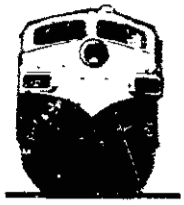
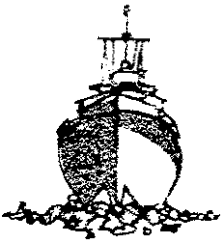
PB83—910408

NATIONAL TRANSPORTATION SAFETY BOARD



WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT



REPUBLIC AIRLINES, INC.
CONVAIR 580, N844H
BRAINERD, MINNESOTA

JANUARY 9, 1983

NTSB/AAR-83/08

UNITED STATES GOVERNMENT

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB/AAR-83/08	2. Government Accession No. PB83-910408	3. Recipient's Catalog No.
4. Title and Subtitle Aircraft Accident Report: Republic Airlines, Inc., Convair 580, N8444H, Brainerd, Minnesota, January 9, 1983		5. Report Date October 18, 1983
		6. Performing organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Accident Investigation Washington, D.C. 20594		10. Work Unit No. 3820
		11. Contract or Grant No.
		13. Type of Report and Period Covered Aircraft Accident Report January 3, 1982
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20594		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

On January 9, 1983, Republic Airlines, Inc., Flight 927, a Convair 580, was a regularly scheduled passenger flight from Minneapolis, Minnesota, to Thief River Falls, Minnesota. En route stops were scheduled at Brainerd, Minnesota and Bemidji, Minnesota. Following a nonprecision instrument approach to runway 23 at Brainerd-Crow Wing County Airport (Brainerd Airport), the airplane touched down about 1,725 feet beyond the threshhold of the 6,500 foot runway. The touchdown was made with the right wing down and the right main gear about 37 feet from the right edge of the 150-foot-wide runway. The airplane continued to the right and the right propeller struck a 2- to 3-foot high snowbank which was between the right edge of the runway and the runway edge lights. The No. 1 blade of the propeller separated and entered the cabin. Of the 30 passengers and 3 crewmembers on board, 1 passenger was injured fatally and 1 passenger was injured seriously by the propeller blade.

The weather was indefinite ceiling, 300 feet, sky obscured, 1 mile visibility, with light snow showers and fog. The temperature was 32°, and the winds were calm. The surface of the runway was ice and compacted snow. Just before the airplane landed, it was reported that there was 1 inch of snow and slush on the runway and that the runway braking taken from a ground vehicle was poor.

17. Key Words Nonprecision approach; snow covered runway; low visibility snowbank, propeller blade separated; nonaligned, low level maneuver; norstandard lighting; absence of NOTAM; .evacuation slide; imprecise measurement.	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)	20. Security Classification (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	37	

NTSB Form 1765.2 (Rev. 9/74)

Abstract Cont'd

The National Transportation Safety Board determines that the probable causes of the accident were the failure of the captain io properly align the airplane with the runway in sufficient time to allow a touchdown with no drift and the position of a snowbank on the edge of the runway the height of which exceeded that specified by regulation. Contributing to the accident were the intensity changes of the runway lights and the Snow–covered terrain, both of which affected the captain's visual landing perception. The absence of a NOTAM on the control of the airport lighting system and failures of the airport management and the company station manager to report the location of the snowbanks to the flightcrew also contributed to the accident.

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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

Adopted: October 18,1983

REPUBLIC AIRLINES, INC.
CONVAIR 580, N8444H
BRAINERD, MINNESOTA
JANUARY 9,1983

SYNOPSIS

On January 9, 1983, Republic Airlines, Inc., Flight 927, a Convair 580, was a regularly scheduled passenger flight from Minneapolis, Minnesota, to Thief River Falls, Minnesota. En route stops were scheduled at Brainerd, Minnesota, ana Bemidji, Minnesota. Following a nonprecision instrument approach to runway 23 at Brainerd–Crow Wing County Airport (Brainerd Airport), the airplane touched down about 1,725 feet beyond the threshhold of the 6,500–foot runway. The touchdown was made with the right wing down and with the right main gear about 37 feet from the right edge of the 150–foot–wide runway. The airplane continued to the right and the right propeller struck a 2– to 3–foot high snowbank which was located between the right edge of the runway and the runway edge lights. The No. 1 blade of the propeller separated and entered the cabin. Of the 30 passengers and 3 crewmembers onboard, 1 passenger was injured fatally and 1 passenger was injured seriously by the propeller blade.

The weather was indefinite ceiling, 300 feet, sky obscured, 1 mile visibility, with light snow showers and fog. The temperature was 32°, and the winds were calm. The surface of the runway was ice and compacted snow. Just before the airplane landed, it was reported that there was 1 inch of snow and slush on the runway and that the runway braking taken from a ground vehicle was poor.

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1. FACTUAL INFORMATION

1.1 History of the Flight

On January 9, 1983, Republic Airlines, Inc., Flight 927, a Convair 580, was a regularly scheduled passenger flight from Minneapolis, Minnesota to Thief River Falls, Minnesota, with en route stops at Brainerd, and Bernidji, Minnesota.

About 1530, 1/ the flightcrew arrived at Republic Airlines operations in Minneapolis and reviewed the weather situation using documents in the operations center. Additionally, the flightcrew was provided a complete set of weather documents with the dispatch package, and this package was again updated with the most current weather just before Flight 927 departed Minneapolis-St Paul International Airport. The flight dispatch package contained a NOTAM 2/ that runway 23 was "covered, 30 percent compacted snow, braking action good-car. ..." The terminal forecast issued by the National Weather Service (NWS) for Brainerd, Minneapolis, at 1540 and valid 1600 to 2200, was, in part, ceiling 700 feet overcast, visibility 5 miles, fog, wind, 170° at 13 knots, with a chance of ceilings of 800 feet overcast, visibility 2 miles, light rain showers, and fog. The captain stated that when he checked the Brainerd weather before departure the ceiling was 800 feet overcast, visibility 1 1/2 miles, light mow showers, and fog. The winds were 170° at 5 knots.

At 1910, Flight 927 departed Minneapolis-St. Paul International Airport with 30 passengers and 3 crewmembers At 1920, the first officer contacted the Republic Airlines station agent at Brainerd and requested the latest weather. The station agent, who was certified by the NWS to make weather observations, reported the weather as indefinite ceiling 400 feet, sky obscured, with 1 mile visibility. However, the ceiling portion of the weather observation was erroneous since the actual ceiling measurement taken by the station agent was indefinite ceiling 300 feet, sky obscured, and visibility 1 mile. The station agent thought he had given a 300-foot report to the crew.

The captain briefed the first officer about the instrument approach to the Brainerd Airport, and the appropriate checklists were completed. At 1929, the first officer made an inrange call to the station agent. The station agent reported that the winds were calm, and that the braking action was poor. He also said that there was "about an inch of slush and snow" on the runway.

At 1929:46, the first officer confirmed that the braking action was poor and requested that the "lights" be turned to the brightest setting. The flightcrew discussed the control of the "lights" from the cockpit and the different settings which resulted from 3, 5, and 7 clicks of the microphone button. At 1932:24, the station agent reported that the lights were on the highest setting. The captain elected to fly a localizer instrument approach to runway 23, and then he conducted a briefing of the procedure.

At 1937:31, the airplane passed the outer marker, and the landing gear was put down. At 1938:18, the captain asked if the first officer had keyed the lights "about 10 tines." At 1938:25, the flaps were extended to 28°, and at 1938:38, the first officer reported that the airplane had descended to the minimum descent altitude (MDA) of 1,680 feet msl (456 feet above the runway). 3/ At 1938:48, the first officer stated that there Were still 20 seconds before the airplane reached the missed approach point. At 1938:53, the first officer said "I'm looking—300 feet." The first officer stated that the 300-foot call was prompted by a radar altimeter-reading caused by hills below the approach path.

At 1939:28, the first officer stated that he saw lights to the left The captain responded that the lights were from a car on the road, and not from the runway.

1/ All times herein are central standard, based on the 24-hour clock.
2/ NOTAM: Notice to Airmen.
3/ All altitudes are Mean Sea Level (MSL).

At 1939:45 and 1939:47, the first officer commented that he could see nothing, followed at 1939:47 by a series of 10 microphone keyings At 1939:49 he stated #at he had "clicked them all the way." At 1939:51 the captain said "There's the flashers," and at 1939:58, the first officer said "got the lights — got the lights." The flight data recorder data indicated that the airplane was at 1,574 feet at 1939:51.

At 1940, the captain ordered the flaps to be set to 40,° and the first officer stated "Flaps forty" followed by a sound similar to flap extension. At 1940:05, the fiit officer said "Okay, you want to shut those off," followed by four microphone keyings The captain responded at 1940:10, "Yeah, that's alot better."

At 1940:11, the fist officer asked if the captain wanted 40° of flaps, and the captain said yes. At 1940:13, the captain again said "Go to forty" This was followed by a sound of flaps extension, and the statement by the first officer of "forty degrees"

The FDR profile indicated a sharp increase in the rate of descent after the 1940:13 order for 40° of flaps At 1940:18, the captain stated "Really watch my descent rate because I'm getting fooled here." At 1940:19, the first officer replied, "Okay, you're a hundred feet," which coincides with the indication on the FDR foil that the airplane was about 100 feet above the runway (1,324 feet).

At 1940:24, the first officer stated "Okay, now you're fifty-now you're fifty feet—your ref speed looks good." At 1940:30, the first officer stated "you're on the left side of the runway" and the captain responded "Ya, I'm trying to ease it back." At 1940:32, the first officer stated, "About ready to come down." Between 1940:35 and 1940:38, there was a series of clicks, followed by the sound of the propellers reversing and increased ambient noise at 1940:39. The power to the CVR was interrupted at 1940:42.

The flightcrew stated that the ceiling was ragged as the airplane was flying at minimum descent altitude, and that there was good visibility when clear of the clouds, despite the moderate snow showers The captain stated that he saw the approach lights, and immediately thereafter, he saw the runway lights and the entire runway. He said ?hat when he saw the approach and runway lights, the airplane was at MDA and aligned properly with the runway. He also stated that he turned on the airplane's landing lights once the runway was in sight and that he noted that the landing lights did not cause vision problems

The captain stated that the intensity of the approach lights was as bright as he had expected, and the strobe lights did not bother him. He said that once he had the runway edge lights in sight, he never lost sight of the runway or the runway lights ahead of the airplane. The captain also stated that the runway edge lights were clear and bright throughout the approach and that there was no "halo" around any of the lights He recalled that the sight-picture of the runway and the runway lights remained as he had expected throughout the approach to touchdown. The captain said that the statement recorded on the CVR about being on the left side of the runway centerline related to a time after the airplane touched down on the runway.

