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15. Supplementary Notes

This report contains no new recommendations

16. Abstract Ozark Air Lines Flight 809, FH-227B(N4215) crashed 2.3 miles southeast of the Lambert-St. Louis International Airport, in St. Louis, Missouri, about 1743 central daylight time on July 23, 1973. Of the 44 persons on the aircraft, 38 were killed. The aircraft was destroyed by impact and fire.

While Flight 809 was making an ILS approach to runway 30L at Lambert-St. Louis, a severe thunderstorm with heavy rain, strong winds, and roll clouds moved across the approach end of the runway and the localizer course from the southwest. After passing the outer marker, the aircraft descended below the glide slope, entered an area of heavy rain, was struck by lightning, and crashed.

There was no in-flight damage to, or malfunction of, the aircraft's structure, powerplants, or systems. There was no evidence that lightning had caused a malfunction of an essential system or structural damage.

The National Transportation Safety Board determines that the probable cause of the accident was the aircraft's encounter with a downdraft following the captain's decision to initiate and continue an instrument approach into a thunderstorm. The captain's decision probably was influenced by the lack of a timely issuance of a severe weather warning by the National Weather Service, and the improper assessment of the weather conditions in the terminal area by the flightcrew and the flight dispatcher.

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AIRCRAFT ACCIDENT REPORT

OZARK AIR LINES, INC.
FAIRCHILD HILLER FH-227B, N4215
NEAR THE LAMBERT - ST. LOUIS
INTERNATIONAL AIRPORT
ST. LOUIS, MISSOURI

JULY 23, 1973

Adopted: April 24, 1974

NATIONAL TRANSPORTATION SAFETY BOARD
Washington, D.C. 20591
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SYNOPSIS

About 1743 c.d.t. on July 23, 1973, Ozark Air Lines Flight 809, a FH-227B (N4215), crashed 2.3 miles southeast of the Lambert-St. Louis International Airport, in St. Louis, Missouri. Forty-one passengers and three crewmembers were aboard the aircraft. Thirty-seven passengers and one crewmember received fatal injuries. The aircraft was destroyed by impact and fire.

While Flight 809 was making an instrument landing system (ILS) approach to runway 30L on Lambert-St. Louis, a severe thunderstorm with heavy rain, strong winds, and roll clouds moved across the approach end of the runway and localizer course from the southwest. After passing the outer marker, the aircraft descended below the glide slope, entered an area of heavy rain, was struck by lightning, and crashed.

There was no in-flight damage to, or malfunction of, the aircraft's structure, powerplants, or systems. There was no evidence that lightning caused any malfunction of essential systems or caused structural damage.

The National Transportation Safety Board determines that the probable cause of the accident was the aircraft's encounter with a downdraft following the captain's decision to initiate and continue an instrument approach into a thunderstorm. The captain's decision probably was influenced by the lack of a timely issuance of a severe weather warning by the National Weather Service, and the improper assessment of the weather conditions in the terminal area by the flightcrew and the flight dispatcher.

As a result of the accident, the National Transportation Safety Board made six recommendations to the Federal Aviation Administration.

1. INVESTIGATION

1.1 History of Flight

Ozark Air Lines Flight 809, an FH-227B (N4215), was a regularly scheduled passenger flight between Nashville, Tennessee, and St. Louis, Missouri. It made scheduled stops at Clarksville, Tennessee, Paducah, Kentucky, Cape Girardeau, Missouri, and Marion, Illinois.

The flight departed Marion, Illinois, at 1705 1/ on July 23, 1973, with an instrument flight rules (IFR) flight plan to Lambert-St. Louis International Airport. Forty-one passengers and three crewmembers were on board. The flight proceeded via the V-335 airway toward St. Louis without difficulty. The flight was under the radar surveillance and control of the Kansas City Air Route Traffic Control Center (KCC).

At 1726:47.7, the KCC controller requested that Flight 809 make a 360^{o} turn to the right. He advised that there would be about a 5-minute delay and that the right turn would keep the flight clear of the weather. The flightcrew indicated that they would comply with the request.

The cockpit voice recorder (CVR) tape indicates that immediately after the controller's request, the first officer said, "We're not going to be able to make it. I don't know, unless we follow it inbound." After the captain replied "Okay," the first officer asked "That's Okay?" The captain said "Yeah." The first officer said, "It's about 30 miles then from us, between us and the outer marker." The captain replied, "About over the outer marker," to which the first officer responded, "That's right."

At 1728:52.3, the KCC controller cleared the flight to proceed to the St. Louis VOR and to contact St. Louis Approach Control. At 1729:47, the first officer transmitted, "Approach, this is Ozark eight oh nine, seven thousand, with Quebec." 2/ The pertinent information in the Quebec broadcast was: Estimated ceiling-4,000 feet broken, visibility-5 miles, haze and smoke, wind-120^{o} at 8 knots, temperature-92^{o}, altimeter-30.06, ILS runway 12R approaches in use, landing and departing runways 12. The approach controller respond: "Ozark eight oh nine, Roger, maintain seven thousand and, . . . continue toward the VOR, be vectors runway three zero left ILS." The first officer acknowledged with "Roger."

The first officer then called Ozark operations personnel on the company radio frequency and reported that the right engine fuel boost pump and the main inverter were inoperative. Then he called the Spirit of St. Louis Airport Unicom and asked the operator to inform a local general aviation company that he would be 15 or 20 minutes late.

1/ Unless otherwise specified, all times herein are central daylight, based on the 24-hour clock.

2/ An Automatic Terminal Information Service (ATIS) broadcast of airport traffic and weather conditions.

Between 1732:26 and 1739:22, the approach controller gave Flight 809 radar vectors through an area of thunderstorm cells that lay south and southeast of the St. Louis Airport. At 1740:12.9, the controller cleared the flight for an ILS approach to runway 30L. At 1740:42.6, he cleared the flightcrew to contact the St. Louis Control Tower and informed them that the flight was 2 miles from Berkley. (See Appendix D.)

At 1741:04.3, Flight 809 established communications with the St. Louis tower local controller. At 1742:00.9, the controller said, "...Ozark eight oh nine, you're in sight and cleared to land runway three zero left..." The first officer acknowledged the clearance and asked for wind information. The controller responded: "Wind is, it's been gusting, ... it's right now, it's two two zero. It's been around to about three four zero degrees, holding at twenty but occasional gust up to thirty-five." The first officer replied, "Roger."

At 1742:31, the local controller said, "Ozark eight oh nine, it looks like a heavy rain shower moving right across the approach end of the runway now." The first officer replied, "Roger, we see it." That was the last transmission from the flight. The CVR stopped at 1743:24.

The local controller stated that he lost sight of the aircraft because of the rain. Until that time, he had observed Flight 809 executing what appeared to be a normal ILS approach. He continued to follow the flight's progress on the tower radar, but lost primary radar contact when the flight was about 2 miles from the runway. When he observed the alpha-numeric radar track of the aircraft move to the left of the localizer course, he tried unsuccessfully to make radio contact with the flight.

Flight 809 crashed into a residential area about 2.5 miles southeast of the approach end of runway 30L and about 700 feet south of the extended runway centerline.

An aeronautically qualified witness, who was about 2,000 feet north-northwest of the accident site, stated that he had observed the aircraft executing what appeared to be a normal ILS approach. As the aircraft continued the approach, it suddenly ascended about 400 to 500 feet and then rapidly descended to 200 feet above the ground. Shortly thereafter, according to the witness, lightning struck the wing just outboard of the left engine. The lightning was followed by a rolling flash of fire. The aircraft again lost altitude and, after several apparent "evasive maneuvers," disappeared into the rain and trees.

Other witnesses, who were east-southeast of the accident site and at various points along the flightpath of Flight 809, reported that the aircraft's altitude had appeared "much lower than normal." They stated that it had been raining heavily and that the wind had been blowing very hard from the southwest. One witness, who was about 1.4 miles east-southeast of the accident site, said that the aircraft had flown low over her house and had disappeared into an area of heavy rain west-northwest of her position.

A Trans World Airlines Boeing 727, Flight 244, approached runway 30L about 1.5 minutes before Flight 809. The captain of Flight 244 stated that because of a strong updraft he had difficulty in slowing his aircraft to the proper final approach airspeed. Because he was unable to establish the desired landing configuration and airspeed, he executed a missed-approach. He said that he had been clear of all clouds about 1,000 feet above the ground and 4 miles southeast of the runway. About 1/4- to 1/2-mile to his left, the captain of Flight 244 saw a "wall of water" that paralleled the localizer course and curved around the southwest corner of the airport.

A light twin-engine aircraft that preceded Flight 244 on the same ILS approach landed on runway 30L at 1740. The pilot stated that he had difficulty controlling his aircraft after intercepting the localizer course about 4 miles southeast of the outer marker (OM). Because of a strong updraft, he was unable to descend from 6,000 feet mean sea level (m.s.l.). A downdraft near the OM caused his aircraft to drop 3,500 feet per minute, the maximum rate displayed on the instantaneous vertical velocity indicator. He flew the aircraft out of the downdraft near glidepath altitude several miles from the end of the runway, continued the approach, and landed. Several minutes later, a dark, heavy rainstorm, with strong, gusty surface winds, moved across the airport from the west and northwest.

