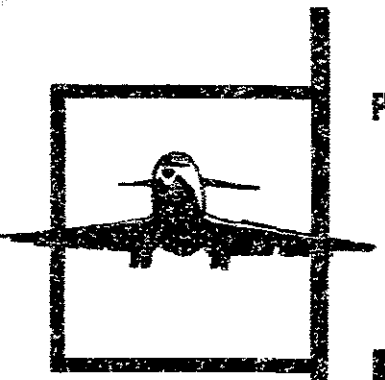

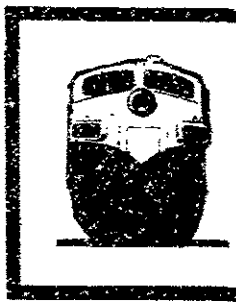

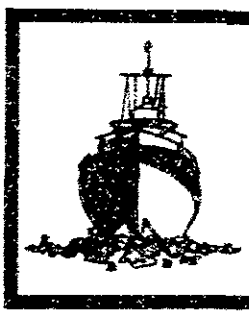

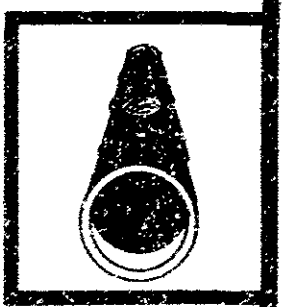

PB88-910403

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT/INCIDENT SUMMARY REPORTS

MODENA, PENNSYLVANIA -- MARCH 17, 1986

REDWATER, TEXAS -- APRIL 4, 1986

NTSB/AAR-88/01/SUM

UNITED STATES GOVERNMENT

TECHNICAL REPORT DOCUMENTATION PAGE

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15. Supplementary Notes

16. Abstract

This publication is a compilation of the reports of two separate aircraft accidents investigated by the National Transportation Safety Board. The accident locations and their dates are as follows: Modena, Pennsylvania, March 17, 1986, and Redwater, Texas, April 4, 1986.

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Barotrauma; cabin pressure; system failure; weather; weather advisories	This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161

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National Transportation Safety Board

Washington, D.C. 20594

AIRCRAFT ACCIDENT/INCIDENT SUMMARY

File No:	DCA-86-IA-035
Aircraft Operator/Owner:	British Airways
Aircraft Type:	Lockheed L-1011-200
Aircraft Registration:	G-BHBO
Location:	Near Modena, Pennsylvania
Date:	March 17, 1986
Time:	About 1400 e.s.t.
Persons on Board:	143 passengers, 12 crew
Injuries:	One passenger fatality
Aircraft Damage:	None
Phase of Operation:	En route descent

On March 17, 1986, a 33-year-old woman, a resident and citizen of the United Kingdom, iiew from London Heathrow Airport, England, io Dulles International Airport, Virginia, on British Airways flight 217. During the airplane's descent from its en route cruise altitude, the passenger told another passenger sitting in the adjacent seat that she had a pain in her right ear and a headache. After flight 217 landed, the passenger left the airplane and the airport without informiag any British Airways' personnel of the occurrence.

On the evening of March 17, she sought treatment at the emergency room of Suburban Hospital in Bethesda, Maryland. The attending physician advised her that she had experienced a reeent perforation of her right ear drum. He treated the ear, prescribed antibiotics and an analgesic, released her, and advised her to consult a specialist the following day.

On March 18, she consulted an ear specialist who advised her to continue the treatment recommended by the emergency room physician and allowed her to return to her hotel. On the morning of March 19, she was found unconscious in her hotel room. Taken to Suburban Hospital, she was placed in the intensive care unit, and, at that time, she was diagnosed to have entered a coma; she died on March 21, 1986.

The death certificate issued by the medical examiner on March 21 stated that the immediate cause of death was a "cardiorespiratory arrest" due to or as a consequence of a meningitis bacterial brain infection, which was due to or as a consequence of a "middle ear infection." The death certificate also stated that the underlying external cause of the fatal illness was "barometric changes" that occurred on an airplane. However, the death certificate issued by the Maryland State Registrar of Vital Records on October 29, 1987, crossed out "cardiorespiratory arrest" as the immediate cause of death and inserted "pneumoccocal meningitis due to acute otitis media with rupture of the eardrum."

On April 30, 1986, the deceased's father asked the British authorities to investigate the circumstances that resulted in her death. The British authorities declined because the injury "occurred over U.S. airspace and as such should be investigated by the U.S. government." The deceased's father then contacted the Federal Aviation Administration (FAA), and on July 28, 1986, the case was referred to the National Transportation Safety Board for investigation.

The Safety Board's regulations, Title 49, Code of Federal Regulations, Section 830.2 (49 CFR Section 830.2) defines an aircrsft accident as:

> . . .an occurrence associated with the operation of an aircraft which takes place between the time any person boards the aircraft with the intention of flight and all such passengers have disembarked, and in which any person suffers death or serious injury . . . .

Section 830.2 defines an incident as:

> . . .an occurrence other than an accident, associated with the operation of an sircraft, which affects *or* could affect the safety of operations.

In addition, Section 830.2 defines a fatal injury as ". . .any injury which results in death within *30* days of the accident." Since *&e passenger's death occurred within *30* days after she disembarked from the airplane, the purpose of this investigation was to determine whether the ear injury, as described in the death certificate, was caused by "an occurrence associated with the operation of (the) aircraft" and, therefore, is an accident as defined in Section Part 830.2. In addition, if the injury was determined to have been related to an accident, the investigation would also determine the probable cause or causes of the accident.

