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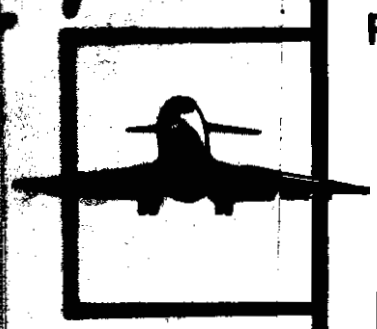

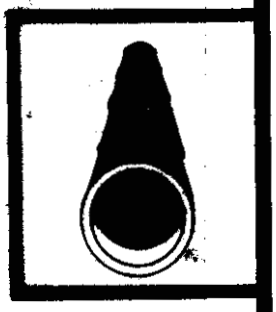

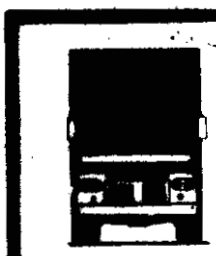

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

LUFKIN INDUSTRIES, INC.,
BEECHCRAFT SUPER KING AIR,
BE-200, N456L
'NEAR PARKER, COLORADO
MARCH 27, 1980

NTSB-AAR-82-9

UNITED STATES GOVERNMENT

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16. Abstract

About 1452 mountain standard time, on March 27, 1980, a Beechcraft Super King Air, 3E-200, N456L, owned and operated by Lufkin Industries, Incorporated, of Lufkin, Texas, crashed and burned in an open field near Parker, Colorado. The flight had departed Arapahoe County Airport, Colorado, at 1434:15 for a flight to Lufkin. About 9 1/2 minutes after departure, the pilots of N456L declared an emergency because of airframe icing. The aircraft was being vectored to land at Stapleton International Airport, Denver, Colorado, when it crashed into an open field about 13 miles east of Arapahoe County Airport. The two pilots and eight passengers on board were killed in the crash and subsequent ground fire. The aircraft was destroyed.

The National Transportation Safety Board determines that the probable cause of the accident was the rapid accumulation of ice on the underwing surface aft of the deicing boots which destroyed the aircraft's capability to maintain level flight because the flightcrew: failed to obtain a current weather briefing before departure; failed to make a timely decision to discontinue the climb and return to Arapahoe Airport; and operated the over-gross-weight aircraft at high angles of attack in severe icing conditions.

17. Key Words: airframe icing—in-flight; SIGMET; ATIS; weather briefing; in-flight decision; postcrash fire; overgross weight; survivability; carbon monoxide; preflight preparation; weather forecast; severe icing

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CONTENTS

	SYNOPSIS	1
1.	**FACTUAL INFORMATION**	1
1.1	History of the Flight	1
1.2	Injuries to Persons	4
1.3	Damage to Aircraft	5
1.4	Other Damage	5
1.5	Crew Information	5
1.6	Aircraft Information	5
1.7	Meteorological Information	5
1.7.1	General	5
1.7.2	Surface Observations	5
1.7.3	Weather Radar	6
1.7.4	Radiosonde Observation	7
1.7.5	Upper Wind Observation	7
1.7.6	Pilot Reports	7
1.7.7	Area Forecast	8
1.7.8	In-flight Weather Advisories	8
1.8	Aids to Navigation	9
1.9	Communications	9
1.10	Aerodrome and Ground Facilities	9
1.11	Flight Recorders	9
1.12	Wreckage and Impact Information	9
1.13	Medical and Pathological Information	11
1.14	Fire	12
1.15	Survival Aspects	13
1.16	Tests and Research	13
1.16.1	Powerplants	13
1.16.2	Aircraft Performance	14
1.17	Additional Information	15
1.17.1	Surface Deicing System	15
1.17.2	Icing Certification	16
1.17.3	Procedure for Dissemination of SIGMET's by the National Weather Service	17
1.18	Useful or Effective Investigation Techniques	18
2.	**ANALYSIS**	19
2.1	General	19
2.2	Power Loss	19
2.3	Airframe Icing	20
2.3.1	Ground Accumulated Airframe Ice	20
2.3.2	In-flight Airframe Icing	20
2.3.3	Deicing System Failure	21
2.3.4	Improper Crewmember Actions or Use of Deicing Equipment	21
2.3.5	Improper Operation of the Aircraft	21
2.3.6	Forecast and Pilot Briefing	23
2.3.7	Icing Certification	23
3.	CONCLUSIONS	24
3.1	Findings	24
3.2	Probable Cause	25

4. RECOMMENDATIONS. 25

5. APPENDIXES 29
Appendix A—Investigation and Hearing 29
Appendix B—Personnel Information. 30
Appendix C—Aircraft Information 31
Appendix D—Wreckage Distribution Chart. 32

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

Adopted: August 14,1982

LUFKIN INDUSTRIES, INC.
BEECHCRAFT SUPER KING AIR, BE-200, N456L
NEAR PARKER, COLORADO
MARCH 27,1980

SYNOPSIS

About 1452 mountain standard time, on March 27, 1980, a Beechcraft Super King Air, BE-200, N456L, owned and operated by Lufkin Industries, Incorporated, of Lufkin, Texas, crashed and burned in an open field near Parker, Colorado. The flight had departed Arapahoe County Airport, Colorado, at 1434:15 for a flight to Lufkin. About 9 1/2 minutes after departure, the pilots of N456L declared an emergency because of airframe icing. The aircraft was being vectored to land at Stapleton International Airport, Denver, Colorado, when it crashed into an open field about 13 miles east of Arapahoe County Airport. The two pilots and eight passengers on board were killed in the crash and subsequent ground fire. The aircraft was destroyed.

According to National Weather Service observations, the weather in the Denver area about the time of the accident indicated instrument meteorological conditions with snow, surface temperatures near 32° F, and moisture extending from the surface through 18,000 feet. An in-flight weather advisory (SIGMET) forecasting moderate to severe icing was in effect for the area at the time of the accident.

The National Transportation Safety Board determines that the probable cause of the accident was the rapid accumulation of ice on the underwing surface aft of the deicing boots which destroyed the aircraft's capability to maintain level flight because the flightcrew: failed to obtain a current weather briefing before departure; failed to make a timely decision to discontinue the climb and return to Arapahoe Airport; and operated the over-gross-weight aircraft at high angles of attack in severe icing conditions.

1. FACTUAL INFORMATION

1.1 History of the Flight

On March 27, 1980, N456L, a Beechcraft Super King Air 200, owned and operated by Lufkin Industries, Incorporated, as a corporate-executive aircraft under 14 CFR 91, landed at the Arapahoe County Airport near Denver, Colorado, at 1017 1/ and taxied to the Arapahoe Aviation, Incorporated, facility at the airport. The flight originated in Lufkin, Texas. The first officer exited the aircraft and instructed ramp personnel to fill the outboard fuel tanks and to put 25 gallons into each inboard fuel tank. During the fueling operation, the captain exited the aircraft and asked ramp personnel about the fueling arrangements made by the first officer. After ramp personnel told the captain how much fuel the first officer had requested, the captain stated, "Do not put a drop more than that in." According to the fuel receipt, N456L was fueled with 214 gallons of jet-A fuel.

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

About 1020, the captain of N456L telephoned the Denver Flight Service Station (FSS) from Arapahoe Aviation to request a weather briefing for a return flight to Lufkin. The captain told the weather briefer that he would be departing at 1330 and was given weather information along his proposed route of flight. The briefer advised him that there were reports of light rime icing in the area between **8,000** feet and 11,000 feet m.s.l. 2/ with a forecast calling for moderate mixed icing for the Denver area in the afternoon.

After the weather briefing, the captain filed an instrument flight rules (IFR) flight plan from the Arapahoe Airport to Lufkin, Texas. **No** alternate airport was filed nor was one required. The captain also advised the weather briefer that he would call back to get an update on the weather before departing. There is no record of the flightcrew's having received an updated weather briefing.

About 1330, the flightcrew returned from lunch and instructed the ramp employee to begin deicing the aircraft. The ramp employee brushed the snow off the aircraft's wings and tail surfaces in the presence of the flightcrew. He described the snow as very wet and said it came off the aircraft easily leaving a beaded film of water. The flightcrew declined the ramp employee's offer to spray the aircraft with deicer fluid. The ramp employee estimated that 1 to 2 inches of snow remained on the upper fuselage from the cockpit back to the vertical fin. None of the ramp personnel saw the pilots preflight the aircraft.

The passengers arrived and began to board the aircraft about 1410, The ramp employee stated that he observed the pilots surveying the passengers and overheard the captain remark to the copilot that they were going to "have to burn off 10 to 15 gallons of fuel during the taxi;" the first officer concurred.

The flightcrew 3/ of N456L contacted Arapahoe ground control at 1429:10 for an IFR clearance and taxi instructions.

At 1431:03, the flightcrew received from Arapahoe Airport ground control an IPR clearance to Lufkin via flight plan route. The flight was to maintain **8,000** feet and to contact Denver departure control when airborne. The crew acknowledged the clearance and confirmed with ground control at 1431:38 that they would be ready for takeoff upon reaching the approach end of runway 34R. At 1434:15, the aircraft departed Arapahoe Airport with eight passengers and a crew of two, and about 1436 Denver departure control established radar contact with the aircraft at an altitude of 6,300 feet.

A witness at the airport stated that N456L lifted off about 4,700 feet from the takeoff end of runway 34R. Other witnesses stated that its initial climb angle was "shallow" as compared to comparable aircraft they had observed that day.

At 1443:51, about 10 minutes after being cleared for takeoff, the copilot of N456L radioed Denver departure control, "okay, we would like to **go** back to Arapahoe County. We're getting (a) little too much ice up here." The aircraft's position at that time was about 14 nmi southeast of the Arapahoe Airport at an altitude of 12,700 feet. Denver departure control provided vectors to N456L for its return to Arapahoe. At 144457, the copilot of N456L radioed, "Want to go to Stapleton now." Stapleton

2/ All altitudes herein are above mean sea level unless otherwise specified.
3/ The first officer was identified by another company pilot as the crewmember handling the majority of the radio communications.

International Airport, Denver, Colorado, was about 25 miles northwest of N456L's position at that time.