The captain further stated that after touchdown he could see the entire length of the runway, Dut he believed that he "was losing some peripheral cues" to either side of the runway that he had expected to have. The first officer made the same observation. The captain stated that after touchdown, the airplane was pointed down the runway but was moving to the right. He stated that he saw a snowbank along the right of the runway and that there was no buildup of swirling snow in front of the airplane caused by the reversing of the propellers

The right main landing gear of the airplane touched down on runway 23 about 1,725 feet from the threshold, about 37 feet from the right edge of the 150-foot-wide runway. The left main landing gear and the nose gear touched down 60 feet and 200 feet, respectively, after the right main wheel on a heading of about 229°, but on a track at 235°. The airplane continued on a track of 235° for about 400 feet until the right main landing gear crossed through a snowbank located at the right edge of the runway, inside the runway lights. At 1941, the airplane struck a snowbank located at coordinates 46°23'52" N latitude and 94°8'12" W longitude, and one propeller blade separated and entered the passenger cabin. The airplane straddled the snowbank for about 800 feet, crossed back over the snowbank onto the runway, and then swerved back to the right through the snowbank. The airplane came to stop on a heading of about 330° off the right side of the runway. The captain attempted to move back to the centerline of the runway; however, he was unsuccessful. He recalled some violent swerves and loud noises. After the airplane came to a stop, he sent the first officer to the cabin to assist the evacuation while he turned off all the power in the cockpit and attempted to shut down the engines. The first officer, however, could not open the cockpit door; he stated that he saw fire on the right side of the airplane. As a result, both the captain and first officer exited the airplane through the captain's side window and proceeded to the rear service door.

The flight attendant said that the approach and landing were routine. After touchdown the airplane was "turning a little bit" and then "he turned back." She said the airplane then turned to the right and stopped. She heard a loud crash and screams in the front cabin and she saw what appeared to be fire in the center cabin. She went to the left rear service door when the airplane stopped, and manually deployed the evacuation slide because it did not deploy automatically as the door was opened. There were no other problems with the slide. The flight attendant then instructed the passengers to evacuate the airplane. She asked five male passengers in the front cabin who were tending an injured 6-year-old passenger to take the child and leave the airplane. Fearing an explosion from the right engine, the flight attendant instructed the passengers to leave one injured passenger whom the attendant believed was dead. The flight attendant then left the airplane.

Shortly afterward, the captain and first officer reentered the airplane by climbing up the evacuation slide at the rear service door. The captain recalled that at the time only one or two passengers remained on the airplane. He and the first officer removed the injured woman from the airplane, checked the area, and determined that no other persons were onboard the airplane. He believed that the woman was dead when she was removed from the airplane. He and the other crewmembers then assisted the passengers to the airport terminal

The passengers reported the flight was normal and that the approach and landing were smooth. The pasengers who had noted the position of the airplane at touchdown said that the airplane was on the right side of the runway. Some passengers noted that the left runway lights were far from the airplane, others said that the right runway lights were near the airplane. Some passengers believed the right main landing gear touched down first and that the airplane moved to the right after touchdown.

According to the flight attendant, the runway was covered with about 2 inches of wet snow and there was slush on the runway. Most passengers recalled that there was 1 to 2 inches of wet snow on the runway, although several believed that the snow depth was 3 or 4 inches The assistant airport manager stated that when he arrived at the airport at 2015, the snow on the runway was 1 1/2 inches deep. The captain stated that the snow

was about 2 to 3 inches deep on the runway and that he would not have landed at Brainerd Airport had he known about the position of the snowbanks The first officer stated that the snow depth was 2 to 4 inches on the runway.

The accident occurred during the hours of darkness.

12 Injuries io Persons

Injuries	Crew	Passengers	Other	Total
Fatal	0	1	3	1
Serious	0	1	0	I
Minor/None	3	28	0	31
Total	3	30	0	33

1.3 Damage to Airplane

The airplane was damaged substantially.

1.4 Other Damage

None.

15 Personnel Information

The flightcrew and flight attendant were qualified in accordance with current regulations (See appendix B.)

16 Aircraft Information

The airplane, a Convair (CV) 580-11-A, was owned and operated by Republic Airlines, Inc. The airplane had been maintained in accordance with applicable regulations. The airplane's gross weight, landing weight, and center of gravity were within prescribed limits. (See appendix C.)

1.7 Meteorological Information

The 1830 National Weather Service (NWS) surface analysis showed a low pressure area in Western Iowa with a cold front extending northward through Central Minnesota. The 2100 NWS surface analysis showed a low pressure area in Central Iowa with a surface trough extending northward through Central Minnesota. The NWS weather depiction chart for 1900 showed Instrument Flight Rule (IFR) conditions extending from Southwestern through Central and Northern Minnesota

The following NWS 1600-2200 *terminal* forecast for Brainerd was issued *about* 1540:

> Ceiling 700 feet overcast, visibility 5 miles, fog, wind 170° at 13 knots, chance of ceiling 500 feat overcast, visibility 2 miles, light rain showers, fog

A Meteorological Impact Statement **(MIS),** issued by the Center Weather Service (CWS) Unit Meteorologist at Minneapolis Air Route Traffic Control Center and valid from 1300 to 2100, called for light to moderate mixed icing in cloud and in precipitation below 20,000 feet with possible severe icing in cloud and in precipitation **below** 5,000 feet in moderate freezing rain in northern Minnesota. The NWS did not issue a SIGMET to warn of the possible severe icing in northern Minnesota.

Surface Weather Observations

The following surface weather observations were taken at Brainerd Airport before and after the accident by **a** Republic Airlines employee certified by the NWS:

Time—1847 - Record - Indefinite ceiling 300 feet, sky obscured, visibility 1 mile, light snow shower, fog, temperature 32° F., dew point 31° **F.,** winds calm, altimeter setting 29.62 inches of Hg.

Time—1945 - Record - Indefinite ceiling 300 feet, sky obscured, visibility ¼ mile, light snow shower, fog, temperature 32° F., dew point 31° F., winds calm, altimeter setting 29.62 inches of Hg.

Upper Air Information

The following information was reported at S t Cloud, Minnesota, at 1700:

Height (feet above msl)	Wind Direction (°)	Wind Speed (Kn)
1,899	**185**	**24**
2,738	198	26
3,665	197	27

Supplementary Aviation Weather Reporting Station (SAWRS)

Brainerd Airport is served by **an** approved Supplementary Aviation Weather Reporting Station (SAWRS) which is staffed by Republic Airlines personnel. However, the NWS had the responsibility to furnish technical advice and guidance; furnish manuals, handbooks, and other weather reporting documents; train and certificate qualified observers; and provide inspection and guidance of the observation program.

Weather observations are made by employees of Republic **Airlines** who are certified by the NWS. The point of observation is near the airline terminal. Wind direction **and** wind speed are determined from a wind instrument located in the main terminal with the sensor located **28** feet above the ground on top of the airline terminal. **The** ceiling height is determined by means of a ceiling light located north of the airline terminal. Surface visibility is determined with reference to the distance of known objects from the point of observation. The altimeter setting is obtained from two aircraft type altimeters which are compared against each other at least once every **24** hours.

At the **time** of the accident, cne Republic Airlines station agent was on duty at the airport. In addition to taking and disseminating weather observations, the station agent's duties included ticketing, **loading** baggage, and handling air freight. The station agent **was** certified by the NWS and had been **a** weather observer at Brainerd for 1 1/2 years.

On the day of the accident, the station agent took the weather observations at 1841 and 1945. He said that before and after the accident the snow was falling straight down. At 1905, using his fingers he measured the snow depth in front of the main terminal and on the taxiway as 1-inch deep. The station agent said that he believed there was a NWS requirement to make a snow depth reading at 0000 Greenwich Mean Time each day. However, he was not aware of any NWS guidance on how to measure snow depth.

A NWS spokesman stated that there was no requirement to take snow depth measurements at the SAWRS at Brainerd Airport.

NWS Snow Measurement Guidance

NWS guidance and detailed instructions for the measurement of snow depth are contained in Federal Meteorological Handbook No. 1. Measurements are to be taken at several spots, with the average of the measurements recorded as the snow depth. Additionally, a measuring stick is to be used, and depth is to be determined to the nearest 0.1 inch. The handbook also provides instructions for the placement of the measuring stick in drifted snow, undrifted snow, and on ice-covered surfaces.

Visibility Observations and Reporting

Federal Meteorological Handbook No. 9 for Supplementary Aviation Weather Reporting Stations specifies the procedures and requirements for determining horizontal visibilities. The handbook suggests that unfocused lights of moderate intensity (about 25 candela) be used as visibility markers for nighttime operations.

The station agent at Brainerd Airport determined surface visibility by referencing the distance of known objects near the airline terminal. Four night markers were located within 1.5 miles of the terminal: the localizer building, 3/8 miles west of the terminal; the threshold lights for runway 12, 1/2 mile northwest of the terminal, the threshold lights for runway 23, 1.2 miles northeast of the terminal; and a windsock, 1/4 mile northeast of the terminal. The station agent stated that the visibility value he determined was based on the fact that the end of runway 5 was visible with the High Intensity Runway Lights (HIRL) turned to light setting 5. The brightness of the HIRL on setting 5 was about 10,000 candela.

1.8 Aids to Navigation

A localizer operating on frequency 109.80 mHz provides a straight-in instrument approach to runway 23. The published minima for a straight-in approach to runway 23, based on the localizer, is 1/2 mile visibility. An outer marker broadcasting on 251 kHz is situated 5.3 miles from the threshold of runway 23. The procedure turn is flown at 2,900 feet. After passing the outer marker, an airplane descends from 2,900 feet inbound on a bearing of 230°. The minimum descent attitude is 1,680 feet, which is 456 feet above the runway elevation.

The airport is also equipped with a very high frequency omnirange station (VOR). After the accident, all navigation aids were flight checked by the Federal Aviation Administration (FAA) and were found to be functioning within specified operating limits.

1.9 Communications

There were no communication difficulties.

1.10 Aerodrome and Ground Facilities

Brainerd Crow Wing County Airport, elevation 1,226 feet, is located 4 miles northeast of the city of Brainerd and is served by three runways: 05/23, 12/30 and 01/19. Runway 05/23, the landing runway, is asphalt surfaced, 6,500 feet long, and 150 feet wide. The airport does not have a control tower.

Runway 05/23 is equipped with high intensity runway edge lights with variable spacing [nominal 190 feet), a medium intensity approach lighting system with runway alignment indicator lights, and a four-box visual approach slope indicator (VASI).

Lighting Systems

The High Intensity Runway Lighting (HIRL) System is owned and maintained by the airport owner (City of Brainerd/County of Crow Wing). The system, commissioned in 1981, contains 30-inch-high L-862 edge lights, located 10 feet beyond the paved edge of the runway. The Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights (MALSR) and the four-box Visual Approach Slope Indicator (VASI-4) on runway 23 are owned end maintained by the FAA.