Although the airplane was equipped with a cockpit voice recorder (CVR) and digital f l i t data recorder (DFDR), no data were available from either recorder *to* support this investigation. The CVR retains only the last 38 minutes of any flight. Since the airline's personnel were never informed of any mishap after the flight landed at Dulles Airport, the CVR was operated throughout the ensuing flights of the airplane. Therefore, there were no CVR data available for the flight in question. In accordance with British Airways' procedures, recorded DFDR information is retained only if an Air Safety Report is initiated concerning a flight. Since no report was filed, the DPDR recordings for this flight were not removed and retained.

Given the nature of the passenger's injury and the manner in which it occurred, the Safety Board's investigation focused primarily on the altitudes at which flight 217 operated, the manner in which it descended from its en route assigned altitude to land at Dulles Airport, and the capabilities and operating condition of the airplane's cabin pressurization system.

Flight 217, a Lockheed L-1011-200, British Registry G-BHBO, and a regularly scheduled passenger flight from Heathrow Airport to Dulles Airport, departed Heathrow Airport about 6:35 rem. 1/ with 143 passengers, 9 cabin attendants, and 3 flightcrew members. The filed instrument flight rules (IFR) flight plan called, in part, for flight 217 to traverse the Atlantic Ocean and portions of northeastern Canada via published air traffic control (ATC) oceanic navigational tracks.

Flight 217's first navigational *fix* within U.S. airspace was the Presque Isle, Maine, VQRTWC. 2/ Thereafter, the remainder of flight 217's flight plan route was as follows: *via* jet airway J55 to the Kennebunk, Maine, VORTAC; via jet airway J581 to the

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1/ All times are eastern standard time.
2/ A colocated very high frequency omnirange station and ultra-high frequency tactical air navigation aid that provides azimuth and distance information to user aircraft.

Kennedy, New York, VORTAC; via jet airway d48 to the Modena, Pennsylvania, **VORTAC;** via Victor Airway V474 Ro **DELRO** intersection; via Victor Airway V39 to SCOBY intersection; and, direct Dulles Airport.

The highest requested altitude was flight level 350 (FL 350). 3/ The flight plan indicated that flight 217 would climb to **FL 350** about 44 minutes before reaching the Presque Isle VORTAC and would remain at FL **350** until it **was** about 10 **minutes** north-northeast of the Kennedy VORTAC. Thereafter, flight **217** was to deseend and cross the Kennedy **VOBTAC** at **18,000** feet mean sea level. The flight plan then called **for** flight **217** to maintain **18,000** feet until after it passed SCOBY intersection and was cleared for its approach and landing at Dulles Airport.

Since the occurrence **was** not brought ***to*** the attention of the Safety Board until July **28, 1986,** written questions were not submitted to the flight and cabin crew personnel on flight **217** until August **22, 1986.** Other than describing the flight as being "completely **normal,"** the captain **was** unable to recall any specific operational details concerning the flight. The recollections of the first officer and flight engineer were similar to the captain's, However, British Airways provided the Safety **Board** with two copies of the computer flight plans that were used and ennotated by two members of the flightcrew during the flight to Dulles Airport on March **17.**

The annotated flight plans showed that about 11:55 a.m., flight 217 climbed to and then maintained FL **370** until it had passed the Kennebunk VORTAC. After passing Kennebunk, flight 217 was vectored to intercept **the** 264-degree radial of the Kennedy VORTAC and to descend to FL **350;** however, **the** flight plans did not show the time the flight received this clearance. One **of** the flight plans showed that the flight overflew the Kennedy VORTAC at **1358,** but ***it*** did not show the altitude at that time.

After flight 217 had been cleared to desnend to FL **350,** ATC then cleared it to descend and to cross a point **25** nmi northeast of the Modena VQRTAC at **18,006)** feet. The annotated flight plans showed that flight 217 crossed the Modena VORTAC at **16,000** feet and that, at **1418,** when it crossed DELRO intersection, it **was** still at **16,000** feet. The final entry on one of the flight plans indicated that flight **217** arrived at 1443 at the Armel, Virgina, VORTAC, which is located on Dulles Airport.

Except for certain selected areas of the airplane that are not relevant to this investigation, the electrically controlled cabin pressurization system meters the exhaust of **cabin** ventilating air to **pressurize** the fuselage between the forward and aft pressure bulkheads. Pressurization control **is** normally operated in ?he automatic mode. **In this mode,** the engineer selects the desired cabin **or** airplane cruise altitude before takeoff and sets barometric correction and landing field altitude before descent. **The** pressurization system responds quickly and pressure transients are controlled below the normal threshold of human detection. The normal pressure differential at which the cabin altitude is maintained is 8.44 psi. ***At*** this pressure differential, the cabin altitude can, should the flightcrew **so** desire, be maintained at sea level when the **airplane** is below **22,000** feet. When cruise altitude is between 22,000 feet and 42,000 feet, cabin altitude is normally selected at the minimum that can be maintained without exceeding an 8.44-psi pressure differential. Based **OR** the 8.44-psi **pressure** differential, at 37,000 feet the cabin altitude

3/ A levei of constant atmospheric **pressure** related to a reference datum **of 29.92** inHg. Each level from **18,000** ***to*** **60,000** feet is stated in three digits representing hundreds of feet. Therefore, FL 350 represents a barometric altimeter indication of **35,000** feet.

would be about 6,500 feet. In the automatic mode, the cabin altitude is controlled at a fixed rate of change. During climb, the rate is about 500 fpm; during descent, the rate is about 300 fpm.

According to British Airways' procedures, the standby mode of the cabin pressurization system is used only if the automatic system malfunctions. To the best of the flightcrew's recollections, the pressurization system was operated in its automatic mode on March 17 and functioned normally throughout the flight.

The examination of the maintenance discrepancies in the airplane's logbook from March 12 to March 22, 1987, did not disclose any entries that would indicate other than a normal operation of the cabin pressurization control system. In addition, on the day of the flight, the airplane's logbook did not contain any allowakle deferred defects entries that would indicate any malfunction of the cabin pressurization system.