The following pertinent radio transmissions were then made between N456L and air traffic control (ATC):

TIME	SOURCE	
1444:59	SR-2 4/	Five six Lima maintain one one thousand and turn left to a heading of zero four zero.
1445:06	N456L	One one thousand zero four zero.
1445:34	SR-2	Five six Lima proceed direct to the Kiowa VOR, cleared to the Kiowa VOR maintain one one thousand contact Denver approach control one two zero point eight they will have further clearance for you.
1445:44	N456L	Direct Kiowa two zero point eight.
1446:41	N456L	Hello Colorado Springs King Air four five ah Denver four five six Lima.
1446:46	AR-1 5/	Four five six Lima fly heading zero three zero vector sequencing runway two six left, be vectors **for** an **ILS** runway two six left at Stapleton.
1446:56	N456L	Okay, what's the weather at Colorado Springs?
1447:00	AR-1	Well, I'll get it when I get a chance sir. Denver altimeter two niner eight two.
1448:18	AR-1	Five six Lima the Springs weather, sky partially obscured measured ceiling five hundred overcast, visibility two and one-half mile and light snow showers and fog, over.
1448:39	N456L	Okay, we were asking below eleven thousand, we can't hold it here at eleven.
1448:44	AR-1	Five six Lima, do you intend to come into Stapleton?
1448:47	N456L	Affirmative (captain - whatever we can get in) anything we can get there.
1448:50	AR-1	Understand, five six Lima descend and maintain one zero thousand. That's the best I can do right now. Unless I have to vector you eastbound just stay on the heading, there's traffic off your left ten o'clock and eight southbound at eight five.

4/ Denver tower satellite radar two position.
5/ Denver tower arrival radar one position.

TIME	SOURCE	
1449:03	N456L	Okay, we'll declare emergency if necessary, just get us straight to the runway.
1449:08	AR-1	I understand five six Lima, do what you have to do stay on the heading.
1449:20	AR-1	Five six Lima, descend and maintain eight thousand.
1449:23	N456L	Kay, coming down to eight.
1449:43	AR-1	Five six Lima turn left heading three four zero vector final approach course. We'll take you right into a base leg from there.
1449:49	N456L	Three four zero, roger.
1449:53	N456L	Five six Lima's gonna be descending all the way.
1450:05	AR-1	Say again?
1450:07	N456L	Six Lima gotta come right on down, you better get us to the nearest airport.
1450:11	AR-1	Five six Lima you're two one southeast of Stapleton that's are you gonna be able to make that or what?
1450:19	N456L	Naw, get us to the nearest airport. We gotta come on down. (This was the last recorded transmission from the flightcrew of N456L).
1450:51	AR-I	Five six Lima, turn left heading three one zero. Five six Lima, try to hold the altitude as best you can cause you still got 10 miles to go to Buckley, that is the closest airport from your position.

At 1451:47, radar contact with N456L was lost 18 nmi southeast of Stapleton Airport. The last known altitude of the aircraft, as reported by the Denver approach controller, was 7,700 feet.

The aircraft crashed into an open field. The crash path was oriented on a magnetic Gearing of 305° and was about 465 feet long from the initial ground impact to where the main wreckage came to rest. The accident occurred during daylight hours at 39°32' north latitude, 104°34' west longitude.

1.2 Injuries to Persons

Injuries	Crew	Passengers	Others	Total
Fatal	2	8	0	10
Serious	0	0	0	0
Minor/None	0	0	0	0
Total	2	8	0	10

13 Damage to Aircraft

The aircraft was destroyed by impact and postcrash fire.

14 Other Damage

None

15 Crew Information

The flightcrew consisted of the captain and copilot. Both were certified and qualified to conduct the flight. (See appendix B.)

16 Aircraft Information

The aircraft was a Beechcraft Super King Air 200, serial No. BB-112. The date of manufacture was December 12, 1975. The aircraft was equipped with two Pratt & Whitney Aircraft PT 6A-41 turbopropeller engines rated at 850 shaft horse power each. (See appendix C.) The Beech Model 200 is certificated under the provisions of 14 CFR 25.1419 for flight into known icing conditions. Only one pilot was required for the flight.

The accident aircraft's maximum authorized takeoff weight was 12,500 lbs. Its gross weight on departure from Arapahoe County Airport was calculated to have been about 13,098 lbs, with an estimated 2,921 lbs of fuel on board. The aircraft's center of gravity (c.g.) was calculated to have been 193.6 inches at departure. The c.g. range for this aircraft was 185.0 inches (forward limit) to 196.4 inches (aft limit).

17 Meteorological Information

171 General

Aircraft N456L arrived at the Arapahoe County Airport at 1017. Snow began falling at the airport at 0906 and continued through 1500. Stapleton International Airport at Denver, Colorado, reported 2 inches of snowfall between 1043 and 1652.

About the time of the accident, surface weather observations from Stapleton, Arapahoe County Airport, Buckley Air National Guard Base, and Colorado Springs, Colorado, indicated instrument meteorological conditions in snow with surface temperatures near 32° F. The radiosonde and upper air observation taken at Stapleton about 1700 showed a freezing level near the surface (5,500 feet) with moisture extending from the surface through 18,000 feet. Upper winds through 14,000 feet were from the east to south-southeast between 5 to 15 knots.

Before the accident, moderate icing was reported in Eastern Colorado by pilots of a number of aircraft. The National Weather Service (NWS) forecasters stated that the conditions that existed in eastern Colorado the morning and afternoon of March 27 were conducive to moderate to severe icing. An in-flight weather advisory (SIGMET) which called for moderate to brief severe icing was in effect for the area at the time of the accident.

1.7.2 Surface Observations

The following surface observations were taken on March 27, 1980, for the times and places indicated:

Denver, Colorado (Stapleton International Airport)

1417: Ceiling — sky partly obscured, measured ceiling 600 feet overcast; visibility -- 2 statute miles; weather —light snow; wind — 020° 6/ at 5 knots; altimeter — 29.81 in.Hg.

1444: Ceiling — indefinite ceiling 500 feet sky obscured; visibility 1 statute mile; weather — light snow; wind — 010' at 5 knots.

1451: Ceiling — indefinite ceiling 400 feet sky obscured; visibility -- 1/4 statute mile; weather — heavy snow; temperature — 35° F; dewpoint -- 28° F; wind -- 020° at 5 knots; altimeter — 29.80 in.Hg.

1504: Ceiling — indefinite 400 feet sky obscured; visibility --1/2 statute mile; weather — moderate snow; temperature — 35° F; dewpoint -- 28° F; wind -- 020° at 6 knots; altimeter — 29.80 in.Hg; remarks — aircraft accident.

Arapahoe County Airport, Colorado

1346: Ceiling — indefinite ceiling 500 feet sky obscured; visibility -- 3/4 statute mile; weather — light snow, fog; wind -- 330° at 7 knots; altimeter 29.80 in.Hg.

1445: Ceiling — indefinite ceiling 500 feet sky obscured; visibility 3/4 statute mile; weather — light snow, fog; wind — 330' at 7 knots; altimeter 29.78 in.Hg.

1545: Ceiling — indefinite ceiling 500 feet sky obscured; visibility -- 3/4 statute mile; weather — light snow, fog; wind 340° at 10 knots; altimeter —29.77 in.Hg.

Buckley Air National Guard Base, Colorado

1455: Ceiling — indefinite ceiling 400 feet sky obscured; visibility — 7/8 statute mile variable; weather — light snow, fog; temperature 32° F; wind —360' at 2 knots; altimeter 29.79 in.Hg.; remarks — visibility 3/4 statute mile, variable 1 statute mile.

173 Weather Radar

At 1515, the National Weather Service (NWS) radar at Limon, Colorado, which is about 60 nmi east of Arapahoe Airport, reported an area 7/10 covered by moderate echoes containing snow showers. The area was 70 miles either side of a line connecting the 305' radial -80 mile fix and the 090' radial -125 mile fix from the Limon weather radar site. The cells were moving from 250° at 10 knots. The maximum echo tops were 24,000 feet at 100' radial at 46 nmi. The weather radar photographs from the Limon radarscope taken at 1435, 1440, 1446, and 1451 indicated an area of weak echoes with embedded moderate echoes within 40 nmi south-southeast of Denver.

6/ All directions are referenced to true north unless otherwise noted.

1.7.4 Radiosonde Observation

At **1700,** a radiosonde observation was taken at Denver and was, in part, as follows:

Height (millibars)	Temperature (°C)	Dewpoint Depression (°C)
830	**1.6**	**3.2**
824	**0.1**	**1.5**
700	**-8.5**	**0.0**
590	**-14.1**	**0.0**
562	**-15.9**	**2.5**
489	**-23.7**	**2.3**
442	**-30.5**	**3.0**

1.7.5 Upper Wind Observation

At **1700,** an upper wind observation was taken at Denver and was, in part, as follows:

Height (feet)	Direction (°)	Speed (knots)
6,000	**090**	**11**
7,000	**085**	**a3**
8,000	**070**	**12**
9,000	**090**	**7**
12,000	**135**	**9**
13,000	**145**	**10**

1.7.6 Pilot Reports

At 0930, the pilot of a Beechcraft **BE-35** on a flight from Scotts Bluff, Nebraska, to Denver, Colorado, reported severe rime icing at **8,000** feet and picked up **1 1/2** inches **of** rime ice. At **0940,** the pilot of a Beechcraft **BE-60** over Fort Collins, Colorado, at **16,000** feet reported moderate rime icing. At **1233,** the pilot of a DC-9 reported moderate rime ice during **a** climb to **13,000** feet. At **1330,** the pilot of a Boeing 727, **20** miles east of Denver at **11,000** feet reported moderate icing. At **1548,** the pilot of a DH-7 reported moderate rime icing when **15** miles northeast of Colorado Springs at **11,000** feet.

The pilot of a Mitsubishi MU-2 aircraft stated that, about the time of the accident, he was on an approach to Arapahoe County Airport. He missed two approaches at the airport because **of** ice on the windshield and encountered severe icing during the missed approaches. During these approaches, he encountered icing from **9,000** feet to **6,200** feet. During the missed approaches, he encountered icing from **7,000** feet to **9,000** feet. Because of the windshield icing, the pilot declared an emergency and landed at Stapleton International Airport at about **1515.** After landing, he noted about **3/4** inch of ice on the windshield and 1/2 to **3/4** inch of ice on the forward half of the fuselage. He said the leading edges **of** the wings were free of ice. The copilot of the MU-2 stated that **1/8** to **1/4** inch of ice accumulated on the leading edge boots every **45** to **60** seconds. Neither pilot observed any ice accumulation **on** the undersurface of the wings.

Another Beech King Air **200, N2030P,** was operating in the Denver area about the time of the accident. According to its pilot, about **1.5** inches **of** ice accumulated on

the aircraft during flight at 11,000 feet and descent from 11,000 to 9,000 feet. He termed the icing as moderate and was able to remove it with the deice equipment. He encountered no significant icing on the descent below 8,000 feet, and there were no downdrafts or significant turbulence in the area above 11,000 feet. Radar data indicated that N2030P was at 11,000 feet at 1438:13 and at 9,000 feet at 1447:29 at a ground speed of about 210 knots. The data also established that portions of N2030P's descent flight track paralleled N456L's ascent flight track at a distance of 2 to 3 miles with a time separation of about 9 minutes. The pilot of N2030P landed at Arapahoe County Airport about 1500.