The captain of Flight 809 stated that except for two minor malfunctions of the aircraft's systems, the flight had been routine until it arrived in the St. Louis terminal area. As the flight approached St. Louis, the captain used the airborne weather radar, which was operating properly, to identify thunderstorm cells.

The captain recalled overshooting the localizer course and disconnecting the autopilot to make the necessary correction to return to course. He could see the runway from outside the OM. After the tower controller had informed him of the heavy rain shower which existed over the approach end of the runway, he could still see the end of the runway through the rain. As the flight proceeded inbound from the OM the captain noticed what appeared to be a roll cloud below to his left, and parallel to the localizer course, and a "wall of clouds" along the southern and western circumference of the airport.

The captain could recall nothing else except: Hearing something like hail hitting the airplane; pushing the throttles forward; and applying back pressure to the control column. He recalled becoming conscious in the wreckage, feeling the injury to his head, seeing fire, and attempting to free himself and the first officer.

According to an Ozark Air Lines employee who had arrived at the scene about 30 minutes after the accident, the captain said that he had been struck by lightning. When he testified at the public hearing, the captain could not recall having made the statement or having been struck by lightning. The first officer did not remember anything that had occurred on the day of the accident. The geographic coordinates of the accident site are 38° 43'07"N. latitude and 90° 18'30"W. longitude.

1.2 Injuries to Persons

Injuries	Crew	Passengers	Other
Fatal	1	37	0
Nonfatal	2	4	0
None	0	0	

1.3 Damage to Aircraft

The aircraft was destroyed.

1.4 Other Damage

Trees and bushes were destroyed or damaged, and a power line was severed. Two residences were slightly damaged.

1.5 Crew Information

The captain and first officer were certificated according to regulations. All crewmembers received the training required by the company and by the Federal Aviation Administration (FAA).

The captain was upgraded from first officer in August 1971. He did not begin flying as captain, however, until March 22, 1973, when he received his captain's checkout in the FH-227. From March 22, 1973, to the day of the accident, he acquired about 66 flight-hours as pilot-in-command of FH-227 aircraft.

Because of an employee strike, neither the captain nor the first officer flew with Ozark Air Lines from April 19, 1973, to July 1, 1973. From July 1 to the day of the accident, the captain and first officer flew 30:25 and 59:30 hours, respectively, in the FH-227. They both had been off duty about 19 hours before they reported for duty at 1000 on the day of the accident. (See Appendix B.)

1.6 Aircraft Information

Ozark Air Lines owned and operated the FH-227B, N4215. Except for the cabin attendant's seat, which did not meet FAA regulations, the aircraft was certificated, equipped, and maintained according to approved company procedures and FAA regulations.

At the time of the accident, the gross weight of N4215 was about 43,000 pounds. The center of gravity and gross weight were within prescribed limits.

The aircraft departed Paducah, Kentucky, with a full load of Jet A kerosene fuel aboard. About 4,830 pounds of fuel were aboard when the plane crashed. (See Appendix C.)

1.7 Meteorological Information

Synoptic Situation

The surface weather chart for 1600 on July 23, 1973, showed a wave on a quasi-stationary front over northeastern Missouri. One portion of the front extended southwestward from the wave and another portion extended east-southeastward. The chart for 1900 showed a warm front which extended northeastward from southern Kansas to northwestern Illinois, then southeastward to northeastern Kentucky. A semicircular squall line extended clockwise from central Illinois, about 60 miles east and 60 miles southeast of St. Louis, to Kansas City. A meso-scale high-pressure system was centered near St. Louis.

Surface Weather Observations

St. Louis

1654 - Estimated ceiling 4,000 feet broken, 25,000 feet overcast, visibility-6 miles, temperature-90° F., wind-130° 12 knots, cumulonimbus northwest moving east-northeast, towering cumulus north, wind 090° variable to 170°.

1725 - Special, 1,200 feet scattered, measured ceiling-2,500 feet broken, visibility-10 miles, wind-320° 22 knots, gusts 26 knots, altimeter setting-30.09 inches, pressure unsteady.

1742 - Special, measured ceiling 1,100 feet broken, 2,800 feet overcast, visibility-10 miles, thunderstorm, heavy rain showers, wind 300° 29 knots, gusts 30 knots, altimeter setting-30.15 inches. Thunderstorm began at 1737, thunderstorm west, moving east, occasional lightning in clouds and cloud to ground, pressure rising rapidly; rain began at 1732.

1746 - Special, measured ceiling 1,100 feet overcast, visibility-1 mile, thunderstorm, heavy rain showers, wind-220° 20 knots, gusts 33 knots, altimeter setting-30.22 inches. Thunderstorm began at 1737, thunderstorm overhead, moving east, frequent lightning in clouds and cloud to ground, pressure rising rapidly, rain began at 1732, runway 24 visual range-2,400 feet variable to more than 6,000 feet.

1755 - Record Special, indefinite ceiling 200 feet obscured, visibility-1 mile, thunderstorm, heavy rain showers, sea level pressure-1,023.7 millibars, temperature-72° F., dew point-72° F., wind-220° 24 knots, gusts 33 knots, altimeter setting-30.24 inches. Thunderstorm began 1737, thunderstorm overhead, moving east, frequent lightning in clouds and cloud to ground, pressure unsteady, peak wind 190° 33 knots at 1745; rain began at 1732, runway 24 visual range-1,400 feet variable to more than 6,000 feet, precipitation 1.03 inches.

The rainfall record in the National Weather Service Forecast Office (NWSFO) at the airport showed that heavy precipitation began about 1740; about 1.55 inches of rain fell in the following 45 minutes. A rainfall recorder which was located about 1 mile southeast of the approach end of runway 30L, recorded about 1.75 inches of rainfall between 1740 and 1800.

National Weather Service (NWS) Forecasts

Part of the aviation terminal forecast issued by the St. Louis NWSFO at 1140, valid from 1200 on July 23, 1973, to 1200 on July 24, 1973, was as follows:

St. Louis, 1500-0100: Ceiling 3,000 feet broken, 10,000 feet broken, wind-180° at 8 knots, occasional ceiling-3,000 feet overcast, visibility-6 miles, thunderstorm, moderate rain showers. This forecast was not changed until 1740.

The aviation area forecast issued at 1340 by the NWSFO at Chicago, Illinois, valid from 1400 on July 23, 1973, to 0200 on July 24, 1973, predicted widely scattered showers and thunderstorms over Missouri. There was no SIGMET or AIRMET advisory in effect for any part of Missouri or Illinois at the time of the accident.

Radar Weather Observations

The NWSFO at St. Louis was equipped with a WSR-57 weather radar unit on the day of the accident.

The WSR-57 is an S-band radar with an effective range of 250 miles. The elevation of weather echoes is displayed on a range height indicator and the position of weather echoes is displayed on a plan position indicator (PPI). Measurements of elevation 100 miles from the antenna and beyond are subject to increasing error, and the 45° limit of antenna tilt precludes measurements above 55,000 feet within 10 miles of the antenna. Photographs of the PPI display at pertinent time intervals are included in Appendix E.

The NWS radar observer records observations at least once an hour when weather echoes exist and more frequently when conditions require them. The observer codes the weather radar data and transmits them to the National Severe Storms Forecast Center (NSSFC) at Kansas City, Missouri. The data were scheduled to be sent via teletype at 40 minutes past the hour. At NSSFC, the data are plotted, analyzed, and developed into radar summary charts of the United States. The charts are transmitted to various organizations via facsimile circuits 14 times every 24 hours. The NSSFC also issues tornado and severe storm watches to affected geographic areas. The radar summary charts issued by NSSFC at 1640 and 1738 on July 23 showed scattered thunderstorms in the St. Louis area.

Portions of the St. Louis narrative weather radar summaries prepared by the forecast office at St. Louis for the times indicated were as follows:

1640 - "Thunderstorms continue over eastern Missouri . . . eastern edge from 30 miles west of Springfield, Illinois, southward to just west of St. Louis to 100 miles southeast of St. Louis in the southern tip of Illinois. . . precipitation is moving toward the northeast at 20 mph. . . isolated storms are expected to produce heavy rain. . . strong, gusty winds and possibly hail as they move northeastward during the next few hours."

1738 - "Conditions were similar to those described in the 1640 summary, except for the line of thunderstorms which was positioned over St. Louis, . . . with the most intense storms in a line 10 miles wide centered over St. Louis and extending 20 miles north and south of St. Louis. . ."

Dissemination of Weather Information

The St. Louis surface weather observations were transmitted through TelAutograph 4/ to the FAA control tower cab and IFR room, the FAA Flight Service Station, Ozark Air Line Flight Dispatch Center, and various other subscriber organizations at the airport. Information was transmitted several minutes after the observation had been made. The coded, but not the narrative, weather radar summaries were also transmitted through TelAutograph. A severe thunderstorm warning was so transmitted about 1748 on July 23.