The examination of the deceased passenger's medical history divulged only one entry reieting to an ear problem. On March 29, 1977, she had received treatment for a congested right ear drum; thereafter, there were no further entries relating to any ear problems.

British Airways' records showed that the deceased passenger and the passenger seated adjacent to her occupied seats 14E and 14F, respectively. The passenger stated that he had met the deceased in the Heathrow Airport departure area and:

> (I) sat next to her, on her right, throughout the flight. The flight was normal and we were both awake at the start of the descent. Shortly after this she mentioned that she had a pain in her right ear which gave her a headache. She said that she had experienced this before on a recent flight or flights. She did not teli the cabin staff of her problem and seemed aware of the reason for her discomfort.

According to her employer's records, the deceased had made 16 air carrier flights to various European cities and one round trip to New York City, New York, between January E and March 11, 1986.

Based on British Airways' operating procedures, the fiightcrew's statements, and the fact that the airplane's logbook did not contain any entries that indicated cabin pressurization system malfunctions, the Safety Board concludes that the pressurization system's controls were operated in the automatic mode by the flightcrew during the descent. The flight engineer would have set the field elevation at Dulles Airport—313 feet--and the barometric correction inio the pressurization system before flight 217 began its descent. Therefore, when the descent began, the airplane's cabin altitude would have decreased at the controlled descent rate of about *300* fpm.

Whiie flight 217 was descending between FL 370 and FL 220, the cabin altitude was controlled by the programmed descent rate and a differential pressure of 8.44 psi. If, for example, the airplane were leveled off at FL 290 daring the descent, the cabin altitude would continue to descend at about *300* fpm and level off when it reached the 8.44-psi pressure differential. At FL 240, this would equate to a cabin altitude of about 4,400 feet. When the descent was resumed, the cabin altitude would resume its controlled descent rete of about 300 fpm. Based on the designed performance criteria of the cabinpressurization system, flight 217's cabin altitude could have decreased to 313 feet

any time after the airplane reached or descended through PL 220. Thereafter, the cabin altitude would be maintained at 313 feet st any altitude between 313 feet and about FL 220.

'When flight 217 was at FL 370, its cabin altitude was about 6,500 feet. Based on the controlled descent rate of about 300 fpm, it would have required about 21 minutes to decrease the cabin altitude from 6,500 feet to 313 feel. In addition, Once flight 217 descended below FL 220, there would have been no system-imposed restrictions on the cabin altitude's descent to 313 feet. The data on the annotated flight plans did not show when flight 217 was cleared to descend from FL 370 and FL 350; however, the data therein does permit the Safety Board to determine how long it was below FL 220.

The annotated flight plans showed that flight 217 was at 16,000 feet when it crossed the Modena VORTAC; that it was at 16,000 feet when it crossed DELRO intersection at 1418; and that the flight arrived at the Armel VORTAC at 1443. Based solely on the elapsed flight time between DELRO and the Armel VQRTAC, flight 217 was below FL 220 for about 25 minutes. However, the flight plans showed that the flight was below FL 220 for longer than 25 minutes. ATC had required flight 217 to be at FL 180 25 nmi northeast of the Modena VORTAC, and the flightcrew had to comply with this clearance. Thus, the flight was at or below FL 180 by the time they were 25 nmi northeast of the Modena VORTAC. Based on the computed ground speeds contained in the flight plan, it would have taken flight 217 about 11 minutes to fly from 25 nmi northeast of the Modena VORTAC to DELRO. Since it was obvious that flight 217 had descended through FL 220 before reaching the level-off point 25 nmi northeast of Modena, the Safety Board concludes that flight 217 was below FL 220 for at least 36 minutes before landing. In addition, the Safety Board concludes that there was ample time for cabin altitude to descend from 6,500 feet to 313 feet at its controlled rate of about 300 fpm.

None of the other 154 passengers and crew, including those passengers seated in the immediate vicinity of the deceased, reported experiencing any discomfort or difficulties during flight 217's descent. Indeed, based on the statement of the passenger seated adjacent to her, there was some evidence to indicate that the discomfort experienced during the descent by the deceased had occurred on recent flights. Therefore, the deceased's medical records, autopsy reports, death certificate, and the circumstances relating to the injury were submitted to the Armed Forces Institute of Pathology (AFIP), Washington, D.C., for review. After reviewing the data, the AFIP stated in part that this case:

> ...represents an otitis media made symptomatic with a change in air pressure during descenr. There is evidence that [the deceased] had experienced similar episodes in the recent past. Records also show that she took 16 commercial flights between January and March of 1986. We believe this represents an opportunity for repeated barotrauma and that there was an ear infection already present when [the deceased] departed London.

In conclusion, the investigation showed that flight 217's cabin pressurization system not only operated properly and within its design limitations during the flight between Heathrow and Dulles Airports, but also that none of the other occupants of the airplane had experienced any discomfort during either its ascent or descent. The investigation also showed that there was an ear infection already present when the deceased boarded flight 217 at Heathrow Airport. Given the evidence herein, the Safety Board concludes

that the injury suffered by the deceased was the result of a preexisting infection, and that the events that occurred on flight 217 cannot be classified as an aircraft accident or incident.