1.7.7 Area Forecast

The area forecast issued by the NWS forecast office in Kansas City, Missouri, at 0540 and valid between 0600 until 0000 on March 28, was, in part, as follows:

Flight Precautions

Mountains south-central and southwest Colorado occasionally obscured above 8,000 to 10,000 feet in clouds and precipitation with occasional moderate mixed icing in clouds and in precipitation. Conditions developing across remainder (of) mountains (in) Colorado and Wyoming by 1100.

Over Eastern Plains - Colorado ...for ceiling below 1,000 feet visibilities below 3 miles in fog and precipitation with occasional moderate mixed icing in clouds and in precipitation above the freezing level. Conditions becoming local in Colorado. ..by 1100.

Icing and freezing level. ..Occasional moderate mixed icing in clouds and in precipitation above the freezing level. Freezing level at or near the surface. ...

1.7.8 In-flight Weather Advisories

The following SIGMET's 7/ pertinent to the time and location of the accident were issued by the NWS forecast office in Kansas City, Missouri:

SIGMET GOLF 1, issued at 1010 and valid from 1010 to 1400. Occasional moderate to brief severe icing in clouds and in precipitation above the freezing level. Conditions continuing beyond 1400. (The title SIGMET GOLF 1 was corrected to read SIGMET HOTEL 1 about 1039. The content of the advisory was not affected.)

SIGMET HOTEL 2, issued at 1445 and valid from 1445 to 1845. Occasional moderate to brief severe mixed icing in clouds and in precipitation above the freezing level. Conditions continuing beyond 1845.

AIRMET 8/ SIERRA 1, issued at 1330 and valid from 1330 to 1930. Moderate icing in clouds and in precipitation. Ceilings 1,000 feet and visibility below 3 miles expected due stratus and rain/snow fog. Conditions continuing beyond 1930.

7/ Significant meteorological information. An advisory issued concerning weather significant to the safety of all aircraft.

8/ Airman's meteorological information. An advisory that concerns weather phenomena of operational interest to all aircraft and potentially hazardous to aircraft with limited capability because of lack of equipment, instrumentation, or pilot qualification.

1.8 Aids to Navigation

There was no evidence that the flightcrew of N456L encountered navigational problems that would have been causal to the accident. The ATC radar equipment located at Stapleton and used to provide radar service to N456L was operating properly at the time of the accident.

1.9 Communications

The investigation revealed no radio communications difficulties between the flightcrew of N456L and appropriate ATC facilities.

1.10 Aerodrome and Ground Facilities

The Arapahoe County Airport is located about 12 miles south of Stapleton International Airport, which is about 5.5 miles east of downtown Denver. (See figure 1.) Arapahoe Airport has three hard-surfaced asphalt runways, with runway 34R served by an instrument landing system (ILS) instrument approach. Runway 34R is equipped with medium intensity runway lights (MIRL), visual approach slope indicator lights (VASI), and a medium intensity approach lighting system (MALSR) with runway alignment indicator lights. The lights and the ILS were operational at the time of the accident.

Instrument approaches into the Arapahoe Airport are controlled by Denver approach control. The localizer outer marker (LOM) at Castle, the final approach fix for the ILS to runway 34R, is located 6.5 miles south of the approach end of runway 34R. The crossing altitude at the Castle LOM is 8,043 feet. Runway 34R at Arapahoe is 8,500 feet long and 100 feet wide. The field elevation is 5,872 feet.

Runway 26L at Stapleton was the primary approach runway in use at the time of N456L's flight. Runway 26L is equipped with a simplified short approach lighting system with runway alignment indicator lights. Altur LOM is the final approach fix for runway 26L and is located 5.5 miles east of the approach end of runway 26L. The crossing altitude at Altur is 7,200 feet. Runway 26L is 10,004 feet long and 150 feet wide. Stapleton field elevation is 5,333 feet.

A ground controlled approach (GCA) to runway 32 at Buckley Air National Guard Base was available at the time of N456L's emergency. Runway 32 at Buckley is 11,000 feet long and 150 feet wide; field elevation is 5,663 feet. The final approach fix for the GCA to runway 32 is positioned by radar 5 miles southeast of runway 32. The crossing altitude at the fix is 7,500 feet.

1.11 Flight Recorders

Aircraft N456L was not equipped with a flight data recorder or a cockpit voice recorder and neither was required.

1.12 Wreckage and Impact Information

The aircraft wreckage was located in Elbert County, Colorado, 15 statute miles east of the approach end of runway 28 at the Arapahoe County Airport, about 14 statute miles southeast of the approach end of runway 32 to Buckley Air National Guard Base, and about 22 statute miles southeast of Stapleton Airport. The wreckage was scattered on rolling, snow-covered range land. The aircraft's initial ground impact was at an elevation of 6,280 feet and the aircraft came to rest at an elevation of 6,270 feet.

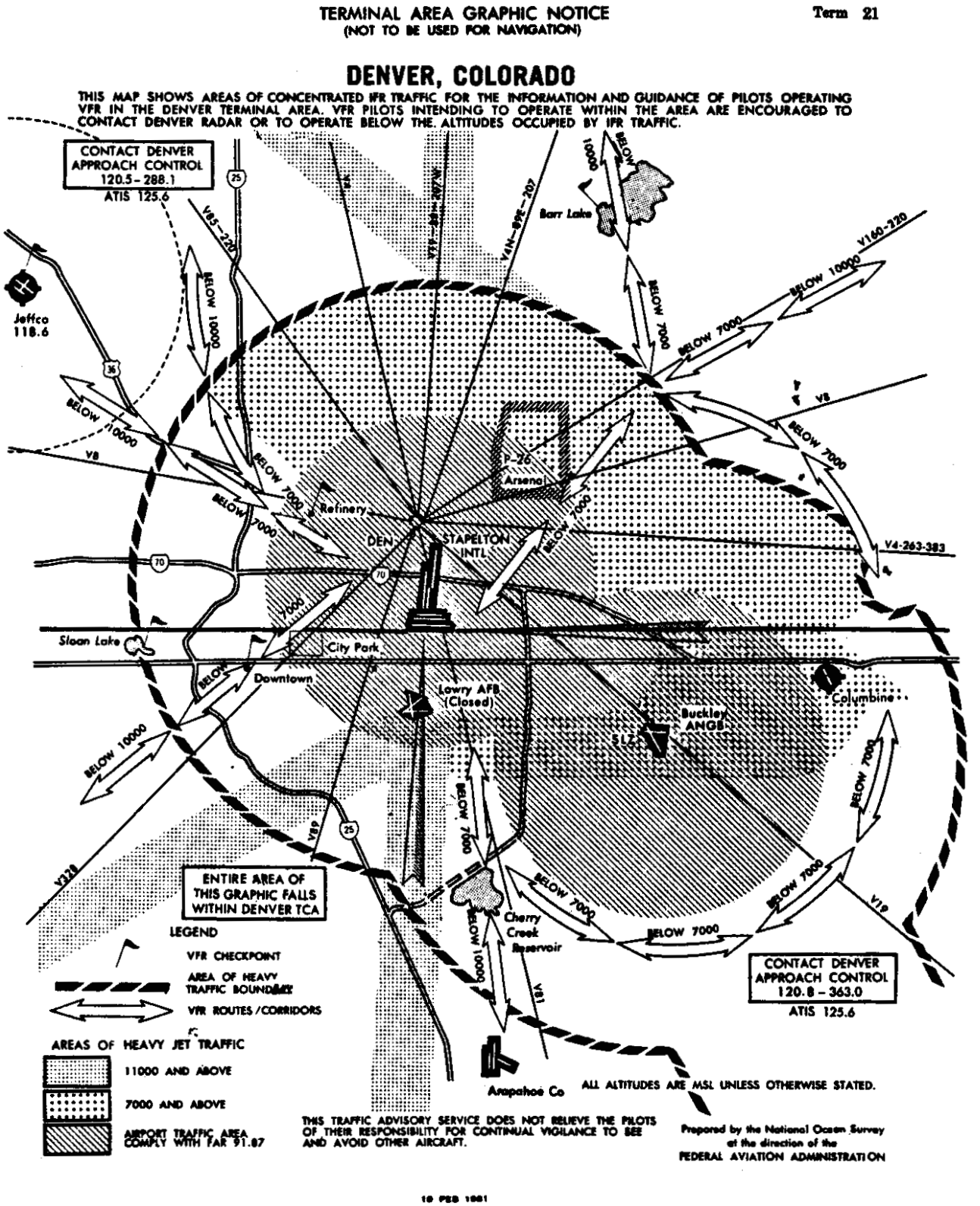


Figure 1. –Terminal Area Graphic Notice.

Marks in the ground made by the left and right engine nacelles, fuselage, and wings were visible at the initial impact area. Various components of the aircraft were located along a 335° magnetic bearing. None of the separated aircraft components found along the wreckage path bore any evidence of preimpact fire damage.

Examination of the initial impact point indicated that the aircraft struck snow-covered level ground in a slight nose-high and wings-level attitude. The aircraft came to rest 465 feet from the initial impact point with the fuselage oriented on a magnetic heading of 065°. The entire wreckage was confined to an area of about 465 feet long and 135 feet wide.

The left wing and wing center section remained attached to the fuselage. The left engine was in .place but nearly burned away from the engine nacelle. An ice formation about 3 feet long was found on the left wing inboard deicer boot. The iced area was between 0.25 inch and 0.375 inch thick. (The ambient temperature had remained at or below freezing from the time of the accident until the arrival of the investigators the next day.) The right wing outer panel had separated from the wing center section, which remained attached to the fuselage. The right engine had separated from the nacelle and was found close to the engine nacelle. A small area of ice about 0.5 inch thick had formed at the junction of the right engine nacelle's inboard side and the wing leading edge. Both engine propellers with the blades attached had separated from the engines and were found along the wreckage path. The entire fuselage, from the nose aft to near the aft pressure bulkhead, was damaged extensively by ground fire. The fuselage structure above the lower edge of the passenger window frames, beginning from the lower edge of the cockpit windshield aft to near the aft pressure bulkhead, was consumed by postimpact ground fire. The entire fuselage interior was gutted by fire. There was no evidence of preexisting structural damage. All fractures observed were typical of those caused by overloads.

Measurements taken of the left and right elevator trim jackscrews corresponded to a 5° tab-down position, which corresponds to noseup aircraft trim. The rudder trim jackscrew measurement corresponded to a 2° right rudder deflection. Measurement of the left aileron jackscrew trim tab established about 5° down deflection. All of the flight control surfaces remained attached and bore no evidence of a preimpact malfunction.

Examination of the landing gear retract actuators and the flap jackscrews indicated that the landing gear was retracted and the flaps were extended 35° at the time of impact.

