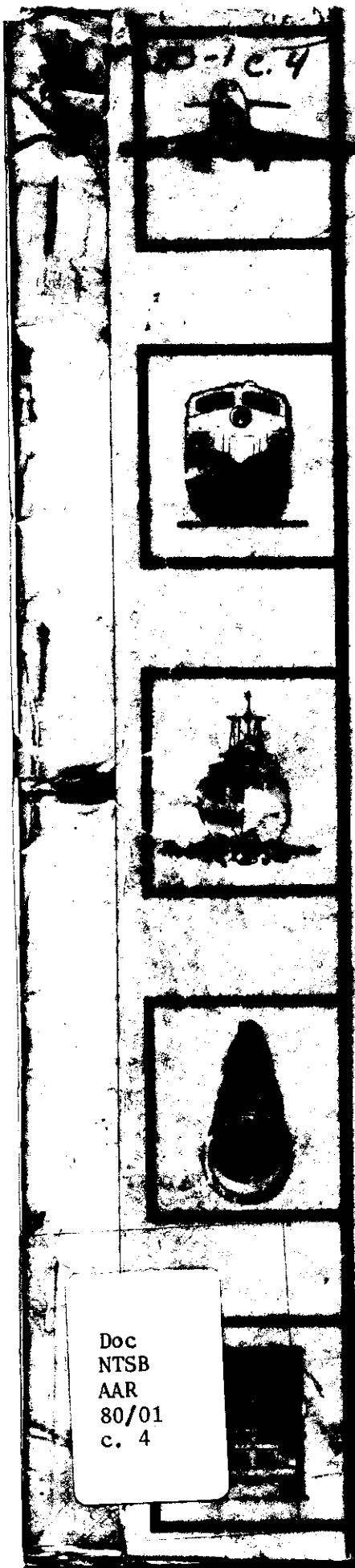

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

AIR NEW ENGLAND, INC.
DeHAVILLAND DHC-6-300, N383 EX
HYANNIS, MASSACHUSETTS
JUNE 17, 1979

UNITED STATES GOVERNMENT

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16. Abstract

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The National Transportation Safety Board determines that the probable cause of the accident was the failure of the flightcrew to recognize and react in a timely manner to the gross deviation from acceptable approach parameters, resulting in a continuation of the descent well below decision height during a precision approach without visual contact with the runway environment.

Although the Board was unable to determine conclusively the reason for the failure to recognize and react to the gross deviation, it is believed that the degraded physiological condition of the captain seriously impaired his performance. Also, the lack of adequate crew coordination practices and procedures contributed to the first officer's failure to detect and react to the situation in a timely manner.

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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

Adopted: January 3, 1980

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DeHAVILLAND DHC-6-300, N383EX
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JUNE 17, 1979

SYNOPSIS

About 2248 e.d.t., on June 17, 1979, Air New England, Inc., Flight 248 crashed into a heavily wooded area about 1.5 nmi northeast of Barnstable Municipal Airport, Hyannis, Massachusetts. The crash occurred during an instrument landing system approach to runway 24 in instrument meteorological conditions. Of the eight passengers and a crew of two aboard, the captain was killed, the first officer and six passengers were injured seriously, and two passengers received minor injuries. The aircraft was destroyed.

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Although the Board was unable to determine conclusively the reason for the failure to recognize and react to the gross deviation, it is believed that the degraded physiological condition of the captain seriously impaired his performance. Also, the lack of adequate crew coordination practices and procedures contributed to the first officer's failure to detect and react to the situation in a timely manner.

1. FACTUAL INFORMATION

1.1 History of the Flight

On June 17, 1979, an Air New England, Inc., deHavilland DHC-6-300 (N383EX) was scheduled for a series of flights between Barnstable Municipal Airport, Hyannis, Massachusetts, and several New England cities. The original flight schedule included 12 trips (legs) between 4 destinations, beginning at Hyannis at 0905 1/ and terminating at Hyannis at 2030. Weather, equipment, and company personnel problems caused several changes in the original schedule.

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

The flightcrew reported for duty about 0845 and flew the 12 legs of the schedule. The first officer stated that he and the captain believed their day was over when they arrived at Hyannis at 1831. However, upon arrival at Hyannis the crew learned that they were to fly two more flights of two legs each. The first officer stated that the captain was annoyed by the instructions from the company. Two other witnesses at the terminal stated that the captain was visibly upset about the additional flights.

The flight from Hyannis to LaGuardia Airport, Flushing, New York, which included an en route stop at New Bedford, Massachusetts, was uneventful except that the captain did not configure his instruments properly for the instrument landing system (ILS) back course approach at New Bedford. The first officer became aware of the problem and advised the captain of his error.

Before loading the aircraft for takeoff from LaGuardia, the flightcrew checked the en route weather for the return flight to Hyannis and learned that a landing at the en route stop at New Bedford might not be possible. When they were advised of the weather situation, the passengers destined for New Bedford decided to remain at LaGuardia. At 2132, N383EX (Flight 248) departed LaGuardia for Hyannis on the last leg of the day. There were eight passengers and two flight crewmembers aboard.

According to the first officer's and a passenger's testimony at the public hearing held during the investigation of the accident, Flight 248 was normal until the approach for landing at Hyannis. At 2234:08, Flight 248 contacted Otis Approach Control 2/ and reported level at 5,000 ft. 3/ At 2239:05, the flight was given the current Hyannis weather which included an indefinite ceiling of 200 ft, sky obscured; visibility--3/4 mi in fog; wind--210° at 10 kns. It also included a visibility of 1 1/8 nmi in light drizzle on runway 24.

At 2244:36, Flight 248 was 4 nmi north-northeast of the outer marker when Otis Approach Control gave the flight a vector of 210° to intercept the localizer at 1,700 ft for an ILS approach to runway 24 at the Barnstable airport. At 2245:34, Flight 248 was instructed to contact the Barnstable airport tower. About 2247, the flight complied with this request and reported crossing the outer marker. The flight was cleared to land; however, no further transmissions were heard from the aircraft.

The Boston Air Route Traffic Control Center (Boston Center) was able to track Flight 248 to within 2.8 nmi of the intended touchdown point on runway 24. (See Figure 1.) Boston Center's computer printout showed the flight's position at 2246:51 about 0.35 nmi northeast of the ILS outer marker at 1,700 ft. It also showed the flight about 0.15 nmi southwest of the outer marker at 1,500 ft at 2247:03. The last radar position shown for the flight was about 1.1 nmi southwest of the outer marker at 2247:27 at 1,100 ft.

2/ The Federal Aviation Administration (FAA) facility which controls traffic into and out of Hyannis.

3/ All altitudes herein are mean sea level unless otherwise specified.