/s/ JIM BURNETT
Chairman

/s/ PATRICIA A. GOLDMAN
Vice Chairman

/s/ JOHN K. LAUBER
Member

/s/ JOSEPH T. NALL
Member

/s/ JAMES L. KOLSTAD
Member

January 28, 1988

National Transportation Safety Board
Washington, D.C. 20594

AIRCRAFT ACCIDENT/INCIDENT SUMMARY

File No.:	198
Operator:	Singer Corp. - Kearfott Division
Type. Registration:	Israel Aircraft Industries IAI-1124A, N50SK
Location:	Redwater, Texas
Date and Time:	April 4, 1986, 1922 c.s.t.
Occupants:	2 Crew, 5 Passengers
Injuries:	7 Fatal
Damage:	Destroyed
Phase of Operation:	Cruise Flight

On April 4, 1986, about 1922 c.s.t., an Israel Aircraft Industries IAI-1124A, Westwind II, N50SK, a twin-engine, eight-passenger, turbojet airplane, was destroyed when it impacted the ground at high speed in an uncontrolled descent near Redwater, Texas, following a loss of control st 37,000 feet The two crewmembers and five passengers aboard were killed. Aa explosion on impact caused minor ground fires nearby. The airplane, owned by Drayton Associates and leased to and operated by the Singer Corporation–Rearfott Division, had departed Redbird Airport ab 1856 c.s.t. under an instrument flight rules (IFR) flight plan on an executive flight from Dallas, Texas, to Teterboro, New Jersey.

Earlier in the day, the crew had flown N50SK from Teterboro to Dallas, arriving around 1030 c.s.t. The computer-generated flight plan Me crew accessed that morning at 1030 listed their estimated departure time from Dallas as 1430; however, one of the passengers called the crew at the Redbird fixed-base operator (FBO) at 1400 and released the crew to return to their home base at Teterboro. The captain subsequently called his flight operations manager, who told him to wait for his passengers and return to Teterboro if the flight could be airborne by 1900 local time.

Following arrival of the passengers, the fright departed Redbird Airport at 1856, cleared for the Dallas 4 Departure (standard instrument departure) to Texarkana VORTAC and then Jet Route J-42 at flight level 370, and was immediately handed off to Dallas/Fort Worth (DFW) Regional Departure. At 1900:35, the captain contacted the Terminal Radar Approach Control (TRACON) and stated, "Our radar is not doing very well this evening." He requested vectors around thunderstorms that were building up to the south and east of the airport. The TRACON controller provided the vectors and subsequently handed off the flight to the Fort Worth Air Route Traffic Control Center (ARTCC) Lake Low Sector controller. The TRACON controller did not pass on the information about the reported radar malfunction to the ARTCC controller when he handed off the flit At 1902:26, the captain requested additional vectors for weather avoidance from the ARTCC controller, but did not state that their radar was malfunctioning. The captain did not inform any subsequent controllers of the radar malfunction. Neither the crew nor the TRACON controller was required by Federal Aviation Administration (FAA) regulations to report the radar outage or to notify other controllers of the malfunction.

With the exception of the vectors for weather avoidance, the flight progressed normally throughout the climb, and at 1910:14 the captain requested and received clearance to proceed "direct" to the Texarkena VORTAC. About 1917, the ARTCC controller requested a pilot report from the crew. The captain stated "well off to the left they're still building uh theres topping nut about 38 39 but off to the eight where we were just passing through there she's topping about 36 to 37." At 1918:57, the captain stated that they needed to maintain their current heading and requested permission to climb from the assigned altitude of 37,000 feet to 39,000 feet. The controller acknowledged receipt of the request and about 60 seconds later, at 1919:51, A crewmember stated, "Center, Westwind fifty SK need to get up." Laboratory and operator analysis of the air traffic control (ATC) audio tapes revealed that these last two transmissions were made by the copilot, whereas all of the previous transmissions had been made by the captain. According to the operator's policy, the person not flying would make the radio calls. After coordinating the new altitude with L e adjoining airspace controller, the ARTCC controller cleared the flight to flight level 390 a? 1920:17 but did not receive an acknowledgment. A garbled transmission from N50SK was received at 1920:13. Transponder and altitude readouts were lost from the ARTCC radarscope at 1920:01 and primary returns were lost at 1922:07. Reconstruction of the ARTCC recorded radar data indicated that during the 30 seconds immediately before the loss of communications and radar contact, the airplane was tracking straight on a course of 083°, directly into an area nf severe weather, and that the climb from FL 370 to FL 390 was not initiated. At the airplane's gross weight, its service ceiling was FL 410.

The airplane crashed in an open pasture on e heading of 275° in an 82° nose-down attitude with the left wing leading. The impact rite vias 41 miles northeast of Ice point where recorded radar data showed the lest transponder encoded return. The airplane disintegrated on impact.

Witnesses said there was a severe thunderstorm at the time of the accident, it was dark, and haii began to fall shortly after they saw the crash. Radar imagery of the storm cell in the immediate vicinity of the accident site indicated that it was a Video Integrator Processor (VIP) level 6 thunderstorm. Thunderstorm intensities are measured from level 1 through 6, with level 6 being the most severe. Several airplanes transiting the area reported that their radarscopes indicated a severe thunderstorm, and a Beech Baron flying underneath the cell at the time of the accident experienced a turbulence upset and a loss of control while flying within 3 miles of the accident site. A passenger aboard the Baron reportedly saw the fireball from the impact of N50SK.

The on-scene investigation revealed that the left horizontal stabilizer and elevator had separated immediately before the impact at low altitude, and the pieces were located about 400 feet southeast of the principal impact crater. An examination of the fracture surfaces on the separated pieces indicated that they fractured as a result. of aerodynamic loading and overstress and were a result of the accident. All of the airplane structure was accounted for at the accident site except for the left main gear door. An examination and layout of the airplane structure indicated that except for the left horizontal stabilizer and elevator and the left main gear door, all of the flight control surfaces were attached end the structure was intact before impact. Because of the airplane destruction, investigators could not determine the control continuity. However, all of the breaks in the flight control system appeared to be from overstress and to have occurred as a result of impact. Both the left and right horizontal stabilizers had a positive set in the spars. Measurements from the fliit control and landing gear actuators revealed that the speed brakes were deployed and the landing gear was down at impact. It was also determined that the flaps were up and the lift dumps were retracted. The actuators indicated that

the stabilizer was trimmed between 1.35° and 1.9° leading edge down and the rudder trim was neutral. The left aileron trim actuator was found in a 9° tab-down, aileron-up position. During the layout and examination, the Safety Board found no evidence of aerodynamic flutter, and there was no evidence that the airplane had been struck by lightning.