The remains of the main entry door and emergency exit window were examined. The upper one-third of the entry door had been consumed by fire. The door locking handle remained in the "trail" or locked position. The forward locking pin was noted to be engaged in the remains of the forward door frame striker plate. Except for a section of lower frame, most of the fuselage emergency exit window and frame was consumed by fire. Three of the four adjustable stops were found in the remains of the fuselage frame for the window structure. The supporting structure for the latching mechanism had been consumed by fire.

1.13 Medical and Pathological Information

Autopsies and toxicological analyses were performed on the remains of the flightcrew. The examinations revealed no preexisting or incapacitating pathology which would have affected the crew's ability to conduct the flight safely. The toxicological analyses were negative for alcohol and basic, neutral, and acidic drugs.

The autopsy report on the pilot stated, "The. . .findings in this case reveal that the cause of death is due to smoke inhalation and carbon monoxide toxicity. Contributory factors include head injuries secondary to blunt trauma sustained in the airplane crash." The autopsy findings for the copilot revealed that the "cause of death is due to exsanguination (extensive loss of blood due to internal or external hemorrhage) secondary to lacerations of the aorta and heart, due to blunt trauma sustained in the airplane crash."

Blood samples from the two pilots and the eight passengers were forwarded to the Federal Aviation Administration (FAA) Aeronautical Center's Toxicology Laboratory in Oklahoma City for toxicological analysis for carbon monoxide (CO) and cyanide (CN). The results of these tests are shown on the chart below in relation to the victims' probable seat location within the aircraft.

Approximate Seating Right (R); Left (L) (Seat No.)	CO Percent Saturation	CN (micrograms per millimeter)
Pilot	48	0.89
Copilot	1	none
Passengers		
R-1	4	0.15
R-2	3	0.07
R-3	1	none
R-4	1	none
R-5	57	1.05
L-1	28	none
L-2	34	0.67
L-3	45	0.52

The remains of the eight passengers were examined externally only. The pathologist who performed the examinations stated that, for those four passengers with negligible levels of carbon monoxide and cyanide, ". . .the cause of death was related to extensive head and internal injuries. . .", and for those four with elevated carbon monoxide and cyanide, ". . .the cause of death was related to extensive head and internal injuries associated with the effects of extensive burning. . . ."

1.14 Fire

About 1515, a pickup truck topped a hill near the accident site and the two occupants saw the aircraft in the open field. The witnesses indicated that there were no visible flames but that there was a lot of smoke from the front section of the plane. They immediately left the scene to notify authorities and to summon help. Upon their return to the accident site with others, about 1530, the witnesses observed flames coming from the right front of the aircraft where only the smoke had been before. The flames were observed to be just above the roof of the aircraft. Some of the witnesses approached the aircraft and observed that the interior was filled with thick black smoke. No exit was obvious to them on the right (east) side of the plane, which was free of smoke. One of the witnesses broke out the right rear cabin window on the fuselage to determine if there were any signs of life inside. No movement was observed nor were there sounds heard from inside. The smoke on the left (west) side was too dense for the witnesses to approach that side. After a loud "popping" sound, all of the witnesses moved away from the wreckage to a safe distance. All of the witnesses agreed that the fire appeared to start in the area of the cockpit and then move gradually back toward the rear of the aircraft.

A deputy sheriff from Elbert County, Colorado, arrived at the scene about 1 hour 23 minutes after the crash. He said the aircraft was engulfed in flames and heavy smoke. He radioed for the Elizabeth Fire Department to be dispatched. The first firefighting equipment arrived about 30 minutes after the sheriff had arrived, and the fire was extinguished. The search by the authorities for the aircraft, after its position was reported, was hampered because of low visibility and blowing snow.

1.15 Survival Aspects

Examination of the wreckage revealed that the entire floor structure and the seats were destroyed in the postimpact ground fire. The remains of all eight passenger seats and the two pilot seats were found in their respective positions. All seats, except the seat located on the right aft section of the fuselage, bore evidence of forward and downward buckling indicative of high vertical deceleration. The structural integrity of this remaining seat, located in the area across from the airstair door on the right side and aft of a regular passenger seat could not be determined because it had been consumed by fire.

Postmortem examinations indicated that a seatbelt or parts thereof were still attached to 6 of the 10 occupants. The remaining four occupants did not have any noticeable evidence of a seatbelt on their remains. The parts of four unattached seatbelts and metal attachments to a pilot's shoulder harness were found in the aircraft debris.

The accident was classified as partially survivable because (a) the occupiable area in the cabin and cockpit remained comparatively intact as evidenced by the relative positions of the occupied seats; (b) the impact forces were at or just below the failure limits of the occupant restraint system and within human tolerance; and (c) the toxicological report indicated that five of the occupants were alive after impact and inhaled lethal levels of carbon monoxide or cyanide, or both.

1.16 Tests and Research

1.16.1 Powerplants

After the initial on-scene examination, the engines were moved to the service center of Pratt & Whitney Aircraft of Canada, Ltd, St. Hubert, Quebec, Canada, for further examination. The propeller assemblies were transported to the facilities of Hartzell Propeller, Inc., in Piqua, Ohio. The left engine had 1,159.1 hours as of January 24, 1980, and the right engine had 1,233.3 hours as of March 20, 1980. The times and dates were obtained from the burnt remains of the aircraft's engine log books.

Examination of the engines revealed that the inlets and the first-stage compressor blades of both engines were sooted. The right engine compressor blades had two curled blades and light foreign object damage on other blades. The left engine compressor blades were not damaged. The shroud segments of the left engine compressor, the turbine interstage baffle, and the compressor turbine disc hub had been rubbed circumferentially. The compressor turbine blade tips were rubbed and smeared. The power turbine blade tip airseals and shroud ring airseal had also been rubbed. The right engine exhibited similar damage. Examination of engine accessories of both engines disclosed no indications of preimpact discrepancies.

Both propeller assemblies had separated from their respective engines. The three-blade left propeller assembly had separated from the engine at the propeller shaft. The separation occurred at the rear of the propeller mounting flange fillet radius. The

three-bladed right propeller assembly had separated from the engine forward of the "A" flange adjacent to the scavange transfer tube boss.

Examination qf the three complete blades of the left propeller revealed various degrees of spanwise bending and twisting to two of the blades. The third blade bore no noticeable evidence of impact twisting. Some chordwise scratching was found on two of the blades with the third blade exhibiting no evidence of chordwise scratching. One blade had slipped in the blade clamps about 10° toward the low pitch direction as indicated by a shift in the electrical deice leads. The three complete blades to the right propeller assembly revealed damage similar to that of the left propeller assembly.

Examination of the engine cowls indicated the interior of the cowl lip heater tubes were sooted; these components were damaged to varying degrees. The inertial particle separator's vane extension actuators for both engines were found in the down (extended) position in the wreckage. The disassembly and examination of both engines, the two propeller assemblies, and associated engine and propeller accessories revealed no evidence of preimpact failure or malfunction.

The propeller deice system components could not be functionally checked because of damage to the deice boots and electrical wiring. Examination of the propeller deice system components revealed no evidence of preimpact failures.

1.16.2 Aircraft Performance

Since the performance charts for the King Air 200 do not include performance data for weights in excess of its maximum authorized gross takeoff weight of 12,500 pounds, the following data are based on that weight, recommended power settings, recommended airspeeds, and temperatures and pressure altitudes that existed during N456L's flight. The actual performance of N456L would be slightly less than the figures derived using the 12,500 pound gross weight.

With a headwind of 7 knots, ice vanes extended, and flaps at 0 percent, the takeoff roll is about 2,500 feet and the distance to a height of 50 feet above the runway is about 4,100 feet. Under the same conditions, but with the flaps extended to 40 percent, the takeoff roll is about 2,300 feet and the distance to a height of 50 feet above the runway is about 3,500 feet. Fuel used for taxi and takeoff is about 90 pounds.

At recommended normal climb speeds (160 KIAS from sea level to 10,000 feet and 140 KIAS from 10,000 feet to 20,000 feet), with ice vanes extended, the King Air 200 should climb from 6,000 feet to 12,000 feet in about 4 minutes, use about 60 pounds of fuel, and fly a straight line distance of about 18 miles. The average rate of climb from 6,000 feet to 12,000 feet is about 1,500 fpm. Under the same conditions, at the best rate of climb speed (126 KIAS), the King Air 200 should achieve a rate of climb of about 2,250 fpm at 6,000 feet, 1,900 fpm at 10,000 feet, and 1,700 fpm at 12,000 feet.

At the Safety Board's request, a computer program was run by the National Aeronautics and Space Administration (NASA) Ames Research Center incorporating ATC radar data, local magnetic variations, winds, temperature gradient, and aircraft performance and aerodynamic data. The program integrated this information to provide calculations of ground track, ground speed, ground track angles, g-forces, thrust minus drag, roll, pitch, heading, true and indicated airspeeds, and angle of attack.

According to the computed data, the aircraft was first tracked on radar while climbing through about 6,900 feet and was climbing about 1,700 fpm at an indicated

airspeed of about 160 knots. During the next 500 feet, the aircraft climbed at a rate of about 1,500 fpm at an airspeed of about 160 KIAS. The airspeed remained at 160 KIAS and higher until the aircraft ascended through about 8,800 feet, after which it decreased to about 145 KIAS and lower. Also, the angle of attack increased from an average of about 2° to 3° to 4°. During the ascent from about 8,800 feet to about 10,800 feet, the airspeed averaged about 140 KIAS with excursions to 150 KIAS and 126 KIAS; similarly, the angle of attack averaged about 4° with excursions to 3° and 6°. The rate of climb averaged about 1,200 fpm. During further ascent to 12,000 feet, the airspeed averaged about 145 KIAS and the angle of attack averaged about 4°. Near 11,500 feet, the rate of climb decreased from about 1,000 fpm to 600 fpm, and from 12,000 feet to 12,800 feet, the rate of climb averaged about 450 fpm. At 12,800 feet, the highest altitude attained, the airspeed was about 150 KIAS and the angle of attack was about 3°. After about 15 seconds at 12,800 feet, the aircraft began descending. During the initial descent, the airspeed increased to about 170 KIAS, and the angle of attack decreased to about 0°. After descending through about 11,700 feet, the airspeed averaged about 150 KIAS with excursions of about ±10 KIAS throughout the remainder of the recorded descent; similarly, the angle of attack averaged about 4° with excursions of about ±1°. During the descent from 12,000 feet to 10,000 feet, the rate of descent averaged about 600 fpm and from 10,000 feet to 8,100 feet, the last recorded radar contact, the rate of descent averaged about 2,000 fpm.

Calculations were also made of the aircraft's drag coefficient and thrust minus drag values which would normally be expected in the clean configuration (no airframe ice) and those which the recorded radar data indicated. According to the calculations, drag increased as the flight progressed. These calculations, however, assumed no power loss.

