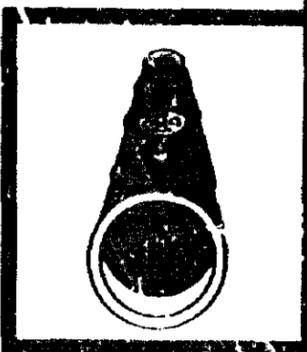
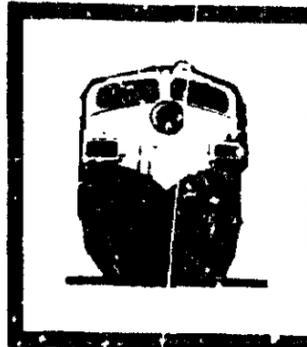
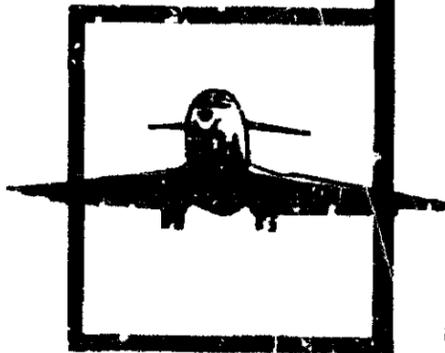


PB82-910407



NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

**PILGRIM AIRLINES FLIGHT 458
deHAVILLAND DHC-6-100, N127PM
NEAR PROVIDENCE, RHODE ISLAND
FEBRUARY 21, 1982**

NTSB-AAR-82-7

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

UNITED STATES GOVERNMENT

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB-AAR-82-7		2. Government Accession No. PB82-910407		3. Recipient's Catalog No.	
4. Title and Subtitle Aircraft Accident Report— Pilgrim Airlines Flight 458 deHavilland DHC-6-100, N127PM, Near Providence, Rhode Island, February 21, 1982				5. Report Date July 20, 1982	
7. Author(s)				6. Performing Organization Code	
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Accident Investigation Washington, D.C. 20594				8. Performing Organization Report No.	
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20594				10. Work Unit No. 3570	
				11. Contract or Grant No.	
				13. Type of Report and Period Covered Aircraft Accident Report February 21, 1982	
				14. Sponsoring Agency Code	
15. Supplementary Notes					
16. Abstract On February 21, 1982, at 1533 e.s.t., Pilgrim Airlines flight 458, a scheduled commuter passenger flight, made an emergency landing on the northwest branch of the Scituate Reservoir near Providence, Rhode Island, after a fire erupted in the cockpit while the aircraft was en route under instrument conditions between Groton, Connecticut, and Boston, Massachusetts, at 4,000 feet. The fire, which spread from the cockpit to the cabin in flight, destroyed the aircraft after impact. The captain and first officer were seriously injured. One passenger was killed, eight passengers had serious injuries, and one passenger sustained minor injuries. The National Transportation Safety Board determines that the probable cause of the accident was the deficient design of the isopropyl alcohol windshield washer/deicer system and the inadequate maintenance of the system which resulted in an in-flight fire. The ignition source of the fire was not determined.					
17. Key Words windshield washer/deicer system; Tygon tubing; isopropyl alcohol; fluid leakage; smoke; in-flight fire; emergency landing				18. Distribution Statement This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161	
19. Security Classification (of this report) UNCLASSIFIED		20. Security Classification (of this page) UNCLASSIFIED		21. No. of Pages 27	22. Price

CONTENTS

SYNOPSIS	7
1. FACTUAL INFORMATION	1
1.1 History of the Flight	1
1.2 Injuries to Persons	2
1.3 Damage to Aircraft	2
1.4 Other Damage	2
1.5 Personnel Information	3
1.6 Aircraft Information	3
1.7 Meteorological Information	3
1.8 Aids to Navigation	4
1.9 Communications	4
1.10 Aerodrome Information	4
1.11 Flight Recorders	4
1.12 Wreckage and Impact Information	4
1.12.1 Cockpit/Cabin Damage Information	6
1.13 Medical and Pathological Information	7
1.14 Fire	7
1.15 Survival Aspects	8
1.15.1 Flightcrew Clothing	9
1.16 Tests and Research	10
1.16.1 Windshield Washer/Deicer System	10
1.16.2 Examination of Seat 6C Seatbelt End Fitting	12
1.17 Additional Information	12
1.17.1 Pilgrim Airlines Operating Procedures	12
1.17.2 DeHavilland DHC-6 Aircraft Operating Manual	13
1.17.3 Federal Regulations	13
2. ANALYSIS	14
2.1 Flightcrew Actions	14
2.2 Fire Origination and Propagation	14
2.3 Fire Extinguishers/Safety Briefing	16
2.4 Survival Aspects	17
3. CONCLUSIONS	18
3.1 Findings	18
3.2 Probable Cause	18
4. RECOMMENDATIONS	19
5. APPENDIXES	21
Appendix A--Investigation and Hearing	21
Appendix B--Personnel Information	22
Appendix C--Aircraft Information	23
Appendix D--Occupant Seating Diagram	24
Appendix E--Wreckage Distribution Chart	25

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

Adopted: July 20, 1982

PILGRIM AIRLINES FLIGHT 458
deHAVILLAND DHC-6-100, N127PM
NEAR PROVIDENCE, RHODE ISLAND
FEBRUARY 21, 1982

SYNOPSIS

On February 21, 1982, at 1533 e.s.t., Pilgrim Airlines flight 458, a scheduled commuter passenger flight, made an emergency landing on the northwest branch of the Scituate Reservoir near Providence, Rhode Island, after a fire erupted in the cockpit while the aircraft was en route under instrument conditions between Groton, Connecticut, and Boston, Massachusetts, at 4,000 feet. The fire, which spread from the cockpit to the cabin in flight, destroyed the aircraft after impact. The captain and first officer were seriously injured. One passenger was killed, eight passengers had serious injuries, and one passenger sustained minor injuries.

The National Transportation Safety Board determines that the probable cause of the accident was the deficient design of the isopropyl alcohol windshield washer/deicer system and the inadequate maintenance of the system which resulted in an in-flight fire. The ignition source of the fire was not determined.

1. FACTUAL INFORMATION

1.1 History of the Flight

On February 21, 1982, a deHavilland DHC-6-100, N127PM, was operated by Pilgrim Airlines as flight 458, scheduled passenger service from La Guardia Airport, New York, to Boston, Massachusetts, with en route stops at Bridgeport, New Haven, and Groton, Connecticut. The flight was normal from La Guardia to Groton where there was a flightcrew change. Flight 458 blocked out at 1501 ^{1/} and took off from the Groton-New London Airport at 1510 with 2 pilots and 10 passengers aboard. The flight operated under instrument flight rules (IFR) and was cleared to Boston by Quonset Terminal Radar Approach Control (TRACON) as previously filed--Groton, direct Norwich, V16 airway to Millis, direct Boston at 7,000 feet. ^{2/} Quonset TRACON gave the flight a choice of the filed altitude of 7,000 feet or 4,000 feet; the crew chose 4,000 feet.

About 15 minutes after takeoff, the flightcrew noted light icing on the front windshield, but none was evident on the airframe. The first officer activated the windshield washer/deicer system which was equipped with washers that used isopropyl alcohol as the deicing agent. He stated that he moved the windshield wiper to ascertain

^{1/} All times are Eastern standard time based on the 24-hour clock unless otherwise noted.

^{2/} All altitudes are mean sea level unless otherwise indicated.

deicing effectiveness and saw little deicing fluid on either side. He activated the deicer system again and, after holding the switch on for several seconds, smelled alcohol. He stopped the deicing. Shortly thereafter, the crew saw light gray-white smoke coming up through the opening where the "Y"-shaped flight control yoke comes through the cockpit floor between the pilots. The captain contacted Quonset TRACON at 1528:39 saying "Quonset - Pilgrim 458 - we need a direct Providence [Rhode Island] - this is an emergency." Quonset TRACON asked if Pilgrim 458 was calling and the captain responded at 1528:47 saying "Directly to Providence please - this is an emergency - there is a fire onboard." The controller gave the aircraft a clearance to turn right to 150° for vectors to Providence. The captain started an immediate descent and turn.

By this time, the light smoke had changed to heavy, black smoke that filled the cockpit and restricted the flightcrew's visibility to a few inches. The first officer said the smoke did not irritate his eyes, but both crewmembers opened their side windows to improve their visibility and breathing. The first officer stated that he noticed a slight rise of the nose of the aircraft so he placed his hand on the yoke and felt the captain's control inputs as the aircraft started down. The smoke was so thick that the first officer could not see the captain. As the aircraft descended below the clouds, fire broke out on the cockpit floor between the pilots and in the forward left part of the cabin. A passenger attempted to put out the fire by covering it with a coat and broke several cabin windows in an effort to clear the smoke. Other than a blind passenger, all of the passengers saw the smoke and fire, and all experienced difficulty in breathing. Four passengers noticed an "alcohol" or distinct chemical smell before the fire broke out.