Before December 1, 1982, Brainerd Airport had a standard system for the operation of the HIRL and the MALSR on runway 23 as approved by the FAA on October 19, 1982. The system allowed the HIRL to be turned on to a predetermined intensity by a pilot controlled sequence of clicks on the airplane radio; however, the intensity of the lights could not be adjusted. The MALSR also was activated with the same sequence of clicks on the airplane radio, and the intensity of the MALSR could be controlled further by the pilot from the airplane. The system was operated in accordance with the guidance in FAA Advisory Circular 150/5340-27, Air-to-Ground Radio Control of Airport Lighting Systems.

In November 1982, a master switch for the field lighting system was installed in the Republic Airlines baggage handling area. The switch allowed the Republic Airlines station agent to activate the system. Additionally, an IFR switch was installed in the same area which activated the airport rotating beacon and the air-to-ground radio control. Neither the master switch nor the IFR switch were approved by the FAA, and no letter of agreement had been executed between the airport and Republic Airlines which outlined the airline's responsibilities for the operation of the switch.

On December 1, 1982, at the request of the Brainerd Airport management, the FAA approved a 6-month test program which allowed modification to the equipment to permit pilots to activate and control simultaneously the intensities of both the HIRL and the MALSR. The test program was similar to programs that had been implemented at other area airports.

The new system was installed on December 8, 1982, and became operational immediately thereafter. The FAA required the airport management to have a NOTAM issued through the Alexandria, Minnesota, Flight Service Station (FSS) to inform pilots of the test program and the capabilities of the pilot-controlled lighting system. The assistant airport manager stated that he informed the Alexandria FSS by telephone on December 8, 1982 of the test program, and that he thought a NOTAM was issued effective

that date- An airport employee stated that he witnessed the telephone call in which the FAA was asked to issue the NOTAM. However, no record existed at the Alexandria FSS of a NOTAM being issued concerning the test program for the lighting systems The Republic Airlines station agent stated that he was Unaware of the test program until after the accident although he routinely operated the lighting system from controls in the airport electrical vault. He did not use the master switch in the Republic Airlines baggage area because he did not know the purpose of the switch. A NOTAM concerning the implementation of the test system for the control of the HIRL an2 the MALSR at Brainerd Airport was issued on January 21, 1983.

The operation of the HIRL and the MALSR was checked after the accident The controls of the intensities of both systems responded to the radio commanded clicks in the proper manner. Additionally, ground checks of the controls in the airport electrical vault and at the Republic Airlines baggage area did not indicate any deficiencies

Snow Removal

The Brainerd Airport contracts snow removal support from a local construction company. The runway(s) and operating surfaces are plowed to the edge of the runway/operating surface. The airport management then requests the Minnesota Department of Transportation (MDOT), which provides snow blowers and crews, to remove the ridge of snow left at the edge of the runway.

The project superintendent for the local construction company stated that the company had contracted with the airport for about 12 years. He was not aware of specific instructions by airport management concerning plowing procedures He routinely plowed the snow off the runways to a point as close as possible to ?he runway lights and without covering the runway lights. He was unaware of any limits on the heights of snowbanks He stated that airport management had never complained about the adequacy of snow removal.

Runway 5/23 had been plowed by the local contractor on January 6 and 7, 1983. After the accident, the airport manager estimated that the height of the snowbanks on the side of the runway was about 18 inches The assistant airport manager estimated the height of the snowbanks to be about 15 inches One passenger on Flight 927 estimated the snowbank as 2 1/2 feet tall and firm enough to support his weight On the day after the accident, measurements of the snowbanks along runway 23 indicated heights between 2 and 3 feet. Tne snowbanks were about 10 feet inside the runway edge lights at the edge of the load bearing surface. The airport manager stated that he had planned to call MDOT on Monday, January 10, 1983, to blow the snowbanks from the sides of runway 23.

Brainerd Airport has an airport operating certificate issued by the FAA under 14 CFR Part 139, Certification and Operations: Land Airports Serving CAS-Certificated Airports. Title 14 CFR Part 139.65 states the following:

> The operator of each certificated airport shall move any drifted or piled snow off usable runway and taxiway surfaces end (except as otherwise authorized in its approved airport operations manual) position any snow or snowbank off those surfaces in height so regulated that all aircraft propellers, engine pods, and wingtips will clear snowdrifts and snowbanks when the aircraft's most critical landing gear is located at any point along the full strength edge of the runway or taxiway. When unable to comply promptly with this requirement, the operator shall issue a Notice to Airmen describing the existing conditions.

The FAA-approved Airport Operations Manual for Brainerd Airport contains the following guidance for snow removal and positioning:

> Any drifted or piled snow will be moved off the usable runways and taxiways and positioned so that all aircraft propellers, engine pods and wing tips will clear the snowbanks and snowdrifts when the aircraft's critical landing gear is located at any point along the full strength edge of the runway or taxiway. When unable to comply with this requirement, the Airport Manager or Assistant Manager shall issue a Notice to Airmen as well as inform Republic Airlines and all other airport tenants concerning the existing conditions.

There were no procedures in the Airport Operations Manual which describe how runway contaminant depth is measured, although 14 CFR Part 139.33 and 14 CFR Part 139.69 specify that each airport have such procedures.

The Republic Airlines, Flight Operations Manual contains the following requirements relative to snow removal. The Republic Airlines station manager at the airport was responsible to monitor the conditions of the runways and airport, and to report the conditions to the flightcrews. The following excerpts are from the Republic Airlines FOM:

> Runways and taxiways should be plowed full length and width. The minimum plowed runway snow banks should be tapered in accordance with the ATA Snow Removal Handbook. This means a maximum height of 1 1/2-feet adjacent to the runway tapering to 5-feet high 35-feet from runway edge. Snowbanks should be outside the runway lights and a clear area provided to give an unobstructed view of the lights at a 20:1 approach angle for night operations.

The Air Transport Association (ATA) Snow Removal Handbook states that:

> The minimum cleared width of a runway should be 150 feet for daytime operations and full width between the runway lights for night operations. This applies to both takeoffs and landings. Taxiways should be cleared full width for day and night operations.

The propeller clearance above the ground for the Convair 580 varies from 12 to 16 inches, depending on the length of the OLEO Strut extension.

Crash-Fire-Rescue (CFR) Response

Brainerd Airport was certificated by the FAA under 14 CFR Part 139, Certification and Operations: Land Airports serving CAB certificated air carriers. The most recent airport inspection by the FAA was conducted on August 30, 1982. Several deficiencies were noted, including one which addressed the adequacy of training records for CFR personnel. However, the deficiencies were corrected and a followup inspection in September 1982 indicated that all items had been corrected to the satisfaction of the FAA, except for the removal of trees in the clear zone of runway 12/30.

CFR services were provided by trained airport employees during normal work hours. At other times, three firemen, who were volunteer members of the city fire department, manned the CFR truck on a rotation basis. Off-hour CFR services were provided only when an air carrier arrival or departure was scheduled.

The airport was required to have one crash-fire-rescue vehicle in accordance with 14 CFR 139.49 for Index 4 airports. The airport vehicle was a 1975 pickup truck, which carried a pallatized "Fire Boss" Model D4.5LTW100N apparatus. The truck could be operated by one person. The truck and tire CFR equipment met the requirements of 14 CFR Part 139, although there was no radio, forced entry tools, flashlight, spotlight, siren, ladder or protective breathing apparatus, and none were required. The vehicle was started and inspected daily.

The City of Brainerd Fire Department was notified of the accident at 1952 and arrived at the airport at 2003. Two trucks responded, but neither had a foam-type extinguishment agent. A truck from a nearby town arrived shortly afteraard with aqueous film forming foam. Ambulance services from Brainerd and three other towns responded to the accident. The injured child and three other passengers were examined in the terminal and transported to a local hospital. The child arrived at the hospital at 2009.

At 1515 on the day of the accident, the Republic Airlines station agent attempted to start the airport CFR truck, which he intended to use to inspect the runway. He tried to start the truck once, but when it would not start, he used his own vehicle. However, he stated the: "I didn't give it a real good try. I just turned it over a few times, it didn't kick right in, and I took my car." There were no other reports of the CFR vehicle not starting, and if was used about 20 minutes after the accident.

The investigation revealed the following facts concerning the airport emergency plan and CFB capabilities:

1. Parts of the FAA approved emergency plan were outdated or incorrect, including telephone numbers for city emergency services and a listing for an ambulance service which had gone out of business;

2. The Airport Operations Manual was revised in 1982, but the revision was made by a consulting company and submitted directly to the FAA for approval. The airport manager and assistant manager were not totally familiar with the manual revisions;

3. Republic Airlines personnel were not familiar with the emergency plan although they were assigned specific duties in the manual;

4. Airport management had not requested Convair 580 familiarization for airport firemen. The full-time CFR personnel had reviewed Convair 580 diagrams but the three part-time CFR personnel had not;

5. The City of Brainerd firetrucks carried no foam extinguishing agents. (The airport CFR vehicle carried foam extinguishing agents in excess of 14 CFR 139 requirements for the airport);

6. The part-time firemen and the Republic Airlines station personnel had not received CFR training. The two full-time airport employees who managed the CFK vehicle ha? received formal CFR training; and

7. The CFR truck had a portable UNICOM transceiver; however, there was no radio communication with City backup CFR units, nor was there such a requirement under 14 CFR Part 139. The part-time fireman had received no training in the use of the transceiver.

1.11 Flight Recorders

The airplane was equipped with a Sundstrand Model FA-542 Flight Data Recorder (FDR) Serial No. 2527 and a Fairchild A-100 Cockpit Voice Recorder (CVR) Serial No. 10391. Both recorders were in good condition.

The FDR and the foil recording medium were intact and undamaged. Examination of the foil medium disclosed that all parameter and binary traces were present and active with no evidence of recorder malfunction or recording abnormalities. The readout was begun at a point where the aircraft was descending from cruise altitude and continued to the end of the recorded traces, a total time of 11 minutes 24 seconds. The altitude information was based on a barometric pressure of 29.63 inches Hg to convert pressure altitude to mean sea level altitude. No other corrections were made to any parameter. (The FDR readout is contained in appendix D.)

The CVR and the FDR data were correlated. The wreckage distribution chart (appendix E) was used to establish the position of touchdown on the runway and the final wreckage location. There were no distinct markings on the FDR foil that were representative of touchdown. Therefore, the time of touchdown was based on comments and sounds recorded on the CVR, after the statement "bout ready to come down" and at the Same time as an unidentifiable sound followed by numerous clicking noises and the sound of engine reversing.

The computer program was used to process the FDR information to produce values of accumulated ground distance covered in relation to altitude and time, and to plot the ground track in relation to the runway. The FDR readout showed time to one significant digit, whereas the CVR times were to the nearest second. Therefore, the relationship of CVR to FDR time should be taken as being accurate to within 20.5 second.

Interpolation was performed to equate specific CVR times to FDR times, and this ratio was used to obtain FDR computed ground distances which corresponded to CFR times

1.12 Wreckage

The airplane stopped just off the right edge of runway 23 and about 3,300 feet beyond the runway threshold. (The wreckage diegram is contained in appendix E.)