The airplane, an IAI-1124A, serial number 309, manufactured in March 1981, was properly certificated in the transport category and maintained under a continuous airworthiness inspection program approved by the FAA as outlined in Federal Air Regulation 14 CFR 91.169f(5). The aircraft maintenance records indicated that all of the required inspections had been completed in accordance with the approved program, except for a required annual avionics inspection, which had been completed but had not been properly signed off. At the time of the accident, the airplane had accumulated 2,745.3 hours. The maintenance records did not reveal any discrepancies that would have affected the airworthiness of the airplane. Weight and balance for the airplane was found to be within limits both at takeoff and at the time of the accident, and it was determined that fuel contamination was not a factor.

Detailed examination of both engines did not reveal any mechanical defect or malfunction that would have prevented either engine from operating normally. Evidence found during the teardown indicated that both engines contained little rotational damage that is associated with an engine developing moderate or higher thrust at impact. The examination revealed damage on both engines that was consistent with engines windmilling in a flamed-out condition on impact.

Safety Board investigators asked Israel Aircraft Industries (IAI) to provide information about engine inlet distortion, high-altitude upset recovery techniques, and airplane flight characteristics for the IAI-1124A. IAI indicated that, based on the available flight test data, the possibility of an engine flameout due to inlet distortion was extremely unlikely during an operation within the normal flight envelope. The engines were flamed out at impact. During the investigation, the Safety Board became aware of one other instance involving an engine flameout on an IAI-1124 series airplane following a high-altitude upset. Investigators determined that the airplane had to have been outside the normal flight envelope for the departure from controlled flight to have occurred and was most certainly out of the normal envelope during the ensuing descent. The information received from IAI indicated that recovery from upsets had been demonstrated up to 390 knots (Mach .81) during certification and that for the conditions as they existed on the accident airplane, a control pull force of 50 pounds would have been required for a 2° control angle deflection.

IAI stated that speeds in excess of those cited could build up in a dive and that wind tunnel data indicated that at Mach .90, a pull force of 200 pounds might be required at the maximum allowable limit of 2.8 G. IAI calculated the theoretical terminal velocity, given the airplane's configuration at the time of impact, and determined that the airplane could have reached a maximum speed of 559 knots; however, in order for this speed to be attained, the pilot would have had to deliberately apply nose-down force during the dive. All of the certification and flight test and recovery aerodynamics were derived on the basis of a clean airframe in visual flight conditions. Any accumulation of ice on the airframe would affect the aerodynamics and thus the ability to recover from an upset.

The airplane was equipped with a Collins WXT-250A color radar, which was center-mounted in the instrument panel between the pilot and copilot. The radar had been repaired or serviced four times since October 26, 1981. The last maintenance performed on the unit was replacement of the radar transmitter unit on April 11, 1985. There were no open write-ups on the radar or any other avionics equipment at the time of the accident. A review of the ATC communications tapes from the flight of N50SK from Teterboro to Dallas revealed that the crew neither requested any weather avoidance vectors nor reported any radar malfunction to controllers. In addition, the captain did not report any equipment malfunctions when he talked to his company operations base before departing on the accident flight. According to airplane logs and statements from the operator's personnel, the airplane departed Teterboro with no known discrepancies regarding the radar system. Due to the impact damage sustained by the radar system components, investigators were not able to determine the nature of the malfunction, nor did the crew's statement about the unit's performance offer any insight into the complete or partial failure of the system. Based on statements made by the crew to the controllers, the radar may have been partially functional. At one point, the crew requested Texarkana "direct" and at 1918:57, the crew stated "center Westwind five zero Sierra kilo we need to maintain the heading we're presently on and like to request three nine oh if you can," which implied that they were providing their own weather avoidance. Yet the airplane proceeded directly toward an area of severe weather.

For attitude reference, the airplane was equipped with two Collins ADI-85A attitude direction indicators mounted in the pilot and copilot primary flight instrument groupings and a JET Electronics AI-804J/B installed as a standby attitude indicator. The primary attitude direction indicators were capable of sustaining 360° of roll and 80° of pitch without precessing. The standby attitude indicator was capable of 360° of roll and 82° of pitch without tumbling. Once these angles were exceeded and sustained, the attitude displays, both the primary attitude direction indicators and the standby attitude indicator, would become erratic and produce conflicting and/or erroneous information. According to information received from IAI, the two primary attitude direction indicators would continue to function as long as the Number 2 Communications and Accessory Bus was powered. The standby attitude indicator had a self-contained power supply.

Both crewmembers of N50SK were properly certificated, qualified, and current for the operation being conducted. The captain had 7,353 flight hours, 657 of which were in the IAI-1124 series. During the 90 days preceding the accident, he had flown 107 hours, 38 of which were in the N50SK. He had flown approximately 4 hours in the 24 hours before the accident. He had a 13-hour duty day and 4 hours of flight time on the day of the accident. In the 7 days before April 4, 1986, he had been off duty for 3 days, and there had been no major interruptions in his normal rest schedule. In addition, the captain's training records indicated that he had received 3 hours of high-altitude meteorology instruction on September 30, 1983, and training on the use of airborne weather avoidance radar in conjunction with normal recurrency training. The training was not equipment specific; however, the operator's chief pilot stated that the captain was very familiar with the use of the color radar installed in N50SK. Also, the captain was one of the pilots who participated in the certification of the IAI-1124 visual simulator.