The first officer stated that when he could see the ground he noted that the captain had the aircraft under control and was descending directly toward a frozen lake. The aircraft landed firmly on the 10- to 12-inch-thick ice of the Scituate Reservoir near Providence about 1533 during daylight hours at coordinates 41°47'26" N latitude and 071°38'10" W longitude. The left main landing gear and the right wing, with engine attached, separated from the aircraft fuselage. The fire continued after impact and destroyed the cockpit and cabin areas. The 2 pilots and 9 of the 10 passengers escaped from the wreckage.

1.2 Injuries to Persons

<u>Injuries</u>	<u>Crew</u>	<u>Passengers</u>	<u>Other</u>	<u>Total</u>
Fatal	0	1	0	1
Serious	2	8	0	10
Minor/None	0	1	0	1
Total	2	10	0	12

1.3 Damage to Aircraft

The aircraft was destroyed by the in-flight fire, impact forces, and postcrash fire.

1.4 Other Damage

Fuel spilled into the Scituate Reservoir, which supplies water to Providence and its surrounding urban area. Rhode Island environmental control personnel stated that the spill was insignificant.

1.5 Personnel Information

The flightcrew was properly certified and qualified for the flight. (See appendix B.) The captain and first officer had been on duty for 1.0 hour and had flown 35 minutes at the time of the accident. The rest period for both crewmembers was 17 hours 35 minutes before reporting for duty at 1435.

1.6 Aircraft Information

The aircraft, a deHavilland DHC-6-100, N127PM, serial No. 105, was certificated, equipped, and maintained in accordance with Federal Aviation Administration (FAA) requirements. (See appendix C.) The aircraft was manufactured in 1967 and acquired by Pilgrim Airlines in 1972. It was equipped with two Pratt & Whitney Aircraft (P.W.A.) of Canada PT6A-20 turboprop engines, each rated at 579 equivalent shaft horsepower at takeoff.

The gross weight of the aircraft was 10,506 pounds at takeoff and 10,256 pounds at landing. Maximum gross takeoff weight for this aircraft is 11,579 pounds. The aircraft center of gravity was within limits at takeoff and at landing. The aircraft had 1,400 pounds of Jet-A fuel onboard at takeoff and about 1,150 pounds at landing.

The cockpit was configured in the conventional captain (left) and first officer (right) crew positions, and their seats were equipped with four-point restraint systems, including shoulder harness inertia reels. Entry doors were located outboard of the captain's and first officer's seats. The cabin was configured with 18 passenger seats, which had "metal-to-metal" seatbelt fittings. There were two emergency exits on the right side of the cabin, one emergency exit and the main "airstair" boarding door on the left side of the aircraft, a cargo door aft of the main boarding door, and an overhead escape hatch over the aisle between seat rows Nos. 4 and 5. (See appendix D.)

The aircraft was equipped with two portable fire extinguishers. The cockpit extinguisher was mounted behind the copilot's seat on the cockpit/cabin bulkhead. The cabin extinguisher was mounted under the left-side passenger seat on the aft bulkhead. The cabin extinguisher was accessible only by a person kneeling on the floor and reaching under the seat to release it from its mounts. The cabin extinguisher was not visible when the seat was occupied.

The DHC-6 must have an electrically heated windshield or a windshield washer/deicer system (primarily designed as a windshield washer) to operate in icing conditions. Of about 780 DHC-6 aircraft, 70 have the washer/deicer systems.

1.7 Meteorological Information

The surface weather observation for the Groton-New London Airport at 1500, February 21, 1982, was:

3,000 feet overcast; visibility--6 miles in haze; temperature--40°;
wind--230° at 3 knots; altimeter setting--29.56 in. Hg.

The surface weather observation at Providence's T. F. Green International Airport at 1540 on February 21, 1982, was:

measured 1,600 feet broken clouds, 1,800 feet overcast, visibility--5 miles with light drizzle, fog; temperature--37°; dew point--33°; wind--050" at 8 knots; altimeter setting--29.57 in. Hg.

1.8 Aids to Navigation

There were no reported navigational aids difficulties.

1.9 Communications

There were no reported communications difficulties.

1.10 Aerodrome information

Groton-New London Airport and T. F. Green International Airport were fully operational at the time of the accident.

1.11 Flight Recorders

The aircraft was not equipped with a cockpit voice recorder or a flight data recorder, and neither was required.

1.12 Wreckage and Impact Information

The accident site was the northwest branch of the Scituate Reservoir, elevation 234 feet, 12.5 miles/295 degrees ^{3/} from T. F. Green International Airport. The wreckage distribution pattern, oriented on a heading of 165 degrees, was about 686 feet long by 80 feet wide. (See appendix E.) The reservoir was covered by ice from 10 to 12 inches deep. The initial impact broke two holes in the ice, one 18 inches in diameter, the other 6 feet by 12 feet. A crewmember's headset and two pieces of aluminum skin from the bottom of the aircraft were found in the initial impact area.

The fuselage came to rest 522 feet from the initial impact point on a magnetic heading of 175 degrees. The complete fuselage from the nose section, including the nose gear section, aft to the empennage, was extensively burned and gutted by fire. The cabin area, which consisted of only the lower fuselage, was melted and the metal was visible in the ice.

The instrument panel, instruments, control wheels, and seats were severely damaged by fire. The aft fuselage was separated at the tail section as the rivet line was pulled apart around the circumference of the fuselage. The right main landing gear assembly, including the strut, was attached to the lower fuselage and was extensively damaged by fire. All plexiglass windows and frames were destroyed by fire. The main boarding door, located on the left rear side of the fuselage, the emergency exit windows located on each side of the fuselage, and the emergency exit door were destroyed by fire.

The left main landing gear wheel, brake assembly, and attached strut were located 80 feet/285 degrees from the main wreckage. The shock absorbers were detached and were within the scatter path. The rear portion of the landing gear strut was cracked where it had been welded to the strut assembly. The strut attachment fittings

3/ All bearings and headings in this section are magnetic unless otherwise noted.

were bent and spread apart. There was no damage to the empennage components, which included the attached rudder, left and right horizontal stabilizers, and left and right elevators.

The left wing was intact and attached to the burned-out left side of the fuselage. Fire damage was noted on the upper and lower surfaces of the wing at the fuselage attachment point. The remainder of the wing had no fire damage. The inboard wing trailing edge between the nacelle and the fuselage was deflected upward about 10 degrees. The outboard wing trailing edge was displaced and deflected upward and slightly forward. The outboard wing leading edge was crushed and deflected upward about 15 to 20 degrees. The left engine propeller assembly and the engine nacelle were intact and attached to the wing. Some fire damage was found on the inboard side of the nacelle.

The left wing's aileron and fore flap were intact and were attached to the rear wing spar by their appropriate attachment fittings. The outboard end of the aileron and fore flap was crushed upward and forward, similar to the wing damage. The inboard trailing edge flap was bent downward, and the inboard end of the flap was burned off.

The right wing was found 164 feet/190 degrees forward of the main wreckage. The wing, which showed no fire damage, was intact, but it had separated at the fuselage beam's upper forward wing attachment. About a 12-inch-long section of the fuselage beam remained attached to the forward spar. The rear spar had separated at the attachment cap. The fracture surface of the spar indicated pulling and twisting forces. The right engine, propeller assembly, and engine nacelle were intact, were attached to the wing, and showed no fire damage.

The right wing's aileron and fore flap were intact and were attached to the rear wing spar by their appropriate fittings. The outboard end of the aileron and fore flap was crushed down and aft. The inboard end of the aileron and fore flap showed no damage. The inboard trailing edge flap was bent downward about 30 degrees and the edges were ripped and torn. A 48-inch-long section of the right wing strut was still attached to the right wing.

The left engine exhaust duct was buckled beginning at the 12 o'clock position clockwise to the 2:30 o'clock position. ^{4/} A second exhaust duct buckle was located at the 6 o'clock position. The engine was covered with black soot. The inlet screen was free of foreign material. All control levers and operating cables were heat charred. A carbon coating pattern also was found on the propeller condition control lever. The coating pattern was consistent with a selected scheduled propeller minimum governing operating speed of 1,650 rpm at impact. The right engine was not heat damaged, nor was the engine damaged from impact, except for the exhaust duct. The exhaust duct was buckled at the 1:30, the 5, the 5:30, and the 7 o'clock positions. The exhaust duct was also radially cracked at the 5:30 o'clock position. Neither engine showed evidence of preimpact damage or malfunction.

The blades of both propellers were bent and twisted similarly. All of the blades of both propellers were found in positions at or near feather. The left propeller sustained fire damage, but the right propeller did not. No preimpact discrepancies were found in either propeller which would have precluded normal propeller operation. No impact-related blade angle markings were found on the right propeller. The interior surface of the left propeller's piston had an impact mark that was equivalent to the propeller blades having been on the low pitch stop at the time the mark was made.

^{4/} All clock positions are as viewed from the rear of the engine.

