Supplementary Notes					
<p>16. Abstract</p> <p>About 1452 Alaska daylight time, on September 6, 1977, Alaska Aeronautical Industries, Inc., Flight 302 crashed into a glacier on the southwest side of Mt. Iliamna, Alaska, about 7,000 feet above mean sea level. The aircraft crashed in level flight in instrument meteorological conditions while en route from Iliamna, Alaska, to Anchorage, Alaska. There were 2 crewmembers and 11 passengers aboard the aircraft; there were no survivors. The aircraft was destroyed. Because of the rapidly changing environmental conditions on the glacier face, recovery of bodies or wreckage was not possible.</p> <p>The National Transportation Safety Board determines that the probable cause of the accident was the failure of the flightcrew to use proper navigational procedures for the route to be flown, especially their failure to use the available backup means of navigation to verify the position and the progress of the flight.</p>					
17. Key Words Level flight; instrument meteorological conditions; low frequency airways; intersections; ADF, VOR/DME, cockpit discipline; false bearing; flightplan. Identifier: DeHavilland DHC-6-200 Accident				18. Distribution Statement This document is available to the public through the National Technical Information Service, Springfield, Virginia 22152	
19. Security Classification (of this report) UNCLASSIFIED		20. Security Classification (of this page) UNCLASSIFIED		21. No. of Pages 28	
				22. Price	

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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

Adopted: May 4, 1978

ALASKA AERONAUTICAL INDUSTRIES, INC.
DEHAVILLAND DHC-6-200, N563MA
NEAR ILIAMNA, ALASKA
SEPTEMBER 6, 1977

SYNOPSIS

About 1452 Alaska daylight time, on September 6, 1977, Alaska Aeronautical Industries, Inc., Flight 302 crashed into a glacier on the southwest side of Mt. Iliamna, Alaska, about 7,000 feet above mean sea level. The aircraft crashed in level flight in instrument meteorological conditions while en route from Iliamna, Alaska, to Anchorage, Alaska. There were 2 crewmembers and 11 passengers aboard the aircraft; there were no survivors. The aircraft was destroyed. Because of the rapidly changing environmental conditions on the glacier face, recovery of bodies or wreckage was not possible.

The National Transportation Safety Board determines that the probable cause of the accident was the failure of the flightcrew to use proper navigational procedures for the route to be flown, especially their failure to use the available backup means of navigation to verify the position and the progress of the flight.

1. FACTUAL INFORMATION

1.1 History of the Flight

On September 6, 1977, Alaska Aeronautical Industries, Inc., Flight 302, a DeHavilland DHC-6-200 (N563MA), operated as a scheduled flight from Iliamna, Alaska, to Anchorage, Alaska. The flight was to be conducted in accordance with 14 CFR 135.

Flight 302 departed Iliamna at 1419 ^{1/} with 11 passengers and 2 crewmembers on board. It was cleared to Anchorage on an instrument flight rules (IFR) flight plan via the low frequency airways--Red Airway 99 (Red 99) to the Kakon Intersection ^{2/}, and then Green Airway 8 (Green 8) to Anchorage. (See Appendix D.) The flight was to maintain 7,000 ft. ^{3/}

^{1/} All times herein are Alaska daylight, based on the 24-hour clock.

^{2/} The intersection of Red Airway 99 and Green Airway 8.

^{3/} All altitudes herein are mean sea level unless otherwise indicated.

At 1425:20, the flightcrew of Flight 302 established radio contact with Anchorage Air Route Traffic Control Center's (Anchorage Center) D2 nonradar 4/ sector controller. They reported that the flight was level at 7,000 ft and that they estimated arrival at Kikon Intersection at 1434.

At 1428:35, Anchorage Center requested the flight's estimate for its arrival at Homer, Alaska 5/. The flightcrew responded that they estimated to be over Homer at 1515.

The flightcrew of Flight 302 did not make radio contact when they were over Kikon Intersection; however, at 1439:40 they requested of Anchorage Center, "302, we would like to file Green 8 and intercept the 192° bearing from Wildwood." 6/ Fifteen seconds later, Anchorage Center cleared the flight to proceed along the new route of flight and to remain at 7,000 ft.

At 1440:50, the flightcrew of Flight 302 advised, "302, we-- we'll estimate Clams 7/ at 15 past the hour." Anchorage Center acknowledged the advisory. This was the last known radio transmission from Flight 302.

At 1452:08, three abrupt, audible sounds were recorded on the Anchorage Center tape of incoming air-to-ground communications with Flight 302. These sounds were similar to those produced by a carrier frequency that was heard during the activation of Flight 302's radio transmitter during earlier radio communications with the Center.

After several unsuccessful attempts to contact Flight 302 by several air traffic control facilities between Iliamna and Anchorage and after the flight could not be detected on radar in the areas where radar coverage was available, Anchorage Center initiated the required actions to alert and notify appropriate authorities of a possible aircraft accident. U.S. Air Force search and rescue aircraft located the wreckage site at 1643 on September 7, 1977. The aircraft had struck a glacier face on the southwest side of Mt. Iliamna 8/ at the 7,000 ft elevation.

4/ There was no flight-following radar available in the Iliamna area.

5/ A VOR along, but not associated with the formation of, Green 8 used for VOR navigational guidance, for reporting, and for other air traffic control purposes. It is located about 6 nmi north of Kachemak nondirectional beacon (NDB) on Green 8.

6/ Wildwood NDB--part of the low altitude airway system located 43 nmi south of Anchorage along Green 8. It is colocated with the Kenai VOR which was out of service on the day of the accident.

7/ Clams Intersection is a point on the 192° bearing from Wildwood NDB located about 23 nmi northeast of the intersection of that Wildwood bearing and Green 8.

8/ Mt. Iliamna is located about 58 nmi east-northeast of Iliamna Airport, about 29 nmi north of Green 8 at its nearest point, and about 25 nmi northwest of the 192° bearing from Wildwood NDB at its nearest point.

There were no survivors. Because of the rapidly changing environmental conditions on the glacier face of Mt. Iliamna, recovery of bodies and wreckage was not possible. (See figures 1A, 1B, 1C and 1D.)

The accident occurred during daylight hours in instrument meteorological conditions at 60°02'N latitude and 153°05'W longitude. There were no witnesses to the accident.

1.2 Injuries to Persons

<u>Injuries</u>	<u>Crew</u>	<u>Passengers</u>	<u>Others</u>
Fatal	2	11	0
Nonfatal	0	0	0
None	0	0	0

1.3 Damage to Aircraft

The aircraft was destroyed.

1.4 Other Damage

None

1.5 Personnel Information

The two crewmembers were properly certificated for this flight. (See Appendix B.) On the day of the accident, both flight crewmembers reported for duty about 0400 and had flown 5.4 hours before the takeoff from Anchorage for Iliamna.

The crewmembers had received the flight training to qualify in the DeHavilland DHC-6-200. The company training manual outlined the applicable criteria for the training program which was, in part, contingent upon the new hire's past air taxi/commuter experience.

1.6 Aircraft Information

The aircraft was certificated and maintained in accordance with Federal Aviation Administration (FAA) requirements. The gross weight and c.g. were within prescribed limits for takeoff. At the time of the accident, about 970 lbs of Jet A-1 fuel was onboard. (See Appendix C.)

The aircraft was not equipped with sufficient low frequency (ADF) navigational radio receivers for the flight from Iliamna to Anchorage.