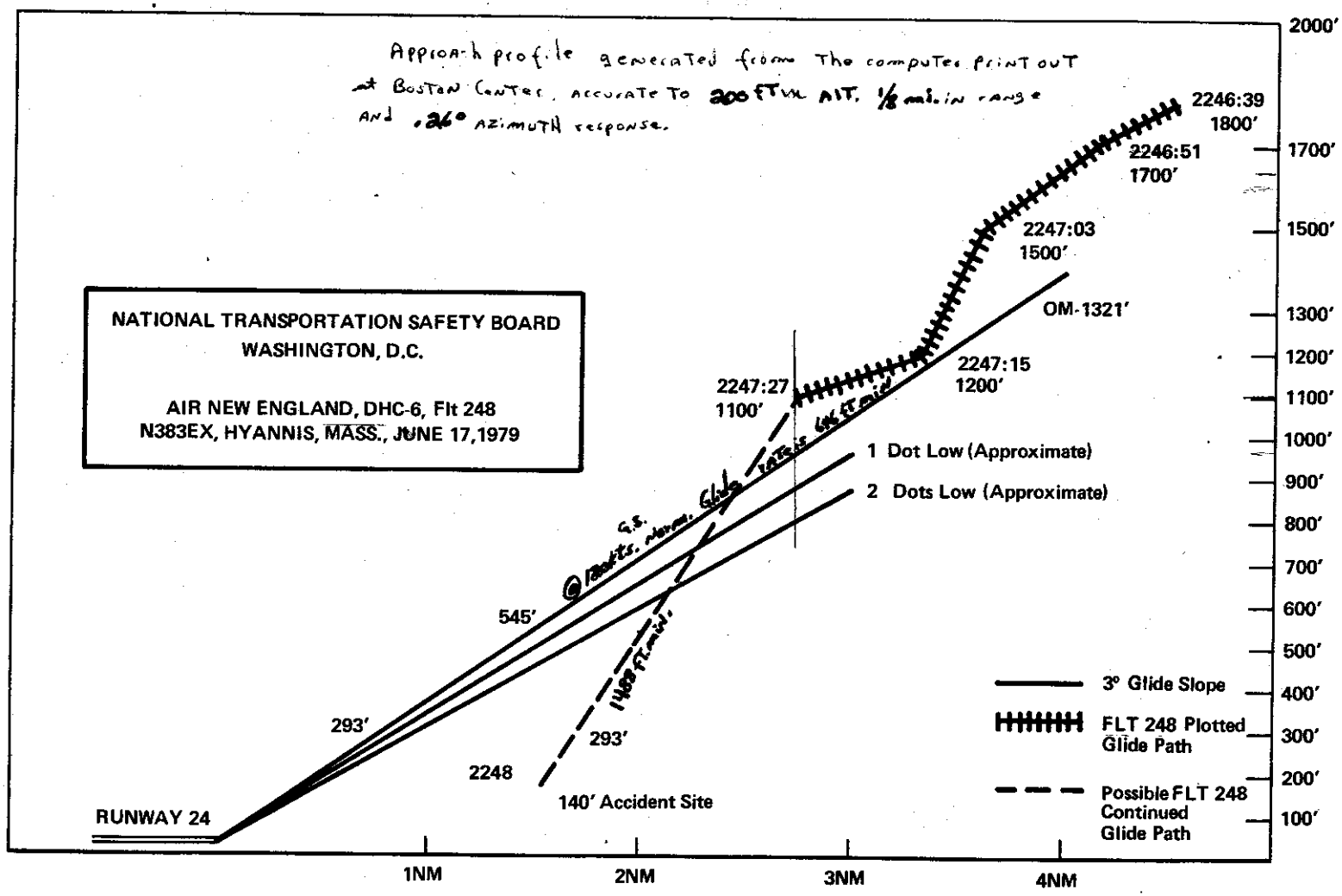

Figure 1.--Probable descent profile of N383EX determined from Boston Center data.

The first officer stated that the captain was flying the aircraft during the approach into Hyannis. He said that he made the following callouts: localizer alive, outer marker, 500 ft above, 200 ft above, 100 ft above, minimums, and 100 ft below. He said that the captain did not acknowledge any of these calls. The first officer said that when he called "minimums," the aircraft was one dot below the ILS glidepath. The first officer said that it appeared that the aircraft was in a continual descent without any excessive sink rates or descent angles from 5,000 ft until impact, with the airspeed near 130 kns for the entire approach. He stated that, as he called "100 ft below," he looked outside the cockpit because he believed that the captain had the approach lights in sight. The first officer said that he did not see the ground before the aircraft crashed about 2248 into a heavily wooded area 1.5 nmi from the approach end of runway 24, on the runway centerline extended.

The accident occurred during the hours of darkness. The coordinates of the accident site were 41° 41' 26" N latitude and 70° 14' 33" W longitude. The elevation of the accident site was about 100 ft.

1.2 Injuries to Persons

Injuries	Crew	Passengers	Others
Fatal	1	0	0
Serious	1	6	0
Minor/None	0	2	0

1.3 Damage to Aircraft

The aircraft was destroyed.

1.4 Other Damage

Numerous trees were destroyed or damaged.

1.5 Personnel Information

The flight crewmembers were qualified and certificated for the flight; they had received the training required by current regulations. (See Appendix B.)

* Even though the captain's medical records indicated that his distant vision was 20/20, he had a limitation to his first-class medical certificate which required that the "Holder shall wear glasses which correct for near and distant vision while exercising the privileges of his airman certificate." The captain's glasses were found in the cockpit, in their carrying case. The first officer stated that he did not believe the captain was wearing the glasses on this approach or anytime that day while flying.

The investigation revealed that the captain's FAA medical record began with his annual physical examination for his second-class medical certificate

performed in 1962. The captain developed hypertension in 1953 as a result of a history of glomerular nephritis. In 1963, a U. S. Marine Corps Reserve aviation physical examination revealed that the captain still had hypertension. He had a sympathectomy, an operation to reduce hypertension, in October 1963. At that time, he was removed from duty involving flying as a pilot in the Marine Corps. His second-class medical certificate was denied by the FAA Regional Flight Surgeon in February 1964 after a physical examination in January 1964 revealed persistent hypertension requiring antihypertension drugs for its control. After a complete cardiovascular evaluation and an apparent return to normal blood pressure levels without the requirement for antihypertensive drugs, the medical certificate was reissued in March 1964, with the requirement for close cardiovascular monitoring.

Until 1968, the captain's annual flight physical examinations resulted in short periods of medical certificate denial and subsequent recertification by the Regional Flight Surgeon after further cardiovascular studies. When the captain's annual physical examination in January 1968 detected blood pressure readings as high as 186/122, his medical certificate was denied by an FAA Aviation Medical Examiner (AME). After extensive evaluations failed to show that the captain met FAA standards for recertification, the denial was upheld by the FAA's Regional Flight Surgeon and referred to the FAA's Federal Air Surgeon in April 1968. His medical records did not show any further cardiovascular evaluations submitted and no medical certificate reissued by the Federal Air Surgeon. However, in August 1970 following 2 1/2 years without apparent medical certification, a physical examination was performed by an AME in Hyannis and a second-class medical certificate was issued after approval, by telephone, by the Chief of the FAA's Aeromedical Certification Branch, Civil Aeromedical Institute, Oklahoma City, Oklahoma.