The aircraft had a mechanical flight control system consisting of control rods, chains, sprockets, pulleys, and cables. Assemblies in those sections of the aircraft that did not burn (empennage assembly and wings) were examined. There was no evidence of preimpact failure or malfunction in the system, nor was there any suspected failure or malfunction based on the statements of the survivors. The aircraft's flaps were down (about 30 degrees) but loss of continuity had occurred when the right wing separated and the fuselage was gutted by the postcrash fire. Physical evidence on both the left and right flap actuating rods indicated that the aircraft had made a flaps-up landing on the ice before loss of continuity in the flap control system. The flap actuator had separated from its mounting flange and was found in the fire area. The rod appeared to be fully extended. Trim tab continuity was disrupted by the impact and postaccident fire. Trim tab positions were:

- o Rudder tab - neutral
- o Elevator tab - about 2 degrees trailing edge down
- o Aileron tab - about 2 degrees trailing edge down

The pilot and copilot rudder pedals and a portion of the pilot's control column were in the cockpit area which was extensively damaged by heat and fire.

1.12.1 Cockpit/Cabin Damage Information

Fire destroyed all of the cockpit/cabin interior furnishings including seat cushions, seatbelts, wall coverings, cockpit/cabin partitions, floors, and carpets. All of the crew and passenger seat frames were recovered and inspected. Some seat frames had little impact-related damage. The diagonal braces on the captain's seat were bent downward. The first officer's seat was not deformed. All of the seat frames were fire damaged; however, the frames were made of stainless steel and survived the postimpact fire. The preaccident location of some passenger seats in the cabin could not be determined.

All seatbelt end fittings were missing from seat 3A, which was occupied by the passenger who died of asphyxiation. The fitting attachment collar was missing from the inboard seatbelt attachment bolt; the outboard collar was in place. The forward and rear wall fittings were loose where they screwed into the seatpan frame. There was no deformation to either fitting. A partially melted floor attachment fitting was inside of the forward seat leg. The bolt was in place and not deformed. The entire floor attachment fitting from the rear leg was missing but the bolt was in place and was not deformed. Neither leg showed any deformation. The outboard forward corner of the seatpan frame was displaced uniformly downward about 1/8 inch along the frame. The seatback frame was twisted slightly inboard.

Six 2-inch-diameter gauges and three 1-inch-diameter gauges were recovered from the burned aircraft cockpit. These gauges exhibited various degrees of fire damage ranging from soot to extreme heat. Readings could not be obtained from these gauges. The 8-day clock was recovered, and although the face sustained extreme heat damage, the time readable on the face was 3:34. Two fuel quantity gauges--the forward with its face destroyed and pointer missing and the aft gauge reading zero--were also found in the cockpit. Both gauges sustained extreme heat damage.

Both fire extinguishers were found in their retaining clips. Both units had been damaged by heat and fire. The pressure gauges and activation handles were missing and not recovered.

1.13 Medical and Pathological Information

A postmortem examination of the fatally injured passenger, conducted by the Rhode Island Medical Examiner's office, found no evidence of blunt force injury of the head, spine, neck, chest, or abdomen; there was soot and smokey material deposits in the respiratory passages including the second- and third-order bronchii; there was moderate to severe chronic obstructive lung disease; marked calcific arteriosclerotic cardiovascular disease; and elevated, but not necessarily lethal, levels of carbon monoxide which indicated the presence of respiratory activity during the fire. The cause of death was reported as: "Asphyxia due to smoke, carbon monoxide and hot gas inhalation." Toxicologic analyses performed by the medical examiner disclosed the following: Urine and blood negative for alcohol; opiates; and acid-, basic-, and neutral-based drugs. Blood showed 32.6 percent carboxyhemoglobin. Toxicologic analyses performed by the FAA's Civil Aeromedical Institute, Oklahoma City, Oklahoma, disclosed the following: no acid and neutral drugs in the blood; no basic drugs in the blood; nicotine found in the urine; no ethyl alcohol found in the blood; 25 percent carbon monoxide in the blood, containing 1.9 gm percent hemoglobin; no isopropyl alcohol in the blood or lung tissue; and, 1.75 µg/ml of hydrogen cyanide in the blood.

During the in-flight fire, the captain and first officer sustained extensive second- and third-degree burns to their extremities, head, face, and upper and lower torsos. The first officer's burns were less extensive than those sustained by the captain and were predominately to the left side of his body. Neither the captain nor the first officer sustained incapacitating blunt force trauma during the landing.

Passengers described the landing as "hard" or "violent," and most were thrown forward and downward at the initial impact. Two passengers who had been attempting to extinguish the in-flight fire in the cabin were not wearing their seatbelts at impact. One passenger was crouched at the forward bulkhead at impact and sustained a dislocated right shoulder and a knee injury. The other passenger, who was in his seat at impact, was not injured, although he and the other passenger sustained first- and second-degree burns to their hands and arms while attempting to extinguish the fire.

At impact, the man in seat 4A (see appendix D) sustained a compression fracture of the T-12 vertebra, and the blind woman in seat 5A sustained a facial contusion. The man in seat 5C sustained multiple contusions when he struck seat 4C. The 9-year-old girl in seat 6A sustained a ruptured spleen and facial lacerations, and the 17-year-old boy in seat 6C sustained a fractured foot and toe and lacerations to the face, head, back, and legs.

All surviving aircraft occupants were treated for smoke inhalation.

1.14 Fire

The initial indication of fire was the presence of light gray-white smoke in the cockpit that occurred shortly after the first officer activated the windshield deicing system and smelled alcohol. The smoke came up through the control yoke hole forward and between the pilots' seats. Within seconds, the gray smoke thickened to black, boiling smoke, and flames broke out in the cockpit and just behind the cockpit/cabin bulkhead on the left side of the forward cabin. Both pilots were seriously burned by the fire. Passengers stated that the flames in the cabin "rolled" and appeared to be liquid or like a "flaming river." The area beneath the cockpit floor which contained avionics equipment, hot bleed air lines, hydraulic system components, and other aircraft accessories, was destroyed by the in-flight fire, impact damage, or postaccident ground fire. There was no useful evidence available in this area.

After the aircraft came to rest on the reservoir, the aircraft continued to burn. The aircraft's fuel tanks, located in the lower fuselage, ruptured on landing and some fuel was lost. However, most of the fuel was consumed by the fire after the aircraft stopped. Four fire departments who had been alerted after the captain declared an emergency responded to the accident with 9 firefighting engines and about 100 firefighters. The first unit arrived on-scene at 1549. About 1,300 feet of 1 1/2-inch-diameter hose was laid from the shore to the wreckage and water fog/spray was used to extinguish the fire. Contaminated water that remained on top of the ice was later pumped into a truck.

1.15 Survival Aspects

The pretakeoff briefings, which were read over the aircraft's public address system, included the sentence: "There are two fire extinguishers; one under [sic] the right pilot's seat and the other under the left rearmost seat of your cabin." The seatback "Emergency Procedures" safety briefing cards in the cabin showed the location of the fire extinguisher at the right cockpit seat, but did not show the location of the fire extinguisher located under the rearmost left seat. The first officer said that he attempted to use the fire extinguisher behind his seat but that it was too hot to touch. No one attempted to use the fire extinguisher in the cabin.

The passenger in seat 2A said the pretakeoff briefings at New Haven and Groton were read quickly and sounded garbled over the public address system. The passenger in seat 2C also recalled that the safety instructions were not clear. The passenger in seat 4A recalled hearing the briefing but could not recall the specific instructions. The passenger in seat 4C said he vaguely recalled the briefing, and the passenger in seat 5C could not recall a briefing. The briefing included the sentence "There are two fire extinguishers; one under (sic) the right pilot's seat and the other under the left rearmost seat of your cabin."

The 9-year-old girl in seat 6A was the only survivor who had read the safety briefing card. The passenger in seat 4C said that he had read the card on several previous flights. The safety briefing card did not show the location of the overhead escape hatch in the cabin.

One passenger stated that he had his attache case on his lap at takeoff. Neither the pretakeoff briefing nor the safety briefing card contained instructions for carryon baggage stowage during takeoff and landing. Stowage space was available beneath the passenger seats.

The impact was survivable. The passenger seated in seat 3A died from asphyxia in the smoke-filled cabin environment and not from impact injuries. There were no reports from passengers of seat failures, seatbelt failure, or difficulty in releasing their seatbelts. The passenger in seat 6C was found unconscious on the cabin floor and had to be rescued from the aircraft after he was thrown from his seat when one of his seatbelt end fittings failed. There were no reports of panic or disruptive behavior among the passengers in flight or during the evacuation. Dense smoke limited visibility to 2 to 5 feet during the evacuation.

After the aircraft came to rest, the cabin remained intact. The captain could not open the left cockpit door, exit L-1, and escaped through the door's window. (See appendix D.) The first officer tried to escape by the right cockpit door, exit R-1, but the door appeared to be jammed and he was unable to open it. He went back into the cabin

where he saw a boy, who had been sitting in seat 2B, attempting to open the forward right emergency exit, R-2. The first officer opened the exit, and he and the boy jumped out. After they left the aircraft, they returned to rescue the boy's injured mother, who was seated in seat 2C. There was no debris blocking access to the exit.