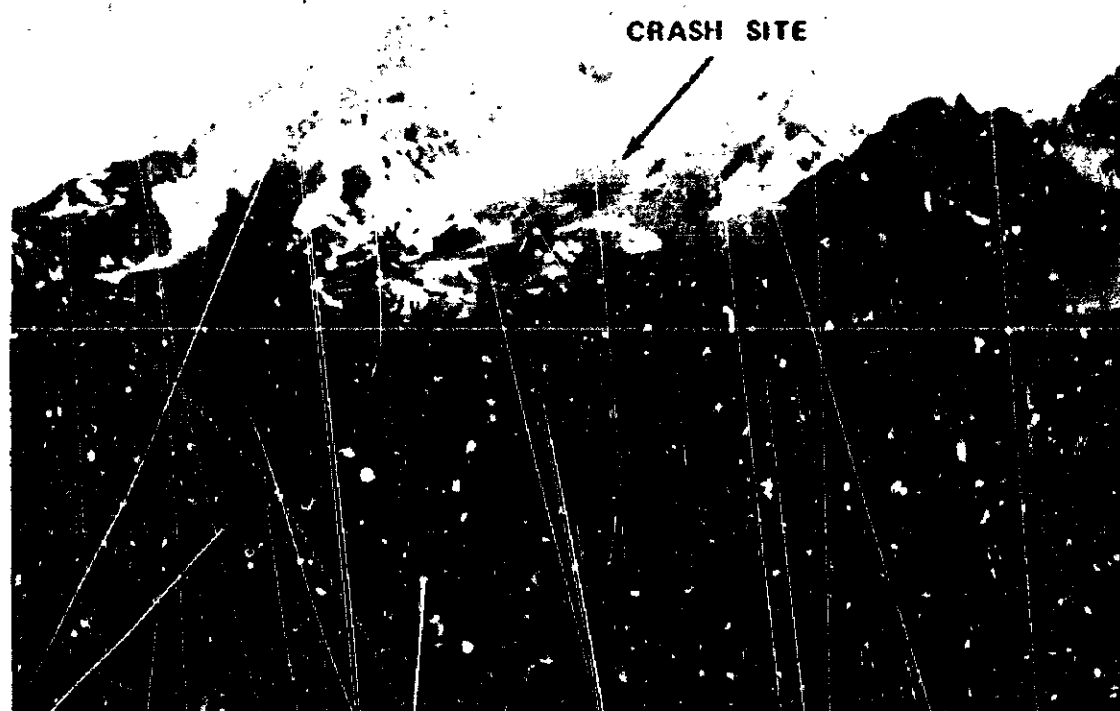


Figure 1A. Mt. Iliamna.

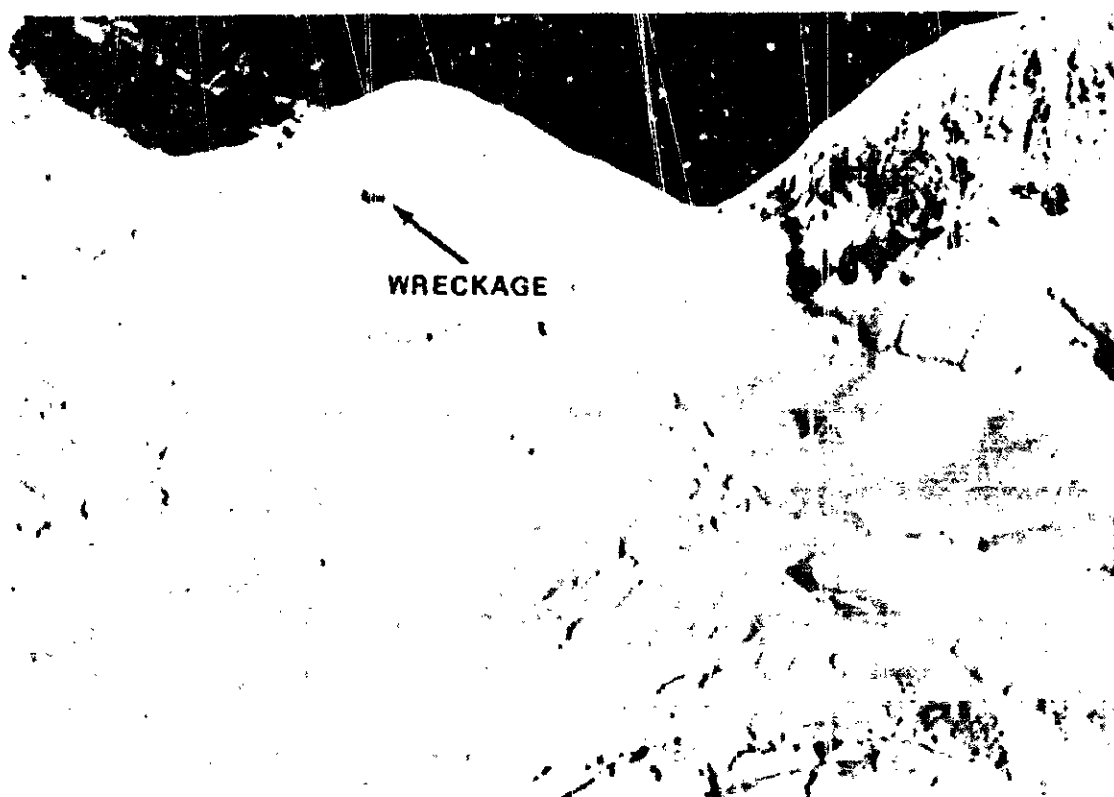


Figure 1B. Glacial field.

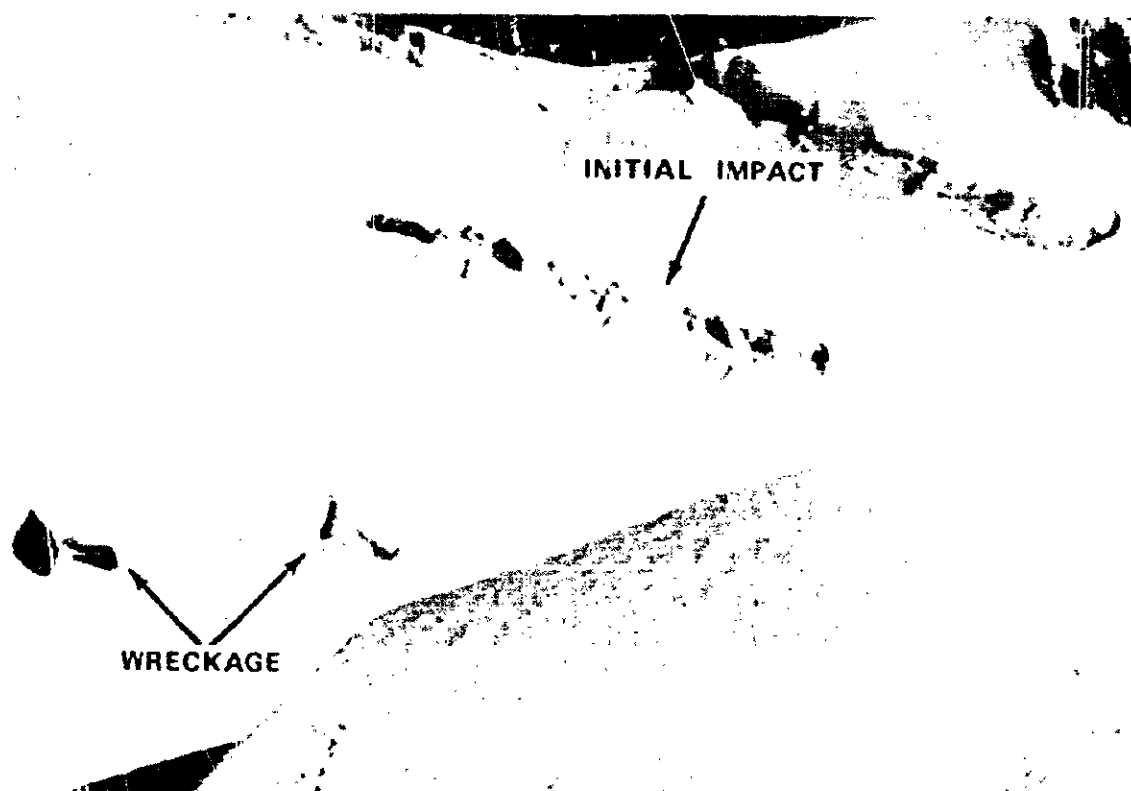


Figure 1C. Impact point on ice cliff.