In August 1971, the captain was issued a first-class medical certificate after a physical examination was performed again by the AME in Hyannis. Since that time, first-class medical certificates had been issued to the captain at 6-month intervals on the basis of physical examinations and cardiovascular evaluations performed by the same AME. On all of these physical examination application forms, the current use of any medication was denied by the captain. Also, the captain's blood pressure was recorded as being within normal limits. However, a cardiologist who reviewed the captain's electrocardiograms after the accident said the tracing could be considered borderline and could be interpreted as abnormal.

In July 1975, the captain's fasting blood sugar was found to be 50 milligram percent (mgm %) and was not subsequently reevaluated. Additionally, the urea nitrogen level was elevated to 26 mgm %, and the uric acid level was elevated to 10.8 mgm %. In August 1978, the fasting blood sugar had elevated to 158 mgm %. An evaluation performed at the request of the FAA reviewing authority in January 1979 revealed normal levels of fasting blood sugar at 97 mgm % and of 2-hour postprandial sugar at 99 mgm %. This abnormal fasting blood sugar determination is one indication of hypoglycemia. However, the captain was never diagnosed as being hypoglycemic.

The captain's latest first-class medical certificate was issued on February 14, 1979. He indicated on the application for this certificate that he currently was not using any medication and had never been denied an airman's medical certificate. The investigation revealed that the captain was on two medications: polythiazide, 1 mgm daily, an antihypertensive medication apparently initiated in 1967 by a doctor in Boston, Massachusetts, and allopurinol, 300 mgm daily, initiated in 1976 by a doctor in Hyannis. The AME in Hyannis denied knowledge of the captain's use of either drug.

The captain's only known food intake on the day of the accident was a Danish pastry and a cup of coffee in the late afternoon between flights.

1.6 Aircraft Information

The aircraft was certificated and equipped in accordance with current regulations. There were about 1,000 lbs of Jet A fuel onboard when the aircraft crashed. (See Appendix C.)

The aircraft's weight was within allowable limits both at takeoff from LaGuardia and at the time of the accident. The center of gravity was computed as slightly forward of the forward limit.

The first officer, during his testimony at the public hearing, said that the cockpit lighting in the DHC-6 was adequate; however, it was not bright enough to make the movements of the other pilot easily discernible. He said also that the aircraft's cockpit was extremely noisy and that intra-cockpit communications were difficult without the use of headsets and interphone. These same views have been expressed by other DHC-6 pilots. 4/

1.7 Meteorological Information

The weather at Hyannis as observed and recorded before and after the accident by qualified FAA tower personnel at the Barnstable airport was:

2237: Indefinite ceiling -- 200 ft, obscured; visibility -- 3/4 mi, fog; temperature -- 67° F; dewpoint -- 66° F; wind -- 210° at 10 kns; altimeter setting -- 29.87 inHg; remarks -- runway 24 visibility 1 1/8 nmi, occasional light drizzle.

A local observation taken at 2249 for the report of the aircraft mishap reported the same weather conditions as at 2237.

Other Air New England aircraft had preceded Flight 248 into the Barnstable airport on the night of the accident. The first officer of one flight which landed at 2130 stated that his aircraft broke out of the clouds at 400 ft. The captain of another flight which landed at 2140 stated that his aircraft broke out of the clouds at approach minimums (293 ft). A piper PA-31 pilot, who flew the ILS approach to runway 24 about 6 min before Flight 248, stated that

4/ Public Hearing, September 11, 1979, at Cambridge, Massachusetts, concerning the Downeast Airlines, DHC-6 accident at Rockland, Maine, May 30, 1979.

he broke out of the clouds at 300 ft. All of these pilots reported "good" visibility under the clouds.

1.8 Aids to Navigation

Not applicable.

1.9 Communications

No communications difficulties were reported.

1.10 Aerodrome Information

Barnstable Municipal Airport has three hard-surface runways -- runway 11/29, 1,913 ft long; runway 15/33, 4,000 ft long; and runway 06/24, 5,563 ft long. The airport elevation is 52 ft and the elevation of the approach/touchdown zone on runway 24 is 43 ft. The Barnstable tower is in operation until 2300 daily.

Runway 24 is served by an ILS. The weather minimum for this approach is 1 mi visibility at a decision height of 293 ft. Associated with the ILS is a standard ALSF-1 (High) approach lighting system with sequenced flashing lights. The runway is also equipped with high-intensity runway lights. A transmissometer is used by the FAA tower personnel in their determination of current minimum visibility on runway 24.

Three pilots who flew the ILS approach to runway 24 within 1 hr 25 min of Flight 248, including one pilot who flew it 6 min before, stated that the ILS and the approach lighting system were on and functioning correctly. The Barnstable tower, which monitors the ILS, reported no abnormalities or warnings of problems with the system.

The terrain off the approach end of runway 24 rises gently to the accident site and is heavily wooded.

1.11 Flight Recorders

The aircraft was not, nor was it required to be, equipped with a cockpit voice recorder or a flight data recorder.

1.12 Wreckage and Impact Information

The initial impact was about 30 ft above the base of some trees in a heavily wooded area along the extended centerline of runway 24. The elevation of the base of these trees was 106 ft. The aircraft continued along a heading of 255° striking about 38 trees over a distance of 193 ft before impact with the ground. As the aircraft descended through the trees at descent angles which varied from 4° to 20°, it shed outboard sections from both wings and other small parts.

The aircraft impacted on 10.2° downsloping terrain. It slid about 101 ft before coming to rest upright about 294 ft from the initial impact with the trees and 1.5 nmi from the approach end of runway 24. The wreckage path was about 55 ft wide. There were no signs of fire.

Fairing from the right main landing gear and a latch from the nose baggage compartment door were found near the initial tree contact point. A 13-ft 8-in left-wing outboard section and a 5-ft 8-in right-wing outboard section were located about 120 ft from the initial impact point. All control surfaces and wing flap sections were located in the main wreckage area. There was continuity of control cables and rods from the cockpit to all control surfaces. All exit covers and doors were accounted for.

The nose landing gear was damaged but remained attached to the main structure. The right main landing gear was in position and was slightly damaged. The left main landing gear had separated from the aircraft and was located behind the fuselage.

Both powerplants and their associated propellers were damaged extensively from impact with trees and terrain; however, there was no indication of preimpact failure of these systems or their components.

Hydraulic fluid was present in all reservoirs and accumulators. Open circuit breakers could be related to airframe damage.