1.17 Additional Information

1.17.1 Surface Deicing System

Surface deicing systems are installed in Beechcraft Model 200 aircraft to remove ice accumulations from the leading edges of the wings and horizontal stabilizers. According to the aircraft manual, ice removal is accomplished by alternately inflating and deflating deicing boots located on the leading edges. Pressure-regulated bleed air from the engines supplies the required pressure to inflate the boots. A venturi ejector, operated by bleed air, creates a vacuum to deflate the boots and hold them down while not in use. To assure operation of the system in the event of a failure of one engine, a check valve is incorporated in the bleed air line from each engine to prevent loss of pressure through the compressor of the inoperative engine. The inflation and deflation phases are controlled by the distributor valve.

A three-position switch on the pilot's subpanel controls the deicing operation. The switch is spring-loaded to return to the **OFF** position from the SINGLE or MANUAL positions. When the SINGLE position is selected, the distributor valve opens to inflate the wing deicing boots. After an inflation period of about 6 seconds, an electronic timer switches the distributor to deflate the boots, and a 4-second inflation begins in the horizontal stabilizer deicing boots. When these boots have inflated and deflated, the cycle is complete. When the switch is held in the MANUAL position, all the boots will inflate simultaneously and remain inflated until the switch is released.

The three-position switch on the pilot's side and the electronic timer located in the fuselage were destroyed by the postcrash heat and fire. The distributor valve and two pneumatic pressure shutoff valves were examined and were found to be capable of normal operation, with no preimpact malfunctions noted.

Examination of the deicing boots disclosed that the horizontal stabilizer boots were intact and they were, in fact, inflated by investigators. The left inboard and right outboard wing deicing boots were damaged severely by fire. The left outboard boots had a vertical cut in the outer skin and the right inboard boots had a tear in the outer skin. These boots could not be inflated during postaccident tests because of impact and fire damage. Examination of the plastic hoses, aluminum tubing, and clamps to the deicer boots indicated varying degrees of impact and postcrash fire damage. None of these items bore evidence of preimpact malfunction or displacement.

The Pilot's Operating Manual for the Beech Super King Air **200** states, "For most effective deicing operation allow at least **1/2** inch of ice to form before attempting ice removal. Very thin ice may crack and cling to the boots instead of shedding. Subsequent cyclings of the boots will then have a tendency to build up a shell of ice outside the contour of the leading edge, thus making ice removal efforts ineffective."

A caution note in the Pilot's Operating Manual states, in part, "Due to distortion of the wing airfoil, stalling airspeeds should be expected to increase as ice accumulates on the airplane. **For** the same reason, stall warning devices are not accurate and should not be relied upon. Maintain a comfortable margin of airspeed above the normal stall airspeed when ice is on the airplane. In order to prevent ice accumulation on unprotected surfaces of the wing, maintain a minimum of **140** knots during operations in sustained icing conditions. . . ."

The Safety Information section of the Super King Air **200** Operating Manual contains a discussion entitled, "Flight Into Icing Conditions," a portion of which reads as follows:

> No airplane or combination of deicing and anti-icing equipment can be designed for the worst possible icing encounter -- this condition cannot even be defined. As competent pilots know, there appear to be no predictable limits for the severest weather conditions. . . . Airplanes equipped for flight in icing conditions cannot be expected to cope with the worst of such conditions that nature can produce. The prudent pilot must remain alert to the possibility that icing conditions may become **so** severe that his equipment cannot cope with them. At the first indication that such conditions may have been encountered or may be ahead, he should react by deciding the most expeditious and safe course of action. The decision should be based on weather briefing, recent pilot reports and ATC observations. Alternatives could be course changes, altitude changes and even continuing on the same course. . . . It is the inexperienced or uneducated pilot who presses on "regardless", hoping that steadily worsening conditions will improve, only to find himself flying an airplane which has become so loaded with ice that he can no longer maintain altitude. At this point he has lost most if not all of his safety options, including perhaps, a **180** degree turn to retreat along the course already traveled. The responsible and well informed pilot recognizes the limitations of his airplane and its systems and reacts accordingly.

1.17.2 Icing Certification

The Beech King Air **200** was certificated for flight into known icing conditions under the provisions of **14** CFR **25.1419.** In preparation for the flight tests in natural icing

conditions, the Beech Aircraft Corporation performed a computer analysis of six icing conditions, the worst of which was identified as involving a liquid water content (LWC) of 0.8 gm^{-3} per cubic meter, a drop size of 15 microns, and a temperature of -1° C. The analysis was used to demonstrate that the ice protection systems on the airplane were adequate to safely operate in the continuous maximum and intermittent maximum icing conditions identified in appendix C to 14 CFR 25. The analysis also demonstrated that high angles of attack (above 4°) increased ice accretion significantly on the underside of the airfoil surfaces, and that it was important to use any means necessary to keep the angle of attack below 4° and as low as possible during heavy icing encounters.

From January 20 to March 3, 1973, a series of flight tests in the King Air 200 were flown in natural icing conditions. A total of 13.5 hours was flown in actual icing conditions and both the continuous maximum and maximum intermittent icing conditions as defined in appendix C, 14 CFR 25, were encountered.

The flights in actual icing conditions were flown at 140 to 150 KIAS, which is the recommended holding airspeed. According to test data, the greatest accumulation of ice (3 inches) occurred during 2 hours of flight in an environment with a mean liquid water content of 0.76 gm^{-3} and temperatures of -3° C to -7° C; the drop size distribution was not accurately measured during the test.

Maximum intermittent icing conditions were encountered twice during one flight. The mean liquid water content was 2.97 gm^{-3} and the times in these conditions were 2 minutes and 1 minute, which corresponded to a liquid water content ratio of 1.113 for distances of 5.85 nmi and 2.94 nmi, respectively. Although test data indicate that a total of 2.0 inches of ice was accreted in about 1 hour 50 minutes during this flight, the data do not indicate the amount of ice accreted during the above encounters.

The aircraft's engine induction system was flight tested a total of 1 hour 37 minutes in icing conditions with total water contents up to 1.5 gm^{-3}. The ice accumulation was not significant in the engine air plenum chamber and on the inlet screen. No fluctuations or discontinuities occurred in the engine indicating instruments.

Since the leading edge of the vertical stabilizer is not protected by deicer boots, preformed shapes simulating the maximum accretion expected were attached to the vertical stabilizer and were tested both in flight and in the wind tunnel. No effects on handling qualities were evidenced with the shapes installed, and it was concluded that deicing protection on the vertical stabilizer was not needed.

No problems were encountered with the propeller deicing system during the flight tests.

1.17.3 Procedures for Dissemination of SIGMET's by the National Weather Service

According to an NWS meteorologist at Kansas City, Missouri, SIGMET GOLF 1 was issued at 1010. The SIGMET was issued based on a report by the pilot of a Beech 35 of severe rime icing about 0930, consultation with the Denver NWS forecaster and a large area of precipitation that was portrayed by the Limon, Colorado, weather radar. The contents of the SIGMET was typed on a cathode ray tube (CRT) which automatically transferred the information to the Weather Message Switching Center (WMSC) in Kansas, City, Missouri. The SIGMET had been entered in the computer by 1015. Once in the computer at Kansas City, the SIGMET was transmitted immediately as priority traffic on the low-speed Service A system.

The Denver FSS had a leased Western Union Service A high-speed weather data system. FSS personnel could retrieve data on in-flight weather advisories, pilot weather reports, and other weather data from the CRT's located on the briefing floor. Since the system was a high-speed data circuit, the FAA believed that priority message handling was not necessary. However, delays of 15 to 45 minutes had been experienced in the receipt of SIGMET and other weather material. As a result of this accident, the system was reprogrammed on April 1, 1980, in an effort to reduce delays. Priority message handling is still available on low-speed circuits. In most cases, urgent weather messages will appear on the low-speed Service A circuits faster than on the newer high-speed circuits.

At the Denver FSS, requests for weather data can be made not only to the leased Service A high-speed system (RQ requests), but also to the WMSC low-speed system. At the Denver FSS, weather requests were usually made to the high-speed system first. If weather data are not available from the system and the data are known to exist, such as a terminal forecast, a request could be made to the WMSC low-speed system. However, saturation of the computer at Kansas City could occur if too many requests are made to the WMSC low-speed system, causing a halt of all data. Delays of 30 seconds to 5 minutes could occur on receipt of requests for weather data from the WMSC low-speed system. Delays of less than 5 seconds occur on receipt of requests for weather data from the leased Western Union Service A high-speed system.

The FAA was aware that urgent weather messages appeared on the Service A low-speed circuits faster than on the leased Service A high-speed circuits. On April 14, 1980, new procedures were implemented by the FAA whereby urgent weather messages appear on the FSS supervisor's printer as soon as these message are transmitted over the Service A low-speed system. In December 1981, additional procedures were implemented by the FAA to allow rapid delivery of SIGMET information to the leased Service A data base.

1.18 Useful or Effective Investigation Techniques

Calculation of the rate of ice accumulation in inches per minute to which the impact areas of N456L were exposed was made using the relationship: liquid water content (LWC), aircraft true airspeed (TAS) x R (constant).

In addition, it was assumed that the LWC was a function of the adiabatic liquid water content (LWC_a):

LWC is in grams per cubic meter (gm^{-3})
TAS is in meters per second ($M\ sec^{-1}$)
R = 2.36×10^{-3} meters squared inches per gram second per minute
LWC_a is in grams per cubic meter (gm^{-3})

The first step in the process was to derive a LWC_a from NWS upper air data for Denver, Colorado. To obtain the LWC_a, the saturation mixing ratio at the base of the clouds was calculated. A value of 4.2 grams per kilogram (gKg^{-1}) of air was obtained. From the cloud base, the moist adiabatic was followed to the cloud top at 18,000 feet. The saturation mixing ratio was then obtained for this point. This method yielded a value of 0.84 gKg^{-1}. The saturation mixing ratio at the cloud base, minus the saturation mixing ratio at the cloud top, multiplied by an average air density in the air column from 6,300 feet to 18,000 feet yielded the LWC_a of 2.89 gm^{-3}.

The LWC observed in the atmosphere is usually only a fraction of the LWC_a. However, there is reasonable agreement that, in the mean, the LWC is about 0.33 to 0.25 times the LWC_a. 9/ Multiplying these values by the LWC_a yielded values for the LWC of 0.7 to 1.0 gm^{-3}.

Atmospheric scientists at the University of Wyoming in Laramie estimated the LWC on the afternoon of March 27, for the Denver area to have been 0.5 to 0.75 gm^{-3}. Also, a calculation of the LWC based on the maximum reflectivity (10^4 mm^6 m^{-3}) observed by the Limon weather radar 10/ between 1430 and 1500 for the area south-southeast of Denver yielded 0.7 gm^{-3}.