The man from seat 5C attempted to but could not open the main boarding door, exit L-3. He saw an opening aft of the main boarding door and kicked jagged metal away as he escaped. This opening may have been the damaged cargo door, exit L-4. There was no debris blocking access to the exit. The man who had been in seat 4A also tried to open the main boarding door and could not. He also exited through the opening aft of the main boarding door. He said that he intended to open the right rear emergency exit, R-3, but did not because there was no time to read the exit's operating instructions. When he left the aircraft, he saw the captain fall from the left cockpit door exit, and he pulled the captain away from the aircraft. He said that the first officer was attempting to count the passengers at the time.

The man from seat 2A said that after the aircraft stopped he did not use the emergency exit, L-2, which was next to his seat because he thought it was a window and he thought that he would not fit through its opening. He said that he would have used it immediately if he had known it was an emergency exit. He went to the rear of the cabin to exit through the opening aft of the main boarding door. He rescued the injured 9-year-old girl in seat 6A next to the opening by releasing her seatbelt and pulling her out of the aircraft.

The man who attempted to put out the fire in the forward cabin by covering it with a coat was not in his assigned seat 4C at the time of impact. He said that as the plane was landing he intended to sit in the first row of seats, but they were in flames, so he crouched down at the cockpit/cabin bulkhead. The force of the impact dislocated his right shoulder. He tried to exit by crawling out a cabin window he had broken in flight (not an emergency exit) but the window opening was too small. As he moved to the rear exit door, he pulled the blind woman from seat 5A and assisted her out the opening aft of the main boarding door. He then tried to rescue the unconscious 17-year-old boy who had been seated in seat 6C, but could not do so because of his dislocated shoulder. He left the aircraft and told the man from seat 5C that there was one more person in the aircraft. The man from seat 5C returned to the aircraft and saw the boy from seat 6C on the floor; he grabbed his collar and dragged him from the aircraft. None of the passengers recalled seeing the woman in seat 3A who died during either the in-flight fire or during the evacuation. By the time the survivors were 10 to 15 feet away, the whole aircraft was on fire. All the survivors walked across the ice to the shore.

The aircraft was located by motorists who noted smoke from the ground fire within 5 minutes of its landing, and the first rescue unit arrived about 9 minutes later or about 14 minutes after the accident. The survivors were expeditiously transported to two hospitals about 17 miles away. The first survivor arrived at one hospital at 1623 or about 30 minutes after the aircraft landed. The fire was out at 1611. Only water was used to extinguish the fire and the contaminated water was later removed from on top of the ice. The body of the victim was found lying across the cabin from where she had been seated. There were no components of the seatbelt system found near the body.

1.15.1 Flightcrew Clothing

According to Pilgrim Airlines, the crew uniforms were made of a material of 55 percent wool and 45 percent Dacron. The captain was wearing his uniform trousers, shirt and tie, and two long-sleeve sweaters at the time of the accident. The first officer

was wearing two-piece long underwear, a uniform shirt and tie, two long-sleeve sweaters, uniform trousers, two pairs of socks, and leather shoes with rubber heels.

1.16 Tests and Research

1.16.1 Windshield Washer/Deicer System

The aircraft was equipped to deice the wings, tail, propellers, and windshield. Wing and tail deicing was accomplished by the use of pneumatically operated boots, and propeller deicing was accomplished through electrically heated boots. Windshield deicing was accomplished by a combination windshield washer/deicer system. A 1.5-gallon reservoir containing isopropyl alcohol was located adjacent to the left side of the captain's seatpan and was held in place by a tray mounted to the cockpit structure just aft of the captain's entry door. (See figure 1.) The reservoir was constructed of formed polyethylene material and was vented outboard through the cockpit structure. The plumbing was Tygon clear plastic tubing (vinyl base). The reservoir supply line was routed from the bottom of the reservoir through the cockpit floor to a 28-volt D.C., electrically driven, low-pressure pump mounted on the cockpit/cabin bulkhead. The supply line then ran from the pump forward, beneath the cockpit floor, and upward to the windshield spray nozzles. The system was operated by a two-position, momentary "ON" type switch, marked "OFF" and "WASHER," located on the windshield switch panel to the right of the overhead console. The pump was protected by a circuit breaker located on the circuit breaker panel.

A Pilgrim Airlines pilot reported that the following incident occurred to the accident aircraft on the afternoon of February 18, 1982. During a stopover at New Haven, the captain saw a clear liquid leaking from the exterior hydraulic access panel which was located below the captain's door. After opening the panel, he found that the tubing from the outlet fitting (pressure side) of the windshield deicing pump had come off and alcohol was leaking from the fitting. The first officer attempted to reattach the tubing, but the tubing was too short. He said that the tubing was secured to the inlet side of the pump with safety wire and that the tubing apparently had been clamped to the outlet side of the pump. The flightcrew then removed the reservoir from the aircraft, wrote up the discrepancy, and since the weather was fair, continued on their scheduled route. The same discrepancy (tubing separated from the pump outlet fitting) was also reported several months earlier while the aircraft was on the ground at LaGuardia Airport in New York, and again it was reported that the tubing was too short.

Investigators determined that the Tygon tubing hardens when it comes in contact with alcohol and becomes misshaped at its connection points, often resulting in leaks. To correct the leaks, the hardened, misshaped ends of the tubing are cut off and the tubing reattached. After successive cuts, a splice is required to make the tubing long enough for an unstrained connection. Maintenance procedures approved by deHavilland allows the connection to be secured with three wraps of safety wire.

The mechanic who reinstalled the reservoir on the evening of February 18, 1982, was interviewed. He stated that the following work was accomplished: the reservoir was reinstalled; the tubing between the reservoir and pump inlet fitting was repaired; all the tubing was reconnected and secured; the system was pressure checked with a quart of fluid; and the discrepancy was signed off as repaired. All repairs to the system were in accordance with deHavilland maintenance procedures. He said that the tubing was secured to the reservoir with safety wire and to both sides of the pump with clamps.

**WINDSHIELD
WASHER - DEICER**
FILL WITH SOLUTION MADE
FROM EQUAL PARTS WATER
AND ISOPROPYL ALCOHOL

FOR DE-ICING USE
100% ISOPROPYL ALCOHOL

DETAIL A

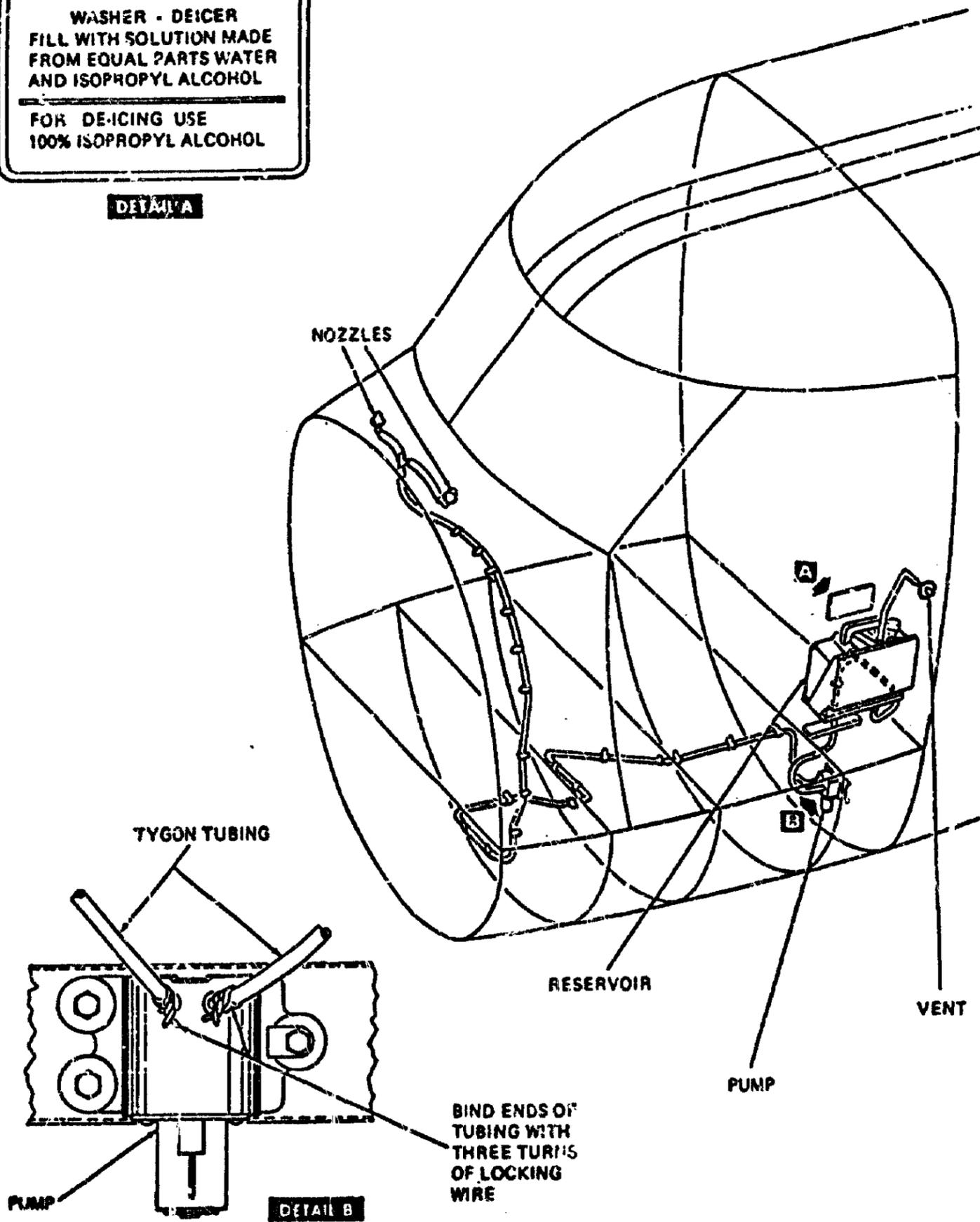


Figure 1.--Diagram of the windshield washer/deicer system installed on the accident aircraft.