Little impact damage was evident along either side of the fuselage from the cockpit/cabin bulkhead aft to the empennage. The cockpit area was partially destroyed by impact with trees. The cockpit was crushed aft about 4 ft on the right side and about 9 ft on the left side. The captain's instrument panel and floor structure back to the cockpit/cabin bulkhead were destroyed. A large tree trunk had passed through the captain's position; the captain's seat was still in the cockpit area, but it had separated from its track attachment.

Most of the flight instruments were destroyed or severely damaged; however, a barometer setting of 29.86 inHg was obtained from one altimeter, all of the radios were set to frequencies associated with the approach phase of flight, and all instrument switches which could be identified were positioned for the approach being conducted at the time of the accident.

The first officer's seat remained in place with minor damage. All but three of the passenger seats remained secure to the cabin floor and wall attach points. The seat in position 1A was separated from its aft floor and wall attachments when trees penetrated the area. Both inboard seat legs were bent forward about 45°. Seat unit 4BC, in which only seat 4C was occupied, was found collapsed on the floor. Both inboard seat leg-to-track attachment fitting buttons had sheared in a forward-inboard direction.

1.13 Medical and Pathological Information

The captain's postmortem examination revealed an old, healed myocardial infarct. The infarct was a firm white scar measuring about 3 cm in

diameter and involved the inner two-thirds of the myocardial thickness. There was no evidence of a recent injury of the myocardium. The beginning of the left anterior descending coronary artery showed 40 to 70 percent occlusion of the lumen by yellow, eccentric atheromatous plaques. The entire descending aorta showed moderate atherosclerosis with areas of calcification and many areas of intimal ulcerations.

Postmortem toxicologic studies did not reveal the presence of polythiazide, allopurinol, or other drugs.

The captain's injuries included crushing of the chest with rupture of the heart, the aorta, and the bilateral hemothorax. There was also rupture of several other internal organs.

A review of the first officer's medical records revealed no evidence of medical problems that might have affected his performance. The first officer's injuries included a fracture of the left tibia, bilateral fracture of radii, fracture of the sternum, and lacerations of the right lower leg and the left vortex scalp.

Injuries to the passengers included a spinal compression fracture, fractures and lacerations of the extremities, fractured ribs, head injuries, multiple abrasions, contusions, and lacerations.

1.14 Fire

There were no indications of preimpact or postimpact fire.

1.15 Survival Aspects

1.15.1 General

This was a partially survivable accident. With the exception of the cockpit area, the structural integrity of the fuselage was not compromised. All passenger restraints that were used functioned normally. Two passengers were not wearing their seatbelts at the time of the accident and were thrown into the seats in front of them by the deceleration forces. The first officer's restraint system functioned normally; however, the captain's system released sometime during the crash sequence because of impact damage to the seatbelt buckle. The captain was ejected from the cockpit and his body was found about 25 ft forward of the cockpit wreckage. The first officer was conscious but trapped in his seat. He was extricated by two passengers, lowered to the ground, and, at his direction, was administered first aid.

Seatbelt and no smoking signs were on during the entire flight from LaGuardia; however, passengers stated that no announcement was made to fasten their seatbelts. The first officer stated that he made the seatbelt announcement at the same time he advised the passengers that the aircraft would be landing in about 10 min. The passengers did recall the 10 min announcement.

After the aircraft came to rest, the occupants immediately decided to get out of the aircraft because of the strong fuel odor and the threat of fire. All of the passengers recalled the flightcrew's briefing on the emergency procedures before departure from LaGuardia. Furthermore, most of them had read the passenger briefing cards sometime during the flight. Repeated attempts were made by several passengers to open all the emergency exits except the left front emergency window exit. A male passenger said he "couldn't get (the) emergency exits open -- handles came off in (his) hand." The passenger said he removed the passenger briefing card from a seatback to reread it "to see how (the) exits work." He finally was successful in opening the main cabin door wide enough to exit through, but the door would not open completely because of a fallen tree. All of the passengers exited through the partially opened main cabin door. The investigation revealed that the exits were moderately distorted and were blocked from the outside by trees.

While the less seriously injured passengers were seeking an exit route, a medical student onboard the aircraft examined the two seriously injured passengers who were in the left front of the aircraft. The student also checked everyone else before they left the aircraft. The two seriously injured passengers were carried out of the aircraft.

The interior cabin lights remained on while the passengers exited the aircraft. Passengers estimated it took them 15 to 20 min to complete the evacuation. The injured were taken about 50 ft from the aircraft. An uninjured passenger agreed to go for help. She made her way through the woods to a road and flagged down a car. She was driven to the airport and subsequently taken to a hospital.

1.15.2 Search and Rescue

The probability of an aircraft accident was first realized by an off-duty Air New England pilot, who, on his way home, saw the airport strobelights go on as he drove by. Expecting an aircraft to land, he pulled into a nearby parking lot. His car was equipped with an aircraft band scanner. He heard the tower response "248 clear to land" and waited for the aircraft. After a reasonable period of time he suspected what had occurred and drove in the direction of a possible crash site along the flightpath where he met a police officer and informed him of what could have occurred. They began searching the immediate area. Shortly thereafter, the officer received a radio transmission informing him of a reported possible aircraft crash near Camp Greenough.

The off-duty pilot and the police officer started toward the entrance of Camp Greenough. En route they encountered the chief of the Yarmouth Fire Department. Using the chief's area map and the pilot's ILS approach plate, they isolated an area to search. A command post was established by the firechief at the entrance to the camp.

State police records indicate that an organized search in the area of Camp Greenough began at 2315. Approximately 49 persons were involved in the search. The downed aircraft was located within 1 hr after the search began

and 1 hr 28 min after the crash. Gaining access to the accident site was difficult. Vehicle access was limited to a small dirt service road which was widened using fire department brush breakers.

Some onscene first aid was administered to the injured by the first rescuers who arrived. Once paramedics and the emergency medical technicians arrived, additional medical procedures were performed. The majority of the ambulances used by the responding local fire departments were capable of communicating directly with the Cape Cod Hospital Emergency Room and transmitted the victims' vital signs, EKG traces, etc.

The Yarmouth Fire Department had 48 of its 65-man firefighting force involved in the emergency at one point. Local fire departments from Hyannis, Dennis, Harwich, Barnstable, and West Barnstable provided 15 additional men and one ambulance each.

The Cape Cod Hospital in Hyannis was advised by the State Police at 0015 that it would be receiving about 10 casualties. The hopital's newly developed disaster plan was not activated because most of the personnel from two shifts were in the hospital at the time and were retained. All of the casualties of this accident were taken to the Cape Cod Hospital. The first casualty was admitted at 0140. The last casualty was admitted at 0428.