Using a range of LWC's of 0.7 to 1.0 gm^{-3} and an average TAS of 160 knots (82 m sec^{-1}), the calculated rate of ice accumulation to which N456L was exposed was 0.14 to 0.19 inches per minute. The amount of ice that might have accumulated on the unheated and impact areas of N456L was calculated by using this rate of ice accumulation multiplied by the time N456L was in icing conditions. N456L was in icing conditions during the climb from 6,300 feet to 12,800 feet for about 8 minutes, and during the descent from 12,800 feet for about 7.5 minutes. Using the above method and data, N456L could have accumulated about 1.0 to 1.5 inches of ice during the climb and about 1.0 to 1.4 inches of ice during the descent.

2. ANALYSIS

2.1 General

The investigation revealed that the crew was properly certificated and qualified to conduct the flight. There was no evidence of preexisting medical problems which would have affected the crew's performance of their duties. The aircraft was certificated, equipped, and maintained in accordance with applicable regulations.

The circumstances of this accident suggest two possible areas of causation--power loss and airframe icing. The analysis of the aircraft's performance during the flight, based on the radar-derived ground track and flight profile, revealed a definite loss of performance either from a lack of power or from aerodynamic factors, including the loss of lift and increased drag.

2.2 Power Loss

The evidence revealed nothing to substantiate a power loss caused by mechanical failures. Disassembly and examination of the engines and propellers revealed that the engines and their operating accessories were capable of normal operation, and were operating normally until impact. The physical rotational-type damage on the engines and propellers revealed that the amount of power at impact was minimal, probably because the pilot reduced the throttles when ground impact was inevitable.

The engine cowl lip heating systems and the inertial particle separator vanes for both engines were functional and operational. The particle separator vane actuators were found in the "extend" position in the wreckage. These conditions should have provided adequate icing protection to the engines during the flight.

9/ Fletcher, N.H. (1962). The Physics of Rainclouds, Cambridge University Press, p. 386.
10/ McAnelly, Ray L., Thompson, Alymer H., and Huebner, George L. (1979). Thunderstorm Characteristics Displayed with Three-Dimensional Digital Radar Data and Digital GOES Infrared Data. Proc. of 19th Radar Meteorology Conference, Miami Beach, American Meteorological Society, pp. 413-416.

The possibility exists that the crew failed to extend the engine particle separator vanes until some point in the initial climb by which time ice had accumulated and decreased engine efficiency. Although this possibility cannot be entirely ruled out, the Safety Board does not believe the crew made this oversight under the meteorological conditions existing at the time of takeoff. Moreover, during engine disassembly, no evidence of icing-type damage was found in either engine compressor or inlet section.

Therefore, the Safety Board concludes that the performance loss encountered by N456L was not caused by engine power loss. Further, although the power loss could have been associated with propeller icing, the Safety Board believes that this was not likely based on the lack of any previously reported discrepancies with the propeller deicing system and on the fact that the flightcrew probably would not have continued an attempt to climb with a malfunctioning or inoperative propeller deicing system.

2.3 Airframe Icing

2.3.1 Ground Accumulated Airframe Ice

The first time that airframe ice could have been a factor in this accident would have been during the takeoff and initial climb phase because of snow and/or ice which had accumulated on the wings when the aircraft was on the ground. The evidence suggests that this condition did not occur, at least not in sufficient quantity to be considered causal. The initial radar data indicate an average climb rate of about 1,500 fpm from 6,900 feet to 7,400 feet, which agrees with the predicted rate of 1,500 fpm for the existing conditions.

Although ground witnesses reported a slightly longer takeoff roll and a more shallow initial climb angle for N456L than for another similar aircraft they observed, several reasons could account for this other than aerodynamic problems because of airframe ice. The crew of N456L may not have begun the takeoff roll at the same point as the other aircraft and the gross weight of the other aircraft may have been less than that of N456L. The pilots obviously were concerned about the aircraft gross weight based on comments overheard by ramp personnel. Therefore, they probably modified their climb angle because of that condition. For these reasons and the factual evidence of the radar data, the Safety Board concludes that ground-accumulated airframe icing was not a factor in this accident.

2.3.2 In-flight Airframe Icing

The meteorological conditions in which N456L was flying consisted of clouds with a high LWC (0.7 to 1.0 gm^{-3}), subfreezing temperatures (0° to -13°), and embedded convective activity. Additionally, the evidence indicated that super-cooled liquid water drops were present and that some of the cloud droplets were large in diameter, probably more than 100 microns. These conditions along with snowfall through super-cooled clouds in temperatures of 0° to -10° C constitute very hazardous icing conditions. 11/

Ice accumulation calculations for N456L indicate that according to quantitative definitions of heavy or severe icing 12/ (1/2 inch on a small probe per 10 miles or less), N456L was in severe icing conditions shortly after takeoff and remained in

11/ Weikmann, Helmut K, (1978). Summary Report--Meteorological Research Committee. NASA Publication 2086, Aircraft Icing Workshop, Lewis Research Center, Cleveland, Ohio, pp. 73-91.

12/ A Forecaster's Guide to Aircraft Icing, U.S. Air Force, 15 September 1964.

severe icing throughout the flight. Moreover, the meteorological data indicate that the icing encountered by N456L was a mixture of rime and clear ice, the latter of which is particularly hazardous because it is dense and heavy and frequently spreads over airfoil surfaces beyond the areas protected by deicing equipment.

Since two Beech King Air 200 aircraft were in these atmospheric conditions at nearly the same time and for about the same duration, and since one of the aircraft was flown successfully through the icing conditions, it is apparent that the flightcrew of N456L encountered problems which resulted in an accumulation of airframe ice that exceeded the aircraft's capability to maintain flight. These problems could have involved failures or malfunctions of the airfoil deice system, improper use of the airfoil deice system, or improper operation of the aircraft.

2.3.3 Deicing System Failure

Many of the components of the aircraft deicing system were located in the lower fuselage and were destroyed by impact and ground fire, precluding positive determination of their functional capability. Those deicing system components examined were found to be properly installed, interconnected, and functional. In fact, the deicing boots on the horizontal stabilizer could be manually inflated after the accident. There were no reported mechanical difficulties with the deicing system before the accident. Additionally, the flightcrew reported no mechanical problems during their radio calls to controllers. Therefore, the Safety Board concludes that mechanical failure of the deicing system was not a causal factor in this accident.

2.3.4 Improper Crewmember Actions or Use of Deicing Equipment

An action which could result in excessive and uncontrollable ice buildup on the airframe involves the improper use of the deicing boots. For the most effective deicing, the BE-200 flight manual recommends that at least 0.5 inch of ice be allowed to form on the boots before attempting to remove it. If the boots are cycled prematurely, ice could cling to the inflated boots and fail to break away. Subsequent deflation of the boots leaves a "shell" of ice outside the inflation contour of the boots. Additional attempts to break the ice free will not be effective because the boots cannot reach the shell of ice. Continued ice buildup cannot be stopped and aerodynamic performance decays rapidly. Under this condition, drag will continue to increase and lift will continue to decrease until a descent is finally required to maintain airspeed. The ice buildup can be removed only by flying to an area of warm air to melt the ice away. If such a problem was encountered by the pilots of N456L, they could not have reached warm air because of the prevailing weather conditions.

Based on the available evidence, the Safety Board was not able to confirm or eliminate improper crewmember use of the deicing boots as causal in this accident. The qualifications and experience of the pilots suggest that they should have been well aware of the proper technique and would not have been expected to use the boots improperly; however, the possibility cannot be ruled out.

2.3.5 Improper Operation of the Aircraft

The computer-derived flight performance for N456L indicates that normal climb speed (160 KIAS) or higher was maintained until the aircraft ascended to about 8,800 feet. After ascending through that altitude, the airspeed decreased to near the minimum airspeed of 140 KIAS for flight in sustained icing conditions. This reduction in airspeed indicates that ice was collecting on the airframe and suggests that the flightcrew

either: (1) attempted to maintain the normal rate of climb by increasing the pitch attitude (and the angle of attack), which resulted in a decrease in the airspeed, **or** (2) attempted to expedite the climb through the icing conditions by reducing the airspeed to or near the minimum icing penetration speed, thereby increasing the rate of climb.

However, the performance data also show that the airspeeds used above **8,800** feet resulted in substantially less-than-normal climb performance and resulted in higher angles of attack than the **4°** angle identified as critical by the manufacturer's icing certification analyses. The higher angles of attack at **140** KIAS were a direct function of the aircraft's high gross weight, because for a maximum gross weight in unaccelerated flight a **4°** angle of attack would occur near **140** KIAS. Additionally, the reductions of airspeed below **140** KIAS and the attendant higher angles of attack would have permitted ice to accumulate on the underside of the airfoil surfaces aft of the deicing boots. Finally, since neither the additional weight of ice accumulations nor airfoil distortion caused by ice contamination was accounted for in the flight performance computations, the above angles of attack for the associated airspeeds would have increased progressively as ice accumulated *on* the airframe. Also, the increasing angles of attack would have increased rapidly the rate of ice accumulations to the point where further ascent was not possible.

Therefore, the Safety Board concludes that the overweight condition of the aircraft in conjunction with flight at **140** KIAS and below and the severity of the icing conditions combined to permit ice to accumulate rapidly on the unprotected surfaces **of** the wing. Further, since these accumulations could not be removed by the deicing boots, the wing airfoil eventually was severely distorted, and the aircraft's capability to maintain level flight was destroyed.

By contrast, the pilot of the other Beech King Air **200 (N2030P)** penetrated the icing conditions at a relatively high airspeed (about **180** KIAS) and consequently at a very low angle of attack. Therefore, although his aircraft probably accumulated ice at nearly the same rate as **N456L,** the ice remained on or very near the deicing boots and was removed by normal operation of the boots.

The Safety Board believes that the flightcrew's decision to cqntinue to climb their aircraft at or near the minimum airspeed **for** flieht in sustained **icing** conditions. once thev encountered severe icing conditions, was onk of the primary reasons for this accident." They failed to realize the significance of the resultant higher angle of attack in these conditions, and also they failed to recognize, in a timely manner, the substantial performance decrease that was occurring. Several minutes passed before they radioed that they were getting too much ice and needed to return to Arapahoe. The seriousness of the situation should have been apparent to the pilots shortly after beginning the climb, notwithstanding the anti-icing and deicing capability of the aircraft. Under these conditions, they should have maintained an airspeed well above the recommended minimum icing penetration speed while seeking diversion alternatives. As the cautionary material states in the Super King Air Operating Manual, the pilot must be alert to the possibility that icing conditions may become **so** severe that his equipment cannot cope with them. At the first indication that such conditions may have been encountered, or may be ahead, a pilot should react by selecting the most expeditious and the safest course of alternative action.