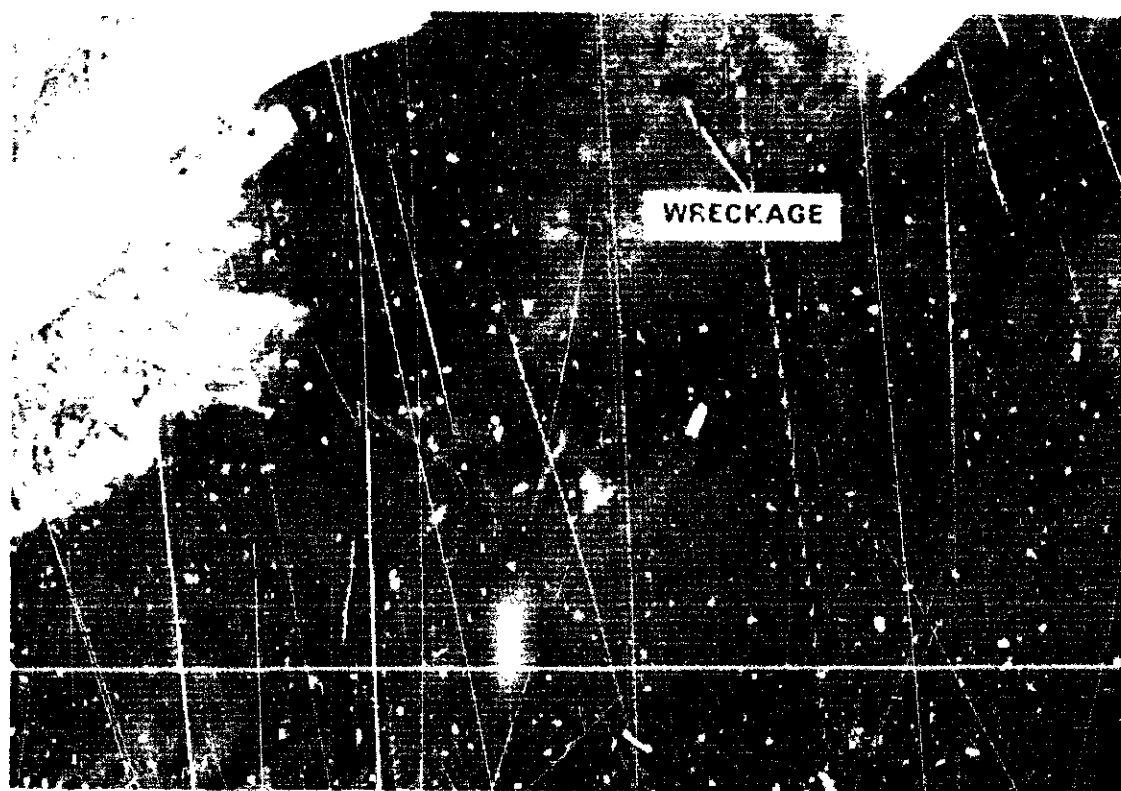


Figure 1D. Wreckage area and crevasses.

14 CFR 135.159(a)(5) states:

"(a) No persons may operate an aircraft under IFR or in extended over-water operations unless it has at least the following radio communications and navigational equipment appropriate to the facilities to be used and able to transmit to, and receive from, at any place on the route, at least one ground facility...:

(5) Two independent receivers for navigation."

The Safety Board requested that the FAA furnish an official interpretation of this regulation. In their reply the FAA stated, "under these circumstances (those of this accident), it is our opinion that operation of the aircraft with only one low frequency navigational receiver available in the aircraft did not comply with the requirement in 135.159(a)(5), since that regulation required the aircraft to have at least two independent receivers for navigation, appropriate to the low frequency facilities, to be used on the particular route involved." Statements made by company personnel during the accident investigation and at the public hearing disclosed that the company and its flight crewmembers had the same understanding of the regulation, and flight operations were to be conducted accordingly.

N563MA had only one low frequency, fixed-card, ^{9/} navigational receiver installed and operational. It was, however, equipped with two operational high frequency (VOR) receivers with distance measuring (DME) capability. About one-half of the Alaska Aeronautical Industries aircraft were equipped in this manner. The remainder of the aircraft were equipped with two ADF receivers.

Company policy was to schedule the aircraft with two ADF receivers on the flights to Iliamna. This was the case on the day of the accident; however, the aircraft originally scheduled had maintenance difficulties early in the day. A decision was made by a company representative, whose responsibilities did not include the dispatch of aircraft, to substitute N563MA to fly the trips of the originally scheduled aircraft, including the trip to Iliamna. The captain accepted this decision.

^{9/} In fixed-card ADF navigation, 0°(360°) remains under the line at the top of the ADF instrument instead of the actual magnetic heading of the aircraft. The pilot must rely on the angular difference between the actual magnetic heading being flown and the needle on the ADF instrument which represents the heading to the tuned ADF station. A turn to the heading to track inbound to the station on a desired bearing from that station is not made until the correct angular relationship is established.

Investigation revealed that the properly equipped aircraft originally scheduled for the Iliamna flight was repaired and available for the flight. However, as far as could be determined, the captain was never informed of this nor did he inquire as to the other aircraft's maintenance status.

In the 30 days before the accident, both the pilot's and the copilot's directional gyro had been reported seven times by several company pilots as having various operational difficulties. These reports recorded gyro precession rates of as much as 30° in 15 minutes. Each report showed that corrective action either was taken or was delayed because no replacement items were available. However, in one case, a gyro malfunction was signed off as corrected, when, in fact, testimony at the public hearing revealed that no work had been accomplished on the item.

According to a statement by the Iliamna Flight Service Station (FSS) specialist on duty when N563MA was inbound to Iliamna, the flightcrew asked if Iliamna had direction finding equipment because of "erratic needle readings on his ADF. I replied that the FSS (Iliamna) had no DF equipment and that Iliamna radio beacon monitored good. Approximately 1 minute later, he (N563MA) cancelled IFR with Iliamna Village in sight." At the Safety Board's public hearing, the specialist testified that he made no further inquiries and the captain made no further remarks concerning the ADF equipment onboard N563MA while the two talked at the Iliamna FSS before Flight 302 departed Iliamna.

14 CFR 135.60 requires a commuter airline to use an FAA-approved aircraft inspection system. The system used by Alaska Aeronautical Industries and approved by FAA is an equalized maintenance maximum availability (EMMA) system. EMMA permits aircraft inspection to be completed in a fixed number of inspection trips to the maintenance facility. During the investigation and public hearing, it was discovered that, although the EMMA inspections were completed on time and recorded properly, the procedures used by the company to record the local maintenance requirements and work were not in keeping with good recordkeeping practices. As a result of these methods, it was difficult for crewmembers to be knowledgeable of previous discrepancy reports.