NWS personnel also broadcast weather information by FM radio located in the St. Louis facility. The broadcasts include surface observations, narrative weather radar summaries, and severe weather warnings. Subscribers to this service can use muted receivers that are activated automatically by the broadcast signal. At 1742 on July 23, NWS personnel broadcast a severe thunderstorm warning which neither Ozark Air Lines nor the FAA heard, since they did not subscribe to the service.

Local surface weather observations and forecasts were also disseminated over Service A teletype facilities to various organizations, one of which was the Ozark Air Lines Flight Dispatch Center.

Postaccident Observations

Trees surrounding the accident site were damaged by wind. The heaviest damage was in an area which extended from a short distance northwest to about 1 mile southeast of the accident site and approximately ½ mile on both sides of the localizer course. A NWS expert estimated that winds of 65-70 mph would have been required to cause such damage.

Witnesses, who were located about 5 miles south-southeast of the accident site, saw a mass of debris rotating counterclockwise near the ground. The time was between 1735 and 1745 on the day of the accident. The wind damaged trees in an area 450 feet wide and 1,500 feet long. The wind blew the roof of a large building a distance of about 300 feet.

Special Weather Study

The National Weather Service prepared a special study of the weather conditions in the St. Louis area. The study showed that two distinct squall lines which contained thunderstorms had converged near the St. Louis airport about the time of the accident. One line was oriented nearly north-south (N-S) while the other was oriented east-southeast-west-northwest (ESE-WNW). Both lines were moving in a northeasterly direction at 30 knots.

4/ A machine on which the sender can write words, symbols, and numbers. This information is then transmitted electronically and reproduced graphically on a receiver.

After considering the temperature and humidity at 1700, the NWS determined that a parcel of air would become saturated after it was lifted adiabatically to the 760-millibar level. If it were lifted to the 500-millibar level, the parcel would be 3.5° C. warmer than the surrounding air, and thereby would generate a highly active thunderstorm cell. The resulting downrush of air within the cell could produce surface winds with gusts to 60 knots and 1/2- to 3/4-inch hail at or near the surface

Since the ESE-WNW squall line was moving northeast at 30 knots, downrush velocities within one of the cells would be added along the northern edge and subtracted along the southern edge. Consequently, strong, southerly surface winds of 60-90 knots might have existed along the northern edge of the line as it moved northeastward and perpendicular to the localizer course. An aircraft north of the line would be flying in an area of strong updrafts. However, if the aircraft flew into the line, the aircraft would encounter strong downdrafts.

The accident occurred during daylight hours but in heavy rain under dark overcast skies.

1.8 Aids to Navigation

The St. Louis airport is equipped with approach surveillance radar and ILS facilities. (See Appendix D.)

After the accident, the radar and ILS equipment were ground-tested and the ILS was flight-tested. All components operated within prescribed tolerances.

1.9 Communications

Tests indicated that pertinent radios in the St. Louis tower were operational. The captain's transceiver was damaged slightly. When tested, it operated according to manufacturer's specifications.

The first officer's transceiver sustained moderate compression damage to the synthesizer assembly. After a serviceable synthesizer assembly was installed, the transceiver operated properly.

The FAA's tape of recorded air traffic control communications and the CVR tape indicated that the aircraft's radios were functioning before impact.

Under existing air traffic control procedures, neither the approach controller nor the tower controller has authority to deny a pilot's request to make an approach or landing, except when aircraft cannot otherwise be safely separated or controlled. The pilot is responsible for adhering to rules and regulations which govern approaches and landings.

Controllers are responsible for providing the pilot with the latest official weather observations. In addition to their primary function of air traffic control, controllers also provide advisory service. This advisory service includes advice and information provided to pilots to assist them in the safe conduct of flight and aircraft movement. FAA tower controllers who are certified weather observers are authorized to make official weather observations. However, if a NWS weather station is located at the airport, FAA controllers make official observations only when the prevailing visibility is less than 4 miles. These controllers may disseminate general weather information, such as, "large breaks in the overcast," "visibility lowering to the south," or similar statements which do not include specific values. Also, they may transmit to pilots or other ATC facilities any weather observations derived directly from instruments, pilot reports, or radar without consulting the weather station. Otherwise, specific values for elements such as ceiling and visibility may be transmitted only if they are obtained from a certified observer or from a report composed or verified by the official weather station.

1.10 Aerodrome and Ground Facilities

The St. Louis - Lambert International Airport is about 9 miles northwest of downtown St. Louis. The airport elevation is 589 feet. It contains one set of parallel runways and two single runways. Three runways, 30L, 12R, and 24, are equipped with ILS facilities.

1.11 Flight Recorders

N4215 was equipped with a Fairchild Hiller flight data recorder (FDR) model F-5424, serial No. 2675, and a United Control cockpit voice recorder (CVR) model V-557, serial No. 1940.

The outer case of the FDR was not damaged and the recording foil was in good condition.

The altitude and airspeed traces were abnormal, a condition that had existed during the preceding 77 flights. The recorder was found in the wreckage with the static pressure line disconnected. The heading and vertical acceleration traces operated properly.

The CVR case and recording tape were not damaged. The quality of the information recorded on the captain's and first officer's radio channels was fair. The recording of the cockpit area microphone (CAM) channel was poor. The input signal to this channel was derived from a single, omnidirectional, dynamic microphone which was mounted on the center overhead instrument panel. The CAM channel of the tape operated intermittently for about 6 seconds, beginning 2 minutes before the end of the recording. After this intermittent operation, the sound level returned to normal, and one of the crewmembers said, "What was that?" About 13 seconds later, the sound level dropped to a low volume level for 1 second, returned to normal

for 2 seconds, and dropped again to a low volume level. It remained at that low level until the end of recording, 97 seconds later.

The CVR, the CAM, and the microphone monitor unit were tested. The system operated within specified tolerances.

1.12 Wreckage

First, the aircraft struck tree tops about 55 feet above the ground. About 280 feet farther west along the flightpath, the left wing struck trees; 200 feet still farther west, the aircraft struck a large sycamore tree. The aircraft continued in a westerly direction for about 140 feet, where it struck the ground. It stopped on a hillside near Lowen Drive in Normandy, Missouri--a suburb of St. Louis.

Damage to the aircraft and the sycamore tree indicated that the aircraft was in a high noseup attitude when it struck the tree. On impact, both wings separated from the center wing section, just outboard of the engine nacelles. The right wing was damaged slightly by fire near its separation point. Fire also damaged the left wing stub of the center wing section, near the left engine nacelle area. The center wing section separated from the aircraft, which created a large hole in the fuselage.

Portions of ailerons and wing flaps remained attached to both wing structures. Wing-flap-jackscrew measurements indicated that the flaps were extended 27^{0}.

Both main landing gears broke off. The nose gear was intact but severely damaged. The condition of the down-lock assemblies and actuating cylinders indicated that the landing gear had been in the extended position.

The fuselage was found lying on its left side. The area where the left wing joins the fuselage was severely damaged. The area from the cockpit aft to the point at which the right wing joins the fuselage was also extensively damaged. The fuselage broke open circumferentially just aft of the cockpit. The cockpit section was found on Lowen Drive.

The empennage section remained attached to the aft fuselage. The left horizontal stabilizer was broken chordwise by overload forces. The vertical and right hortizontal stabilizers remained intact.

The aircraft was examined for evidence of lightning damage. About 75 randomly spaced pits, which ranged from 1/32- to 1/8-inch in diameter, were found on the entire length of the underside of the fuselage. Several similar pits were found on the top surface of the left aileron. There was no other evidence of electrical arcing or burning.

The ten precipitation static eliminators showed no evidence of lightning damage. Antennae, waveguides, navigation and conspicuity light systems, circuit boards, transistors, and other electronic components in the communications and navigation equipment were examined for evidence of a high flow of electrical current; none was found.

Both engines and propeller assemblies were recovered from the wreckage. Although the left engine was only slightly damaged, the right engine was extensively damaged.

The turbine-to-reduction-gear torque shafts in both engines were fractured. The condition of the reduction gear components indicated that the propellers had stopped suddenly, while under power. The propeller blade angles were commensurate with a final approach airspeed and power setting.

There was no evidence of in-flight malfunction or failure of either powerplant.

The captain's and first officer's altimeters were recovered intact. The barometric setting was 30.04 inches on the captain's altimeter and 30.02 inches on the first officer's altimeter. The flightcrew was not aware that the St. Louis altimeter setting at 1739 was 30.15 inches.

The internal sector gear counterweight, mounting screw, and a compensator pin were loose in the instrument case of the captain's altimeter. The altimeter contains two compensator pins, one behind the rocking shaft and the other behind the balance assembly support. The identity of the loose compensator pin was not established before its reinstallation. Therefore, the altimeter was tested first with one and then with the other compensator pin removed.

The altimeter functioned within tolerances after removal of the pin behind the rocking shaft. After removal of the pin behind the balance support assembly, however, an error of +530 feet and erratic movement of the pointer were recorded at a pressure altitude of 1,000 feet. Vibration testing did not cause either pin to come loose from its normal position.

The sector gear counterweight was removed from the altimeter and the instrument was tested. Tests showed that altimeter accuracy and performance were not significantly affected. Because the sector gear pivots and the first officer's altimeter were broken, the altimeter could not be functionally tested. There was no internal evidence of preimpact damage.