The bottom of the reservoir opposite to the filler neck was found in the burned cockpit area during the postaccident inspection. The edges were melted and deformed from heat and fire. No other deicer system components (pump and lines) were found.

A modification bulletin issued by deHavilland on February 2, 1968, made mandatory the use of 100-percent isopropyl alcohol in the washer/deicer system. Labels to this effect were to be placed either on the reservoir located in the front baggage compartment or on the cabin structure immediately above the reservoir located in the cockpit compartment. A sample of the commercially purchased deicing fluid stored at Pilgrim Airlines headquarters was analyzed and shown to be 87 percent isopropyl alcohol.

A test was conducted at the Safety Board's laboratory to determine functional aspects of the windshield deicer system under static and "pump on" conditions. A pump assembly, reservoir, and a small section of supply line tubing, which had been removed from another Pilgrim Airlines DHC-6-100, was used for the test. There was no tubing connected to the pump outlet. Specifications for the pump assembly, P/N 14-81464-02, manufactured by the Marquette Metal Company were: voltage required--28 volts D.C.; amperage--1.5 to 1.8; rated output--0.2 gallon per minute at 3 pounds discharge pressure. The reservoir, containing about 1 gallon of water, was positioned 8 to 10 inches above the pump assembly. The supply line was connected to the reservoir outlet fitting and to the pump inlet. When the 24-volt D.C., 1-ampere power supply was applied to the pump, water was discharged from the outlet fitting a distance of 7 feet. The static leakage rate through the pump was measured with the reservoir in the same position. The leakage rate was 90 milliliters (about 0.2 pint) per minute. In the aircraft, the reservoir was located about 20 inches above the pump.

The tests demonstrated that with the tubing not properly fastened on the outlet pressure side of the pump, isopropyl alcohol could have leaked through the pump and accumulated in the compartment beneath the cockpit floor without the washer/deicer system having been activated, and once the system was activated, alcohol would have been sprayed from the pump outlet forward into the compartment area which contained numerous ignition sources.

1.16.2 Examination of Seat 6C Seatbelt End Fitting

The Safety Board's laboratory examined the separated outboard end fitting from seat 6C and found characteristics of an overstress fracture. Examination also showed that the fitting had been exposed to intense heat after the fracture had occurred.

1.17 Additional Information

1.17.1 Pilgrim Airlines Operating Procedures

The Pilgrim Airlines Operations Manual (section 3, page 3021) states the following:

It is the responsibility of the captain to insure that the passengers are orally briefed at the required times. (1) Before each takeoff; this briefing shall include the following: (a) A "welcome aboard" with the flight number, destination, time en route; (b) The location and operation of the No Smoking and Fasten Seat Belt signs; (c) The location of Emergency Exit hatches in the passenger cabin and the method of opening those exits, and the airstair entry door; (d) The location and operation of fire extinguishers; (e) The location

and operation of emergency equipment; (f) The location and content of the seatback emergency cards; (g) If the flight is carrying a passenger who will require assistance in order to reach an exit in an emergency, then that passenger and attendant, if any, must be briefed in advance by the flightcrew as to what to do in the event cabin emergency evacuation is necessary.

The operations manual briefing did not include a description of the operation of passenger seatbelts.

The aircraft operating checklist used by Pilgrim Airlines flightcrews in the DHC-6 aircraft consists of a hand-operated scroll device. The emergency checklist contains the following items: engine failure on takeoff, single-engine climb speeds, engine fire, flameout, hydraulic pump failure, low suction, and boost failure. There is no item on cabin fire or smoke removal.

1.17.2 DeHavilland DHC-6 Aircraft Operating Manual

Section 3 (emergency procedures) of the Approved Aircraft Operating Manual states the following concerning fuselage fires:

3.3.3 FUSELAGE FIRE. If a fire occurs within the aircraft which is located and is accessible, extinguish the fire with the hand operated fire extinguisher. If the source of the fire cannot be located or is inaccessible, proceed as follows:

- a. All electrical switches - off.
- b. Reduce air circulation and drafts as much as possible.
- c. Heating and ventilating system - off.
- d. Land as soon as possible.

1.17.3 Federal Regulations

The deHavilland DCH-6-100 was certificated under Civil Aviation Regulation CAR 3 dated May 15, 1956, and Amendments 3-1 to 3-8 plus Special Conditions for Multi-Engine Turbine Powered Aircraft dated November 6, 1964. Type certificate No. 49EA was issued on June 22, 1966. The aircraft was approved for operation in icing when equipped with modifications that include either an electrically heated windshield or a windshield washer/delcer system.

Title 14 CFR 135.153, which applies to aircraft in commuter service, requires that the aircraft be equipped with at least two fire extinguishers. One must be located on the flight deck for use by the crew and at least one must be "conveniently located" in the passenger compartment of each aircraft that has 10 to 31 passenger seats.

Title 14 CFR 135.117 requires that the oral pretakeoff briefing of passengers by the crew be supplemented by printed cards that contain "(1) a diagram of, and method of operating the emergency exits; and (2) other instructions necessary for the use of emergency equipment on board the aircraft." This section further requires that the cards "must contain information that is appropriate to the aircraft on which it is to be used." Title 14 CFR 135.117 also requires that the pretakeoff briefing include information concerning the use of seatbelts.

Title 14 CFR 135.87(c)(6) requires carryon baggage to be properly stowed before takeoff and before landing, but does not require the flightcrews to inform passengers of the requirement. Furthermore, there is no requirement that the safety briefing cards contain information concerning the stowage of carryon luggage.

2. ANALYSIS

The aircraft was certificated and maintained in accordance with approved procedures. There was no evidence of preaccident failure or malfunction of the aircraft powerplants, structures, or flight controls. The flightcrew was properly certificated and qualified for this scheduled domestic passenger flight. They held current medical certificates. Weather was not a factor in this accident, other than the icing conditions which caused the initial icing of the windshield.

2.1 Flightcrew Actions

The initial action of the first officer in response to ice covering the windshield was to activate the windshield washer/deicer system in accordance with standard procedure. When the first activation did not result in expected deicing, the first officer reactivated the system. Again, he obtained less than expected results. Deicing efforts were stopped when the first officer smelled the alcohol odor. The captain declared an emergency and requested vectors to the Providence airport at the first sighting of the gray smoke. The Safety Board notes that the captain did not hesitate to declare an emergency and had previous knowledge of his position relative to the nearest suitable airport.

The gray smoke quickly intensified to heavy black smoke that blocked the crew's vision and prevented normal breathing. Although air admitted into the cockpit when crewmembers opened their side windows may have contributed to the intensity of the fire, the Safety Board believes that the crew probably would have been overcome by smoke and lost control of the aircraft had the windows not been opened.

Fire developed in the cockpit and burned the clothing of both crewmembers. The captain selected the nearest suitable emergency landing site when he was able to see the ground and expeditiously landed the aircraft on the frozen reservoir. The Safety Board concludes that the flightcrew's actions did not contribute to the accident and commends the captain and first officer for their prompt and heroic actions in response to an in-flight emergency.

2.2 Fire Origination and Propagation

The emergency report to air traffic control by the flightcrew and subsequent statements given by the surviving passengers indicated that the fire started below the cockpit/forward cabin area during cruise flight. The fire and intense smoke were preceded by the smell of alcohol. The statements of Pilgrim flightcrews and maintenance personnel indicate that the windshield washer/deicer system, consisting of a 1.5-gallon polyethylene reservoir containing isopropyl alcohol, a 28-volt D.C. motor-driven pump, spray nozzles, and Tygon clear plastic tubing (vinyl base), was susceptible to leaks caused by the tubing becoming disconnected from the pump. The accident aircraft experienced a leak on February 18, 1982, 3 days before the accident. The leak was repaired by a combination of wire and clamps to secure the tubing connections.