The copilot had 2,745 flight hours, 895 of which were in the IAI-1124 series. During the 90 days preceding the accident, he had flown 100 hours, 30 of which were in the N50SK. He had flown approximately 4 hours in the 24 hours before the accident. In the 7 days before April 4, 1986, he had been off duty for 3 days, and there had been no major interruptions in his normal rest schedule. The investigation did not determine if the copilot had received any formal training in high-altitude meteorology or in the use of weather avoidance radar.

The crew received two weather briefings from the Dallas Flight Service Station (FSS) before departure. In the first briefing at 1128, a flight service specialist advised a crewmember to expect thunderstorms in the local area and throughout the planned route of flight through northeast Texas and Arkansas and that the storm cells would continue building throughout the afternoon. In addition, the specialist provided the forecasts for the rest of the flight and the arrival terminal area. This briefing ended approximately 7 1/2 hours before the flight's departure.

At 1714, a crewmember called the Dallas FSS to revise the flight plan departure time and to receive a weather update. This second briefing was not conducted in accordance with the procedures in the FAA Flight Services Handbook because it did not include all the elements required for the full weather briefing. The FSS specialist mentioned a line of weather that at the time was located to the south of the DFW area and ran to the northeast and indicated to the crew that the line generally would not be a factor once the flight was outside the immediate Dallas area. In addition, the specialist provided the crewmember with an overview of the conditions that could be expected along the route of flight and the terminal observations at the destination. In a postaccident interview, the specialist stated that she recalled giving the crewmember the current Convective Significant Meteorological Information (SIGMET), but did not remember which SIGMET it was. A review of the briefing tape revealed that no specific SIGMET was mentioned, but some elements of the text of SIGMET 46C, current at the time, were given during the briefing.

In addition to not giving the SIGMET number and all pertinent information, the specialist also did not provide the crewmember with the details of Alert Weather Watch (AWW) No. 66, which was valid from 1500 to 2100 and covered the entire route of flight of N50SK up to the point of the accident. The specialist did not alert the crewmember to AWW No. 66 because, although the AWW area of coverage was posted on the plotting board, the effective times were not properly posted and it appeared that the AWW had expired. AWW No. 66 stated, in part, "Tornadoes. Hail surface and aloft 3 1/2 inches. Wind gusts to 75 knots. Maximum tops to 55,000 feet." In addition, the National Weather Service (NWS) issued several severe thunderstorm warnings during the evening to residents in many counties in northeast Texas, including Bowie County where the accident occurred. When the briefing was terminated at 1718, the specialist suggested that the crewmember "Might get a recheck here . . . when you're ready to go and see what this line is going to do." There is no evidence that either crewmember called the FSS for an update before departure 1 hour 38 minutes later. In addition to accessing their own contracted weather service earlier, the crew also used the contracted weather service at the FBO at 1826, but did not access the hazardous weather codes on the computer. It was not determined if the crew listened to any other recorded weather information frequencies.

A review of the weather data by Safety Board meteorologists indicated that the area of the accident flight was dominated by a stationary front that ran from southwest Texas up through northern Arkansas. A review of the weather radar data indicated that at the time of N50SK's last radio transmission, the airplane was encircled by at least three storm cells located within 13 miles of the airplane's position that varied in intensity from VIP level 4 to VIP level 6. The core of the level 6 cell, with tops to 45,000 feet, was 7 miles northeast of the last recorded position of the airplane. The best information available indicated that the cells were still building at the time of the accident. However, the weather data review indicated that the airplane was in visual meteorological conditions (VMC) when the crew lost control, and that following the loss of control, the airplane penetrated the level 6 cell and descended through it. The airplane could have encountered severe airframe icing in the thunderstorm. The study also indicated that it would have been a dark, moonless night both at the cruise altitude and on the ground.

As the airplane was lifting off at Redbird Airport at 1856, the NWS National Aviation Weather Advisory Unit issued Convective SIGMET 2C, which covered the route of flight of N50SK. A review of the ATC transcripts determined that SIGMET 2C was not transmitted on any of the ATC frequencies while N50SK was on those frequencies. The Air Traffic Control Handbook, 7110.65E, requires that the text of a SIGMET be transmitted over all operational frequencies at least once when any part of the area described in the text is within 150 miles of the en route facility's jurisdiction. In addition, the handbook states that terminal facilities may transmit an abbreviated text if the area of coverage is within 50 miles of the facility. While the required transmission of SIGMET 2C may have been made over the appropriate frequencies, it was not made during the time that N50SK was maintaining an active listening watch. The handbook also requires that an active SIGMET and AWW be transmitted over the voice band of the affected VOR facilities at 15-minute intervals beginning at 15 minutes past the hour. The investigation revealed that the SIGMET and the AWW that were pertinent to the accident were not transmitted over the Texarkana VORTAC during the timeframe in question. The Safety Board realizes that traffic conditions could preclude the dissemination of this information by controllers every 15 minutes. However, the Board believes that the handbook should be amended to require the frequent broadcasting of the significant hazardous weather reports that are in effect.

The final transmissions from the airplane indicated that the crew was aware that they were in or about to be in a hazardous situation. Evidence indicated that the VIP level 6 thunderstorm was growing in front of them and they were going to attempt to climb over it. Shortly thereafter, the airplane apparently experienced a turbulence-related upset while in clear air as a result of the outflow of the level 6 storm cell. Following the upset, the airplane penetrated the cell and descended through it until it broke out of the bottom at approximately 4,000 feet agl. Research indicated that the crew probably would have had to attempt a recovery using partial control panel techniques. In addition, the severe airframe icing that is indicated by the Safety Board weather study would have adversely affected the flight characteristics and recoverability of the airplane.