The investigation revealed also that it was difficult for the company pilots to determine the maintenance status of the aircraft they were to fly on any specific day. The pilots who were to fly the first flight of the day on an aircraft had the maintenance records available to them because they went to the aircraft at the company hangar where the records were kept. However, pilots who flew those same aircraft later in the day would have to rely on verbal information about any aircraft problem because they boarded the aircraft at the airport terminal about a mile from the company hangar. No records except the aircraft logbook were kept on the aircraft. It was company procedure not to leave "carry-over" items in the aircraft logbook.

1.7 Meteorological Information

The 1500 surface weather chart showed a cold front near the Anchorage-Homer-Kodiak line, with a moist, unstable west-southwest flow of air to the west of the front.

The 1500 850-millibar chart (about 5,000 ft) showed a deep low pressure system that was centered over Norton Bay, with strong southwesterly winds at King Salmon and strong south-southeasterly winds at Anchorage.

Surface weather observations made by the FSS specialists at Iliamna and Homer, both of whom are certified by the National Weather Service (NWS), were as follows:

Iliamna

1400: 1,200 ft scattered; ceiling--estimated 2,500 ft broken, 4,000 ft overcast; visibility--20 mi; temperature--54°F; dewpoint--50°F; wind--210° at 12 kn; altimeter setting--29.58 in.Hg. Rain ended at 1335, breaks in the overcast.

1500: 2,500 ft scattered, 4,000 ft scattered; visibility--30 mi; temperature--57°F; dewpoint--50°F; wind--220° at 18 kn; altimeter setting--29.57 in.Hg. Rainshowers of unknown intensity east.

Homer

1400: 600 ft scattered; ceiling--estimated 2,000 ft broken, 4,000 ft overcast; visibility--8 mi, light rain; temperature--56°F; dewpoint--52°F; wind--200 at 12 kn; altimeter setting--29.66 in.Hg.

1500: 1,000 ft scattered; ceiling--estimated 2,500 ft broken, 4,000 ft overcast; visibility--10 mi, light rainshowers; temperature--56°F; dewpoint--51°F; wind--090° at 6 kn; altimeter setting--29.62 in.Hg.

At 1029, the flightcrew received a complete weather briefing from the Kenai FSS. At 1058, a man who identified himself as the pilot of Flight 301 ^{10/} received another complete weather briefing including winds aloft information from the Anchorage FSS. About 1135, a man who identified himself as the pilot of Flight 301 received the 1100 Iliamna weather, the Bristol Bay area forecast, and a pilot report for occasional light rime ice at 16,000 ft from the Iliamna FSS via telephone. The pilot of the accident aircraft received a weather briefing over the radio from the Iliamna FSS about 1419. The briefing contained only the 1400 Anchorage surface weather observation.

^{10/} The flight number used by the accident aircraft during its earlier flight from Anchorage to Iliamna.

The 1500 King Salmon winds aloft observations were as follows for the heights indicated: (King Salmon is about 83 nmi southwest of Iliamna.)

Height (ft)	Direction (°True)	Speed (Kn)
1,000	220	27
2,000	220	31
3,000	225	33
4,000	225	34
6,000	235	35
7,000	240	35
8,000	235	36
9,000	230	34

The 1500 King Salmon radiosonde observation (below 10,000 ft) showed moist, generally conditionally unstable air below 9,000 ft, with dry, stable air above. The freezing level was 5,157 ft.

1.8 Aids to Navigation

Red 99 and Green 8 are low to medium frequency airways formed by NDB's. -- Red 99 is formed by a bearing from the Iliamna NDB, and Green 8 is formed by bearings between the Big Mountain, the Kachemak (Homer), and the Wildwood NDB's. These four NDB's are Class H 11/ radio facilities. Each facility was flight checked after the accident and was found to be within acceptable tolerances.

The normal Green 8 route from Kikon Intersection to Anchorage proceeds eastward from Kikon to the Kachemak NDB, turns north to the Wildwood NDB, and then northeast to Anchorage. The new routing which the flightcrew of Flight 302 requested and received from Anchorage Center would have shortened the flight time.

The 192° bearing from the Wildwood NDB is coincident with Victor Airway 334 (the 192° radial of the Kenai VOR) and intercepts the Green 8 route about 37 nmi west of Kachemak NDB which is located about 6 nmi south of Homer VORTAC. At the time of the accident, the use of the 192° bearing from Wildwood as a substitute part of the low-frequency navigation structure had been approved and flight checked by the FAA while the high-frequency structure (Victor 334) was out of service for facility maintenance. The FAA flight check showed that, even though the

11/ A Class H radio facility is a nondirectional homing beacon with a power range between 50 watts and 2,000 watts and a guaranteed usable distance of 50 nmi at all altitudes and on all bearings. Testimony at the public hearing revealed that the Wildwood NDB was designed to serve a 100-nmi radius with a minimum of 70-microvolt signal at that distance.

intersection of the 192° bearing from Wildwood NDB and Green 8 was about 76 nmi from Wildwood NDB, signal strength at the intersection was sufficient for receiving the bearing. No reception difficulties at the intersection had been reported by other aircraft.

On September 10 and 11, 1977, the flightcrews of three aircraft, two Cessna 402's and a Douglas DC-3, reported that the ADF needle in their aircraft indicated that they were intercepting the 192° bearing of the Wildwood NDB when their actual position was between 14 nmi and 20 nmi east of Kakon Intersection. These crews reported no difficulty in receiving a good aural identifier or a steady needle indication at that distance -- about 100 nmi. They reported also that, at the time they had received these indications on their ADF equipment, their DME distance from Homer VOR ranged from 68 nmi to 74 nmi.

At the request of the Safety Board, the FAA discontinued immediately the use of the 192° bearing of Wildwood NDB as a part of the substitute route structure for Victor 334. The use of the 192° bearing has not been reinstated because the Kenai VOR was placed in service shortly after this accident thereby reactivating Victor 334.

1.9 Communications

No air-to-ground communications difficulties were reported.

1.10 Aerodrome Information

Not applicable.

1.11 Flight Recorders

No flight data recorder or cockpit voice recorder was installed in N563MA, nor was either required.

1.12 Wreckage and Impact Information

The aircraft wreckage site was located about 56 nmi east-northeast of Iliamna Airport on September 7, 1977, by U.S. Air Force search and rescue aircraft. The wreckage was oriented along a heading of about 012°. A rescue team was landed at the site and they determined that there were no survivors. Because of the extremely hazardous environmental conditions, the team was forced to leave the area shortly after their arrival.

Weather in the Mt. Iliamna area delayed until September 12 attempts to fly a team of mountain climbers into the area to attempt recovery of aircraft parts or documents. The team reached the accident site but was unable to recover anything from the wreckage except two pages of avionics maintenance records. Snow had covered the wreckage, most of which was situated in numerous deep crevasses.

Further attempts to recover the bodies of the crash victims, aircraft parts, and flight instruments were abandoned because of the extremely hazardous climbing conditions and the inability of the mountain climbers to locate either the bodies of the victims or the cockpit area of the aircraft in the deep snow.

1.13 Medical and Pathological Information

A review of the flightcrew's medical records disclosed no evidence of preexisting physical problems which could have affected their judgment or performance.

Since bodies were not recovered, post-mortem examinations were not possible.

1.14 Fire

There were no indications of fire at the accident site.

1.15 Survival Aspects

The accident was not survivable.

1.16 Tests and Research

None.