1.13 Medical and Pathological Information

Pathologists from the St. Louis County Coroner's Office examined all the deceased passengers and the cabin attendant. They also conducted toxicological studies of blood samples from the deceased. Typical injuries included compound fractures of the extremities, skull fractures, crushed chests, dismemberment, fourth degree burns, massive internal injuries, and other traumatic injuries.

The cabin attendant's injuries included a skull fracture, crushed chest, and massive internal injuries. Toxicological tests indicated no evidence of carbon monoxide or hydrogen cyanide in the deceased.

Four passengers, who were seriously injured in the accident, were thrown clear of the fuselage during the crash sequence. Their injuries included compound fractures to their extremities, vertebra fractures, rib fractures, multiple contusions, and severe lacerations to the head and body.

The captain received serious head, chest, and leg injuries. The first officer received massive facial injuries. The aircraft was not equipped with crewmember shoulder harnesses, nor were they required.

1.14 Fire

Several small fires broke out in various portions of the wreckage after final impact.

At 1746, the Normandy Fire Protection District Dispatcher was notified that a house on Lowen Drive was on fire. Fire and rescue equipment were dispatched immediately and arrived at the scene about 1749. The fires were quickly extinguished. Rescue operations began immediately upon arrival of the equipment. Several residents of the area assisted.

1.15 Survival Aspects

When the fire chief realized the severity of the accident, he requested five more rescue units and all available ambulances. The rescue efforts were hampered by heavy rain, high winds, and some flooding in the area. The last passenger was removed from the wreckage about 2215. Thirty-four police departments participated in the rescue and salvage activities; 9 fire departments and 16 ambulances were dispatched.

The Inspector of the St. Louis County Police arrived at the scene about 1808. He established a communications command post and began coordinating the dispatch and routing of ambulances and other rescue vehicles. He also directed the control of traffic that began to congest the accident area.

All passenger seats but one broke loose from the fuselage floor structure. According to rescue personnel, most of the passengers were found scattered throughout the final impact area, still strapped to their seats. Only three seatbelts failed. One belt buckle jammed in the open position; another buckle failed at the belt attachment point; the third belt separated from the seat attachment anchor.

The seats in the first three rows and in rows 8 through 11 failed in a left, forward direction; the seats in rows 4 through 7 failed in a right, forward direction.

1.16 Tests and Research

When the captain's flight director instrument (Collins FD-108) was found in the wreckage, it displayed a command bar indication of pitch down 10° and bank right. The instrument case was pressed into the command bar gears, which were not movable.

After the dent in the case was removed, the command bars functioned normally during testing, as did other flight director components. The captain's flight director system, which consisted of the flight director instrument, flight control computer, and amplifier, was tested to determine what caused the pitch-down display.

The flight control computer did not function properly, and its case was warped slightly. After the warp was relieved, however, the computer pitch attitude channel functioned properly. The bank channel remained inoperative. Tests revealed that the pitch control function of the flight director instrument operated satisfactorily, and a component defect that might have caused a pitch-down indication could not be found.

In normal ILS mode operation, the command bars in the flight director instrument indicate to the pilot the direction in which to fly the aircraft to intercept the ILS glide slope and localizer course. When the aircraft is directly on course and glide slope, the command bars will be centered appropriately in the instrument case. If the aircraft descends below the glide slope, the command bars will move toward the top of the instrument case, displaying a fly-up indication to the pilot. A reverse indication is displayed if the aircraft is above the glide slope beam.

However, the system is designed so that when the aircraft exceeds a 9.8° noseup attitude, the vertical gyro in the flight control computer signals a command bar pitch-down display, regardless of the aircraft's position with respect to the ILS glide slope beam.

The gyro signal is proportional to the aircraft pitch angle when the angle exceeds 9.8° noseup. For instance, if the aircraft is positioned in a 19.8° noseup attitude, the vertical gyro will signal a command bar display of 10° nosedown.

Metallurgical tests were made of two sections of the aircraft fuselage skin which contained pits believed to have been caused by lightning. These pits were similar to those produced by an electrical arc when it contacts the surface of the skin. The pits appeared to have been freshly made, since they contained little or no dirt and soot deposits.

1.17 Other Information

The Ozark Air Lines Operations Manual contained procedures for thunderstorm recognition and avoidance. The company's general policy was to suspend operations over a route or a particular area if thunderstorms generated an unacceptable level of turbulence. Also, the company advised against penetrating any known thunderstorm cell which had been detected visually or by airborne weather radar. The avoidance criteria specified were: (1) The pilot should attempt to avoid thunderstorms which are suspected to be severe, by 20 miles at all levels, and (2) he should attempt to avoid all other thunderstorms by 10 miles at all levels.

With reference to operations into terminals with high-density traffic, the manual cautioned pilots as follows: ". . . little space is available to permit deviations; therefore, you must evaluate the weather situation in the terminal area well prior to arrival and inform ATC of your intentions so that the area and approach controllers can take appropriate action to avoid conflict."

2. ANALYSIS AND CONCLUSIONS

2.1 Analysis

General--Except for the cabin attendant's seat, the aircraft was equipped, certificated, and maintained according to company procedures and FAA requirements. The cabin attendant's seat did not conform to FAA regulations, and it should not have been certificated for use. Effective August 27, 1973, the carrier discontinued use of this seat. (See Appendix F.)

There was no evidence of any failure or malfunction of the aircraft's structure, powerplants, or systems that would have affected the aircraft's performance before impact with trees. There was no evidence of a fire in flight.

The crewmembers were qualified and certificated. They received the training prescribed in the company training programs, which were approved by the FAA. Both pilots had received the crew rest period required by FAA regulations.

The thunderstorms which moved across the St. Louis Airport and the surrounding area were severe. The storms were more intense in a small area along the localizer course, where the accident occurred, than they were at the airport.

The aircraft was struck by at least one bolt of lightning, after it had descended to within several hundred feet of the terrain. Possibly, the aircraft was also struck by lightning earlier, as indicated by the malfunction of the CAM channel of the CVR about 2 minutes before the CVR ceased operation.

The CAM channel malfunction could have been caused by static discharges of electric energy from the aircraft. These discharges may have caused one or more of the capacitors in the CAM monitoring unit to become sufficiently charged to back bias at least one of the transistors in the preamplifier circuit. If this had occurred, the microphone amplifier would have ceased operation until the excess charge dissipated. When the charge had dissipated, testing would not have revealed the problem.

Other than the CVR malfunction, there was no evidence of any other malfunction caused by lighting in the aircraft's electrical circuits, including those circuits which involve the navigation and communication systems. Although the pilots were unable to recall lightning strikes near the cockpit, it is possible that lightning might have had an adverse effect on the pilots. If lightning had struck near the cockpit, the pilots could have been temporarily blinded for 10 to 20 seconds--a sufficient amount of time for a pilot to lose control of an aircraft on final approach.

The low barometric settings on the pilot's altimeters would have caused the altimeters to indicate an altitude lower than the actual altitude of the aircraft.

The condition of the captain's altimeter when it was recovered and the results of subsequent tests suggest that it might have indicated about 500 feet too high at the OM altitude if the compensating pin behind the balance assembly support had been out of position.

However, during vibration tests, the pin could not be removed, which indicates that the pin was probably displaced by impact.

Although the first officer made a number of references to altitude during the approach, the flightcrew did not mention a difference in altitude indications between the two altimeters. A difference of 500 feet would have been detected and challenged. Finally, no record of altimeter malfunction appeared on the aircraft flight logs. Therefore, altimeter error was not a factor in the accident.

The captain's flight director system was believed to be functioning properly until the case of the flight director instrument was dented, which locked the command bars in a pitch-down display. The aircraft was in a nosehigh attitude about midway through the crash sequence. This conclusion is supported by the captain's recollections and the impact damage to the sycamore tree. Consequently, it is possible that the attitude was near 20° , which caused the command bars to display a pitch-down indication of about 10° .

The flight was routine until it approached the St. Louis terminal area. At that time, the flightcrew was aware that thunderstorms which existed near the airport might block the flight's approach.

After receiving information "Quebec" on the ATIS, the flightcrew would have expected to receive radar vectors for an ILS approach to runway 12R. Consequently, when the first officer said, "It's about 30 miles then from us, between us and the outer marker," and the captain replied, "About over the outer marker," they were talking about a precipitation return (thunderstorm) displayed on the aircraft weather radar, which indicated that the storm was near the OM for runway 12R. Immediately preceding these remarks, the flightcrew, in anticipation of an eastward movement of the storm, apparently had elected to follow the thunderstorm to the airport (First Officer: ". . . I don't know, unless we follow it inbound." Captain: "Okay." First Officer: "That's Okay?" Captain: "Yeah").

However, after the approach controller had informed the flightcrew that he would give them radar vectors for an ILS approach to runway 30L, the captain apparently elected to accept those vectors, believing that he would be able to land at the airport in front of the thunderstorm.