1.16 Tests and Research

None

1.17 Other Information

1.17.1 Air New England Callouts During Approach

The company procedure for standard callouts by the nonflying pilot during an instrument approach are:

"(1) 500 ft above minimum descent altitude (MDA) or decision height (DH);

(2) 200 ft above MDA or DH;

(3) 100 ft above MDA or DH;

(4) MDA or DH;

(5) While on final - anytime a deviation of more than 1 dot - should be called out and acknowledged;

(6) Sink rate should be monitored closely -- excessive sink rate beyond the final approach fix (FAF) will be called and acknowledged;

(7) Whenever an airspeed excursion of minus 0 or plus 10 kns from planned final approach speed is observed, it will be called out and acknowledged.

(8) At Missed Approach Point (MAP)--runway in sight or no contact."

1.17.2 Air New England Crew Procedures

The normal company crew coordination procedures for all IFR approaches are:

"(1) At not less than 100 ft above MDA or DH -- Pilot not flying directs primary attention outside;

(2) At DH or MAP -- if the pilot not flying calls out "No contact" the pilot flying will immediately call out "Go Around";

(3) Full scale deflection of either glide slope or localizer needle inside the FAF will require the immediate execution of the missed approach procedure."

1.18 New Investigation Techniques

None

2. ANALYSIS

2.1 The Accident

The flightcrew was properly certificated and qualified in accordance with company and FAA requirements.

The aircraft was certificated and maintained according to applicable regulations. There was no evidence of preimpact failure, malfunction, or abnormality of the airframe, systems, or powerplants.

Because of the circumstances of the accident and because the aircraft's ILS equipment was too damaged to be tested adequately, the possibility of an aircraft ILS system malfunction was considered. However, the first officer's testimony that his ILS instruments appeared to be functioning normally, that no off-flags were visible on any of his instruments, that a positive identification of the Hyannis ILS was received at the outer marker, and that the aircraft's ILS equipment had operated normally during the previous approach at LaGuardia seemed to eliminate or at least lessen considerably the possibility of an aircraft ILS system malfunction.

The possibility that the Hyannis ILS malfunctioned is remote because of two factors. First, the ILS monitoring system in the Hyannis tower showed no abnormalities or warnings. Second, a pilot who had landed at Hyannis utilizing the ILS approach about 6 min before Flight 248 stated that the ILS and the associated

approach lights functioned normally. Furthermore, if either the aircraft's ILS instruments or the airport's ILS equipment had malfunctioned during the approach, the captain should have leveled immediately and conducted a missed approach if the airport environment was not visible. Therefore, the Safety Board concludes that the accident was not related to an equipment malfunction.

Flight 248 struck trees about 1.5 nmi northeast of the approach end of runway 24 at an altitude of about 140 ft. If the aircraft had been on the 3° ILS glideslope into the Barnstable airport, it would have been at an altitude of about 545 ft at that distance from the runway. Therefore, the aircraft was 405 ft below the normal glide slope altitude and 153 ft below the decision height of 293 ft when it struck the trees.

Flight 248's approach profile (see Figure 1) was derived from a computer printout from the Boston Center. The computer printout is accurate to within 200 ft in altitude, 1/8 mi in range, and 0.26° in azimuth. Three significant readouts obtained from the computer printout placed Flight 248 at 1,560 ft at the outer marker, at 1,500 ft 0.15 nmi inside (southwest) of the outer marker at 2247:03, and at 1,100 ft 1.1 nmi inside of the outer marker at 2247:27. The distance between the last computer-plotted position of Flight 248 and the accident location is 1.29 nmi.

The first officer testified that the aircraft's indicated airspeed was about 130 kns during the approach. Because of a headwind of about 10 kns, the aircraft's ground speed was close to 120 kns. This ground speed is consistent with the information derived from the computer printout, which had Flight 248 traversing the 5.74 nmi before its last plotted position in 2 min 48 sec, which represents a ground speed of 123 kns. From the aircraft's last plotted position at 1,100 ft to the crash site, Flight 248 covered 1.29 nmi and descended 960 ft. Assuming that Flight 248 began its descent from its last plotted position at 1,100 ft at 2247:27, the aircraft would have had to descend at 1,488 ft/min with a descent angle of 6.976° in order to impact the ground 1.5 nmi from the end of runway 24.

The first officer's recollection of Flight 248's flight profile differs from the one constructed from the computer printout. The first officer testified that Flight 248 crossed the outer marker at the proper altitude (1,321 ft). Since the aircraft crashed 2.3 nmi inside the outer marker at 140 ft, the aircraft's descent rate would have been 925 ft/min with a descent angle of 4.3° if the flight crossed the outer marker at 1,321 ft. For a ground speed of 120 kns, the aircraft's normal rate of descent for a 3° glide slope is 646 ft/min.

The first officer also testified that when he called minimums, the aircraft was one dot below the glide slope. Assuming a 6.976° descent angle, Flight 248 would have descended through the 293-ft decision height about 1.69 nmi from the runway. At 1.69 nmi from the runway, a one dot-low indication represents a position about 50 ft below the 3° glide slope. However, Flight 248 was actually 400 ft below the glide slope when the aircraft descended through minimums, and the glide slope indicator should have indicated full-scale deflection.

The profile as derived from the computer printout is believed to be the most accurate presentation of Flight 248's actual flightpath for two reasons. First, the computer printouts have been historically accurate and comparison to past accident aircrafts' flight data recorders has substantiated their accuracy. Second, the first officer's recollection of the aircraft's flight profile is contrary to a number of known facts. For example, since the aircraft crashed 1.5 nmi from the runway it would have been impossible for Flight 248 to be only one dot below the ILS glide slope when it descended through minimums. Also, the first officer stated that he did not recall any excessive sink rates or descent angles. Even if Flight 248 had passed over the outer marker at the normal altitude of 1,321 ft, it would have required a 925 ft/min descent rate and a 4.3° glide slope to reach the accident location.

The Safety Board believes that Flight 248 approached the outer marker 300 ft high, crossed the outer marker 220 ft high, remained above the glide slope until about 1.4 nmi inside the outer marker, began a steeper than normal descent about 1.25 nmi inside the outer marker, and maintained this descent until ground impact. The Safety Board concludes that Flight 248's altitude and descent angle were controlled in an imprecise and careless manner.

2.2 The Captain's Role

While Flight 248's flight profile has been established, the question of why the aircraft was 400 ft low 1.5 nmi from the runway must be explored. The captain, who was flying the aircraft, could have intentionally descended to decision height and below in an attempt to visually acquire a familiar landmark, the ground, or the approach lights. Testimony at the public hearing revealed that this captain had used a similar "duck under" procedure on other flights. On one occasion while flying an ILS approach into Hyannis in similar weather conditions, he descended through the glide slope. However, on that flight the pilot in the right seat was a qualified captain who took control of the aircraft at 600 ft and leveled out at 200 ft. The majority of Air New England pilots who were interviewed stated that the captain of Flight 248 disregarded checklists and crew coordination when they had flown with him.