Once the airplane experienced the turbulence-related upset, the crew was faced with multiple emergency situations: a dual engine flameout, possible interruption of electrical power, erratic or erroneous attitude displays, darkness, flashing lightning, extreme turbulence, and severe airframe icing. The crew's ability to recover from this situation would have been taxed to the limit, even before considering the physical and psychological stress that such a situation induces. However, evidence indicated that they were trying to regain control and cope with the situation. When the airplane came out of the bottom of the cell, it did so in an inverted, nose-down attitude. The crew may have acquired some outside visual cues that prompted a recovery attempt that included pulling back on the yoke. The result of the action appears to have been the separation of the left main gear door, which struck the left horizontal stabilizer, weakening it to the point that it failed in overstress. At that point, the airplane rolled upright and impacted the ground.

The handling of the accident flight by DFW Regional Departure and Fort Worth ARTCC controllers was in accordance with the Air Traffic Control Handbook, 7110.65D. The ARTCC controller was aware of the possibly severe weather in the Texarkana area and briefed his relief on the storm cells in the area. However, he made no attempt to inform the crew of N50SK that they were heading into the severe weather, probably because of the crew's indications that they were providing their own weather avoidance and because he was not aware that the airplane's radar was malfunctioning, and the crew did not request assistance. The Safety Board believes that had the controller been aware of this radar outage, he would have provided additional assistance.

The Airman's Information Manual (AIM), Chapter 4, Section 7, Paragraph 342, Subparagraph (1)(h), advises pilots to inform ATC when they experience a loss or malfunction of certain navigational and communication equipment. The Safety Board believes that pilots should also report to ATC when they are aware of a loss or malfunction of the airplane's airborne weather radar equipment and that paragraph 342 should be expanded to include this type of report.

Additionally, the Air Traffic Control Handbook, 7110.65D, Section 2, Paragraph 2-7, directs controllers to determine the nature and extent of any special handling desired when a pilot reports an in-flight malfunction. The Safety Board believes this paragraph should be expanded to include a loss or malfunction of airborne weather radar. This information would be passed on to other controllers or facilities who would subsequently handle the aircraft.

The Safety Board concludes that the crew was probably misled by the FSS briefing into thinking that the en route weather conditions were less severe than the conditions that actually existed and were forecast. The FSS specialist did not completely inform the crew of the hazardous conditions that were expected and did develop. Despite the fact that the crew checked the weather four times from three different sources, they did not receive all of the pertinent information about the dynamic convective activity along their intended route. Their decision to continue the flight after they became aware of a malfunction in the airplane's radar may have been affected by the weather they expected to encounter en route and by what appeared to be only a partial malfunction of their weather avoidance radar.

The Safety Board is aware of the FAA's current Hazardous In-Flight Weather Advisory Service (HIWAS) program. HIWAS is a continuous broadcast over selected Very High Frequency Omnidirectional Range Stations (VORs) of hazardous weather information contained in Alert Weather Watches (AWWs), SIGMETs, Convective SIGMETs, Center Weather Advisories (CWAs), Airmen's Meteorological Information (AIRMETS), and urgent pilot reports (PIREPs). The program is currently operational in the Miami, Jacksonville, and Houston ARTCCs. According to the FAA, HIWAS is to be implemented in the conterminous United States by the end of calendar year 1988. The Safety Board supports the intent of HIWAS and believes this program addresses the need for the timely dissemination of hazardous meteorological information to flightcrews. However, the Safety Board believes that the program can be completed before the end of 1988 and urges the FAA to expedite its implementation.

The attached Brief of Aviation Accident contains the Safety Board's findings and determination of probable cause(s) and factors relating to this accident.

As a result of this investigation, the National Transportation Safety Board made the following recommendations to the Federal Aviation Administration:

> Amend Chapter 2, Section 6, paragraph 2-101, of the Air Traffic Control Handbook, 7110.65E, to require air traffic controllers to frequently broadcast the significant hazardous weather reports that are in effect. (Class II, Priority Action) (A-88-20)
>
> Amend Chapter 4, Section 7, Paragraph 342, subparagraph (1)(h) of the Airman's Information Manual to include airborne weather radar as an item of equipment whose complete or partial loss of capability should be reported to air traffic control. (Class II, Priority Action) (A-88-21)

Amend Chapter 2, paragraph 2-7 of the Air Traffic Control Handbook, 7110.65E, to include airborne weather radar equipment as an in-flight equipment loss or malfunction covered by this paragraph. (Class II, Priority Action) (A-88-22)

Expedite the implementation of the Hazardous In-Flight Weather Advisory Service program in all Air Route Traffic Control Centers within the conterminous United States, prior to the summer convective weather season of 1988. (Class II, Priority Action) (A-88-23)

/s/ JIM BURNETT
Chairman

/s/ PATRICIA A. GOODMAN
Vice Chairman

/s/ JOHN K. LAUBER
Member

/s/ JOSEPH T. NALL
Member

/s/ JAMES L. KOLSTAD
Member

February 2, 1488

National Transportation Safety Board
Washington, D.C. 20594

Brief of Accident

File No. - 198 4/04/86 REDWATER,TX A/C Reg. No. N50SK Time (Lcl) - 1922 CST

----Basic Information----
Type Operating Certificate-NONE (GENERAL AVIATION)
Type of Operation -BUSINESS
Flight Conducted Under -14 CFR 91
Accident Occurred During -DESCENT

Aircraft Damage
DESTROYED
Fire
ON GROUND

Injuries	Fatal	Serious	Minor	None
Crew	2	0	0	0
Pass	5	0	0	0

----Aircraft Information----
Make/Model - ISRAEL ACFT INDUSTRIES 1124A
Landing Gear - TRICYCLE-RETRACTABLE
Max Gross Wt - 23500
No. of Seats - 8
Eng Make/Model - GARRETT TFE731-3-1G
Number Engines - 2
Engine Type - TURBOFAN
Rated Power - 3700 LBS THRUST
ELT Installed/Activated - YES/NO
Stall Warning System - YES