The airplane was at a level attitude and was intact on all three landing gears.

Left Engine and Propeller

The left propeller had separated from its engine when a propeller blade struck the snow bank on the right side of the runway. The left engine remained in the engine nacelle and remained attached to the forward engine mounts. The propeller separated at the split line of the reduction gearbox between the front and rear housings. The left propeller assembly was recovered from under the right wing of the airplane. The Nos. 2

and 4 blades with cuffs and fairing caps, remained attached to the hub assembly. The No. 1 blade had separated from the hub assembly and was recovered about 5 feet forward of the left propeller. The No. 3 blade was recovered from inside the airplane's forward cargo and passenger entrance compartment.

Right Engine and Propeller

. The right propeller separated from its engine when the blades struck the snow bank on the right side of the runway. The right engine remained in the engine nacelle and remained attached to the forward engine mounts. The right engine air inlet cowl had separated from the nacelle at the engine mount frame. The cowl was recovered in small identifiable pieces along the ground track of the airplane in an area starting about 400 feet from the airplane's final stopping point. The right propeller assembly was recovered about 300 feet from the airplane's final stopping point and about 30 feet to the right of runway 23. The Nos 3 and 4 propeller blades remained attached to the propeller hub. The No. 1 propeller blade was recovered from imide the passenger compartment of the airplane; it entered the cabin from beneath the first and second row of passenger seats on the right side of the cabin. The No. 2 propeller blade was recovered about 1,162 feet from the airplane and about 146 feet from the left side of runway 23. This location was almost directiy left of the estimated position of the airplane when it first entered the snow bank on the right side of the runway.

The propeller units were disassembled to determine blade angles at impact; these angles were measured as:

	Left Propeller	Right Propeller
Blade No. 1	5.635°	13.40'
Blade No. 2	4.385°	13.88°
Blade No. 3	*	14.61'
Blade No. 4	4.057°	14.61'

* Torque cylinder not recovered.

Fuselage, Wings, and Empennage—The propeller assemblies separated from both engines. A blade from the right propeller substantially damaged the fuselage when it penetrated the passenger cabin. The fuselage was intact but sustained several vertical slashes on the left and right sides near the planes of the propeller rotation.

On the right side, the fuselage had two slashes which penetrated the skin at fuselage stations (FS) 227 and 261. At FS 227, the slash extended from the top center of the fuselage downward to about 1 foot below the bottom of the cabin window line and penetrated the fuselage understructure, including the cabin interior walls. At FS 261, the slash extended from about 5 inches below the lower forward corner of the forward passenger window to the hinge line of the belly cargo door and penetrated the fuselage understructure, including the cabin interior. It also separated the cargo door into two sections: the forward section was still latched and the aft section was hanging open from its hinges.

The left side of the fuselage at FS 160 had an inward crease in the main entry door. Above the door frame, the fuselage was cut through the upper structure and across the top to about 1.5 feet above the upper forward cargo door on the right side of the fuselage. Additionally, at the upper rear main entry door frame on the left side, the fuselage skin was torn inward in a down and aft direction for about 3 feet.

Between FS 180 and 195 on the left side, a 1.5-foot-high 1.5-foot-wide triangular shaped tear was found above the static port area. The torn section of fuselage skin was crushed in the downward direction. The static source plumbing beneath the torn area was not damaged.

The remainder of the fuselage was not damaged. No fuselage distortion was observed at the overwing exits or at the rear service door.

The wings and empennage areas were not damaged with the exception of an area near the right wing's leading edge near wing station (WS) 47. This area had a dent about 10 inches square on an inspection plate, below an3 aft of the leading edge.

1.13 Medical and Pathological Information

There was no evidence of incapacitation or pre-existing physical or physiological problems which could have affected the flightcrew's performance.

At the request of the Safety Board, the captain underwent auditory, visual, and vestibular examinations by private physicians. The medical examinations were reviewed by the United States Air Force (USAF) School of Aerospace Medicine. No abnormal findings were reported.

The injuries sustained by the fatally injured and the seriously injured passengers were the result of the separation of the propeller blade and its entry into the passenger compartment. A propeller blade severed bilaterally the legs of a 68-year-old woman who was sitting in seat 2-C; the woman died of loss of blood. The blade also severed the lower right leg and fractured the left foot of a 6-year-old girl sitting in seat 2-D.

1.14 Fire

Postimpact fire was confined to the turbine section of the engines and did not propogate. The fires self-extinguished when the fuel supply to the engines was exhausted.

There was no pre- or postimpact fire in the airframe.

1.15 Survival Aspects

There were no severe decelerative forces, and the accident was survivable. The penetration of the right side of the cabin between seat rows 1 and 2 below the floor by a propeller blade and the continuation of the blade upward into the cabin caused fatal injuries to the female adult passenger and amputation of the right lower leg and fracture of the left foot of the female child passenger. One passenger in seat 3-C received minor leg injuries when the floor was displaced upward and his legs were forced up into seat 2-C. His face and scalp were lacerated when the seatback from seat 2-C separated and struck him. The occupant of seat 2-B was struck on the back when the propeller blade struck and separated the back of his seat.

The evacuation of the airplane was accomplished in about 1 minute. The passengers and flight attendant said that no problems were encountered in the evacuation. The flight attendant stated that, during the landing, an ice container slid out of the buffet and came to rest against the cover of the evacuation slide. She opened the service door and the evacuation slide fell from the stowage pack. However, it stayed on the door sill

instead of falling toward the ground, She then kicked the slide from the door sill, but because the slide did not inflate automatically, the attendant pulled the **manual** inflation lanyard, and the slide inflated. The slide components were inspected by the Safety ***Board,*** but no reason was found to explain the failure to deploy.

All passengers left through the rear service door, although three of the five cabin window exits were opened without direction from the flight attendant None were **used** because of the engine fires The injured 6-year-old passenger was carried to the terminal while a compress was held on the leg wound to slow the loss of blood The flight sttendant believed the injured woman was dead, and fearing an explosion from the right engine, instructed the passengers to leave the woman and evacuste the airplane. The naise from the No. **2** engine interferred with the ability of some passengers to hear the flight attendant's shouted command to evacuate through the rear service door.

1.16 Tests and Research

1.16.1 Cockpit Visibility Study

A cockpit visibility study was conducted to provide baseline data to analyze the captain's cockpit visibility at touchdown on runway **23.** The purpose of tine study was to determine if the snowbanks would have blocked the line of sight from the captain's eyes to the runway edge lights. The study was based on the worst assumptions -- 3-foot, homogeneous snowbanks and an airplane attitude of zero degrees pitch and zero degrees bank angle. Although the physical evidence indicated that the airplane toucher! down in a right-wing low, nose-high attitude, the pitch and roll angles were assumed to be **zero.** This was necessary since no pitch and roll data are required to be recorded by the FDR. Additionally, the evidence suggested that the angles would have been relatively small, and would have had iittle effect on the captain's visibility.

The location of the pilot's zero eye reference point relative to the right main landing gear was determined from engineering drawings of the Convair **580.** The resultant dimensions are as follows:

Height above runway	--	12 feet **2** inches
Lateral displacement from right main landing gear centerline	--	70 inches
Longitudinal displacement from main landing gear centerline	--	26 feet 7 inches

The runway edge *lights* were ***30*** inches above the ground and 19 feet from the edge of the runway. There was a 5 percent slope downward from the runway edge to the runway lights The downward slope placed the runway lights **24** inches above the runway surface. The spacing of the runway lights, which should have been visible beyond the initial touchdown point, was **192** feet. The initial touchdown point **was 1,725** feet from the threshold, with the right main gear **37** feet from the edge of the right side of the runway. The airplane's heading, taken from the FDR data, was 229° at touchdown.

The visibility study indicated that in the worst possible case, — *e* 3-foot-high snowbank on both sides of the runway — the captain had an unobstructed view of at least six runway lights to the right side of ?he runway extending from a point to *the* right Side of the captain's field of vision down the runway. If the snowbank had been 3 feet high on the left edge of the runway, the captain's line of sight to the lights would have been blocked.

1.17 Additional Information

1.17.1 Republic Airlines Flight Operations Manual

The following excerpts are from the Republic Airline Flight Operations Manual:

Takeoff and Landing Restrict+

Landings should not be made (unless coordinated with Flight Control) when it is apparent that runway conditions will not meet takeoff minimums prior to expected departure time, Furthermore, particular caution **should** bc xercised **when** operating in slush if the temperatures ere at or near freezing. Large accumulations of slush on such parts as gear doors or movable wing sections could quickly freeze into ice as the aircraft later ascends into colder temperatures, possibly resulting in damage during subsequent operation **of** these parts.

In addition, no landings should be made when the following maximum runway contaminant depths are exceeded:

Type of Contaminant	CY-580
Standing Water/Slush	1 inch
Wet Snow	4 inches
Dry Snow	**8** inches

To facilitate compliance with slush and snow depth restrictions, the following definitions apply:

Slush: Partially melted snow with high water content will splash when a vehicie is run through it or when stamped with a foot.

Wet Snow: Snow with sufficient moisture content so that it packs easily, will "roll up" when a foot is pushed through it. Does not fly into a "cloud" when kicked (if it does, it is dry). Packs down when stamped with a foot, but has no tendency to splash. If there is any tendency to splash, it must bc considered slush. Cet snow quickly becomes slush under certain conditions. If in doubt, be conservative--treat it as slush.

Takeoff Limitations

CV-580

Takeoffs should not ,e attempted with the CY-580 under conditions which exceed the maximum allowable figures shown below.

Type of Contaminant	Maximum Allowable
Standing Water/Slush	1 inch
Wet Snow	4 inches
Dry Snow	8 inches

1.18 New Investigative Techniques

A computer aided cockpit visibility study was performed to establish baseiine data for the analysis of the captain's visibility at touchdown. The specific purpose was to determine if the snowbanks blocked the line of sight from the pilot's eyes to the runway lights.

A computer generated binocular vision envelope was developed from a binocular photograph from a Convair 580 cockpit. The photograph was digitized and plotted in the Safety Board's laboratory. The digitization and the plotter have a resolution of 0.1 inch and 0.25 mil, respectively.

The airplane and runway dimensions were correlated with the binocular vision envelope. The location of the captain's zero eye reference, the runway surface, the snowbank peaks, and the top of the runway lights were established in a common coordinate system. The center point of the runway was selected as the coordinate system origin with the runway centerline on the X axis, the lateral displacement from the eenterlinc on the Y axis, and the height or! the Z axis. The touchdown point on the runway was established by actual measurements A snowbank height of 3 feet was assumed along with an airplane attitude of zero degrees and zero degrees of bank angle.