The captain continued the approach through the area of thunderstorm cells which were located south and southeast of the airport, and the aircraft emerged from the clouds about 6 miles southeast of the OM for runway 30L. The flight was essentially in visual conditions from that point until it passed the OM. Shortly after passing the OM, the aircraft descended below the glidepath. The Board was not able to determine the reason for the descent, but believes that it was a result of strong downdrafts and severe thunderstorms near the localizer course. Witnesses' accounts of the aircraft's behavior and an analysis of the weather conditions support this belief. It is also possible that the captain descended in order to remain below clouds and to maintain visual reference with the ground as he continued the approach.

Approach Analysis -- The Board attempted to determine why a qualified air carrier pilot would continue an approach into severe thunderstorm conditions when alternate courses of action were available to him. Because of the crew's lack of recollection of the events that preceded the accident, it is necessary to hypothesize regarding those factors that might have affected the captain's decision. The factors considered by the Board included: (1) company pressure to adhere to published flight schedules, (2) company training regarding recognition and avoidance of thunderstorms and associated severe weather phenomena, (3) available weather information, and (4) assessment by the captain of the available weather information.

The Board did not find any conclusive evidence of undue company pressure on pilots to adhere to published flight schedules. Additionally, the captain denied that such pressure would have affected his decision to continue the approach.

The Board's review of Ozark Air Line's training program and company policies concerning thunderstorm avoidance and the operations manual indicated that the material on thunderstorm avoidance was comprehensive with one exception -- encounters with thunderstorms in the terminal area.

The manual stipulated that thunderstorms were to be avoided by 10 to 20 miles depending on their severity. No exceptions were listed. The captain did not maintain 10- to 20-mile separation from observed thunderstorms after coming under control of the approach controller. However, Ozark management personnel and pilots applied these provisions to en route operations. In terminal area operations the pilot should have evaluated the weather in the terminal area, made a decision regarding his intentions, and kept ATC advised of his intentions so that the controller could take appropriate action. In this instance, the pilot did evaluate the weather and decided to continue to accept the approach clearances issued by the controller. The Board believes that more definitive criteria should be included in the operations manual for operations in the terminal area when thunderstorms exist in that area. In addition, more information regarding the low-altitude hazards associated with thunderstorms should be provided to the flightcrews.

The captain of Flight 809 and other Ozark pilots who testified at the public hearing did not appear to be familiar with pertinent portions of the operations manual. The Board believes that additional company emphasis is required to assure that all pilots are thoroughly familiar with the company operating policies and procedures.

There was an adequate amount of weather information available to the captain visually and through use of the aircraft's weather radar. The fact that the captain could see the runway lights through the rain may have misled him in evaluating the intensity of the thunderstorm. However, other cues regarding the intensity of the storm should have been as visible to him as they were to other pilots on the approach.

These cues, with his extensive pilot experience, should have been sufficient to alert him to the possibility of turbulence and downdrafts in the vicinity of the heavy rain and the roll cloud.

An experienced pilot should have been aware of the updraft and downdraft hazards associated with roll clouds that precede thunderstorm activity. These clouds are a direct indication of the extreme severity of the associated thunderstorm activity, and they should be avoided by a substantial distance.

Additionally, the surface wind information and the heavy rain observation provided by the local controller should have alerted the captain that he was continuing his approach into difficult conditions. He was faced with landing the aircraft in heavy rain on a wet runway in a strong crosswind.

Considering these factors, the Board believes there were sufficient cues available to the captain to alert him to the possibility of turbulence, downdrafts, and limited visibility if he continued the approach through the rain area on the final approach. Because he could see the runeay through the rain the captain continued the approach into the area of severe downdrafts and restricted visibility. Had the captain been better informed regarding the hazards associated with low-level turbulence in thunderstorms, his decision might have been to execute a missed approach and hold until the weather improved or to divert to an alternate airport.

The captain's experience as a pilot-in-command was limited. Although he was upgraded to captain in August 1971, he did not perform duties as pilot-in-command until March 22, 1973. From March 22, to the day of the accident he flow about 66 hours as pilot-in-command of FH-227B aircraft. About half of that time was flown in 23 days preceding the accident. The remainder was flown during the latter part of March and early April 1973. The captain's opportunity to develop the judgment required to make an appropriate decision in the circumstances he faced on this flight was limited to his experience as a first officer.

Weather Analysis -- The captain derived virtually all his information about the location and severity of the thunderstorm activity from visual observations and the airborne weather radar. The area and terminal aviation weather forecasts did not provide significant information about the location or severity of the storms.

The narrative radar summary issued at 1640 and the aviation terminal forecast for St. Louis are difficult to reconcile. The latter issued at 1140, remained unchanged until 1740, which was shortly before the accident. It predicted nothing worse than occasional ceilings of 3,000 feet overcast, with 6-mile visibility in thunderstorm and moderate rain showers. This forecast should have been amended to reflect the conditions identified in the radar summaries. If the forecasts were amended, the aviation community would likely have been alerted to the potential severity of the thunderstorms that were moving into the area from the west and south.

Additionally, it is difficult to reconcile the NWS's failure to issue a timely severe weather warning with the information contained in the weather radar summary which was issued at 1640. The NWSFO at St. Louis did not issue a severe thunderstorm warning until 1742; the warning was not transmitted over the TelAutograph until 1748, after the thunderstorms had moved over the airport. A continuous watch on the weather radar would have enabled the NWS to project accurately the location and severity of the thunderstorm cells as they moved eastward. A continuous watch would have provided time to prepare and issue a more timely warning. Photographs of the WSR-57, PPI scope support this opinion. (See Appendix E.)

Severe weather warnings mean more to a pilot than just a warning of potential hazards. They also stimulate him to think of alternative courses of action if severe conditions materialize. Also, such warnings may confirm what the pilot suspects but is unable to verify, because of equipment limitations, cockpit workload, his position relative to the severe weather, and existing flight conditions. To be effective, however, these warnings must be timely.

The weather radar summary charts issued at 1640 and 1740 by the NSSFC at Kansas City showed scattered thunderstorm activity in the St. Louis area. However, local weather radar summaries showed moderate to severe activity from 40 to 60 miles west of St. Louis as early as 1530. The severe activity was moving eastward at 20 knots. The Board was unable to determine why the NSSFC had failed to locate and identify the thunderstorm activity near St. Louis, except that earlier in the day, the NSSFC had determined that all the meteorological conditions required for severe thunderstorm activity did not exist.

The Ozark flight dispatch center at St. Louis had little official weather information that was not available to Flight 809. At 1638, the dispatcher had received a coded weather radar summary by TelAutograph, which showed that St. Louis was in the midst of a large area of thunderstorm activity. The coded summary should have alerted the flight dispatch center to expect thunderstorm activity in the immediate area. Also, the flight dispatch center should have tried to determine more precisely the location and severity of the thunderstorm activity. Such an endeavor, however, was not made until shortly before the thunderstorms moved across the airport. By then, insufficient time remained for the dispatcher to warn Flight 809.

The Ozark flight dispatch center did not have the equipment to receive either the narrative weather radar summaries or the FM broadcast of the severe thunderstorm warning. The Board believes that the information contained in these summaries should have received wider dissemination, because it was the best analysis of the local weather situation.

As a result of this and several other accidents which have occurred during thunderstorms in terminal areas, the question arises whether FAA controllers should be authorized to refuse pilots' requests for an approach, landing, or takeoff, when the weather conditions at the airport are too severe, in the controller's opinion, for safe terminal area operations. (See Appendix F.)

Under existing procedures, controllers may provide only official weather data, general observations without specific values, and information derived from instruments, radar, or pilot reports, which is generally adequate under most circumstances. However, when the controller is able to observe severe weather activity affecting the airport or the approach or departure paths, the Board believes that he should have authority to refuse approach, landing, and takeoff requests except upon the declaration of an emergency by the pilot.

Survivability -- The accident was nonsurvivable with respect to the passengers because the decelerative forces approached the limits of human tolerance, the restraint mechanisms failed, and the occupiable area did not remain intact. The fatal and nonfatal injuries alike indicated that the decelerative forces had been near the limits of human tolerance. All but one of the passenger seats failed during the crash sequence. The passenger cabin was torn open by impact with trees, and the unrestrained occupants were ejected with sufficient force to produce fatal injuries upon collision with unyielding objects. Four passengers survived because they were thrown clear, without colliding with any objects that could inflict more serious injuries.

Both pilots survived because the cockpit remained relatively intact and their restraint mechanisms (seats and seatbelts) did not fail. Significantly, both pilots probably would have received only minor injuries, had their upper torsos been restrained by shoulder harnesses.

The cabin attendant received fatal injuries when she was struck by cargo after the failure of the aft cargo compartment restraint net. The failure indicated that the decelerative forces were quite high in the aft section of the aircraft.

The rescue was conducted in a timely and fairly orderly fashion. Initially, because of a lack of centralized control, more fire and police units responded than were needed. Although the presence of too many people and the adverse weather conditions probably contributed some confusion, the speed with which the rescue was accomplished was not a factor in the survivability of the accident. However, the Board's experience indicates that in the event of an accident involving a substantially higher number of injuries, a more coordinated response is required to care for survivors adequately.