The deHavilland practice of securing the tube connections with three wraps of safety wire is not as positive as other common methods in preventing tubing disconnects, especially on the outlet pressure side of the pump. Although clamps are the better method of securing the tubing, even they do not insure a leak-free, disconnect-free environment that is critical since the system down to the pump is gravity fed. Any leak or disconnection at any point between the reservoir and the outlet side of the pump will cause a complete loss of fluid unless the leak is detected and stopped.

Tests demonstrated that if the outlet side of the pump was disconnected from the tubing, fluid would flow through it into the compartment beneath the cockpit, even when the pump was not running. The most insidious form of leak or disconnect would be with the tubing on the outlet side of the pump disconnected and the alcohol under pressure sprayed into the compartment area and forward under the instrument panel into the avionics and radar component bays. The tests demonstrated that the pump could force fluid out of its outlet port for a distance of about 7 feet. The pump's position was less than 7 feet from the nose of the aircraft; consequently, any leakage under pressure would have sprayed alcohol onto several potential ignition sources including:

- o Engine bleed air ducting--A duct passed downward, forward, and inboard from the cockpit floor to the intake of the heater ejector. The duct was well insulated, but the bleed air temperature in the line beneath the cockpit floor could have been as high as 150° F.
- o Ejector, mixing box, and silencer--The units were grouped near the aircraft centerline. The discharge side of the silencer provided heated air to the cockpit and cabin through fiberglass ducting.
- o Hydraulic power package--A reservoir, an electric motor-driven pump, two accumulators, and associated plumbing for flap, nose wheel steering, and brake actuation were located near the aircraft's centerline. The electrical motor only operated after activation of the flap system, nose wheel steering, or wheel brakes.
- o Windshield washer/deicer motor-driven pump--The pump and electric motor assembly were mounted on the aft cargo bulkhead. It was noted that the motor housing becomes hot during pump operation. The pump assembly from the accident aircraft was not recovered.

The pressure tubing probably disconnected from the pressure side of the pump at some time before the first officer activated the windshield washer/deicer system. Fluid could have accumulated beneath the cockpit floor as small amounts of alcohol leaked through the pump when it was not running. When the windshield deicing system was activated twice, about 20 minutes after the aircraft departed Groton, alcohol probably was sprayed from the discharge side of the pump into the compartment beneath the cockpit floor. The fire probably originated within the compartment and spread to the forward cabin area by burning into and through the left fiberglass heating duct.

Although Pilgrim Airlines removed the windshield washer/deicer systems from all of their DHC-6 aircraft on February 23, 1982, Pilgrim Airlines maintenance supervisors did not realize the significance of the maintenance problems with the DHC-6 windshield washer/deicer system until after the accident. While there has not been a history of accidents caused by the system, repeated leakage of a highly volatile and flammable liquid into the interior of an aircraft should have alerted the operator to a

potential problem. Although only 70 of about 780 DHC-6 aircraft in service have the windshield washer/deicer system, neither the manufacturer, the Canadian authorities, nor the FAA recognized the potential hazards of the system. The Safety Board believes that the isopropyl alcohol windshield deicing system on deHavilland DHC-6 aircraft presents a fire hazard and has issued a safety recommendation to eliminate the potential of system leakage.

2.3 Fire Extinguishers/Safety Briefing

The Safety Board believes that the pretakeoff briefing described the locations of the fire extinguishers. However, because the pretakeoff briefing announcement was garbled and hurried, passengers said they were unaware that a fire extinguisher was located in the cabin. The location of the fire extinguisher in the cabin was not shown on the safety briefing card as required by 14 CFR 135.117 and was not indicated by a sign in the cabin. The extinguisher could not be seen under the left rear passenger seat and was not accessible with the seat occupied. No one attempted to use the cabin extinguisher. Although the fire extinguisher behind the first officer's position was accessible, the first officer could not use it because it was too hot to handle.

Although 14 CFR 135.155 requires that a fire extinguisher be "conveniently located" in the passenger compartment, no requirement exists that the extinguisher be readily accessible and properly identified. The Safety Board is aware that 14 CFR 91.193(c)(4), which applies only to large aircraft and to turbojet-powered multiengine aircraft, specifies that fire extinguishers located in the cabin "must be readily accessible, and unless the locations of the fire extinguishers are obvious, their stowage provisions must be properly identified." The Safety Board is concerned that the requirements of 14 CFR 135.155 are less definitive than the requirements of 14 CFR 91.143 and do not provide for the equivalent level of safety in passenger-carrying operations.

The passenger seats were equipped for underseat stowage of carryon baggage in accordance with 14 CFR 135.87, but one passenger said he had his attache case on his lap during takeoff. Although 14 CFR 135.87(c)(8) requires carryon baggage to be stowed before takeoff and before landing, there is no requirement that flightcrews inform passengers of the requirement or that safety cards contain this information. Neither the pretakeoff briefing nor the safety briefing cards on the accident aircraft mentioned requirements for carryon baggage. This type of safety information becomes most important in commuter operations because operators usually are not required to have onboard cabin attendant who would insure that the passengers have their seatbelts fastened, that there is no smoking, and that carryon baggage is stowed beneath seats. Consequently, the Safety Board believes that the pretakeoff briefing and safety briefing cards should be amended to inform commuter passengers of the carryon baggage stowage requirement.

Title 14 CFR 135.117 requires that the pretakeoff briefing of passengers include information concerning the use of seatbelts. The Pilgrim Airlines flightcrew pretakeoff briefing did not address seatbelt use. Likewise, the seatback safety briefing cards did not address seatbelt usage or operation of the seatbelts as supplemental information. The Safety Board believes that the oral briefing should comply with the regulatory requirement and that the seatback safety briefing cards should provide supplemental information on the operation and the use of the seatbelts.

The safety briefing card also did not show the location of the overhead escape hatch located in the rear cabin.

The Safety Board believes that more comprehensive surveillance by FAA inspectors would have discovered the obvious discrepancies in the safety card and the lack of instructions for the use and operation of seatbelts in the pretakeoff briefing. The FAA's surveillance of air taxi and commercial operators which operate under 14 CFR Part 135 should certainly place heavy emphasis on occupant safety and safety equipment. The rapid growth of the commuter industry, as discussed in the Safety Board's special study on commuter airline safety, ^{5/} clearly requires that FAA inspectors be aware of the need for operators to conform to all applicable requirements in the Federal Aviation Regulations under which they operate.

2.4 Survival Aspects

Fire injuries were sustained by the captain, first officer, and two passengers. The crew sustained their injuries in flight and before escaping from the aircraft after it landed. The captain's injuries were more severe and extensive because the fire appeared to have been more extensive in the left cockpit and left forward cabin. The first officer was wearing several layers of clothing and was thus afforded more protection from radiant heat and direct flames.

None of the surviving passengers was incapacitated during the in-flight fire. The rapid evacuation of the passengers was possible because the cabin remained intact and no debris hampered access to the forward right emergency exit or to the opening in the rear of the cabin. Only one of the four emergency exits was used. Two additional exits could have been used if the passengers had read the safety card and been familiar with the emergency exits. It is noteworthy that of the nine surviving passengers, only the 9-year-old girl in seat 6A, which was directly above the cabin fire extinguisher, had read the safety card on this flight.

Most of the passengers were not incapacitated by injuries sustained at impact; only three--the passengers in seats 2C, 6A, and 6C--had to be helped from the aircraft because of their injuries. The blind woman in seat 5A also was assisted from her seat to the exit. There was no reported panic or disruptive behavior among the passengers during the evacuation. The evacuation was rapid because the two exits could be reached quickly in the relatively small cabin even though visibility was reduced.

The autopsy of the 59-year-old woman who did not escape revealed that she had severe chronic obstructive lung disease and severe cardiovascular disease. No blunt-force traumatic injuries were found. The elevated, though not necessarily lethal, level of carbon monoxide, 25 to 32.6 percent, and the 1.75 $\mu\text{g}/\text{ml}$ level of hydrogen cyanide indicate respiratory activity in the presence of the byproducts of fire. The seat occupied by the victim exhibited slight deformation to the seatpan frame and the seatback frame. The man who occupied the seat directly behind her sustained a compression spinal fracture, and the seat he occupied exhibited damage which was consistent with his injuries. The man who occupied the seat directly in front of her received minor injuries, and his seat was one of three undamaged single seats. Thus, the lack of blunt-force injuries to the spinal column, head, and internal organs and the lack of major impact-related damage to her seat indicates that the woman who died was not subjected to crash forces of sufficient magnitude to damage her seat and inflict severe injury.

Because the woman's body was found lying across the cabin from where she had been seated and because no seatbelt release buckle was found with the body, the Safety Board concludes that after the aircraft landed and after other passengers had

^{5/} Special Study--"Commuter Airline Safety," dated July 22, 1980 (NTSB-AAS-80-1).

escaped, the woman attempted to escape but succumbed to the effects of hot gases and carbon monoxide before she was able to do so.