The visibility study resulted in two plots which showed the runway surface, the snowbank peaks, and the tops of the runway lights projected on the pilot's vision envelope. Figure 1 shows the entire visual envelope of the Convair 580 at e scale of 10° per inch. Figure 2, which is a blowup of figure i, shows only a portion of the captain's windscreen at a scale of 2.5° per inch.

2. ANALYSIS

2.1 General

The airplane was Certificated, equipped, end maintained in accordance with Federal regulations and approved procedures. There was no evidence of a malfunction or failure of the airplane, its components, or its powerplants that would have caused the accident. The flightcrew was certificated properly for the flight, and each crewmember had received the training and off-duty time prescribed by FAA regulations. There was no evidence of any preexisting medical or physiological condition that might have affected the flightcrew's performance.

2.2 The Accident

The investigation revealed that the landing approach was conducted in weather characterized by a low ceiling, reduced visibility, and snow and fog. The ceiling in the Brainerd Airport area was at, or slightly below, the minimum descent altitude for the instrument approach, which, when coupled with the light snow showers and fog, imposed an increased workload on the flightcrew. The ceiling and visibility conditions also prevented the flightcrew from seeing the runway and runway environment until 44 seconds

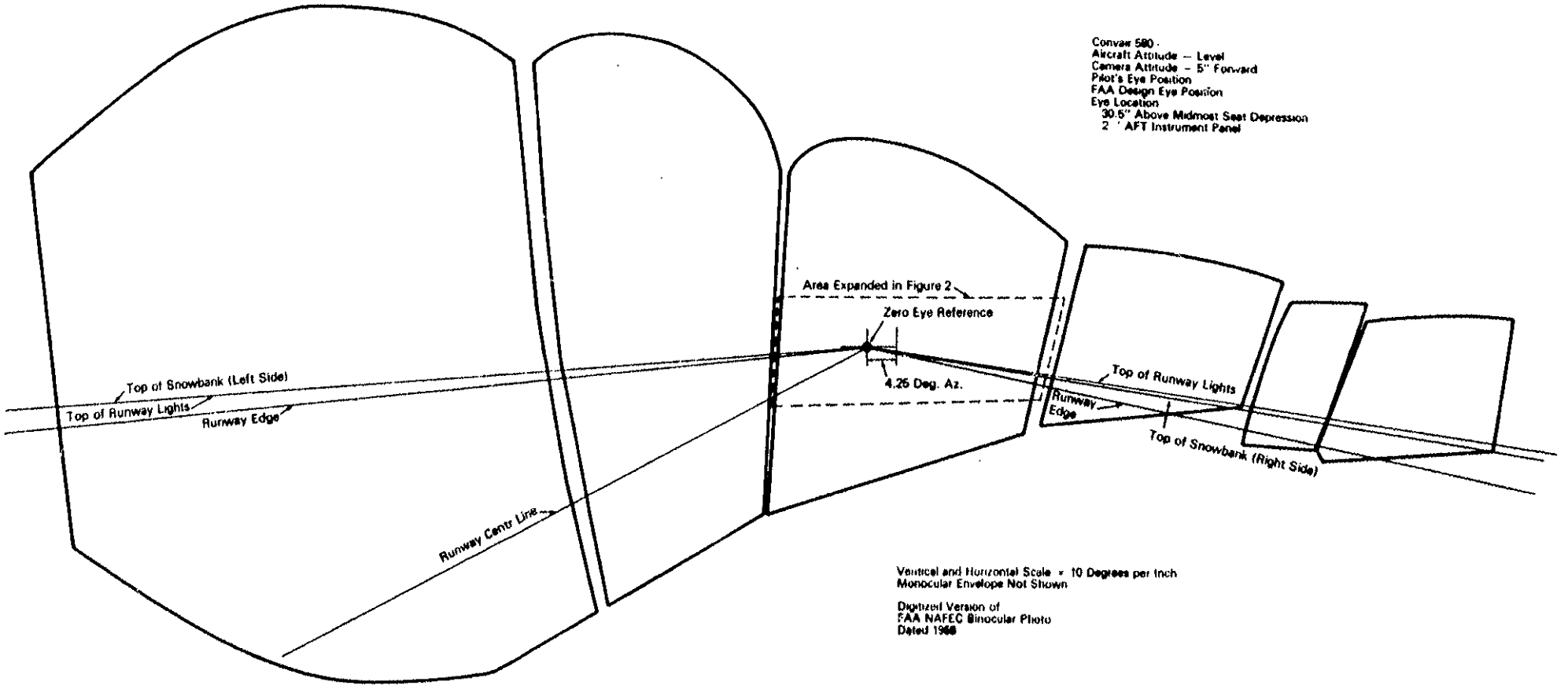


Figure 1.—Full vision envelope at touchdown.

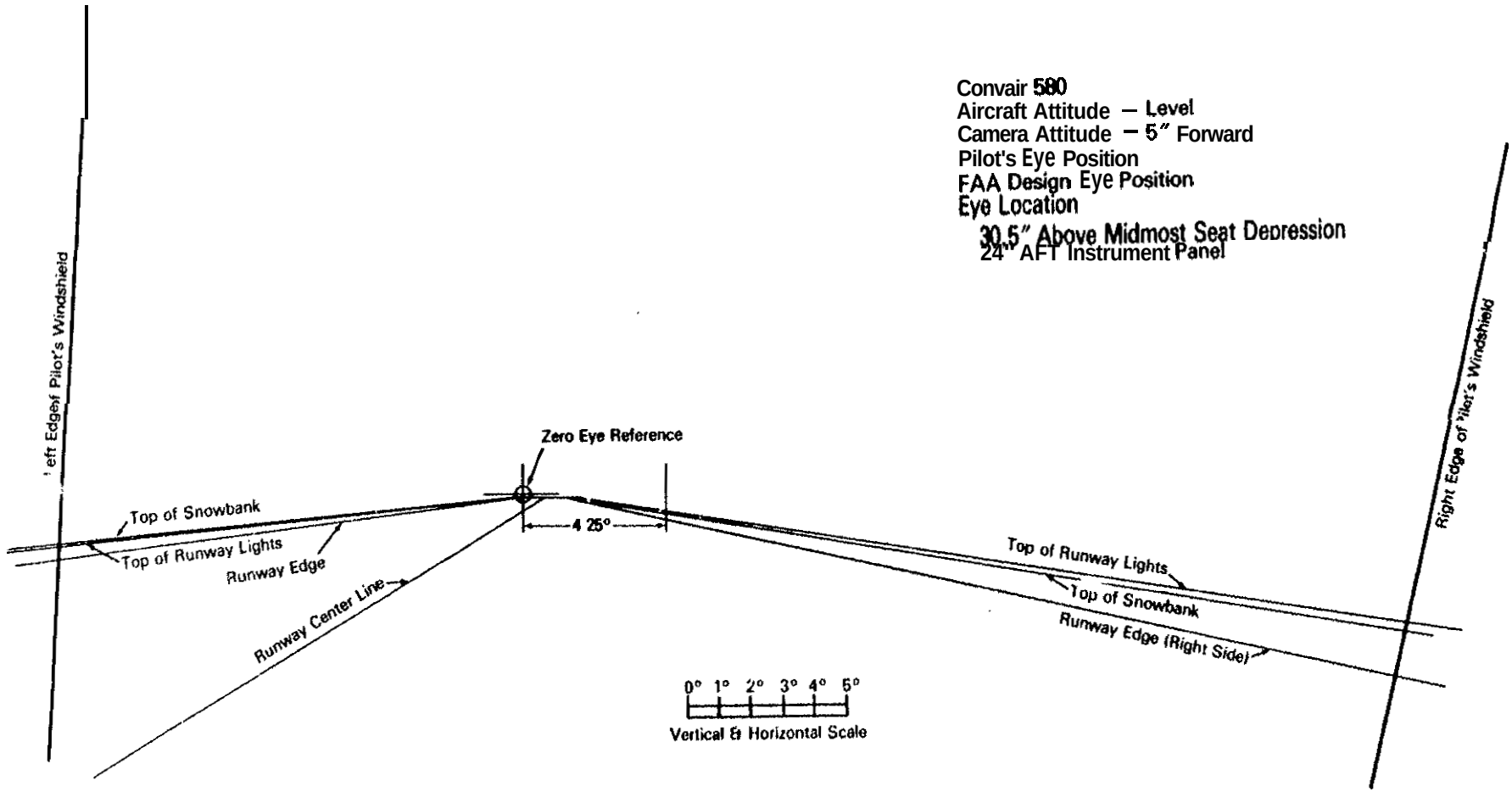


Figure 2.—Expanded view of runway at touchdown.

before the touchdown. Even though the visibility was good once the flightcrew had the runway and runway environment in sight, the airplane was located only about 1 mile or less from the threshold when the captain observed the approach lights at 1939:51.

The FDR and CVR indicate that the airplane may have been about 100 feet under the MDA of 452 feet when the captain saw the approach light system at 1939:51. However, the airplane had been clear of the clouds as early as 1938:28 when the first officer saw the lights of a car on a road. The airplane was then descended to MDA at 1939:38, when the first officer stated, "There's minimums." However, instead of steadying at MDA, the descent apparently continued until 1939:51 when the approach lights were observed. The Safety Board was not able to determine whether or not the visual conditions at MDA were sufficient to allow the flightcrew to see the runway environment et or before the missed approach point. However, the descent below MDA was contrary to Republic Airlines and FAA regulations, and was not the proficiency expected of a professional flightcrew.

Although the airplane was in a position to complete the instrument approach and landing once the airport was sighted, several ensuing factors unnecessarily increased the workload of the flightcrew. The final flap setting of 40° was ordered by the captain at 1940, but the flaps were not positioned at 40° until 1940:14. During the 14-second lapse, the first officer had questions about the windshield wipers and had lowered the brightness of the approach and runway lights on his own initiative. Additionally, the captain turned on the three airplane landing lights individually soon after he saw the approach and runway lights Simultaneously, the captain began to reduce the airspeed to the desired approach speed.

The captain stated that the final stages of the approach were normal. The first officer had dimmed the runway lights at 1940:07, but the captain stated that he was not distracted by either the runway lights or the airplane's landing lights.

The flight data recorder (FDR) indicated that after the 1940:13 command of "Go to forty," the rate of descent increased significantly, while the airspeed decreased from about 122 knots to about 100 knots just before touchdown. However, the rate of descent and the airspeed had stabilized, and the airplane was flown to a proper position to complete a normal landing. The Safety Board concludes that except for the premature descent below MDA the instrument approach was normal until just before touchdown on runway 23 and that the flightcrew followed the proper checklist and airplane procedures

The flightcrew's first indication of a difficulty was at 1940:30, or 5 seconds before touchdown, when the first officer warned that the airplane was to the left side of the runway and the captain responded that he was correcting back to the center. The Captain recalled that the airplane was aligned properly before landing and that the warning by the first officer came after landing. The CVR and FDR data, however, indicate that the airplane was stilt airborne at 1940:30.