2.2 Conclusions

(a) Findings

1. The accident was nonsurvivable.

2. The cabin attendant's seat was not properly certificated, because it did not meet FAA regulations.

3. The captain's and first officer's injuries would have been much less severe, had these crewmembers been restrained by shoulder harnesses.

4. The thunderstorm that moved across the airport and the localizer course shortly after 1740 was severe; the storm was more severe in a small area along the localizer course where the accident occurred.

5. The severity of the storm was not reflected in the official NWS weather data available to the flightcrew, company dispatchers, or air traffic controllers.

6. The NWS aviation terminal forecast valid at the time of the accident for St. Louis did not predict accurately the weather conditions that could have been expected to affect the area, and an amended forecast was not issued.

7. The NWS narrative radar summaries accurately reflected the weather conditions moving into the St. Louis area.

8. The narrative weather radar summaries were not available to either the FAA air traffic control facilities, the Ozark Air Lines Flight Dispatch Center, or the flightcrew.

9. Ozark Air Lines did not provide its flightcrews with specific thunderstorm avoidance criteria for terminal area operations.

10. The airborne weather radar on N4215 functioned properly, and the flightcrew used the radar to locate the thunderstorms in the St. Louis area.

11. Between the OM and the accident site, the aircraft was struck by one or more bolts of lightning.

12. There was no evidence that lightning adversely affected any of the vital systems or components of the aircraft.

13. The aircraft descended below the glide slope after passing the OM; this descent was probably caused by a severe downdraft.

14. The captain decided to continue his approach into weather conditions associated with a thunderstorm; the severity of these conditions should have been apparent to him.

(b) Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the aircraft's encounter with a downdraft following the captain's decision to initiate and continue an instrument approach into a thunderstorm. The captain's decision probably was influenced by the lack of a timely issuance of a severe weather warning by the National Weather Service, and the improper assessment of the weather conditions in the terminal area by the flightcrew and the flight dispatcher.

3. RECOMMENDATIONS

The Safety Board made three recommendations (A-73-66 and A-73-105 and 106) to the Federal Aviation Administration on September 6, 1973, and October 25, 1973, respectively. These recommendations involved the cabin attendant's seat in F-27 and FH-227 aircraft and the addition of crewmember shoulder harnesses in all transport category aircraft that were certificated before January 1, 1958.

The Safety Board made three additional recommendations (A-74-12, 13, and 14) on April 18, 1974. These recommendations involved revision of air traffic control procedures in the terminal area, new air traffic control radar for terminal areas, and a system to improve the dissemination of severe weather information. (See Appendix F.)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JOHN H. REED
Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ LOUIS M. THAYER
Member

/s/ ISABEL A. BURGESS
Member

/s/ WILLIAM R. HALEY
Member

April 24, 1974

Appendix A

INVESTIGATION AND HEARING

1. Investigation

The National Transportation Safety Board was notified of this accident at 1915 e.d.t. on July 23, 1973. The Board immediately sent an investigation team to the scene. The team established investigative groups for operations, air traffic control, witnesses, weather, human factors, structures, powerplants, systems, maintenance records, flight data recorder, and cockpit voice recorder.

Representatives of the Federal Aviation Administration, Ozark Air Lines, Inc., Air Line Pilots Association, Fairchild Industries, Inc., Rolls Royce, Ltd., Dowty Rotol, Ltd., Air Line Dispatchers Association, Aircraft Mechanics Fraternal Association, and the Professional Air Traffic Controllers Association assisted the Board during the investigation.

2. Hearing and Deposition

A 3-day public hearing was held in the Sheraton Jefferson Hotel, St. Louis, Missouri, beginning August 28, 1973.

The deposition of a passenger was taken in Chicago, Illinois, on September 3, 1973. The deposition of the first officer on Ozark Air Lines Flight 809 was taken in St. Louis on October 17, 1973.

Appendix B

AIRMAN INFORMATION

Captain Arvid L. Linke

Captain Linke, 37, has been employed by Ozark Air Lines since April 1, 1965. He holds Airline Transport Pilot Certificate No. 1349358, with a type rating in FH-227 aircraft. He was advanced from first officer to captain in August 1971, but did not assume command responsibilities until he received his captain's checkout in the FH-227 on March 22, 1973. He successfully completed a proficiency check in the FH-227 on March 19, 1973, and a recurrent ground training on March 16, 1973. He was last issued a first-class medical certificate, without limitations, on February 14, 1973.

During his flying career, Captain Linke has accumulated 9,170:05 hours of flying time, of which 4,382:03 hours were flown in F-27 and FH-227 aircraft. He has flown 65:55 hours as pilot-in-command of FH-227, and during the 30-day period preceding the accident, he flew 30:25 hours.

First Officer Michael D. Williams

First Officer Williams, 28, was employed by Ozark Air Lines on January 31, 1972. He holds Airline Transport Pilot Certificate No. 1744164 with a type rating in DC-3 aircraft. He also has a flight instructor certificate for airplane and instruments. He passed his initial second-in-command check on February 26, 1972, his last line check on July 14, 1972, and his last second-in-command check on December 28, 1972. He was last issued a first-class medical certificate, without limitations, on December 13, 1972.

First Officer Williams has accumulated about 3,921 hours of flying time during his career to the date of the accident. He has flown about 989 hours in the FH-227, of which 59.5 hours were flown in the 30-day period preceding the accident.

Cabin Attendant Beth A. Williams

Cabin attendant Williams, 23, was employed by Ozark Air Lines on July 13, 1970. She completed cabin attendant training on August 7, 1970. She passed a check-ride in the FH-227 on March 19, 1973. Her last recurrent training in FH-227 and DC-9 aircraft was completed on July 4, 1973.

Appendix C

AIRCRAFT INFORMATION

Aircraft N4215, an FH-227B, was manufactured by the Fairchild-Hiller Aircraft Company on July 15, 1966. Ozark Air Lines received the aircraft on August 5, 1966, and placed it in service on December 9, 1966.

The aircraft total time in service and the time since overhaul was 14,300:19 hours. The last line check was completed on July 23, 1973.

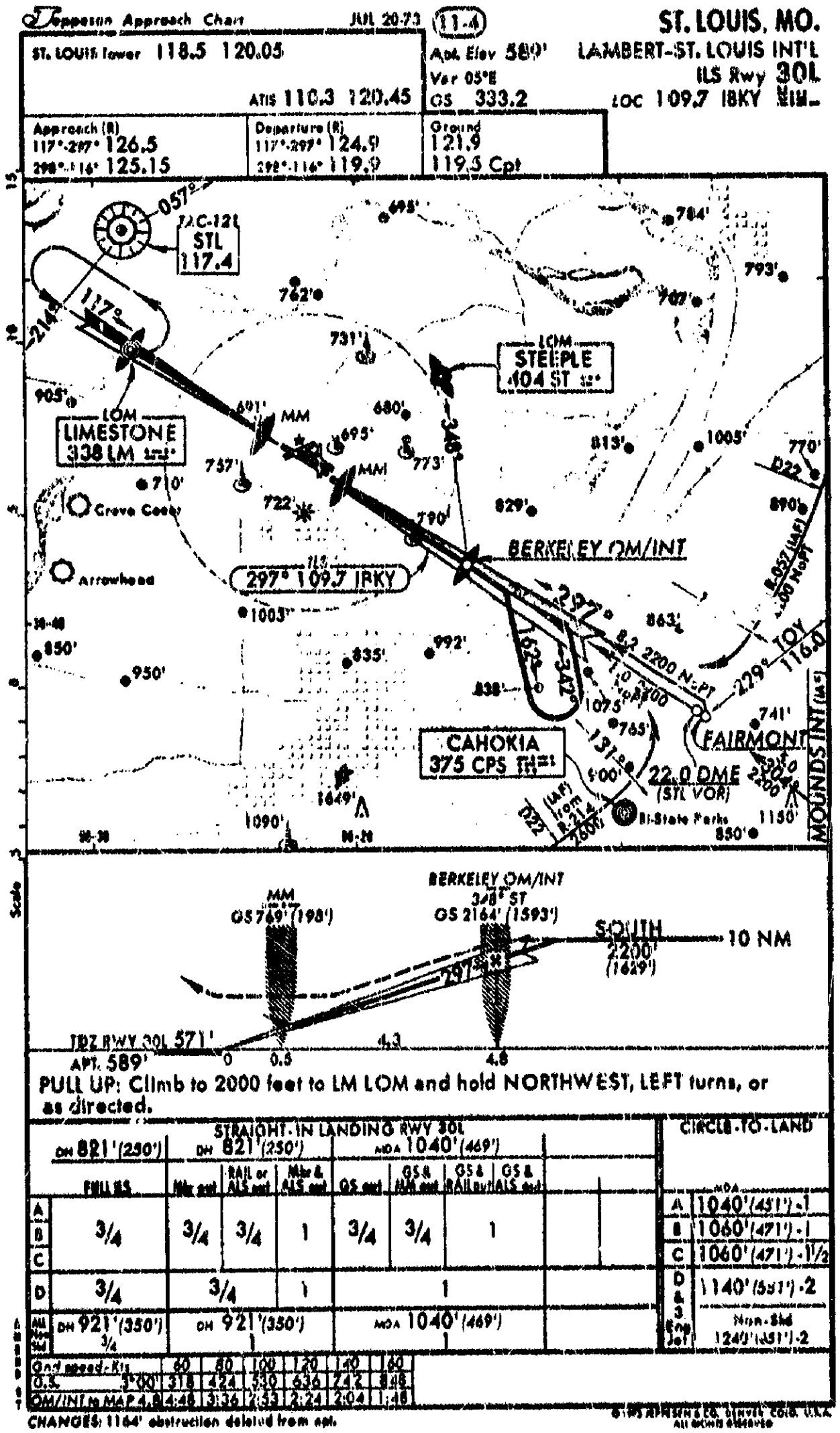
N4215 was powered by two Rolls-Royce Dart 532-7 jet turbine engines each equipped with a Dowty-Rotol R257/4-30-4/60 propeller. The engines were each rated at 1,990 shaft horsepower with water/methanol injection and 1,835 minimum to 1,910 maximum shaft horsepower without injection.