Although past instrument approaches by this captain may lend credence to the possibility that he intentionally descended to the decision height and below, certain other factors tend to diminish the possibility of an intentional descent. Very little could have been gained by descending below a precision glidepath in such poor ceiling and visibility conditions. The steep descent angle which was initiated late in the approach and which was maintained through the decision height is not conducive to looking for the ground or lights or for leveling off. The higher than normal airspeed that was maintained could have placed an added burden on a pilot who was intentionally descending below a decision height. It seems improbable that a pilot would fly the aircraft above the glide slope early in the approach and then descend steeper and faster than normal while intentionally descending through the decision height.

It is possible that the captain's intention was to descend to and level at decision height and that a combination of other human performance-related factors had degraded his skills enough so that he was unable to arrest the descent

or stabilize at the decision height. One of the factors that may have contributed to an unintentional descent below the decision height was deteriorated flying proficiency. Although the captain had accumulated over 20,000 flight-hours and over 3,500 hours of instrument flight time, his recent flying time had been limited to 12 hours in the last 90 days before the day of the accident. According to statements from pilots who had flown recently with the captain, most of his recent flying was in visual meteorological conditions. Also, the captain approached the outer marker initially at 1,800 ft when he could have been at 1,400 ft until intercepting the glideslope outside the outer marker. It is possible that the captain's proficiency, particularly in instrument meteorological conditions, was degraded by the lack of recent experience.

There were also aeromedical factors which could have contributed to a continued unintentional descent. Because of the onset of hypertension in 1953 from a history of glomerular nephritis leading up to a sympathectomy in 1963, he was permanently removed from duty involving flying as a pilot in the U.S. Marine Corps. He was able to continue his career in commericial aviation with the requirement for close cardiovascular monitoring by the FAA even though the results of repeated evaluations were equivocal medically. At the time of the accident, the exercise of his Airline Transport Pilot Certificate was limited to operation under 14 CFR 135 because of the existing "over 60 rule" contained in 14 CFR 121.

A review of available medical records for the captain revealed findings of significance relating to preexisting disease. In addition to nonspecific electrocardiogram changes, abnormal blood chemistry determinations were apparent. Both blood urea nitrogen levels and uric acid levels were elevated. In addition to these, and of even more significance, fasting blood sugar was elevated on one occasion and was lower than normal on another, indicating the probable existence of an error in glucose metabolism and a possible predisposition to hypoglycemia.

While the existence of hypertensive cardiovascular disease was well documented in medical evaluations since 1963, the fact that the captain had suffered a subclinical myocardial infarction sometime before the accident was not detected by the required cardiovascular evaluations for continued FAA certification. The presence of the well healed myocardial infarct was noted on the postmortem examination after the accident. Of further significance, and also not detected by the required stress testing, were the atherosclerotic changes in the left anterior descending coronary artery resulting in from 40 to 70 percent occlusion.

The human factors investigation revealed that the captain was currently taking polythiazide and allopurinol. This information was not reported by the captain on his FAA physical examination form, and the AME denied knowledge of the captain's use of medication. However, the captain's past military medical records did indicate the use of these drugs. Polythiazide is a diuretic commonly used in the treatment of hypertension, and allopurinol is prescribed for the treatment of gout. While both drugs are among those which can be "waivered" by the FAA for pilot certification, such a waiver had not been considered in the

captain's case because the AME and the FAA were not aware of their use. Postmortem toxicologic studies did not reveal the presence of these or other drugs, but discussion with the toxicologist at the FAA's Civil Aeromedical Institute indicated that these particular drugs were difficult to detect in therapeutic levels.

Because he was in management at Air New England, the captain flew only occasionally as a replacement pilot. Early in the morning, on the day of the accident, he had been notified that he was needed to replace a line pilot and he reported for duty about 0845 for a scheduled 12.5-hr duty day. At 1830 at Hyannis, after several changes in the flying schedule during the day, he had anticipated the end of his duty day and was visibly upset when informed that it was necessary to extend his day for about 5 hrs to fly additional scheduled flights.

The accident occurred about 2248 during the 15th approach for landing at the end of a 14-hr duty day. A 14-hr duty day including 9 hrs 16 min actual flight time and 15 approaches in an aircraft well known for its dark, noisy cockpit environment would almost certainly have produced some degree of pilot fatigue even in the hardiest individual and particularly in an individual who was almost 61 years old and had chronic hypertensive cardiovascular disease. The probability also exists that the captain was predisposed to hypoglycemia because of an apparent error in glucose metabolism -- it is significant that his only known food intake during the 14-hr duty day was a Danish pastry and a cup of coffee during the late afternoon while on the ground between flights. Symptoms of hypoglycemia such as subtle mental confusion, slowing of cognitive processes, and diminution of psychomotor ability cannot be distinguished from symptoms of fatigue and, even when mild, would certainly contribute to the effects of fatigue. These physiological factors, which are known contributors to the degradation of human performance, were further compounded by the captain's emotional upset over the extension of his duty day.

The Safety Board believes that the multiple stresses which contributed to the captain's physiologic fatigue, in concert with his personal flying habits (disregard for procedures and lack of communication with his first officer) and his age, contributed greatly to a marked human performance degradation.

2.3 The First Officer's Role

The DHC-6 cockpit is dark and it is difficult for one pilot to see and assess the actions of the other pilot. Further, neither pilot can easily see the other pilot's flight instruments. The cockpit is also noisy, making verbal communication difficult except by use of headsets and interphone. The captain was a company vice president with over 20,000 flighthours who was known to rarely acknowledge checklist items or other callouts from any first officer. The first officer, although previously qualified in the DHC-6, had only been with the company for 2 months. For the first year, pilots are on probation, are not represented by the pilot's union, and may be terminated with or without cause.

It was within this environment that the first officer's role in this accident must be evaluated. The first officer testified that he made all of the

required callouts except the "no contact" call and that the captain did not acknowledge any of his calls. Because the captain rarely acknowledged calls, even calls such as one dot low, this lack of response probably would not have alerted the first officer to any physiologic incapacitation of the captain. However, the first officer should have been concerned by the aircraft's steep glidepath, excessive descent rate, and high airspeed. These three factors limited the amount of time available to the first officer to react once Flight 248 descended through the decision height.

The poor altitude and pitch control exhibited by the captain and the steep descent rate that the aircraft achieved should have alerted the first officer to the existence of an abnormal situation. However, a flight simulator study of subtle incapacitation conducted by United Air Lines demonstrated that recognition of the phenomenon by the other crewmember is a difficult task. 5/ In the United simulator study, when the captain feigned subtle incapacitation while flying the aircraft during an approach, 25 percent of the aircraft hit the "ground." The study also showed a significant reluctance of the first officer to take control of the aircraft. It required between 30 sec and 4 min for the other crewmember to recognize the captain was incapacitated and to correct the situation. The first officer of Flight 248 had 1 min 9 sec from the outer marker to impact. It is quite possible that the first officer also was suffering from fatigue which dulled his senses and reactions.