1.17 Additional Information

1.17.1 Flight Information Publication, Alaska Supplement, effective 11 August 1977

"Navigational Aid Disturbances:

Radio beacons and low frequency ranges are subject to disturbances that result in false and displaced or multiple courses, ADF needle deviations, signal fades and interference from distant stations, particularly during night operations. Be alert for these conditions, particularly in mountainous terrain....

Extreme variations in compass deviations may be experienced due to magnetic storms at geographic latitudes greater than 60°N. The variations may have durations of several minutes to several hours and cause compass swings of 5°-10°."

1.17.2 Federal Aviation Administration Surveillance

The FAA General Aviation District Office (GADO) at Anchorage was responsible for the surveillance of Alaska Aeronautical Industries operations. This GADO was responsible also for the surveillance of 171 other 14 CFR 135 operators in and around Anchorage, 1 of which was 400 miles from Anchorage, at Bethel. The principal operations inspector assigned to the company was also responsible for the surveillance of 53 other 14 CFR 135 operators, including the 1,400 miles away. There are 221 14 CFR 135 operators in Alaska. The FAA surveillance of these operators is accomplished by 15 principal operations inspectors and 10 principal maintenance inspectors.

From January 1977 until the date of this accident, 13 en route inspections of company pilots had been conducted. During the same period 15 separate base, ramp, and other surveillance inspections had been conducted.

1.17.3 Seismograph Recording

A seismograph belonging to the Geophysical Institute of the University of Alaska, located at Fecoubt, Alaska, (about 27 nmi from Mt. Iliamna) recorded a small tremor beginning at 1452:06. This tremor was about twice the magnitude and three to four times the duration of other tremors recorded before and after that time. The travel time for sound waves between the seismograph and Mt. Iliamna is about 7 seconds.

1.17.4 14 CFR 135.136-Flight and Duty Time Limitations

"(a) No certificate holder may assign any flight crewmember, and no flight crewmember may accept an assignment, for duty during flight time if the total flight time of that flight in addition to any other commercial flying by that flight crewmember exceeds the following during any 24 consecutive hours:

(2) Ten hours for a flight crew consisting of two pilots required by this chapter.

(b) No certificate holder may assign a flight crewmember, and no flight crewmember may accept an assignment, for duty during flight time unless that assignment provides for at least 10 consecutive hours of rest during the 24-hour period preceding the planned completion of the assignment."

1.17.5 14 CFR 91.3-Responsibility and Authority of the Pilot in Command

"(a) The pilot in command of an aircraft is directly responsible for, and is the final authority as to, the operation of that aircraft."

1.17.6 Company Maintenance Practices

A review of the company's maintenance practices disclosed that aircraft spare parts were not tagged or otherwise identified as to their operational status. Serviceable parts were intermixed with unserviceable parts. The company's Chief of Maintenance stated that he knew the exact condition of each item in stock and, therefore, there was no need to tag them. He stated further that if replacement parts were needed, he could determine the condition of the item.

At the public hearing, company pilots and company maintenance personnel were confused as to the correct use of the maintenance logbook. Their opinions varied when asked to determine from a logbook page entry the status of individual parts which had been reported deficient or the airworthiness of an aircraft to be flown on a particular flight.

1.17.7 Company Training Practices

A review of the company training records and testimony at the public hearing disclosed that often crewmembers did not receive training required by the company training manual before they became a first officer or a captain. When training was received, it was usually the minimum required by the manual, which was the case for the two crewmembers of the accident aircraft.

1.18 New Investigation Techniques

None.

2. ANALYSIS

The flight crewmembers were certificated and qualified in accordance with company and FAA regulations.

The aircraft was certificated and maintained according to applicable regulations; however, it was not equipped properly for an IFR flight to Iliamna. Two independent navigational receivers for the en route facilities to be used are required by 14 CFR 135.159. The route to be flown in this case was served by low- and medium-frequency navigational radio facilities only. N563MA was equipped with only one ADF receiver. The company was aware of the FAA's requirements for this route with regard to the navigational receivers and dispatched the aircraft in spite of this knowledge. The Safety Board further believes that the captain accepted the aircraft for flight to Iliamna with knowledge that two ADF receivers were required and that only one ADF receiver was installed aboard N563MA.

The aircraft's gross weight and c.g. were within prescribed limits. Its airframe, powerplants, and components were not factors in this accident.

There was no reason to believe that the flightcrew was experiencing any major difficulties with the ADF receiver on board N56MA. It is true that, when Flight 301 approached Iliamna, the crew asked the FSS attendant if the station was equipped with direction finding equipment. However, the crew stated that their reason for the request was erratic needle readings on the ADF. The captain made no further reference to a problem with his ADF before landing or when he filed the IFR flight plan back to Anchorage. If he believed there was a problem he would not have left Iliamna, since he would have had no means of navigating via the route specified in his clearance. Thus, the Safety Board concludes that the one ADF navigation receiver was operating satisfactorily.

After takeoff, the aircraft flew along Red 99 to Kakon Intersection. This was the routing the crew had requested, and it was the route they had used to reach Iliamna earlier that day. This routing is also the only IFR routing out of the Iliamna area. The conclusion that the aircraft was flown southeast on Red 99 is further supported by ATC reports made by Flight 302. At 1425:20, the crew reported level at 7,000 ft, estimating Kakon Intersection at 1434. Other facts which support the conclusion that the aircraft was flown toward Kakon on Red 99 are: (1) The impact heading -- the heading was 012°. Had the crew flown directly to Wildwood NDB from Iliamna, the impact heading would have been closer to 050°. (2) The time of the last radio contact. The last radio contact with Flight 302 was at 1440:50. Had the aircraft been flown directly toward Wildwood NDB, the flying time to the crash site would have been about 20 min based on wind from 210° at 37 kn. The time of impact would then have been near 1440, which would not correspond with the last ATC transmission or the suspected time of impact of 1452. (3) The crew did not mistune the ADF. In order to have flown other than the requested route, the crew would have had to mistune the ADF, then accept a heading of 050° rather than a southeast heading of 123° toward Kakon Intersection. Thus, the Safety Board concludes that the first leg of the route, to Kakon via Red 99, was flown according to the flight plan.

After a takeoff at 1419, and based on estimated winds of 210° at 37 kts between Iliamna and the accident site, the top of Flight 302's climb would have been reached at 1427, and Kakon Intersection would have been reached at 1434. This is verified by the report of level at 7,000 ft at 1425:20, with an estimate of 1434 to Kakon. Once reaching Kakon Intersection the crew should have used Big Mountain NDB to track outbound on Green 8 toward Kachemak NDB. However, based on testimony received at the public hearing, the crew would have probably selected Kachemak NDB to track outbound from Kakon Intersection on Green 8 because of the general feeling by company pilots that Big Mountain NDB was weak and unreliable. If Wildwood NDB was tuned at Kakon, the aircraft would have been flown on a course which would have gone almost directly to the

accident site. However, this would have required the crew to accept a heading of about 023° when they should have expected to turn to about 070° to stay on Green 8 (059° plus 11° wind correction).

Furthermore, they would have had to tune in the wrong NDB. Although the frequencies of Wildwood NDB (379 kHz) and Kachemak NDB (387 kHz) are similar, there is no evidence that the NDB was mistuned. The only fact which would support the theory that the aircraft was flown directly to Wildwood NDB from Kakon Intersection is that it would take about 20 min to travel the 54 nmi from Kakon to the accident site (wind 210° at 37 kns, groundspeed 170 kn). This would place the time of impact near 1453, close to the suspected time of impact. However, other explanations for the accident which involve fewer assumptions can also place the aircraft at the accident site at 1452.