The airplane touched down on the right side of the runway, with the right landing gear about 37 feet from the edge of the 150-foot-wide runway. Although the airplane was pointing down the runway on a heading of 229,° it was moving on a track of 235°. The tire marks in the snow indicated that the touchdown was made in a right wing down attitude.

The evidence indicates that during the approach the captain attempted to realign the airplane with the center of the runway and overcorrected the alignment to the right The airplane then contacted the runway just as it was aligned on the proper heading, probably using rudder control. However, at that time, the captain had not leveled the wings and had not checked the movement of the airplane to the right. Consequently, after touchdown, the airplane continued to the right and went through the snowbank on the right side of the runway.

The Safety Board examined all the factors which might have misled the captain during the approach and landing. The snowshowers and fog were factors; however, a professional flightcrew is trained to accept such meteorological elements in a low visibility instrument approach. The Safety Board does not believe that the fog or the snowshowers affected the ability of the captain to align the airplane with the center of the runway. Additionally, the presence of the snowbanks on either side of the runway did not obstruct his vision of the runway edge lights before touchdown. In fact, both flight crewmembers recalled seeing the runway lights until after touchdown, and stated that they could see runway lights ahead of them after touchdown

There were, however, two visual elements which did affect the captain's efforts to align the airplane properly: (1) a landing at night over darkened areas and terrain made featureless by snow could have given the impression to the pilot that the airplane was higher than it actually was; and (2) when, at 1940:07, the first officer dimmed the approach lights, he also dimmed the runway edge lights The dimming of the lights could have made the runway lights seem farther away, creating the illusion that the airplane was higher than it actually was, especially if the pilot was not aware that the intensity of the lights had been reduced. Thus, the airplane may have landed before the captain expected it to land, and he may have thought he nad more time to align the airplane with the runway.

The Safety Board believes that a cause of the accident was the failure of the captain to align the airplane properly with the runway before the actual touchdown. While factors which may have distorted the captain's perception of the altitude and lateral displacement of the airplane existed, he was sufficiently trained and experienced that he should have recognized the problems associated with landing on snow-covered runways Given his level of experience, the captain should have been aware of the hazards of maneuvering the airplane close to the ground, especially under conditions of limited visibility. Rather than an attempt to correct the airplane's position while at a low altitude, a go-around should have been started where the captain realized the airplane was not properly aligned with the runway. The maneuver to correct the position of the airplane to the right resulted in an overcorrection in the position of the airplane- As a result, the airplane may have touched down earlier than the captain anticipated because of a misjudgment due to poor visual perception.

The Safety Board believes that the captain had little control of the airplane once it touched down on the runway with the momentum to the right The runway was slippery because of the approximately 2 inches of wet snow on top of ice and compacted snow. Additionally, the Safety Board found no evidence to indicate that improper application of reverse thrust contributed to the inability of the captain to control the airplane. The captain's perception of the location of the airplane on the runway was also limited by the obscuration of the runway centerline for reference and by the snow-covered terrain. He stated that after touchdown, he lost some of his peripheral vision. The Safety Board's cockpit visibility study confirmed that it was possible, if there had been a 36-inch snowbank, that the captain might not have seen the runway edge lights

on the left side of the runway, and that he could have had even a more limited view of the runway lights on the right side. However, since the captain said he had a continuous view of the runway lights toward the end of the runway, and since many passengers recalled seeing runway edge lights from their windows, the Safety Board concludes that the captain's line of sight was not limited to the extent described in the 36-inch case situation in which he may not have seen runway edge lights on the left side, end may have seen only six lights on the right side. However, it is possible that at and just after touchdown, the captain may have lost some peripheral cues because of the snowbanks

The wreckage distribution data showed that the No. 2 blade of the right propeller was found about 540 feet down the runway from the point of initial touchdown This location was close to the point where the airplane first struck the snowbank, and at the time there were power interruptions to the CVR and FDR. The right propeller struck the snowbank and the No. 1 blade separated and penetrated the airplane cabin on the right side between seat rows 1 and 2, injuring passengers in the cabin- It is likely that the right propeller failed and separated instantaneously after striking the snowbank, creating an imbalance which resulted in the separation of the engine reduction gearbox at the parting flange. It is likely also that the left propeller failed in a similar manner as the airplane veered to the right and again passed through the snowbank.

2.3 Airport Snow Removal

The Brainerd Airport Operations Manual and 14 CFR 139.85, Snow Removal and Positioning, state clearly the requirements for the removal and positioning of plowed snow at the airport. The usable surface of runway 23 was to be clear of snowbanks and the plowed snow was to be banked so that "all aircraft propellers, engine pods, and wingtips will clear snowdrifts and snowbanks when the aircraft's most critical landing gear is located at any point along the full strength edge of the runway." The airport management was required to ask the FAA to issue a NOTAM when the airport did not comply with the requirements of the operations manual.

Airport management had implemented the snow removal plan on January 7, 1983 according to the procedures set forth in the airport operations manual. At that time, runway 23 was plowed and the snow was positioned at the edges of the runway. The local Contractor who was responsible for the clearing of the runways stated that he had received no instruction on how to plow the runways or position the snow. However, the Safety Board believes that the physical location of the snowbanks at the edges of the runways indicates that the intent of that phase of the snow removal plan had been accomplished.

The second phase of the snow removal plan called for the MDOT to blow the snowbanks away from the edge of the runway. This phase was scheduled to be completed after the local contractor plowed the runway. The airport manager had elected not to start snow blowing operations until Monday, January 10, 1983. In the meantime, since there were snowbank which did not conform to the position and height requirements of the airport operations manual and 14 CFR 139.85, the airport manager should have requested a NOTAM describing the condition of the runway and the position and height of the snowbanks along runway 23. However, such a NOTA31 was not issued on the day of the accident. Further, the investigation indicated that the airport management had not requested similar NOTAM's in the past when plowing operations had left snowbanks.

The Safety Board is concerned about several factors regarding the snow removal operations at Brainerd Airport. The airport operations manual and 14 CFR 139.85 make allowances for the problems of plowing a runway and the positioning of the snow to meet 14 CFR 139.85. However, when airport management realized that the Snowbanks would nut be moved until 3 days after the plowing operations, it took no steps to see that a required NOTAM was issued to advise pilots of the potentially dangerous situation. Additionally, the investigation revealed that neither the airport manager nor the assistant manager was aware of the 12-inch propeller clearance height of the Convair 580. However, both individuals knew that the snowbanks were too high to allow a 12-inch clearance. Finally, the Republic Airlines station agent, who was responsible for monitoring the airport conditions, failed to notice or report that the snowbank were present. The Republic Airlines Flight Operation Manual had specifications concerning the location of snowbanks, especially in relation to the runway lights, which were not met

This accident investigation uncovered both a casual acceptance of the hazards created by snow-covered runways and positioning of plowed snow, and the communications breakdown which can occur between the airport management, the airline, and the pilot concerning the transmission of critical airport and runway condition reports. On April 22, 1983, the Safety Board issued a special investigation report 4/ on large airplane operations on contaminated runways which addressed specifically the need to improve the flow of critical information to pilots, the airlines, airport management, and air traffic control. As a result of the special investigation, the Safety Board concluded, in part, that the following actions should be taken to provide optimum safety during operations on contaminated runways:

> Refine communications between pilots, ATC, and airport management to keep all parties informed promptly when runway surface conditions change, particularly when braking performance is degraded.

The January 9, 1983, accident provides another clear example of a lack of communications -- communications which were required by regulation -- between the primary interests at the airport, and a lack of knowledge on the part of airport management and the Republic Airlines station agent about the snow plan and company procedures.

Additionally, the Safety Board believes that the Republic Airlines station agent should have been more observant and more aggressive in reporting airport conditions. Station agents at smaller airports serve as the representative of the airline and have the responsibility to provide specific information to the dispatch system, especially during periods of changing runway conditions. In addition to notifying Republic Airlines of the snowbanks on runway 23, a field condition report about the depth of snow on the runway should have been available to the flightcrew. The information concerning the depth of the runway contaminants was particularly important since there are suggested airplane operating limitations set forth in the Republic Airlines Flight Operations Manual based on runway contaminant depth. Although most passengers recalled only snow rather than slush on the runway, the station agent had reported slush to the flightcrew. The judgment of the station agent that there was slush on the runway underscores the imprecise manner in which he made the single snow depth measurement, since the depth of snow/slush was a factor which would affect continued Convair 580

4 Special Investigation Report--"Large Airplane Operations on Contaminated Runways" (NTSB/SIR-83/2).

operations at Brainerd Airport. Had the amount of slush increased by the time Flight 927 was ready to depart, the takeoff wouid have been cancelled. As a mstter of fact, the Safety Board has concluded that there was wet snow on runway 23 to a probable depth of 2 inches. A proper procedure to measure snow depth would have resulted in the correct information being passed to the flightcrew.

Although there were proper surface visibility markers available to take night visibility readings, the station agent at Brainerd Airport used the HIRL at the end of runway 5. These lights, on light setting 5, were a brightness of about 10,000 candela. The recommended intensity for night visibility reading is about 25 candela. The use of this reference for night visibility readings was contrary to NWS procedures and provided inaccurate information to flightcrews. Although this departure from standard procedures was not a factor in the accident, it did indicate an inadequate performance of duties by the station agent with regard to reporting conditions at the airport.

2.4 Brainerd Airport Lighting Control System

The investigation indicated that the lighting system for the HIRL and the MALSR operated properly and was fully controllable by the flightcrew of Flight 927 at the time of the accident. However, the field lighting plan of operation had yet to be approved by the FAA. Additionally, no agreement had been worked out by the airport management with Republic Airlines concerning its responsibilities for the operation of the system. Most significantly, however, was the fact that a NOTAM had not been promulgated which informed pilots of the test program, and of the fact that when activated by radio the intensities of the HIRL and the MALSR would change simultaneously. The Safety Board received sworn testimony from airport management that the information concerning the test system was transmitted to the Alexandria FSS on December 8, 1982. FAA personnel stated in sworn testimony that the information was not transmitted to the Alexandria FSS until January 21, 1983. Although the Safety Board was able to determine only that no NOTAM was issued until after the accident, the investigation revealed that the Republic Airlines station agent had no knowledge of the new lighting system. The Safety Board conciudes that although the new lighting system operated properly, the necessary approval and notification aspects of the installation program were not completed by airport management. The failure to inform airport tenants and user pilots of the functioning of the system reduced the usefulness of the test program and may have misled some pilots. The fact that the flightcrew of Flight 927 was not aware that they were dimming both the NIRL and the MALSR at 1940:07 could have reduced the captain's visual cues when the runway edge lights unexpectedly dimmed. Without regard to whether the airport management or the FSS were responsible for the fact that a NOTAM was not issued on December 8, 1982, the Safety Board believes that dissemination of information on the field lighting system to the Republic Airlines personnel was a responsibility of the airport management. It had the obligation to inform the major air carrier tenant at Brainerd Airport of the new system and to initiate an agreement specifying the responsibilities of the airline for the operation of the lighting system. The failure of airport management to complete the notification process contributed to the confusion about the operation of the lights and precluded important information from reaching the flightcrew of Flight 927.