The No. 1 engine, serial No. 13951, had a total time of 20,662 hours, including 4,751 since overhaul. The No. 2 engine, serial No. 13961, had a total time of 10,359 hours, including 690 hours since overhaul. The last inspection on the No. 1 engine was accomplished on March 3, 1972; the last ground check and runup was completed on May 27, 1972. The last inspection on the No. 2 engine was accomplished on January 13, 1973, and the last ground check and runup was accomplished on January 14, 1973.

The No. 1 propeller had a total time of 10,936 hours, including 1,236 hours since overhaul. The No. 2 propeller had a total time of 11,785 hours, including 4,890 since overhaul.

All airworthiness directives and service bulletins on the aircraft and powerplants were complied with.

APPENDIX D


Jeppesen Approach Chart
JUL 20-73
11-4
ST. LOUIS, MO.
LAMBERT-ST. LOUIS INT'L
ILS Rwy 30L
LOC 109.7 IBKY
ST. LOUIS tower 118.5 120.05
ATIS 110.3 120.45
Apch Elev 589'
Var 05°E
GS 333.2
Approach (R)
117°-297° 126.5
298°-116° 125.15
Departure (R)
117°-297° 124.9
298°-116° 119.9
Ground
121.9
119.5 Cpt
057°
TAC-121
STL
117.4
117°
214°
LOM
STEEPLE
404 ST
LOM
LIMESTONE
338 LM
MM
MM
Creve Coeur
Arrowhead
297° 109.7 IBKY
BERKELEY OM/INT
CAHOKIA
375 CPS
22.0 DME
(STL VOR)
FAIRMONT
TOY
229°
MOUNDS INT
Bi-State Parks
BERKELEY OM/INT
3.8 NM
GS 2164' (1593')
MM
GS 769' (198')
SOUTH
2200'
(1629')
10 NM
297°
IBZ RWY 30L 571'
APT. 589'
0
0.5
4.3
4.8
Scale
PULL UP: Climb to 2000 feet to LM LOM and hold NORTHWEST, LEFT turns, or as directed.
STRAIGHT-IN LANDING RWY 30L
CIRCLE-TO-LAND
DH 821'(250')
DH 821'(250')
MDA 1040'(469')
FULL ES
Min std
RAIL or ALS out
Min & ALS out
GS out
GS & MM out
GS & RAIL or ALS out
GS & RAIL or ALS out
A
B
C
3/4
3/4
3/4
1
3/4
3/4
1
D
3/4
3/4
1
1
All Jet Std
DH 921'(350')
3/4
DH 921'(350')
1
MDA 1040'(469')
1
MDA
A 1040'(451')-1
B 1060'(471')-1
C 1060'(471')-1½
D & Comp Jet 1140'(551')-2
Non-Std 1240'(551')-2
Ground speed-Kts
60
80
100
120
140
160
O.R. 3°00'
318
424
530
636
742
848
OM/INT to MAP
4:48
3:36
2:53
2:24
2:04
1:48
CHANGES: 1164' obstruction deleted from apt.
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APPENDIX E

National Weather Service Radar Photos 1 of 2. 1715 CDT, July 23, 1973. Range 50 NM. Hatch marks represent approximate area where ground clutter return can be expected.

Appendix E

National Weather Service Radar Photos 2 of 2. 1744 CDT, July 23, 1973. Range 50 NM. Hatch marks represent approximate area where ground clutter return can be expected.

WASHINGTON, D.C. 20590

OFFICE OF
THE ADMINISTRATOR

APPENDIX F

SEP 19 1973

Honorable John H. Reed
Chairman, National Transportation Safety Board
Department of Transportation
Washington, D.C. 20591

Dear John:

This replies to your Safety Recommendation A-73-66 requesting the use of all flight attendant seats in F-27 and FH-227 aircraft be prohibited until modifications are accomplished.

There are many different seat designs, locations and positions of the flight attendant in this series of airplanes. In many airline configurations, the attendant occupies a specific passenger seat designated exclusively for the attendant. This seat does not resemble the seats you mentioned on Mohawk and Ozark Airlines' airplanes. Due to these differences, we have assessed these seats on an individual basis. Our AD 72-7-12 dealt with the Mohawk Airlines installation which, at the time of issuance, was the only seat considered hazardous due to its particular location.

With respect to prohibiting further use of the seat installed on Ozark's FH-227B airplanes, action along these lines began a month prior to the accident in St. Louis, Missouri. We were advised on August 20 that Ozark is initiating action to relocate the flight attendant to a forward facing type seat in the rear of the cabin. The new location and seat configuration will be subject to FAA evaluation for compliance with all requirements. As an interim action, a notice was issued by Ozark, effective August 27, to require flight attendants to occupy the rearmost passenger seat, on the left side, at the aisle, until final seat relocation modifications are accomplished.

We believe the present Ozark interim seat location and final seat location, both of which are presently used by other airlines for locating their attendants, will meet the objective of your recommendation as it applies to the Ozark configuration. This type of passenger-cargo combination does not exist among other domestic air carrier operators of the F-27 and FH-227 airplanes.

Sincerely,

Alexander P. Butterfield
Administrator

Appendix F

UNITED STATES OF AMERICA
NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

ISSUED: September 6, 1973

Adopted by the NATIONAL TRANSPORTATION SAFETY BOARD
at its office in Washington, D. C.
on the 22nd day of August 1973

FORWARDED TO:
Honorable Alexander P. Butterfield
Administrator
Federal Aviation Administration
Washington, D. C. 20591

SAFETY RECOMMENDATION A-73-66

After the Mohawk Airlines FH-227B accident at Albany, New York, on March 3, 1972, the Federal Aviation Administration issued an Airworthiness Directive prohibiting the further use of the aft-facing stewardess' crew seat mounted against the lavatory wall in all F-27 and FH-227 aircraft. This prohibition was to continue in effect until the seat was modified to comply with the provisions of section 4b.358 of the Civil Aeronautics Manual (CAM).

The prohibition against use of the flight attendant seat was made because the proximity of the occupant's head to the entry door actuating mechanism did not conform to the provisions of CAM 4b.358(b). This provision states that passengers and crew shall be afforded protection from head injuries by one of the following means:

1. Safety belt and shoulder harness.

2. Safety belt and elimination of all injurious objects within striking radius of the head.

3. Safety belt and a cushioned rest which will support arms, shoulders, head, and spine.

Additionally, the proximity and orientation of the carry-on luggage rack directly opposite this flight attendant seat was cited in the Airworthiness Directive.

Honorable Alexander P. Butterfield (2)

During our investigation of the recent accident involving an Ozark Air Lines FH-227 at St. Louis, Missouri, our investigators examined the flight attendant crew seat attached to the aft galley structure next to the cargo loading door.

Because of the many similarities with respect to the impact parameters of this and the previously mentioned "Mohawk" accident, they assessed the hazard potential of this seat as compared to the previous seat installation which had been restricted. In our view, the Ozark installation does not conform to the provisions of CAM 4b.358 in that the occupant's head is 18 inches from the actuating mechanism and upper track of the cargo door. Moreover, there is no protective padding provided at this location. The flight attendant station is not equipped with a shoulder harness. There are no cushioned supports for the shoulders or head which might prevent lateral movement.

Also, the seat location is directly opposite the passage to the cargo compartment. Although this passageway is blocked by cargo netting, the openings in the netting are large enough (8 inches by 8 inches) to allow smaller cargo parcels to pass through. Additionally, the top of this netting is located approximately 8 to 11 inches from the ceiling, allowing passage of articles in turbulence or emergency conditions.

Finally, the design of this flight attendant seat is such that, in our view, it does not meet the requirements of CAM 4b.362(g) and CAM 4b.362-6(a). The seat pan folds downward against the bulkhead in the stowed position. When in use, the seat is supported by an over-center retraction mechanism and a bar, which is attached to the side of the seat pan with a keyhole arrangement. In this position, the seat reduces the passageway width of the cargo door exit to 12 inches. The semipermanent support of this flight attendant seat, therefore, is not in conformance with FAA policy as it applies to CAM 4b.362(g), since it is not springloaded for automatic retraction when the seat is vacated to allow a 20-inch passageway leading to this exit.