Assuming that the aircraft was established on Green 8 after passing Kakon at 1434, the next call to Anchorage Center at 1439:40 would be logical since the crew did want to take the shortest route back -- the 192° bearing from Wildwood NDB -- and they would have had more than 5 mins to establish the aircraft on Green 8 and to discuss the proposed route. From 1434 at Kakon to 1439:40 on Green 8, the following conditions would have existed: Wind 210° at 37 kns, heading 070°, groundspeed 161 kns, and distance traveled about 14 nmi. This would have placed the aircraft on Green 8, 14 nmi east of Kakon, and about 40 nmi to 43 nmi from the accident site. Once the flight was cleared via the 192° bearing, the crew could have, and logically would have, checked their position on Green 8 by tuning in the Wildwood NDB. At this point, if the ADF indicated that the aircraft was already on the 192° bearing and the error was not discovered, the aircraft would be turned to track to the Wildwood NDB. Using winds of 210° at 37 kns and a groundspeed of 170 kns, it would have taken 14 or 15 mins to arrive at the accident site. This would place the aircraft at the impact site within seconds of 1452 -- within seconds of the sounds similar to the carrier frequency of the aircraft heard on the Anchorage Center tape at 1452:08 and the seismographic recording of a small tremor which started at 1451:59.

During the investigation, the Safety Board determined that the Wildwood NDB could be received while on Green 8, in a position 14 nmi east of the Kakon Intersection. The direct distance between this point and Wildwood NDB was about 100 nmi. This was proven by successive flights in a Cessna 402 and a Douglas DC-3 at altitudes from as high as 7,000 ft to as low as 2,800 ft. In this position the station could be identified by the aural identifier and the ADF needle would point to that station. Based on readings taken from ADF's in a DC-3 used by the FAA for flight checks, a point 14 nmi east of Kakon Intersection is about the 206° to 204° bearing from Wildwood NDB. A properly operating ADF would indicate the position of the aircraft on Green 8 and its relation to the 192° bearing from Wildwood NDB, thus no turn to a

heading of 012°, the inbound heading to Wildwood NDB on the 192° bearing, would begin until the aircraft reached the 192° bearing. Furthermore, the 192° bearing intersects Green 8 about 52 nmi east of Kakon, or 19 mins flying time from Kakon Intersection.

Clearly, the 192° bearing was not intercepted at the proper point on Green 8. Had this interception been made, the aircraft would have had to be turned back to a heading of about 325° to reach the accident site, rather than the 012° (+ wind correction) required to be properly on the 192° bearing to the Wildwood NDB. It is unlikely that this drastic change from the general direction of the flight would have gone unnoticed by the flightcrew. The question which must be resolved, then, is why the aircraft left Green 8 before the 192° bearing was actually reached.

The most reasonable explanation is that Kachemak ADF was used to establish the aircraft on Green 8. Once on course, the amended routing was requested via the 192° bearing from Wildwood. At 1440:15, when this request was granted, Wildwood NDB was tuned. The aircraft would have been about 14 nmi east of Kakon. The crew should have expected arrival at the 192° bearing about 1453. However, they did not report their arrival at Kakon at the estimated time of 1434, and they may not have noted what time they actually did pass it. It is apparent that they did not note or pay attention to the time when Kakon was passed or they would not have turned toward the Wildwood NDB at 1440 to 1442 instead of an estimated time of 1453. The Safety Board believes that the indications of the ADF needle, and not actual time-distance planning or DME distance from Homer VOR, were the primary means the crew used to identify the 192° bearing.

As stated before, at a point 14 nmi east of Kakon the ADF should indicate about the 206° bearing. Two facts must be considered as to why the aircraft left Green 8 at that time. First, the aircraft's ADF was a fixed-card system. The accuracy of a fixed-card system is based on correct heading information from the directional gyro heading indicator. In this case, if the aircraft was on the airway with a no wind heading of 059°, the aircraft would be flown on that heading until the ADF needle pointed 47° to the left. Forty-seven degrees to the left would be 012°, or the inbound course for the 192° bearing. If a wind correction was needed to keep the aircraft on the airway, the wind correction would be applied to 059°. For example, if the required heading was 070°, a turn onto the 012° course would be made when the needle pointed 58° to the left of the nose of the aircraft.

The angular relationship between the aircraft heading and the station, measured clockwise from the nose of the aircraft, is the relative bearing. However, by itself, the ADF needle does not indicate the position of the aircraft. The actual position, as shown by the relative bearing, must be related to the aircraft heading. If the heading indicator is incorrect, incorrect information will be derived from the ADF indications.

If the heading indicator was not reset after takeoff from Iliamna, or even if it was allowed to precess only 10° by 1439, the crew would have had an indication that the aircraft was on the 196° or 194° bearing from Wildwood NDB at a point 14 nmi east of Kakon. If the aircraft was farther east, at a point 20 nmi from Kakon, the ADF might actually have indicated the 192° bearing.

The same 10° error could have been induced even if the crew reset the heading indicator by reference to the magnetic compass. At 7,000 ft in the existing conditions, there was a strong possibility of light to moderate turbulence. This would have made it difficult to obtain precise heading information. Furthermore, compass swings of 5° to 10° are not uncommon in this area as a result of the north latitude. Whatever the reason the aircraft left Green 8 and tracked inbound to Wildwood NDB, it is logical that the crew would believe their ADF since the entire flight was probably in instrument meteorological conditions and conducted solely by reference to the one ADF for navigation. This does not explain, however, the failure to use backup methods of navigation as a crosscheck. (There were two operable VOR navigational receivers with DME capability onboard.)

Another situation which must be considered is that of an unreliable signal from the Wildwood NDB. Kakon Intersection is 120 nmi from Wildwood NDB. A point 14 nmi east of Kakon is about 107 nmi away from Wildwood. The Wildwood NDB is a Class H facility, which has an optimum range of 50 nmi. According to testimony taken at the public hearing, the Wildwood NDB was designed to operate up to a radius of 100 nmi. Thus, any signal received at or in the vicinity of Kakon Intersection may have been beyond the usable range of the facility. The company chief pilot testified that any ADF signal from a station more than 50 nmi distant should not be relied on.

The reliability of the signal at that range (100 nmi) is even more questionable because of the warning in the Flight Information Publication Supplement for Alaska that warns of disturbances, especially in mountainous terrain, which may affect ADF indications.

On September 10 and 11, the flightcrews of three separate aircraft, located 14 to 20 nmi east of Kakon Intersection, reported that the ADF needle indicated their aircraft were on the 192° bearing from Wildwood NDB. At this time, the DME equipment aboard these aircraft indicated distances ranging from 68 nmi to 74 nmi from Homer VOR. If this occurred to Flight 302 and any DME indications were ignored, the crew could have believed the ADF needle and turned to 012° .

The crew of Flight 302 must have had some indication from the ADF that they were on the 192° bearing from Wildwood. When Wildwood NDB was tuned, they probably received a signal indicating they were on or

near the 192° bearing. This could have been a result of a precessing heading indicator, difficulty in setting precisely the heading indicator, or because of the great distance of the aircraft from the Wildwood NDB. Whichever was the case, a prudent pilot should have known the range limitation of the NDB, the effect of disturbances which might affect an ADF, and how much time should elapse before the aircraft could travel from Kakon to the interception point of the 192° bearing from Wildwood.