25 survivability

There were no severe decelerative forces in the course of this accident, and the accident was classified as survivable. The No. 1 blade from the right engine entered the passenger cabin and was the sole cause of the fatal injuries to one passenger and the serious injuries to another passenger. The blade also destroyed two passenger seats and

penetrated the cabin floor between the first two rows of seats on the right side of the cabin. There was no smoke, fire, or major disruption of the cabin which would have impeded the evacuation which was orderly and was accomplished in probably less than a minute. The right engine operated until well after the evacuation was completed.

No conclusive evidence was found to account for the failure of the evacuation. slide to fall from the airplane and failing to inflate automatically after it was kicked from the airplane by the flight attendant. The slide was inflated manually by the flight attendant and functioned properly during the evacuation.

Timely action by passengers in keeping pressure on the kg of the injured child, the medical attention she received at the terminal, and the prompt transport to the hospital contributed to her survival.

2.6 Crash-Fire-Rescue Response

Although CFR response was not involved in the accident, the Safety Board is concerned about several aspects of the response planning which came to light during the investigation. The success of the CFR effort and the emergency plan at an airport depends entirely on the training of the CFR personnel and the training of all CFR and airport personnel with the relevant parts of the emergency plan. The investigation indicated that insufficient emphasis was placed on emergency planning and CFK training at Brainerd Airport, with the result that some persons were unfamiliar with the emergency plan. Additionally, because the Republic Airlines station personnel were unaware of their roles in the emergency plan, all the airport resources could not have been used in a full emergency. The training and use of airport tenant personnel is an important subject at small airports where paid airport personnel may be scarce. On January 25, 1977, the Safety Board issued Safety Recommendation A-76-143 which addressed CFR problems at airports which used part-time CFR personnel. The recommendation urged the CFR-training of personnel at airports to enable them to perform CFR duties, even though they were not employed as firefighters The recommendation was "Closed--Acceptable Action" when the FAA responded that CFR training of airport tenant personnel was encouraged, and that when the individuals were included in the emergency plan, their training was evaluated by FAX airport inspectors. Although Republic Airlines personnel were not assigned specific CFR duties in the emergency plan, the fact that they were not trained or familiar with the emergency plan indicates that the FAA should again stress these areas in annual 14 CFR Part 139 certification inspections.

3 CONCLUSIONS

3.1 Findings

I. The flightcrew was properly certificated, qualified. and trained for the flight.

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

3. The weather forecast and briefing received by the flightcrew for the Brainerd Airport reflected the weather conditions the flight encountered during the approach and landing at Brainerd.

4. The Republic Airlines station agent misinformed ?he flightcrcw that the ceiling at Brainerd Airport was 400 feet Obscured, when his actual observation had been 300 feet obscured.

5. Although the Republic Airlines station agent reported the snow depth as 1 inch, the actual wet snow depth at the time of the accident on the runway was about 2 inches.

6. The Republic Airlines station agent's method of measuring snow depth was inaccurate and imprecise.

7. There were no procedures in the airport operations manual which established a method for the measurement of snow depth on the runway.

8. The use of the high intensity runway lights by the Republic Airlines station agent did not conform to National Weather Service criteria for night visibility markers.

9. Runway plowing activities 2 days before the accident had left snowbanks at the edge of runway 23, inside the runway edge lights. The snowbanks had not been removed in accordance with 14 CFR 139.85 and the airport operations manual.

10. A NOTAM had not been issued to alert pilots about the snowbanks on each side of runway 23.

11. The Republic Airlines station *agent* had not reported the presence of the snowbanks to Republic Airlines flight control in a field condition report.

12. The high intensity runway lights and the approach light system worked properly and could be controlled by the flightcrew from the airplane.

13. The flightcrew was not aware of the nonstandard field lighting system because a NOTAM had not been issued which explained that both the medium and the high intensity lights would be dimmed simultaneously if activated by radio intensity controls.

14. The Republic station agent was unaware of the nonstandard field lighting system and no letter of agreement had been executed which specified the responsibilities of the Republic Airlines personnel for the operation of the field lighting system.

15. The plan for the operation for the field lighting system had not been approved by the Federal Aviation Administration.

16. The flightcrew had the approach lights and the runway edge lights in sight continuously from the time the lights were first observed when the airplane was about 1 mile from the runway until after landing.

17. The flightcrew believed that the approach. and the landing were routine until just before touchdown.

18. The flightcrew was not aware that when the first officer dimmed the intensity of the approach lights at 1940:07, the intensity of the runway edge lights was also dimmed.

19. The captain did not recall any difficulties with the runway or approach lights or his perception of the lights before landing.

20. The eirplane was slightly left of the runway centerline before touchdown

21. The captain attempted to maneuver the airplane to align it with the runway centerline while at a very low altitude.

22. The captain overcorrected to the right while attempting to align the airplane with the runway.

23. The captain's perception of the airplane's relationship to the runway was adversely affected by the snow and the dimmec runway lights.

24. The airplane touched-down earlier than the captain had anticipated in a right-wing low attitude, about 37 feet from the right edge of the 150-foot-wide runway.

25. The airplane was on a heading of 229° and a track of 235° at touchdown.

26. The airplane rolled off the runway on a track of 235° and the right propeller struck a snowbank on the right edge of the runway.

27. The flightcrew may have lost some peripheral vision at touchdown because the runway edge lights were masked by the snowbanks.

28. The captain was no? able to control the direction of the airplane on the runway between the time of touchdown and impact with the snowbank because of the slippery surface of the runway.

29. When the right propeller struck the snowbank two blades separated. The No. 1 blade penetrated the cabin, causing the injuries to the passengers

3.2 Probable Cause

The National Transportation Safety Board determines that the probable causes of the accident were the failure of the captain to properly align the airplane with the runway in sufficient time to allow a touchdown with no drift and the position of a snowbank on the edge of the runway the height of which exceeded that specified by regulation. Contributing to the accident were the intensity changes of the runway lights and the snow-covered terrain, both of which affected the captain's visual landing perception. The absence of a NOTAM on the control of the airport lighting system and failures of the airport management and the company station manager to report the location of the snowbanks to the flightcrew also contributed to the accident.

4. RECOMMENDATIONS

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

Require that airport operations manuals (AOM) contain explicit instructions and procedures for the reporting of any known change in the operating status of the airport crash/fire/rescue (CFR) equipment to backup fire department providing CFR services and that **all** airport or airport tenant employees who may be required to operate CFR equipment be knowledgeable of the instructions and procedures **(Class II,** Priority Action) **(A-83-84)**

Amend 14 CFR **139.49** to prescribe a minimum list of rescue/support equipment to be carried on each crash/fire/rescue vehicle which is commensurate with the airport's index of firefighting and rescue service. (Class II, Priority Action) **(A-83-85)**

Develop training programs for airport tenants at Index **A** and B airports on the basic techniques of fighting aircraft fires for use by airport inspectors in providing guidance to airport operators. (Class II, Priority Action) **(A-83-86)**

Issue appropriate notices and instructions to airport inspectors to encourage the operators of Index A and B airports, **as** well as State airport officials, to provide hands-cn firefighting training to airport tenants (Class *4* Priority Action) **(A-83-87)**

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.

G. H. Patrick Bursley, Member, filed the following concurring and dissenting statement:

I concur in the report but I do not agree with the majority in respect to the probable cause.

Notwithstanding the adverse circumstances attendant on the landing, i.e., the weather, the possibility the dimming of the runway edge lights may have passed unnoticed to create the illusion the airplane was higher than it actually was, and the fact snow was banked on the sides of the runway, the critical event in the cause of this accident was the pilot's failure to make a go-around when he realized the airplane was improperly aligned with the runway and only 50 feet above it. Moreover, the presence of the snowbanks along the sides of the runway affected the severity of the accident rather than caused the accident. Given the airplane's alignment upon landing there would have been an accident in any event. Accordingly, I believe the probable cause should be:

> The National Transportation Safety Board determines that the probable cause of the accident was the failure of the captain to align the airplane with the runway in sufficient time to make a touchdown on the centerline with no drift The failure of airport management to remove plowed snow on the sides of the runway contributed to the severity of the accident.

October 18,1983

5. APPENDIXES

APPENDIX A

INVESTIGATION AND HEARING

Investigation

The National Transportation Safety Board was notified of this accident at 2105 e.s.t., on January 9, 1983. An investigative team was dispatched at 0800 on January 10, 1983. Team departure was delayed until that time because weather conditions limited access to the accident site.

Investigative groups were established for Operations, Air Traffic Control, Witnesses, Human Factors, Weather, Structures, Systems, Powerplants, Aircraft Records, Flight Data, and Cockpit Voice Recorders.

Parties to the investigation were the Federal Aviation Administration, Republic Airlines, the Air Line Pilots Association, the Association of Flight Attendants, and the National Weather Service.

The National Transportation Safety Board did not hold a public hearing in this accident, but it did take depositions from persons involved in the operation of the flight and the City of Brainerd/Crow Wing County Airport.

APPENDIX B

PERSONNEL INFORMATION

Captain Henry L. Didier

Captain Henry L. Didier, 32, was employed by Republic Airlines on April 4, 1977.

Captain Didier holds Airline Transport Certificate Number 1789440; Airplane Multi-Engine Land CV A-340 CV A-440 CW-46; Commercial Privileges Airplane single Engine Land and Sea; Flight Instructor Certificate Number 1789440 CFI; Airplane Single and Multi-Engine; Instrument and airplane; Ground Instructor Number 2009786; Advance Ground Instructor; Instrument Ground Instructor.

Captain Didier's total flying time at the time of the accident was approximately 12,730 hours. Approximately 3,000 hours were in CV-580 aircraft; of this, approximately 2,000 hours were as CV-580 captain. Total pilot in command time was approximately 10,000 hours. He had varied experience in light aircraft which included:

> Cessna 300 to 400 series aircraft; Beech A-90, BE-18: King Air; Stearman; Cessna 120, 140, 180, 185; Piper Navajo; Aztec; Twin Commanche; Apache and various single engine aircraft on floats.

He was a designated FAA pilot examiner for single engine aircraft, commercial and private.

Captain Didier's last proficiency check was accomplished on October 14, 1982, and his last line check was administered on August 25, 1982.

He had flown 77:44 flight hours in the last 30 days, 153:29 flight-hours in the last 60 days, and 232:39 flight hours during the previous 90 days. He had flown 3:22 hours on the day of the accident. Captain Didier held a fist class medical certificate, dated September 3, 1982, with no limitations.