In view of the above, the National Transportation Safety Board recommends that the Federal Aviation Administration:

> Issue an immediate Airworthiness Directive prohibiting the use of all flight attendant seats in F-27 and
>
> FH-227 aircraft until these stations are modified to comply with the applicable regulations.

McAdams, Thayer, and Haley, Members, concurred in the above recommendations. Reed, Chairman, and Burgess, Member, were absent, not voting.

William R. Haley, acting

By: John H. Reed
Chairman

UNITED STATES OF AMERICA
NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

ISSUED: October 25, 1973

Adopted by the NATIONAL TRANSPORTATION SAFETY BOARD
at its office in Washington, D. C.
on the 10th day of October 1973

FORWARDED TO:
Honorable Alexander P. Butterfield
Administrator
Federal Aviation Administration
Washington, D. C. 20591

SAFETY RECOMMENDATIONS A-73-105 & 106

A significant advance toward improved crew protection has been made by recent rulemaking requirements that crewmembers of transport-category aircraft operating under 14 CFR 121 wear their shoulder harnesses during takeoff and landing. Similarly, the recently issued Notice of Proposed Rule Making 73-1, "Crashworthiness of Small Airplanes," proposes to provide for the installation and use of shoulder harnesses for occupants of small airplanes. The provisions of this NPRM will afford a significant amount of additional protection to virtually the entire aviation population.

The National Transportation Safety Board is encouraged by these steps, which are positive indications of the increased emphasis being placed on accident survivability. However, the Board believes that further consideration is merited for including in these shoulder-harness provisions the following two categories of aircraft:

Transport Category Aircraft Certificated Prior to 1958

In a letter dated January 29, 1973, to the Administrator, Federal Aviation Administration, the Safety Board stated that Part 121 should be amended to require that all transport-category aircraft be equipped with shoulder harnesses after a reasonable date in order to encompass all air commerce segments, regardless of the type of equipment flown. We expressed this opinion in light of the findings made during the investigation of a Mohawk Airlines FH-227 which crashed into a residence at Albany, New York, on March 3, 1972, killing 14 passengers as well as the 2 crewmembers in the cockpit. The Safety Board's investigation revealed that both pilots probably could have survived if they had worn shoulder harnesses. Expert medical testimony corroborated our findings.

In the recent Ozark FH-227 accident at St. Louis, Missouri, on July 23, 1973, both pilots survived the accident but suffered serious injuries. Our investigation revealed that the copilot received a serious head injury because he was thrown against the instrument panel. The captain sustained several rib fractures when he was thrown into the control wheel. He also received serious head injuries.

The FH-227 is now exempted by 14 CFR 121 from the shoulder-harness requirement, since it was type certificated prior to January 1, 1958. Federal Aviation Administration statistics show that approximately 268 aircraft are still in use which are so exempted. The recent Ozark accident not only reemphasizes the need for shoulder-harness protection in these aircraft but also focuses attention on the less stringent safety provisions for pilots who fly older equipment.

In light of this discussion, the National Transportation Safety Board recommends that the Federal Aviation Administration:

> Amend 14 CFR 121 to require that all transport-category aircraft certificated prior to January 1, 1958, be equipped with shoulder harnesses at each crew station, after a reasonable date, to allow operators to retrofit their equipment.

Corporate/Executive Aircraft

Our review of the impact of FAA's recent rulemaking action to improve the safety of flightcrews disclosed that with implementation of the provisions of NPRM 73-1, virtually all pilots will benefit from shoulder-harness protection with the exception of pilots who fly large corporate and executive aircraft. The Board is not aware of any existing or proposed requirement for shoulder harnesses for this class of aircraft operating under the rules of 14 CFR 91. Specifically, although 14 CFR 25 requires provisions for shoulder harnesses in such aircraft, Part 91 does not now require, and the proposed changes of NPRM 73-1 would not provide for, the installation of such restraint in large corporate and executive aircraft.

On February 21, 1973, a Lear Jet crashed at Willow Run Airport, Ypsilanti, Michigan. Although the cockpit remained structurally intact, both crewmembers died as a result of loss of restraint when their seat-belts failed at the outboard attach points. Our investigation disclosed that shoulder harnesses not only would have redistributed the forces applied to the seatbelts, thereby reducing the possibility of failure, but also would have prevented violent upper torso movement, thereby alleviating the crewmembers' injuries.

In order to provide increased protection for crewmembers, and to avoid a potential inconsistency in the regulations, the Safety Board believes that steps should be taken to require the installation of shoulder harnesses in large corporate and executive aircraft. Accordingly, the National Transportation Safety Board recommends that the Federal Aviation Administration:

> Amend 14 CFR 91 to require the installation of shoulder harnesses at flight deck stations on large aircraft which operate under this Part.

REED, Chairman, McADAMS, THAYER, and HALEY, Members, concurred in the above recommendations. BURGESS, Member, was absent, not voting.

By: John H. Reed
Chairman

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

ISSUED: April 18, 1974

Forwarded to:

Honorable Alexander P. Butterfield
Administrator
Federal Aviation Administration
Washington, D. C. 20591

SAFETY RECOMMENDATION(S)

A-74-12 thru 14

On July 23, 1973, an Ozark Airlines Fairchild Hiller FH-227B was involved in an accident at St. Louis, Missouri. The National Transportation Safety Board's investigation of the accident revealed three safety items which warrant corrective action.

First, until just before the accident, air traffic controllers at St. Louis issued clearances for approaches and landings, despite the thunderstorms which were over the initial approach path, the final approach path, and the airport. Immediately before the accident, the local controller stopped issuing departure clearances. Although the controller did not have authority to stop departures because of the weather, the Safety Board believes that he acted in the best interest of safety. It further believes that, in conditions they deem hazardous, controllers should be given the authority to deny (1) approach and landing clearances when thunderstorm activity exists over either the approach path or the airport and (2) departure clearances when thunderstorm activity exists over either the airport or the departure path. This new authority would make more effective use of the wealth of terminal weather information available to the controller, specifically:

a. His direct and continuing visual observation of local atmospheric conditions and associated aircraft behavior.

b. His receipt and evaluation of pilot reports (PIREP's) regarding flight conditions in the terminal area.

c. The informative capacity of ground-based radar.

d. The direct links for transmission of terminal weather reports between the National Weather Service and ATC.

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Since 1963, accidents in which thunderstorm activity was a factor have caused over 100 deaths, 40 serious injuries, and millions of dollars in property damage. Among these accidents are the following:

American Airlines, Knoxville, Tenn., 1962
Mohawk Airlines, Rochester, N.Y., 1963
American Airlines, New York, N.Y., 1964
DH-125, Paducah, Ky., 1966
Grumman TBM, Elko, Nev., 1966
Lockheed PV-1, Philadelphia, Pa., 1971
Eastern Air Lines, Ft. Lauderdale, Fla., 1972
National Airlines, New Orleans, La., 1972
Convair 990, Agana, Guam, 1973

Second, just before the accident in St. Louis, through the use of radar incapable of displaying different levels of precipitation echo intensity, controllers vectored several aircraft through a solid squall line which contained severe thunderstorm and tornado activity. The controllers vectored the aircraft through the narrowest portion of the precipitation echo pattern displayed on the radarscope in order to get the aircraft to a final approach course. In our opinion, this was a very dangerous practice because the controller's radarscope display did not indicate whether the line of echoes contained a severe thunderstorm or tornado. The Safety Board believes that radar capable of locating severe weather and displaying convective turbulence should be developed for and used in the terminal areas.

Third, the Safety Board learned that the tower and approach control facility at St. Louis has no system by which to relay severe thunderstorm warning bulletins to inbound and outbound flights when the terminal area is included in such bulletins. The lack of such a system was not a factor in this accident, because the severe thunderstorm warning bulletin which had been issued about 3 minutes before the accident by the National Weather Service, was not relayed to the tower and approach control until after the accident. Nevertheless, the Safety Board believes that the information contained in these bulletins is vital to every pilot who must decide whether to fly into or out of a terminal area which is affected by thunderstorm activity. We also believe that these bulletins should be relayed expeditiously.

Accordingly, the National Transportation Safety Board recommends that the Federal Aviation Administration:

1. Revise terminal air traffic control procedures to authorize controllers, when they deem an operational hazard is present, to deny (1) approach and landing clearances when thunderstorm

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activity exists over either the approach path or the airport, and (2) takeoff clearances when thunderstorm activity exists over either the airport or the departure path.

2. Develop and install terminal air traffic control radar capable of locating severe weather and displaying convective turbulence. This radar should be used to vector aircraft around severe weather.

3. Implement, in cooperation with the National Weather Service, a system to relay severe thunderstorm and tornado warning bulletins expeditiously to inbound and outbound flights when such bulletins include the terminal area.

Members of our Bureau of Aviation Safety will be available for consultation if desired.

REED, Chairman, McADAMS, THAYER, BURGESS, and HALEY, Members, concurred in the above recommendations.

By: John H. Reed
Chairman

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