Finally, a prudent pilot should use all available navigation aids to assist in his navigation. Flight 302 had VOR and DME capability. The company chief pilot stated that he would expect company pilots to use the ADF as the primary means of navigation on Green 8. However, he would expect them to tune the VOR to the Homer VOR and to use the DME to doublecheck the progress on the route. Since the Kachamak NDB and the Homer VOR are almost colocated, once established on Green 8 using the ADF, the Homer VOR would be tuned. This would allow a pilot to observe the mileage to Homer. When the DME mileage read 40 nmi to Homer, the aircraft would be near the 192° bearing from Wildwood. This would be used to verify the ADF needle indications. The point 14 nmi east of Kakon Intersection would be 74 nmi from Homer on the DME. If the crew had used the VOR/DME in this accepted manner, there is no way they could have accepted and believed they were on the 192° bearing from Wildwood.

Thus, the Safety Board believes that the VOR/DME was not used to monitor the progress of the aircraft on Green 8. The Board also believes that the crew was not aware of the expected flying time from Kakon Intersection to the 192° bearing. The fact that they could have had an indication that they were on the 192° bearing should not have been the only information which the flightcrew should have relied upon at that point. Thus, the Board concludes that while it is possible that the crew observed indications that the aircraft was on the 192° bearing, and this indication came from a spurious signal from the Wildwood NDB, it should not have, by itself, influenced the crew. Additional cross-checks -- time-distance and VOR/DME backups -- were available and virtually required to be used.

The Safety Board concludes that the operational control exercised by company management was deficient because N563MA was dispatched for the flight from Anchorage to Iliamna by a company representative who had no knowledge of the navigational equipment requirements for the flight and whose responsibilities did not include the assignment or the dispatch of company aircraft. Company personnel with this knowledge and responsibility were available, but were not consulted. The aircraft originally scheduled for the flight was equipped with two ADF receivers.

The FAA regulations give the pilot the ultimate responsibility to accept or refuse an aircraft for a flight based on his own judgment of the situation. The Board was unable to positively identify the reason or reasons why the pilot did not exercise his authority to refuse

this aircraft. He was either not aware of the requirement for two ADF receivers on the route to be flown or he knowingly disregarded it. In view of the pilot's experience and qualifications, and the company's stated policy in this regard, it is unlikely that he was not aware of the requirement. It is equally unlikely that he would willingly disregard the requirement without reason.

One reason for the pilot's acceptance of the aircraft could have been his desire to complete the day's flights. This was his last trip after a long day of flight in adverse meteorological conditions. Also, the flight to Iliamna was already late leaving Anchorage. These two factors could have been inducement enough for the pilot's actions.

Another possibility was pressure placed on him by the company to complete the assigned flight in the assigned aircraft. Testimony at the Safety Board's public hearing revealed that, on at least one occasion, a captain was dismissed by a company official for his refusal to accept a flight because of adverse weather which was forecast for the proposed route of flight. Other instances of company pressure of this kind were reported to the Board during the investigation. If these pressures were present, or inferred, when the captain of this flight was awaiting the start of his trip to Iliamna, his decision to accept N563MA for the trip could have been affected.

The Safety Board concluded that the one ADF navigational receiver onboard the aircraft was operational. Along this particular airway system, with two VOR receivers and DME capability to cross-check the ADF information being received, the flight should have been completed successfully. Notwithstanding the fact that the Board believes that one ADF should have been sufficient to navigate this route, the dispatch of an aircraft without the required equipment by persons not qualified or authorized to do so, constitutes an unsafe and dangerous practice and is a matter of concern to the Board.

During its investigation and public hearing, the Safety Board realized that the company's management of operations, its training program, its maintenance practices and procedures, and FAA's surveillance of these areas were inadequate. Improper aircraft scheduling and dispatch procedures and the failure by management to assign these responsibilities to key company personnel places an undue decisionmaking burden on the individual pilots. This burden is increased when other pressures, such as the threat of disciplinary action, are brought to bear on the pilot when company management does not agree with his decisions.

Although the company training program meets the requirements of 14 CFR 135.55, the Board also believes that the administration of the program was weak and contradictory to the specifications of the company training manual. Several instances were found where, although the training manual set forth requirements for newly hired pilots, the actual training given before qualification was granted was less than

required. These conditions indicated that the training program lacked the control and supervision necessary to implement and monitor an aggressive and comprehensive program.

The company maintenance practices were deficient because it was extremely difficult for a pilot to know the exact maintenance status of his aircraft before takeoff. Also, the company maintained no control over serviceable and unserviceable items in its spare part stock. The Board believes that these practices could lead to unserviceable parts being placed in an aircraft.

The Safety Board believes that the FAA's surveillance of the company's operations and maintenance practices should have detected and caused to be corrected the deficiencies discovered during the Board's investigation. The Board realizes that the same FAA personnel responsible for surveillance of this company were also responsible for about 151 other Part 135 operations in the Anchorage area. However, the detection and correction of operations such as the one uncovered during this investigation are vital to safe operation.

3. CONCLUSIONS

3.1 Findings

1. The flightcrew was certificated and trained for the flight.
2. The aircraft conformed to the proper takeoff weight and c.g. limitations.
3. The aircraft was not properly equipped for the flight in that there was only one ADF receiver on board.
4. The aircraft was dispatched by a company representative whose responsibilities did not include the dispatch of aircraft.
5. The crew accomplished the preflight planning properly with the exception of accepting an aircraft with one ADF receiver instead of the two required for this flight.
6. The one ADF on board the aircraft was operating properly at the time of the accident.
7. The flight plan route was followed from Iliamna Airport to Kakon Intersection via Red 99.

8. The accident did not result from tuning the wrong ADF.
9. The Wildwood NDB signal can be received, although not necessarily with a reliable signal, while on Green 8, 14 nmi east of Kakon Intersection.
10. About 14 nmi east of Kakon Intersection, while established on Green 8, the crew turned northeastward toward Wildwood NDB.
11. The crew believed they were tracking inbound to the Wildwood NDB because the heading indicator was not properly set, because of precession of the heading indicator, or because they were relying on the Wildwood NDB beyond its reliable range.
12. The 192° bearing from Wildwood NDB would not be intercepted until a point about 40 nmi from the Kachemak NDB. This should have been known by the crew.
13. The flying time from Kakon Intersection to the 192° bearing from Wildwood NDB was about 18 min. This should have been known by the crew.
14. The crew was not using the Homer VOR/DME to backup or doublecheck the primary ADF navigation on Green 8.
15. The company's operational, maintenance, and training practices were inadequate. The FAA's surveillance of these areas was also inadequate.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the failure of the flightcrew to use proper navigational procedures for the route to be flown, especially their failure to use the available backup means of navigation to verify the position and the progress of the flight.

4. SAFETY RECOMMENDATIONS

As a result of this accident, the National Transportation Safety Board recommended that the Federal Aviation Administration:

"Revise the surveillance requirements of commuter airlines by FAA inspectors to provide more stringent monitoring.
(Class II - Priority Action) (A-78-37)

"Identify FAA offices responsible for the surveillance of large numbers of air taxi/commuter operators and insure that an adequate number of inspectors are assigned to monitor properly each operator. (Class II - Priority Action) (A-78-38)

"Review the flight operations and training manuals of all commuter airlines to insure that the requirements of 14 CFR 135 are met and practiced. (Class II - Priority Action) (A-78-39)

"Amend 14 CFR 135.27 to require that flight operations manuals specify: (1) The duties and responsibilities of key management personnel, and (2) positive means to insure the control of flights by company management as well as by the pilots. (Class II - Priority Action) (A-78-40)

"Review the maintenance procedures of air taxi and commuter airlines operators to evaluate the effectiveness of those procedures and to insure adequate company control. (Class II - Priority Action) (A-78-41)"

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JAMES B. KING
Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ PHILIP A. HOGUE
Member

/s/ ELWOOD T. DRIVER
Member

May 4, 1978

5. APPENDICES

APPENDIX A

INVESTIGATION AND HEARING

1. Investigation

The Safety Board was notified of a missing aircraft about 1640 on September 6, 1977. About 1143 on September 7, 1977, notification was received that the wreckage had been located. The investigation team went immediately to the scene. Working groups were established for operations, air traffic control, and maintenance records.