First Officer Daniel J. Fry

First Officer Daniel J. Fry, 31, was employed by Republic Airlines on October 22, 1979. He held Airline Transport Certificate Number 2128495, Type rating in a CE-500 airplane, single and multi-engine land, and Flight Instructor.

First Officer Fry has a total of approximately 5,100 hours of flying time, including about 1,500 hours in the CV-580. His last proficiency check was accomplished on December 18, 1982. First Officer Fry had flown 13:38 flight-hours in the last 7 days and 16:38 hours in the last 30 days. He had flown 3:22 hours on the day of the accident.

First Officer Fry held a first class medical certificate dated October 8, 1982. Limitations: Holder shall wear correcting glasses for distant vision while exercising the privileges of his Airman Certificate.

APPENDIX C

AIRCRAFT INFORMATION

The airplane a Convair 580-11-A, Serial No. 327A was manufactured on May 9, 1956.

Total airframe time accumulated at the time of the accident was 39,511.46 hours. Total airframe cycles were 64,033.

The airplane was equipped with Allison 501D-13 engines and A-6441FN606A Aeroproducts propellers.

Engine and propeller historical data are as follows:

Left Engine

Manufacturer:	Detroit Diesel Allison Division, Indianapolis, IN
Model:	501-D13
Serial:	501809
Total Time:	11,800.5 hrs.
*TSLMC:	209.6 hrs.

Right Engine

Manufacturer:	Detroit Diesel Allison Division, Indianapolis, IN
Model:	501-D13
Serial:	501543
Total Time:	11,974.5 hrs.
*TSLMC:	71.3 hrs.

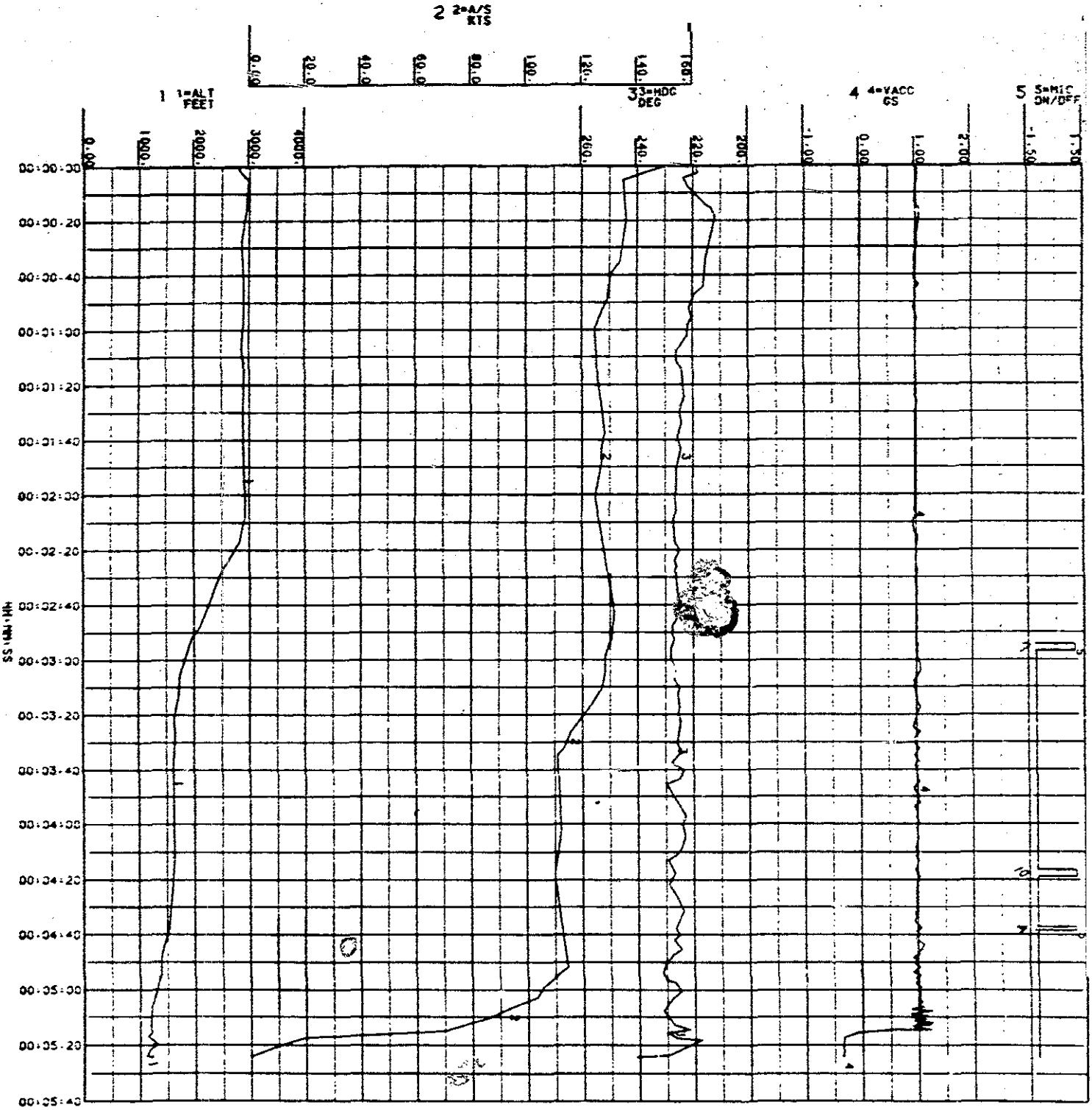
	Left Propeller	Right Propeller
Manufacturer:	Aero Products Propeller Div., Indianepolis, IN	
Model:	A-6441FN-606A	A-6441FN-606A
Serial:	RR 10033	HC2675
Total Time:	9,644.6 hrs.	12,998.0 hrs.
TSLMC:	209.6 hrs.	634.5 hrs.

Propeller Blade S/N.S.	Left Propeller	Right Propeller
	RR10033	HC 2675
Blade No. 1 ser.:	WY16540	WY16466
Blade No. 2 ser.:	WY11191	WY1.1861
Blade No. 3 ser.:	B 12178	WY16517
Blade No. 4 ser.:	WY1656A	WY16430

*/ TSLMC = Time Since Last Major Check

APPENDIX D

FDR TRANSCRIPT



NATIONAL TRANSPORTATION SAFETY BOARD
BUREAU OF TECHNOLOGY
WASHINGTON, D. C.

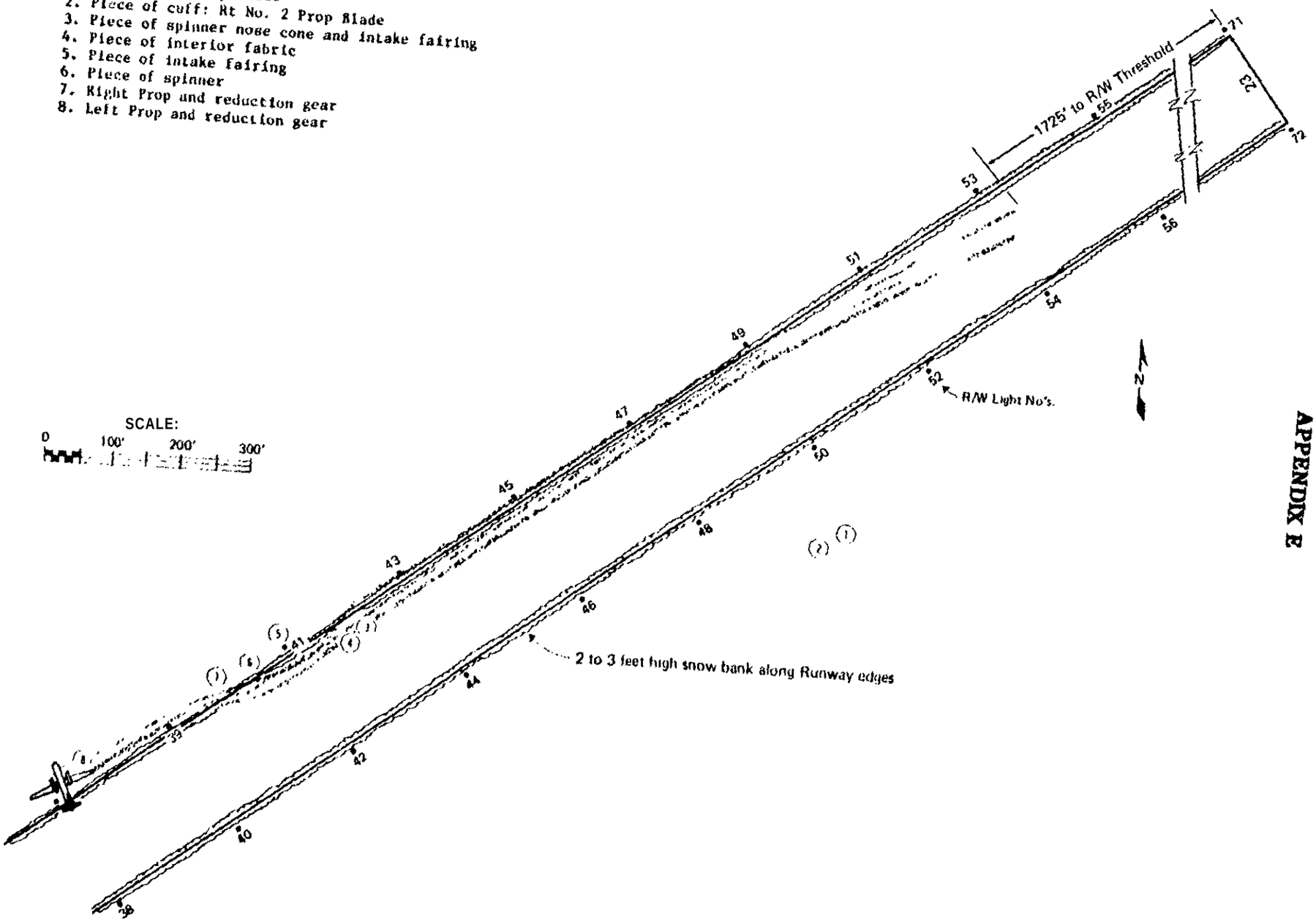
LOCATION:	BRAINERD, MINN.	RECORDER M/M:	SUND FA-542
DATE :	JANUARY 9, 1982	RECORDER S/N:	252?
AIRCRAFT:	CONVAIR 580, N8444M	IDENT. NO :	DCA 82-A-A013
OPERATOR:	REPUBLIC AIRLINES	REPORT NO. :	82-6
FLT NO.:	927		

ORIGINAL AS

WRECKAGE DISTRIBUTION CHART

Legend

1. Right No. 2 Prop Blade
2. Piece of cuff: Rt No. 2 Prop Blade
3. Piece of spinner nose cone and intake fairing
4. Piece of interior fabric
5. Piece of intake fairing
6. Piece of spinner
7. Right Prop and reduction gear
8. Left Prop and reduction gear



APPENDIX E