3. CONCLUSIONS

3.1 Findings

1. The aircraft was certificated and maintained in accordance with approved procedures.
2. There was no evidence of preaccident failure or malfunction of the aircraft powerplants, structures, or flight controls.
3. The flightcrew was properly certificated and medically qualified for the flight.
4. Weather was not a factor in this accident.
5. Flightcrew actions did not contribute to this accident; their prompt and heroic responses were appropriate for the in-flight emergency.
6. A leak in the windshield washer/deicer system had allowed isopropyl alcohol to accumulate in the compartment below the cockpit floor. When the tubing disconnected from the pressure side of the pump and the pump was activated, alcohol was sprayed through the compartment where it was ignited.
7. The ignition source of the isopropyl alcohol could not be determined.
8. Pilgrim Airlines maintenance supervisory personnel did not realize the significance of the repeated maintenance problems in the windshield washer/deicer system and take positive remedial action before the accident to correct the defects.
9. The design of the deHavilland DH-6-100 windshield washer/deicer system was deficient.
10. The locations of the fire extinguishers in the aircraft were not prominently marked.
11. The seatback safety cards in the cabin did not indicate the location of the cabin fire extinguisher or the overhead escape hatch.
12. The preflight passenger briefing did not address usage of the passenger seatbelts.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the deficient design of the isopropyl alcohol windshield washer/deicer system and the inadequate maintenance of the system which resulted in an in-flight fire. The ignition source of the fire was not determined.

4. RECOMMENDATIONS

During its investigation of this accident, the National Transportation Safety Board on July 13, 1982, recommended that the Federal Aviation Administration:

Issue an Airworthiness Directive to require a redesign and modification of isopropyl alcohol windshield deicing systems installed on DHC-6 aircraft to eliminate the potential for alcohol leakage or, if practicable, to require replacement of these systems with the electrically heated windshields offered by the manufacturer as an alternative installation. (Class II, Priority Action) (A-82-56)

Review and evaluate the design of all isopropyl alcohol windshield deicing system installations on aircraft to verify compliance with applicable Federal Aviation Regulations pertaining to flammable fluid fire protection, and take action to correct any deficiencies found. (Class II, Priority Action) (A-82-57)

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

Issue an Operations Bulletin requiring Principal Operations Inspectors of 14 CFR Part 135 operators to determine: (1) that oral briefings by the crew and safety briefing cards in the cabin comply with 14 CFR 135.117 and 14 CFR 135.87(c)(6) regarding use of passenger seatbelts and stowage of carryon baggage, (2) that fire extinguishers and other safety equipment are accessible and that their locations are identified by placards, and (3) that operators stress to their flightcrews the importance of making public address announcements slowly and articulately. (Class II, Priority Action) (A-82-70)

Issue a Maintenance Bulletin calling attention to the need for properly functioning public address systems to assure that safety messages by the crew are understandable in all parts of the cabin both on the ground and in flight. (Class II, Priority Action) (A-82-71)

Amend 14 CFR 135.155 to make the requirements regarding the accessibility and location of fire extinguishers in passenger compartments of aircraft in commuter service at least as stringent as the requirement in 14 CFR 91.193(c)(4). (Class II, Priority Action) (A-82-72)

Review the training of and the surveillance procedures followed by Federal Aviation Administration inspectors and modify them if necessary to provide increased emphasis on the provisions of 14 CFR Part 135 with regard to occupant safety and safety equipment. (Class II, Priority Action) (A-82-73)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JIM BURNETT
Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ G.H. PATRICK BURSLEY
Member

/s/ DONALD D. ENGEN
Member

PATRICIA A. GOLDMAN, Vice Chairman, did not participate.

July 20, 1982

5. APPENDIXES

APPENDIX A

INVESTIGATION AND HEARING

1. Investigation

The Safety Board was notified of the accident about 1645 on February 21, 1982. A partial team was immediately dispatched from the Washington, D.C., headquarters and arrived on scene about 2130. Working groups were established for structures, systems, operations, powerplants, and human factors.

Parties to the investigation were the Federal Aviation Administration, Pilgrim Airlines, the deHavilland Aircraft of Canada, Ltd., Pratt & Whitney Aircraft of Canada, and TRW Hartzell Propeller.

2. Public Hearing

A public hearing was not held. Depositions were not taken.

APPENDIX B

PERSONNEL INFORMATION

Captain Thomas N. Prinster

Captain Prinster, 36, was employed by Pilgrim Airlines on February 1, 1979, and upgraded to Twin Otter captain on May 30, 1979. He held Air Transport Pilot Certificate No. 160648 for multiengine land aircraft and commercial privileges for single-engine land aircraft. His latest proficiency check was on December 26, 1981.

Captain Prinster had about 6,500 total flying hours with about 2,700 hours in the DHC-6. He had flown 260 hours in the past 90 days with 300 landings and 86 hours in the past 30 days with 150 landings.

Captain Prinster's most recent examination for a first-class medical certificate was performed on November 20, 1981. The first-class medical certificate contained no limitations. Medical applications dated May 7, 1979; July 20, 1979; December 21, 1979; June 27, 1980; December 23, 1980; May 26, 1981; and November 20, 1981, contained in response to the question of medication currently being used, the answer "tolectin-arthritis"; "tolectin-sinocondromatosis-left hip"; or "tolectin." This medication is not contraindicated for flying according to the FAA.

First Officer Lyle W. Hogg

First Officer Hogg, 27, was employed by Pilgrim Airlines on September 14, 1981, and qualified for first officer on the Twin Otter on September 19, 1981, when he received his proficiency check. He held Commercial Pilot's Certificate No. 45525979 for multi- and single-engine aircraft.

First Officer Hogg had about 2,100 total flying hours with about 400 hours in the DHC-6.

First Officer Hogg's most recent medical examination for a first-class medical certificate was dated April 29, 1981. The certificate contained no limitations. He listed on his application for the medical certificate that he was taking "cytomill" (sic) thyroid medication. He had had a thyroidectomy on April 3, 1981.

On September 16, 1981, an FAA letter to Mr. Hogg acknowledged that his first-class medical certificate was valid and requested that at the time of his next FAA medical examination in April 1982, that the medical examiner submit to the FAA "a current interval followup status report regarding your history of thyroid trouble." The letter brought to Mr. Hogg's attention pursuant to 14 CFR 61.53: "operation of an aircraft is prohibited: at anytime new symptoms or adverse changes occur; at anytime medication is changed on a continuous daily basis; and, at anytime you experience side effects."

APPENDIX C

AIRCRAFT INFORMATION

DeHavilland DHC-6-100, N127PM, serial No. 105 was manufactured in 1967. The aircraft total flying hours were about 27,015 hours at the time of the accident. The aircraft was maintained under an FAA-approved Enhanced Maintenance Program with 28 separate checks with 50 flying hours (+ 10) between checks. There were no significant discrepancies other than the February 18, 1982, deicer system writeup described elsewhere in this report.

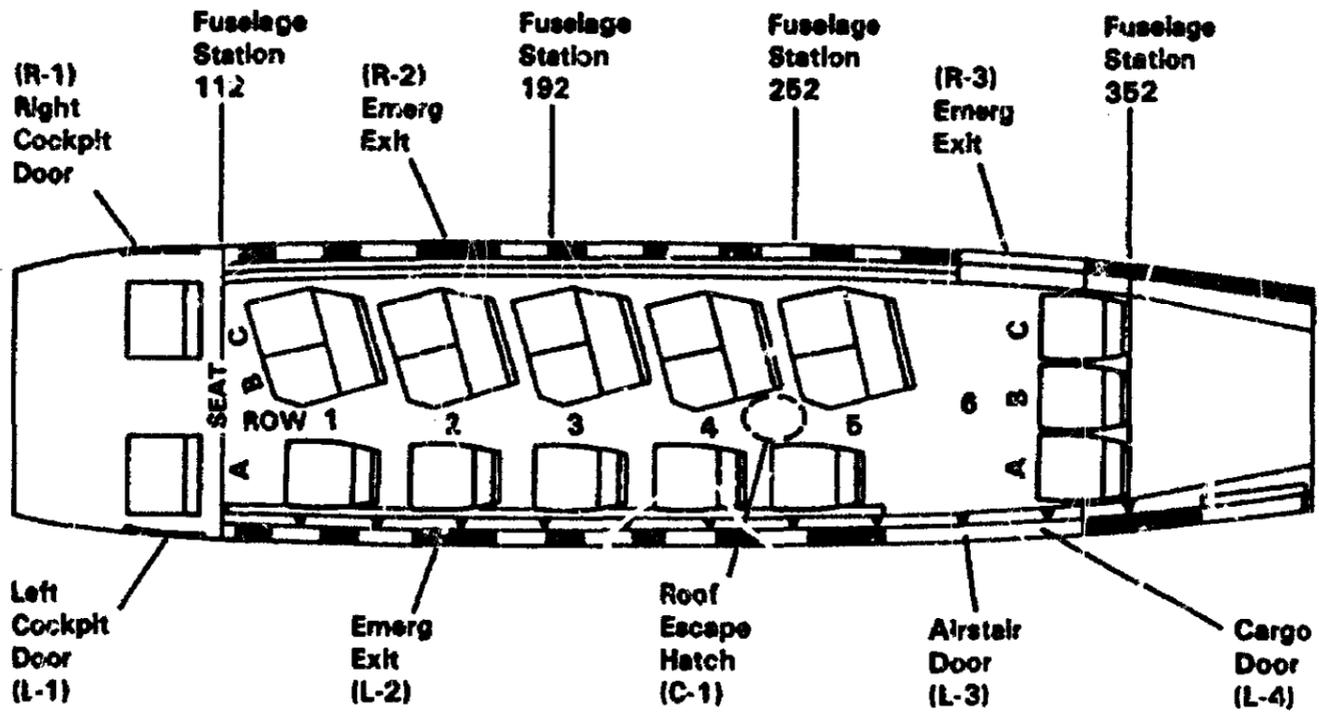
The accident aircraft was equipped with two Pratt & Whitney Aircraft of Canada Ltd. PT6A-20 turboprop engines and two Hartzell model HC-B3TN-3B constant-speed, controllable-pitch, reversible propellers; three model T10173+1 blades were installed in each propeller. This model engine develops 579 equivalent shaft horsepower at standard day operating conditions.