The evidence shows that aircraft performance began to deteriorate substantially before the flightcrew decided to return to Arapahoe. Therefore, the flightcrew failed to make a timely decision to return to Arapahoe, leading to a situation from which they could not recover.

13.6 Forecast and Pilot Briefing

The area forecast and the in-flight weather advisories SIGMET HOTEL 1, HOTEL 2, and AIRMET SIERRA 1, issued by the NWS forecast office in Kansas City, Missouri, are considered substantially correct.

The pilot of N456L did not receive the contents of SIGMET GOLF 1, subsequently changed to HOTEL 1, calling for moderate to brief severe icing for eastern Colorado during the weather briefing from the Denver FSS at 1020. The overall weather briefing provided by the specialist to the pilot of N456L was considered adequate and performed in accordance with the Flight Services Handbook 7110.10E.

Although the pilot of N456L received a complete weather briefing, including weather reports and forecasts from the Denver FSS at 1020, there is no record that he obtained an updated briefing before departure. Therefore, over 4 hours elapsed from the time of the weather briefing to the time of departure from Arapahoe. During this time period, meteorological conditions in eastern Colorado changed significantly. These changes were reflected in new weather reports and weather forecasts which indicated deteriorating conditions, including the forecast for occasional severe icing.

Operational regulations and accepted pilot practice dictate that pilots familiarize themselves with all available information concerning proposed flights. The failure of the pilots of N456L to comply with these standards cannot be explained, especially in view of the weather conditions existing at the time of the flight's departure.

The Safety Board believes that the pilots of N456L would have been much better prepared for the flight if they had obtained a current weather briefing, which would have contained the forecast for occasional severe icing for their departure route. If they had obtained the current information, they might have changed their departure time, altered their route, returned to Arapahoe more promptly, or taken other available alternatives. Therefore, the crew's failure to familiarize themselves with the current weather conditions was one of the primary causes of this accident.

In summary, based on the flightcrew's radio transmission "getting a little too much ice," the reported ice accumulations observed and found on similar type of aircraft in the area at the time of the accident, and analysis of the performance of N456L, the Safety Board concludes that significant amounts of ice had accreted to the aircraft's unprotected surfaces. These accretions obviously decreased the lift and increased the drag of the aircraft and adversely affected its performance capability. Although the icing conditions in which N456L was operating after departure from Arapahoe Airport were severe, and were worse than those which the King Air 200 encountered during certification, the Board believes that the operation of the aircraft at high angles of attack led directly to uncontrolled icing of the airframe. Moreover, since the aircraft was not able to sustain flight under such conditions, the accident probably was unavoidable after the flightcrew elected to proceed to Stapleton instead of returning in a timely manner to Arapahoe which was the closest airport. The flightcrew's failure to obtain a current weather briefing precipitated the events which led to this accident.

2.3.7 Icing Certification

Although the King Air 200 was properly certificated for flight into known icing conditions in accordance with the applicable regulations, it is clear from comparative meteorological data and ice accumulation rates that neither the conditions encountered during the certification flight tests nor the precertification conditions analyzed by

computer were as severe as the conditions encountered by both N2030P and N456L on March 27, 1980, in the Denver area. As a result of this accident and other similar accidents, the Safety Board believes that the icing certification process could be improved and it addressed this issue in a recent Safety Report. 14/

3. CONCLUSIONS

31 Findings

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

2. The aircraft was certificated, properly equipped, and maintained in accordance with the applicable FAA requirements.

There was no evidence of preimpact malfunction or failure of the aircraft's structure, flight controls, powerplants or systems, including anti-icing and deicing systems.

4. The flightcrew did not obtain a current weather briefing to familiarize themselves with the existing weather conditions.

5. The area forecast and pertinent in-flight weather advisories issued by the NWS are considered substantially correct.

6. The continuity of the SIGMET series of SIGMET HOTEL 1 and SIGMET HOTEL 2 was maintained by a statement appended to the end of SIGMET HOTEL 1 calling for a continuation of icing conditions beyond 1400.

7. The pilot of N456L did not receive the contents of SIGMET GOLF 1 (corrected to read HOTEL 1), calling for moderate to brief severe icing conditions for eastern Colorado, during the weather briefing from the Denver FSS since it was not available at the time of the briefing because the FSS did not have priority message handling on the leased Service A high-speed circuit at the Denver FSS.

8. The flightcrew exceeded the maximum allowable aircraft takeoff gross weight by about 600 pounds. This condition, in itself, normally would not have had a serious detrimental effect on the performance of the aircraft; however, the overweight condition and speeds of 140 KIAS or less required high angles of attack that led to ice accretions on the airfoil surfaces aft of the deicing boots.

9. The components of the deicing system were determined to be intact, properly connected. and functional and were considered to have been functioning properly before ground impact.

10. Both engines, their respective accessories, and the propellers were capable of operating normally and capable of attaining full power until the time of impact.

14/ For more information see Safety Report—"Aircraft Icing Avoidance and Protection, September 9, 1981" (NTSB-SR-81-1).

11. Both engines were operating at a minimal level of power at impact, probably because the pilot reduced power just before impact.

12. The engine/cowl anti-icing systems were functional and operational. There was no evidence of ice ingestion in either engine.

13. Aircraft N456L was operating in a prevailing stratiform cloud system with embedded convective elements from the time of departure from Arapahoe to the accident site; these conditions included severe mixed rime and clear icing conditions.

14. The flightcrew failed to make a timely decision to discontinue the climb and return to Arapahoe Airport.

15. The rate of ice accumulation to which the impact areas of the airframe of N456L were exposed was estimated at 0.14 to 0.19 inch per minute of flight.

16. The aircraft wing lost lift because of a rapid rate of ice accumulation on unprotected surfaces which prevented it from sustaining the aircraft in level flight.

17. The fire, which destroyed the aircraft, occurred after impact and did not reach the cabin interior until about one-half hour after the aircraft came to rest.

18. The occupiable environment in the cockpit and the cabin remained comparatively intact and impact forces were at or just below the limits of the restraint systems and within human tolerance.

19. Neither of the aircraft exits was opened from the inside by the occupants in preparation for evacuating the aircraft.

20. Five of the 10 occupants, including the pilot, survived the impact but succumbed to the effects of the postcrash fire.

32 Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the rapid accumulation of ice on the underwing surface aft of the deicing boots which destroyed the aircraft's capability to maintain level flight because the flightcrew: failed to obtain a current weather briefing before departure; failed to make a timely decision to discontinue the climb and return to Arapahoe Airport; and operated the over-gross-weight aircraft at high angles of attack in severe icing conditions.

4. RECOMMENDATIONS

On June 3, 1980, during its investigation of this accident, and as a result of an aircraft accident at the Arapahoe airport on March 9, 1980, and an aircraft accident at Billerica, Massachusetts, on February 16, 1980, 15/ the Safety Board recommended that the Federal Aviation Administration:

15/ Aircraft Accident Report—"Redcoat Air Cargo, Ltd., Bristol Britannia 253F, Registration G-BRAC, Billerica, Massachusetts, February 16, 1980" (NTSB-AAR-81-3).

> Insure that the ATIS (Automatic Terminal Information Service) Advisories contain all essential forecasted meteorological conditions, including SIGMETs, which are likely to affect aircraft operating in terminal areas serviced by the ATIS. (Class II, Priority Action) (A-80-46).

On August 29, 1980, the FAA responded that the recommendation was accepted and the FAA Facility Operation and Administration Handbook (7210.3E) was being revised. The appropriate changes were incorporated in the January 1, 1981, handbook revision.

Also, as a result of this investigation, the Safety Board, on January 28, 1981, recommended that the Federal Aviation Administration:

> Develop and implement a priority message handling procedure to assure the immediate delivery of urgent weather messages to all weather circuits that originate from the Weather Message Switching Center in Kansas City, Missouri. (Class II, Priority Action) (A-81-8).

The FAA responded favorably and the recommendation is being held in the "Open—Acceptable Action" status, pending completion of action to implement the intent of the recommendation.

The facts, conditions, and circumstances involved in this accident and other icing accidents, led the Safety Board to conduct a special investigation into the problems of aircraft icing from the standpoint of icing statistics, the meteorological factors which cause icing, the certification of aircraft by the FAA for flight into known icing conditions, and the forecasting of icing conditions. As a result of the special investigation, the Safety Board issued 'Safety Report: Aircraft Icing Avoidance and Protection" (NTSB-SR-81-1) and recommended that the Federal Coordinator for Meteorological Services. and Supporting Research:

> Develop instruments to measure temperature, liquid water content, drop size distribution, and altitude in the atmosphere on a real-time basis that are sufficiently economical to use on a synoptic time and grid scale. (Class III, Longer-Term Action) (A-81-113)

> Use the developed instrumentation to collect icing data on a real-time basis on a synoptic grid and, in turn, develop techniques to forecast icing conditions in terms of liquid water content, drop size distribution, and temperature. (Class III, Longer-Term Action) (A-81-114)

On March 22, 1982, the Acting Federal Coordinator for Meteorological Services and Supporting Research responded that actions were being contemplated to satisfy recommendations A-81-113 and -114. These recommendations are being held in the "Open--Acceptable Action" status, pending the results of the planned actions.

Also as a result of the Safety Report, the Safety Board recommended that the Federal Aviation Administration:

Evaluate individual aircraft performance in icing conditions in terms of liquid water content, drop size distribution, and temperature, and establish operational limits and publish this information for pilot use. (Class III, Longer-Term Action) (A-81-115)

Review the icing criteria published in 14 CFR 25 in light of both recent research into aircraft ice accretion under varying conditions of liquid water content, drop size distribution, and temperature, and recent developments in both the design and use of aircraft; and expand the certification envelope to include freezing rain and mixed water droplet/ice crystal conditions, as necessary. (Class III, Longer-Term Action) (A-81-116)

Establish standardized procedures for the certification of aircraft which will approximate as closely as possible the magnitudes of liquid water content, drop size distribution, and temperature found in actual conditions, and be feasible for manufacturers to conduct within a reasonable length of time and at a reasonable cost. (Class III, Longer-Term Action) (A-81-117)

Reevaluate and clarify 14 CFR 91.209(c) and 135.227(c) to insure that the regulations are compatible with the definition of severe icing established by the Federal Coordinator for Meteorological Services and Supporting Research as published in the Airman's Information Manual. (Class II, Priority Action) (A-81-118)

The FAA responded to these recommendations on December 21, 1981. The reply to recommendations A-81-115 and -116 was not responsive, and in a letter to the FAA dated April 16, 1982, the Safety Board asked the Administrator to reconsider these recommendations. Pending further correspondence from the FAA, recommendations A-81-115 and -116 are being held in the "Open—Unacceptable Action" status. The FAA's reply to recommendations A-81-117 and -118 was responsive and these two recommendations are being held in the "Open—Acceptable Action" status, pending completion of actions to satisfy the intent of those recommendations.