If Flight 248 was descending at 1,488 ft/min, it would have descended from the decision height to impact in about 6 sec and from 100 ft below decision height to impact in 2 sec. The short time available from decision height to impact coupled with a usual nonresponsiveness of the captain to callouts made it extremely difficult, if not impossible, for the first officer to detect a deteriorating situation and react once he called decision height and verified that no approach lights were visible. The Safety Board believes that the limited time from descent through the decision height to impact combined with the previously cited factors made the possibility that the first officer could have successfully assumed control of the aircraft after decision height extremely remote. However, the Safety Board also believes that the first officer should provide the maximum feasible redundancy in the cockpit during a landing approach. The gross deviation from glidepath, descent rate, and airspeed should have alerted him to the possible need for further action on his part during the latter stages of the approach.

2.4 Survivability Aspects

Assuming that the aircraft's groundspeed was 120 kns and the rate of descent was 1,488 ft/min, the aircraft's initial impact with the trees was at a velocity of 204.37 ft/sec at an angle of 6.97°. Since the aircraft descended to the ground through trees, the rate of the onset of g-forces, both vertical and horizontal, was assumed to increase linearly as the aircraft impacted the lower,

5/ "Study of Simulated Airline Pilot Incapacitation: Phase II, Subtle or Partial Loss of Function," Aerospace Medicine, Volume 42, Number 9, September 1971. This flight simulator study culminated in a training film.

larger, more rigid tree trunks. Vertical and horizontal stopping distances, including airframe crushing and earth crushing plus the distance traversed were 30 ft and 303 ft, respectively. Thus, the resultant g-loads along the horizontal and vertical axis of the aircraft were determined to be 5.69 g's and 0.14 g, respectively. These peak g-forces are a best estimate of the probable magnitude of the crash forces experienced in this accident by those individuals not located in the area of destruction. These estimated g-loads seem to be consistent with what was seen within the aircraft because the horizontal decelerative forces were below the design load of 9 g's where failure would normally be expected. In addition, the vertical g-loads were described by passengers as merely resembling moderate turbulence.

Crash survivability in general refers to structural crashworthiness, tie-down chain strength, occupant acceleration environment, interior environment hazards, and postcrash hazards. In this accident, the first four survivability factors were significant. However, postcrash hazards did not develop mainly because there was no postcrash fire.

Considering the aircraft's crashworthiness, the structural integrity of the aircraft's fuselage was compromised primarily in the cockpit region. The cabin remained virtually intact except for some floor disruption and tree penetration localized at the left front. The failure to maintain a living space for all occupants during the crash sequence was exhibited by the complete destruction, by multiple tree impacts, of the left side of the cockpit and a small portion of the left front cabin. This encroachment into the occupant environment produced the more serious and fatal injuries.

The tie-down chain for passenger seats was actually severed at only one seat location due to decelerative forces. The seat failure was influenced by local fuselage deformation. Seat unit 4BC collapsed because the sidewall buckled and a missing locking pin on the side wall attach fitting permitted the side wall attachment button to pull out of the track. Once the side wall attachment was compromised, and because the inboard seat legs were hinged at the seat pan, the seat collapsed. Consequently, under the decelerative forces, the seat leg attach buttons were sheared off. However, the collapse of the seat did not produce any significant injuries. Nevertheless, the injury potential of seat failures of this nature in this and other survivable accidents is considerable.

In addition, the failure of the pilot's restraint system at the buckle did not influence his chance for survival. Although he was ejected from the aircraft as a result of this failure, his fatal injuries were caused by trees impacting the left cockpit and by the collapsing cockpit structure as the aircraft descended through the trees. It was during this portion of the crash sequence that the restraint system buckle sustained a direct impact, most likely from the collapsing instrument panel or other nearby structure. This blow broke two spacers inside the buckle, thus permitting the retraction of all of the springloaded dogs which held the lapbelt and shoulder harness inserts. This action released the entire restraint system including the fixed left lapbelt, permitting the captain to be thrown clear of the wreckage when the aircraft came to a stop.

The structural deformation and resultant dissipation of energy which occurred when the aircraft collided with the trees served to reduce the magnitude and to extend the duration of the decelerative forces imposed on the occupants seated aft of the area of the destroyed section of the cabin. The reduced forces resulted in much less severe injuries in most cases, as compared to those injuries sustained by occupants exposed to the blunt impact forces caused by the penetrating trees. Most of the serious injuries were due to secondary impacts with bulkheads, seatbacks, and ashtrays. The severity of the injuries sustained by the two passengers who were not wearing their lapbelts could have been markedly reduced had they been restrained and properly positioned in their seats. The occupant acceleration environment for most of the passengers was within survivable limits, and the interior environment hazards produced injuries to both restrained and unrestrained passengers.

This accident must be considered partially survivable since several of the survivability factors were violated and since fatalities occurred. A definition of a survivable accident is one in which the forces transmitted to the occupant do not exceed the limits of human tolerance to abrupt acceleration, either positive or negative and in which the structure in the occupant's immediate environment remains substantially intact to the extent that an occupiable volume is provided for the occupants throughout the crash sequence. In this accident, only a portion of the aircraft fuselage's structural integrity was breached and only some of the occupants were exposed to decelerative forces beyond the limits of human tolerance.

2.5 Flight Recorders

The investigation of this accident was made more difficult by the lack of definitive information concerning the aircraft's actual flightpath and the flightcrew's actions and procedural conduct. Information from a flight data recorder and a cockpit voice recorder would have provided invaluable information and would have contributed significantly to the total investigative effort. The Safety Board believes, as it has stated in the past, that these recorders are virtually a prerequisite to improvements in safety in commuter/airtaxi operations involving complex multiengine aircraft.

3. CONCLUSIONS

3.1 Findings

1. The flightcrew was properly certificated and qualified.

2. The aircraft was properly certificated and maintained according to approved procedures.

3. The aircraft was 220 ft high at the outer marker.

4. The distance from the aircraft's last plotted position to impact was 1.29 nmi.

5. From the aircraft's last plotted position to impact, the aircraft descended at 120 kns ground speed with a descent rate of 1,488 ft/min and a descent angle of 6.976°.

6. The aircraft descended from the decision height to impact in 6 sec.

7. The captain was almost 61 years old, a company vice president, and a part-time line pilot for 14 CFR 135 operations only.

8. The first officer had been with the company only 2 months.

9. The captain may have lacked proficiency in the DHC-6 as he had flown only 12 hours in the 90 days preceding the day of the accident.

10. The captain's lack of recent flying time in instrument meteorological conditions may have resulted in deteriorated instrument flying proficiency.

11. The captain had developed hypertension while in military service. Both his military and FAA medical records reflect the existence of hypertensive cardiovascular disease.