Engine and propeller statistical data are presented below. The times expressed herewith are in hours and are as of the date of the accident.

<u>Engines:</u>	<u>Left</u>	<u>Right</u>
Serial numbers	PC-E 22491	PC-E 21621
Total time	15,500	16,599
Time since overhaul	6,868	728
Date of installation	4-30-81	11-7-81

<u>Propellers:</u>	<u>Left</u>	<u>Right</u>
Serial numbers	BU 1740	BU 2639
Total time	36,015	23,459
Time since overhaul	1,646	2,871
Date of installation	4-30-81	11-7-81

APPENDIX D
SEATING DIAGRAM



SEAT	OCCUPANT	INJURY	OCCUPANT EXITED VIA
LEFT COCKPIT	T. PRINSTER	SERIOUS	L-1 (THROUGH WINDOW IN DOOR)
RIGHT COCKPIT	L. HOGG	SERIOUS	R-2 (OPENED R-2)
ROW 1 SEAT A	UNOCCUPIED		
SEAT B	UNOCCUPIED		
SEAT C	UNOCCUPIED		
ROW 2 SEAT A	ADULT MALE, 51	MINOR	L-4*
SEAT B	16-YEAR-OLD BOY	SERIOUS	R-2 (TRIED TO OPEN EXIT)
SEAT C	ADULT FEMALE, 46	SERIOUS	R-2 (ASSISTED FROM AIRCRAFT)
ROW 3 SEAT A	ADULT FEMALE, 59	FATAL	
SEAT B	UNOCCUPIED		
SEAT C	UNOCCUPIED		
ROW 4 SEAT A	ADULT MALE, 47	SERIOUS	L-4* (TRIED TO OPEN L-3)
SEAT B	UNOCCUPIED		
SEAT C	ADULT MALE, 35 (UNOCCUPIED) AT IMPACT	SERIOUS	L-4*
ROW 5 SEAT A	ADULT FEMALE, 26 (BLIND)	SERIOUS	L-4* (ASSISTED FROM AIRCRAFT)
SEAT B	UNOCCUPIED		
SEAT C	ADULT MALE, 26	SERIOUS	L-4* (THROUGH "HOLE") (TRIED TO OPEN L-3)
ROW 6 SEAT A	9-YEAR-OLD GIRL	SERIOUS	L-4* (PULLED FROM AIRCRAFT)
SEAT B	UNOCCUPIED		
SEAT C	17-YEAR-OLD BOY	SERIOUS	L-4* (PULLED FROM AIRCRAFT)

*It is not clear from passenger interviews whether the "hole" referred to by the occupant of 5-C and others was a hole in the side of the cabin or the partially opened/damaged cargo door, L-4

APPENDIX B

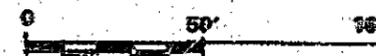
WRECKAGE DISTRIBUTION CHART

LEGEND:

- 1. 50" HOLE AND 6X12" HOLES IN ICE
- 2. HEADSET
- 3. PIECE OF SKIN
- 4. PIECE OF BOTTOM RIGHT ENGINE COWL
- 5. MAIN WRECKAGE
- 6. RIGHT WING SEPERATED AT WING ATTACH FITTING WITH A 48" SECTION OF WING STRUT
- 7. LEFT WHEEL AND STRUT ASSEMBLY
- 8. RIGHT WING TIP DRAG MARKS
- 9. INBOARD RIGHT WING DRAG MARKS
- 10. RIGHT PROPELLER BLADE SLASH MARKS

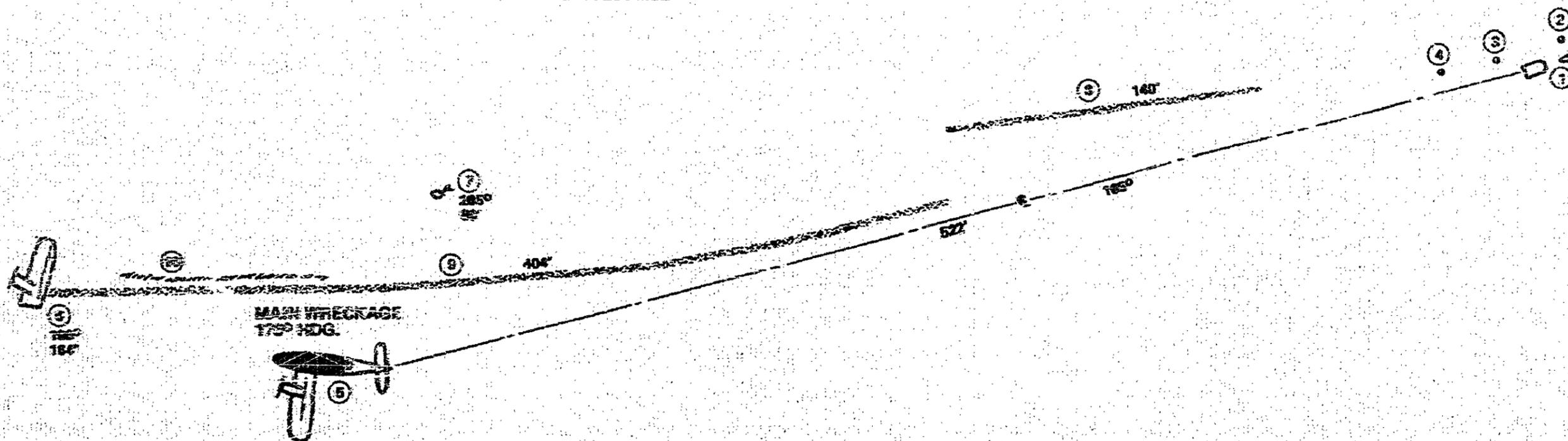
286° FROM T.F. GREEN AIRPORT
12-1/3 MILES

SCALE:



12° NORTH M.H.

ACCIDENT SITE COORDINATES:
LAT. 41°47'26" N
LONG. 71°38'16" W
ELEV. 284 MSL



E R R A T A

* THESE CORRECTIONS SHOULD BE *
* MADE TO THE PREVIOUSLY PUBLISHED *
* REPORT IDENTIFIED AS FOLLOWS *

AIRCRAFT ACCIDENT REPORT
PACIFIC SOUTHWEST AIRLINES, INC.
B-727, AND A GIBBS FLITE CENTER, INC.
CESSNA 172, N7711G
SAN DIEGO, CALIFORNIA
SEPTEMBER 25, 1978

During its evaluation of the ALPA Petition for Reconsideration of Probable Cause of the subject accident, the National Transportation Safety Board also reviewed the entire accident report and its supporting evidence. As a result of this reexamination, the Board concluded that the cause contained in the accident report did not reflect all the causal areas involved in the accident and has amended the probable cause. Therefore, amend the probable cause in (1) paragraphs 3 and 4 on the Technical Report Documentation Page (NTSB Form 1765.2), and (2) on page 1, paragraphs 3 and 4, and (3) page 36 of the accident report to read as follows:

The National Transportation Safety Board determines that the probable cause of this accident was the failure of the flightcrew of Flight 182 to comply with the provisions of a maintain-visual-separation clearance, including the requirement to inform the controller when visual contact was lost; and the air traffic control procedures in effect which authorized the controllers to use visual separation procedures in a terminal area environment when the capability was available to provide either lateral or vertical separation to either aircraft. Contributing to the accident were (1) the failure of the controller to advise Flight 182 of the direction of movement of the Cessna; (2) the failure of the pilot of the Cessna to maintain his assigned heading; and (3) the improper resolution by the controller of the conflict alert.

August 6, 1982

24