Participants in the on-scene investigation included representatives of Alaska Aeronautical Industries, Inc., the Federal Aviation Administration, the Union of Professional Airmen, the Pratt & Whitney Aircraft Division of United Technologies, Inc., and the Alaska Transportation Commission.

2. Public Hearing

A 3-day public hearing at Anchorage, Alaska, began on November 9, 1977. Parties represented at the hearing were: Alaska Aeronautical Industries, Inc., the Federal Aviation Administration, the Union of Professional Airmen, the State of Alaska Transportation Commission, and the National Association of Air Traffic Specialists, Inc.

APPENDIX B

PERSONNEL INFORMATION

Captain Mitchell E. Crandall

Captain Mitchell E. Crandall, 31, was employed by Alaska Aeronautical Industries, Inc., as a first officer on February 27, 1977. He was upgraded to DHC-6 captain on April 28, 1977. The captain held Airline Transport Pilot Certificate No. 2178380 with a type rating in the DHC-6 and as a Flight Instructor. His ratings included airplane, single- and multi-engine, instruments, and airplane and ground instructor. His first-class medical certificate was dated September 2, 1976, with no limitations.

Captain Crandall had a total of 4,335 flight-hours, of which 1,124 hours were in the DHC-6 aircraft. He had accumulated about 591 flight-hours as a DHC-6 captain. He had flown about 220 flight-hours in actual instrument meteorological conditions, of which 12.6 hours were recorded in August and September of 1977. On the day of the accident, he had reported for work about 0400 and had flown 5.4 hours before the takeoff of Flight 302.

First Officer Gary F. Bible

First Officer Gary F. Bible, 21, was employed by Alaska Aeronautical Industries, Inc., as a first officer on June 14, 1977. He held Commercial Pilot Certificate No. 564060746 dated May 26, 1975, with ratings in airplane single- and multi-engine land and instrument airplane. His first-class medical certificate was dated February 17, 1977, and had no limitations.

First Officer Bible had accumulated 1,380 total flight-hours of which 371 flight-hours were in the DHC-6 aircraft. He had flown 53 flight-hours in actual instrument meteorological conditions. On the day of the accident, he had reported for work about 0400 and had flown 5.4 hours before the takeoff of Flight 302.

APPENDIX C

AIRCRAFT INFORMATION

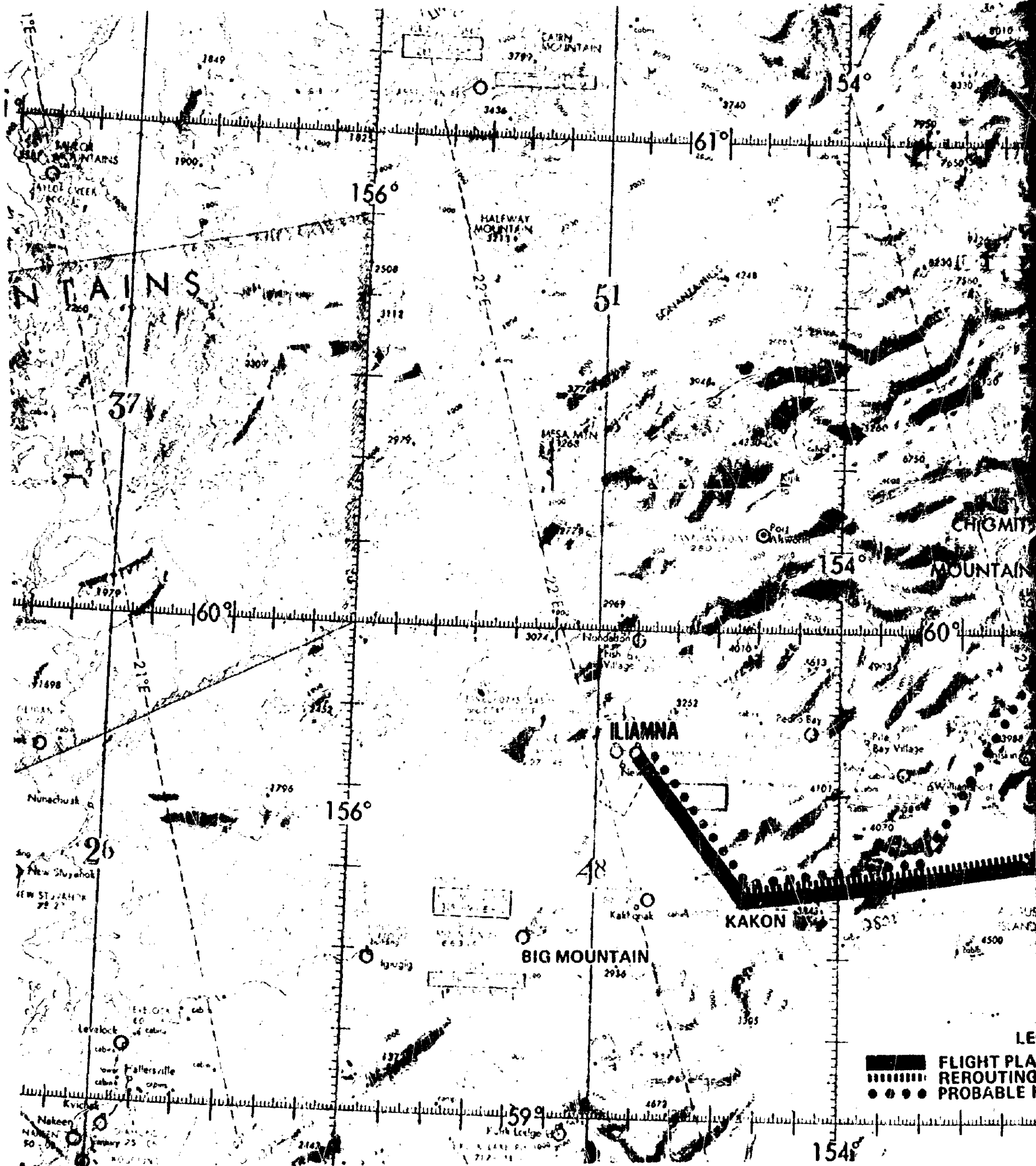
DeHavilland DHC-6-200, Serial No. 19837, N563MA, was owned by NBC Leasing Co., of New York, New York, and operated by Alaska Aeronautical Industries, Inc., under a lease-buy back arrangement. It was certificated and maintained according to procedures approved by the FAA. The aircraft was manufactured in 1969. At the time of the accident the aircraft had accumulated 15,369.2 flight-hours; 69 hours had been flown since the last progressive inspection.

Engines: Two Pratt & Whitney PT-6-A-20's

	<u>Serial No.</u>	<u>Total Time</u>
No. 1	PC-E-21101	5,690.3 hrs.
No. 2	PC-E-22232	2,491.9 hrs.

Propellers: Two Hartzel HCB-3-TN-3B's

	<u>Total Time</u>
No. 1	978.2 hrs.
No. 2	1,609.6 hrs.



A

APPENDIX D