----Environment/Operations Information----
Weather Data
Wx Briefing - FSS
Method - TELEPHONE
Completeness - PARTIAL,LMTD BY FCSTR
Basic Weather - VMC
Wind Dir/Speed- 060/006 KTS
Visibility - 10.0 SM
Lowest Sky/Clouds - UNK/NR
Lowest Ceiling - 4000 FT BROKEN
Obstructions to Vision- NONE
Precipitation - RAIN
Condition of Light - NIGHT(DARK)

Itinerary
Last Departure Point
DALLAS,TX
Destination
TETERBORO,NJ

ATC/Airspace
Type of Flight Plan - IFR
Type of Clearance - IFR
Type Apch/Lnds - NONE

Airport Proximity
OFF AIRPORT/STRIP

Airport Data
Runway Ident - N/A
Runway Lth/Wid - N/A
Runway Surface - N/A
Runway Status - N/A

----Personnel Information----
Pilot-In-Command
Certificate(s)/Rating(s)
COMMERCIAL,ATP,CFI
SE LAND,ME LAND
Instrument Rating(s) - AIRPLANE
Age - 35
Biennial Flight Review
Current - YES
Months Since - 4
Aircraft Type - L-1329
Medical Certificate - VALID MEDICAL-NO WAIVERS/LIMIT
Flight Time (Hours)
Total - 7353
Make/Model- 657
Instrument- UNK/NR
Multi-Eng - 5253
Last 24 Hrs - 3
Last 30 Days - UNK/NR
Last 90 Days - 197
Rotorcraft - UNK/NR

----Narrative----
AIRPLANE CRASHED DURING A UNCONTROLLED DESCENT, FOLLOWING A TURBULENCE UPSET AT FL370. THE UPSET OCCURRED AS A RESULT OF CLR AIR TURB ASSOCIATED WITH A VIP LVL 6 THUNDERSTORM LOCATED WITHIN 7 MILES OF THE LAST FOS OF THE AIRPLANE. AFTER THE UPSET, THE AIRPLANE PENETRATED AND DESCENDED THRU THE CELL WHICH CONTAINED LIGHTNING, EXTREME TURB AND SEVERE ICING. DURING THE UPSET/DESCENT BOTH ENG'S FLAMED OUT AND THE CREW'S ATTEMPTS TO RECOVER THE AIRPLANE WERE UNSUCCESSFUL DUE TO CONDITIONS IN THE CELL. CREW RECV'D AN IMPROPER BRIEFING FROM FSS AND REP'D THEIR RADAR WAS MALFUNCTIONING TO THE DEP CONTROLLER. SIGMET AND AWW INFO WAS NOT GIVEN DURING THE BRIEFING. AS THE AIRPLANE CAME OUT OF THE BOTTOM OF THE CELL AT 4,000', THE CREW OVERSTRESSED THE AIRPLANE CAUSING THE LFT MLG DOOR TO SEPARATE AND HIT THE LFT HOR/ STAB WHICH SUBSEQUENTLY SEPARATED IN OVERLOAD. IMPACT WAS 82 DEGREES NOSE DOWN. NATURE OF THE AIRFLANE RADAR MALF COULD NOT BE DETERMINED.

File No. - 198 4/04/86 REDWATER,TX A/C Reg. No. N5CSK Time (Local) - 1927 CST

Occurrence #1 AIRFRAME/COMPONENT/SYSTEM FAILURE/MALFUNCTION
Phase of Operation CLIMB - TO CRUISE

Finding(s)
1. FLIGHT/NAV INSTRUMENTS,WEATHER RADAR SYSTEM - FAILURE,PARTIAL
2. OPERATION WITH KNOWN DEFICIENCIES IN EQUIPMENT - CONTINUED - PILOT IN COMMAND

Occurrence #2 IN FLIGHT ENCOUNTER WITH WEATHER
Phase of Operation CRUISE - NORMAL

Finding(s)
3. UEATHER CONDITION - THUNDERSTORM
4. WEATHER CONDITION - TURBULENCE,CLEAR AIR
5. WEATHER CONDITION - GUSTS
6. WEATHER CONDITION - DOWNDRAFT
7. LIGHT CONDPTIOH - DARK NIGH?
8. PREFLIGHT BRIEFING SERVICE - IMPROPER - ATC PERSONNEL(FSS)
9. HAZARDOUS UEATHER ADVISORY - NOT ISSUE0 - ATC PERSONNEL(FSS)
10. IN FLIGHT UEATHER AUVISORIES - NO? ISSUED - ATC PERSONNEL(FSS)
11. IMPROPER USE OF FACILITY,INFORMATION UNCLEAR - ATC PERSONNEL(FSS)

Occurrence #3 LOSS OF CONTROL - IN FLIGHT
Phase of Operation CRUISE - NORMAL

Finding(s)
12. REMEDIAL ACTION - ATTEMPTED - PILOT IN COMMAND
13. IMPROPER USE OF PROCEDURE,EXCESSIVE WORKLOAD (TASK OVERLOAD) - PILOT IN COMMAND
14. IMPROPER USE OF PROCEDURE,EXCESSIVE WORKLOAD (TASK OVERLOAD) - COPILOT

Occurrence #4 LOSS OF POWER(TOTAL) - NON-MECHANICAL
Phase of Operation DESCENT - UNCONTROLLED

Occurrence #5 IN FLIGHT COLLISION WITH TERRAIN
Phase of Operation DESCENT - UNCONTROLLED

----Probable Cause----

The National Transportation Safety Board determines that the Probable Cause(s) of this accident is/are finding(s) 1,3,4,5,6,8,9,10,11

Factor(s) relating to this accident is/are finding(s) 2,7,13,14