12. The captain's FAA medical records indicate nonspecific electrocardiogram changes, abnormal blood chemistry, and occasional elevated fasting blood sugar.

13. The captain's autopsy findings revealed a well healed myocardial infarct and a 40 to 70 percent occluded left anterior coronary artery.

14. The captain was taking polythiazide, a hypertensive medication, and allopurinal, a gout medication.

15. The captain listed no medications on his most recent FAA medical application form; however, his military medical records indicate the use of these drugs. Both drugs can be waivered by FAA AME's if the use of the drugs is known.

16. The captain's only known food intake occurred in the late afternoon between flights.

17. The Hyannis weather was near approach minimums which forced the flightcrew to fly the ILS and significantly increased the crew's workload.

18. The crew had worked to a 14-hr duty day involving 9 hrs 15 min of flight time.

19. The captain was outwardly upset when ordered to undertake additional flights at the conclusion of his anticipated workday.

20. The probability of the first officer recognizing and reacting to any possible physiologic incapacitation in the captain was remote.

21. Two passengers were not wearing their lapbelts.

22. Longitudinal crash loads were estimated to be 5.7 g's, which is within the limits of human tolerance.

23. Vertical crash loads were estimated to be 0.14 g which also is within the limits of human tolerance.

24. The structural integrity of the aircraft's occupiable volume was partially compromised.

25. There was no fire.

26. The fatal and more serious blunt trauma injuries of the occupants in the front of the aircraft were a direct result of the loss of structural integrity in this area because of impact with trees.

27. The less severe injuries were caused by secondary impacts with surrounding structure such as seatbacks and bulkheads.

28. The accident was partially survivable since the major part of the occupiable volume was virtually intact and the decelerative forces were within the limits of human tolerance.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the failure of the flightcrew to recognize and react in a timely manner to the gross deviation from acceptable approach parameters, resulting in a continuation of the descent well below decision height during a precision approach without visual contact with the runway environment.

Although the Board was unable to determine conclusively the reason for the failure to recognize and react to the gross deviation, it is believed that the degraded physiological condition of the captain seriously impaired his performance. Also, the lack of adequate crew coordination practices and procedures contributed to the first officer's failure to detect and react to the situation in a timely manner.

4. SAFETY RECOMMENDATIONS

As a result of this accident, and other commuter air carrier accidents, the Safety Board issued the following recommendation to the Federal Aviation Administration on October 17, 1979:

Expedite rulemaking which would make the flight time and duty time limitations, and rest requirements for commuter air carriers the same as those specified for domestic air carrier crewmembers under 14 CFR 121. (Class II, Priority Action) (A-79-81)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JAMES B. KING
Chairman

/s/ ELWOOD T. DRIVER
Vice Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ PATRICIA A. GOLDMAN
Member

/s/ G.H. PATRICK BURSLEY
Member

January 3, 1980

5. APPENDIXES

APPENDIX A

INVESTIGATION AND HEARING

Investigation

The Safety Board was notified of the accident about 0310 e.d.t., on June 18, 1979. The investigative team went immediately to the scene. Working groups were established for operations, air traffic control, systems/structures, powerplants, maintenance records, human factors, and weather.

Participants in the onscene investigation included representatives of the FAA, Air New England, Inc., deHavilland Aircraft of Canada, Ltd., the Air Line Pilots Association (ALPA), Pratt & Whitney Division of United Technologies Corporation, and Hartzell Propeller Company.

2. Public Hearing

A 2-day public hearing was held in Cambridge, Massachusetts, beginning September 13, 1979. Parties present at the hearing were Air New England, Inc., FAA, ALPA, and the Transport Workers Union.

APPENDIX B

PERSONNEL INFORMATION

Captain George Edward Parmenter

Captain George Edward Parmenter, 60, had been with Air New England since its formation and was a vice president of the company. He held Airline Transport Pilot Certificate No. 102193 for airplane multiengine land and single-engine land and sea. He was a certified flight instructor--airplane and instruments. He had a first-class medical certificate dated February 14, 1979, with the limitation that "Holder shall wear glasses which correct for near and distant vision while exercising the privileges of his airman certificate."

Captain Parmenter passed his last proficiency check in the DHC-6 on June 12, 1979. He had accumulated about 25,101 total flight-hours, 951 hours of which were in DHC-6 aircraft. His total instrument time was 3,542 flight-hours. His flying time during the last 90 days and 30 days were 21 hrs 16 min and 12 hrs 16 min, respectively, including the time accumulated on the day of the accident. In the last 24 hours he had flown 9 hrs 16 min. His duty time for the last 24 hrs was 14 hrs and his rest period in the 24 hrs before reporting for duty on the day of the accident was over 20 hrs.

First Officer Richard Daniel Roberti

First Officer Richard Daniel Roberti, 32, was hired by Air New England, Inc., in April 1979. He holds Airline Transport Pilot Certificate No. 2016426 for airplane single- and multiengine land. He has a first-class medical certificate dated March 12, 1979, with the limitation that "Holder shall wear corrective lenses at all times while exercising the privileges of this airman's certificate."

First Officer Roberti had passed his DHC-6 flight check and was qualified as a first officer on May 2, 1979. He had accumulated about 4,362 flight-hours, 102 hours of which were in DHC-6 aircraft. His total instrument time was 429 hrs; total night time was 502 hrs. His flying time during the last 30 days was 64 hrs 16 min, including the time accumulated on the day of the accident. In the last 24 hours he had flown 9 hrs 16 min. His duty time for the past 24 hours was 14 hrs 30 min and his rest period in the 24 hours before reporting for duty on the day of the accident was over 20 hrs.

APPENDIX C

AIRCRAFT INFORMATION

DeHavilland DHC-6-300, serial No. 245, was owned and operated by Air New England, Inc. It was certificated and maintained according to procedures approved by the FAA. At the time of the accident, the aircraft had accumulated 17,058.2 flight-hours; 82.4 flight-hours had been flown since the last major inspection.

The aircraft was equipped with two Pratt & Whitney of Canada, Ltd., PT6A-27 turboprop engines and two Hartzell Propeller, Inc., Model HC-B3TN-3DY, three-bladed propellers.

Engine Data

Installed position:	Left	Right
Serial numbers:	PC-E40160	PC-E40137
Total times (hrs):	16,415.7	16,631.8
Total cycles:	30,509	31,234
Time since last overhaul (hrs):	6,592.3	6,938.4
Date of installation:	01-02-78	01-03-79
Date of manufacture:	March 1969	February 1969

Propeller Data

Installed position:	Left	Right
Hub serial number:	BU4193	BU2594
Total time (hrs):	8,379.1	Unknown
Time since last overhauls (hrs):	1,834.9	1,424.6
Date of installation:	08-10-78	03-05-79
Date of manufacture:	07-30-73	04-05-69