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

Issue an Airworthiness Directive directing all operators of airplanes equipped with emergency exits openable from the outside to mark the exits and their means of operation on the airplane fuselage in the manner prescribed by 14 CFR 25.811(f)(1), (2), and (3), irrespective of the rules under which the aircraft are being operated. (Class II, Priority Action) (A-82-94)

Amend FAA-approved flight manuals, where applicable, to prescribe minimum airspeeds and appropriate flight precautions during flight in icing conditions. (Class II, Priority Action) (A-82-118)

Require that accident prevention specialists review with pilots the critical nature that extended operation at high angles of attack in icing conditions can have on the accretion of ice and aircraft

performance with special emphasis on the need **for** strict adherence to prescribed operational procedures and on the proper procedures for use of deicing equipment. (Class II, Priority Action) (A-82-119)

The Safety Board **also** reiterated the following recommendation made to the Federal Aviation Administration on May **1,** 1979:

Amend 14 CFR 135 Appendix **A** (paragraph 32) by incorporating the general provisions of 14 CFR **25.811(f)(1),** (2), (3) with regard to exit conspicuity and operability. (Class II, Priority Action) (A-79-15)

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.

August 14, 1982

5. APPENDIXES

APPENDIX A

INVESTIGATION AND HEARING

1. Investigation

The National Transportation Safety Board was notified of the accident about 1510 m.s.t., on March 27, 1980, and immediately dispatched an investigator from its Denver Field Office to the scene. An investigative team from Washington, D.C., arrived in the area the next day. Investigative groups were established for operations/air traffic control/witnesses, meteorology, human factors, powerplants, systems, and structures.

Parties to the investigation were the Federal Aviation Administration; Beech Aircraft Corporation; Professional Air Traffic Controllers Organization; Hartzell-Propeller, Inc.; Pratt & Whitney Aircraft Group; and Lufkin Industries.

2. Public Hearing

No public hearing was held and no depositions were taken.

APPENDIX B

PERSONNEL INFORMATION

Pilot Barbara Ray Fisher

Captain B. R. Fisher, age 52, was employed by Lufkin Industries, Inc., for about 22 years as a corporate pilot. He held airline transport pilot certificate No. 1196805, dated June 27, 1974, for airplane multiengine land, with a type rating in the DC-3 and commercial privileges--airplane single-engine land. In addition, he held flight instructor certificate No. 1196805 CFI, dated August 3, 1979, for airplane single- and multiengine instrument airplane. He held a second-class medical certificate, dated January 14, 1980, with the limitation that the holder wear glasses for near and far vision while exercising the privileges of his airman certificate.

No current records were found to indicate the recent flight experience of the captain. Information obtained from an aircraft insurance form dated July 25, 1979, indicated Captain Fisher had accumulated about 10,225 flight-hours, of which 9,225 which were in multiengine land aircraft. At that time, he had about 550 hours as pilot-in-command of N456L. Insurance records indicated that Captain Fisher received a biennial flight review on October 7, 1977, with his last proficiency flight in a Beech King Air 200 conducted on December 29, 1975. Beechcraft training records indicate Captain Fisher completed the Beechcraft King Air Series Pilot School in November 1975. The text for this program included the aircraft flight manual, slides, and schematic diagrams4 The course curriculum included the usage of anti-ice and deicing equipment.

Copilot Charles Luther Gilstrap

First Officer C. L. Gilstrap, age 47, was employed by Lufkin Industries, Inc., for about 2 months as a pilot/airplane mechanic. He held commercial pilot certificate No. 1440063, dated April 13, 1968, with airplane single- and multiengine land instrument privileges. In addition, he held airframe/powerplant mechanic certificate No. 1451618, dated June 30, 1960. He held a second-class medical certificate dated February 26, 1980, with the limitation that the holder wear corrective lenses while exercising the privileges of his airman certificate.

Information obtained from an aircraft insurance form, dated July 25, 1979, indicated that First Officer Gilstrap had accumulated 5,600 flight-hours, of which 4,000 were in multiengine aircraft. At that time he had about 200 hours of flight time in N456L. His flight time the previous 90 days, 7 days, and 24 hours before this flight (as obtained from his personal flight log) was 100 hours, 7 hours, and 5 hours, respectively. Insurance records indicated that First Officer Gilstrap received a biennial flight review on November 1, 1978, with his latest proficiency flight in a Beech 90 conducted in August 1979.

APPENDIX *C*

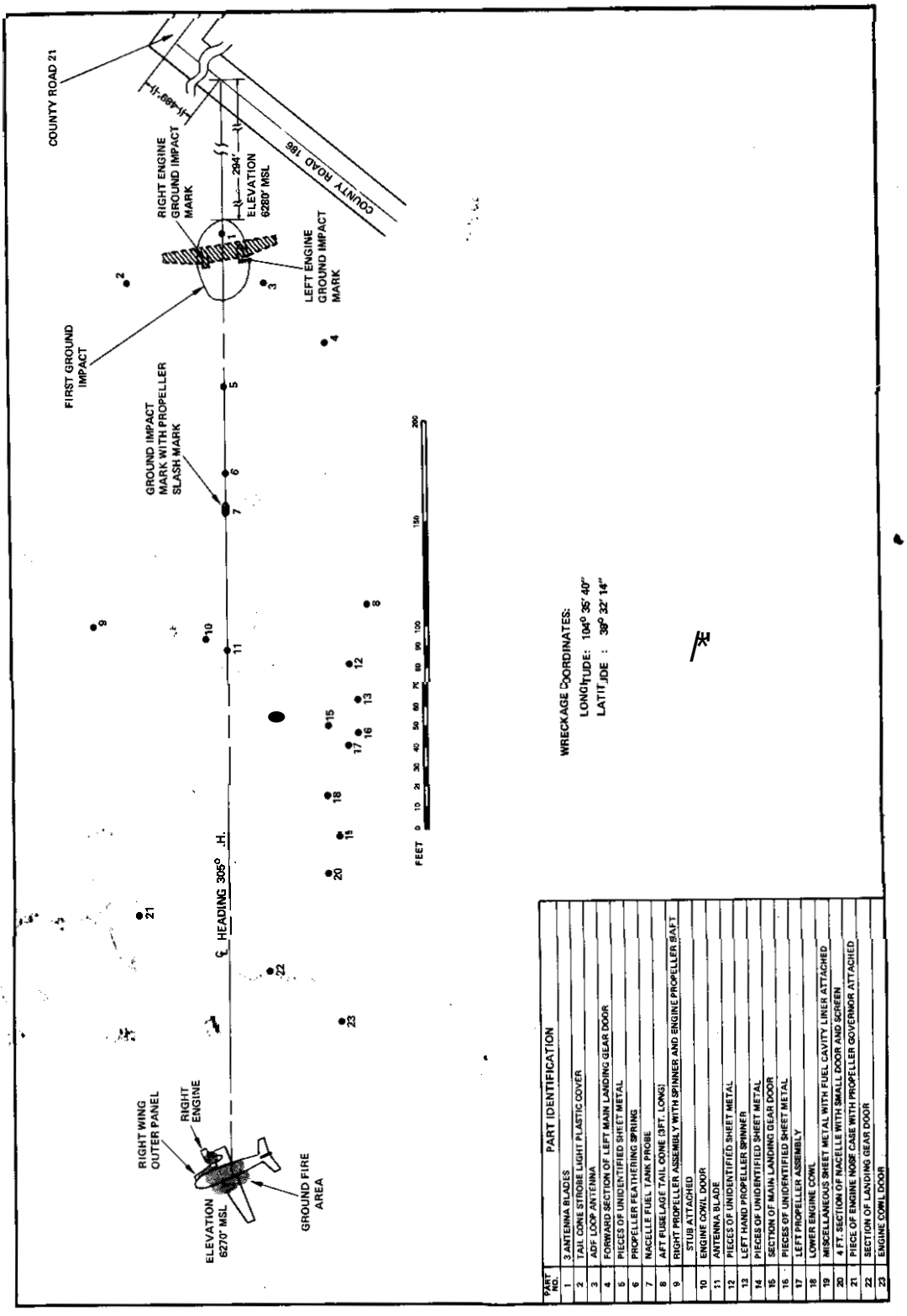
AIRCRAFT INFORMATION

The aircraft was a Beechcraft Super King Air 200, SN-BB-112, Registration No. N456L. The date of manufacture was December 12, 1975. N456L was equipped with two Pratt & Whitney Aircraft of Canada, Ltd., PT6A-41 turboprop engines. Two Hartzell Propeller, Inc., Model HC-B3TN-3G propellers with Model No. T10178B-3R propeller blades were installed in the aircraft. Information pertaining to the powerplants and propellers follows:

	Left Engine	Right Engine	Left Propeller	Right Propeller
Serial No.:	PCE-80243	PCE-80267	BU5683	BU5685
Time since new:	1159.1 hrs as of 1/24/80	1233.3 hrs as of 3/20/80	N/A	N/A

APPENDIX D

WRECKAGE DISTRIBUTION CHART



PART NO.	PART IDENTIFICATION
1	3 ANTENNA BLADES
2	TAIL CONE STROBE LIGHT PLASTIC COVER
3	ADF LOOP ANTENNA
4	FORWARD SECTION OF LEFT MAIN LANDING GEAR DOOR
5	PIECES OF UNIDENTIFIED SHEET METAL
6	PROPELLER FEATHERING SPRING
7	NACELLE FUEL TANK PROBE
8	AFT FUSELAGE TAIL CONE (3FT. LONG)
9	RIGHT PROPELLER ASSEMBLY WITH SPINNER AND ENGINE PROPELLER SHAFT STUB ATTACHED
10	ENGINE COWL DOOR
11	ANTENNA BLADE
12	PIECES OF UNIDENTIFIED SHEET METAL
13	LEFT HAND PROPELLER SPINNER
14	PIECES OF UNIDENTIFIED SHEET METAL
15	SECTION OF MAIN LANDING GEAR DOOR
16	PIECES OF UNIDENTIFIED SHEET METAL
17	LEFT PROPELLER ASSEMBLY
18	LOWER ENGINE COWL
19	MISCELLANEOUS SHEET METAL WITH FUEL CAVITY LINER ATTACHED
20	4 FT. SECTION OF NACELLE WITH SMALL DOOR AND SCREEN
21	PIECE OF ENGINE NOSE CASE WITH PROPELLER GOVERNOR ATTACHED
22	SECTION OF LANDING GEAR DOOR
23	ENGINE COWL DOOR