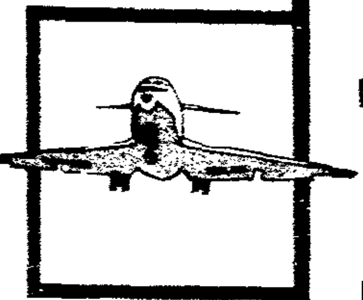

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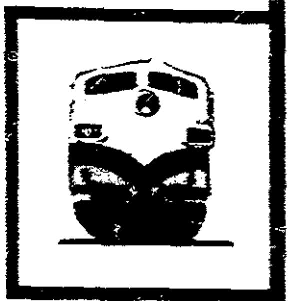

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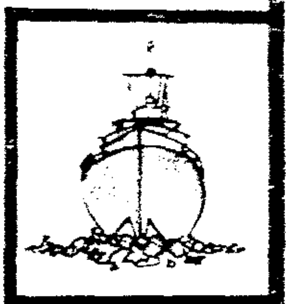
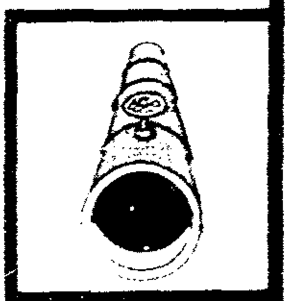


AIRCRAFT ACCIDENT REPORT

IBEX CORPORATION
GATES LEARJET 23, N100TA,
ATLANTIC OCEAN
NEAW SAVANNAH, GEORGIA
MAY 6,1982



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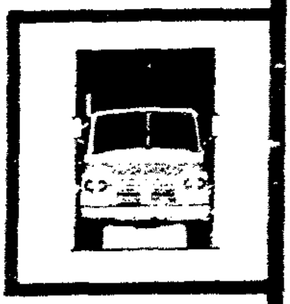

UNITED STATES GOVERNMENT

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16. Abstract

On May 6, 1982, at 1155:28 eastern daylight time (edt), while in cruise flight on Airway J79-121 *en route to Orlando*, Florida, from Teterboro, New Jersey, the flightcrew of N100TA, an IBEX Corporation Gates Learjet 23, was cleared by the Jacksonville Air Route Traffic Control Center to descend from its altitude of Flight Level 410 to Flight Level 390. The flightcrew acknowledged the clearance, and air traffic control observed the radar target descend. About 2 minutes later, the airplane crashed into the Atlantic Ocean, from a steep, high-speed descent about 12 miles from Savannah, Georgia. The air traffic controller made several unsuccessful attempts to contact the airplane. The pilots had reported no difficulties in any of their radio transmissions. The pilot, copilot, and the two passengers on board were killed.

The National Transportation Safety Board determines that the probable cause of the accident was an uncontrolled descent from cruise altitude for undetermined reasons, from which a recovery was not or could not be effected.

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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

Adopted: April 8, 1983

IBEX CORPORATION
GATES LEARJET 23, N100TA
ATLANTIC OCEAN, NEAR SAVANNAH, GEORGIA
MAY 6, 1982

SYNOPSIS

On May 6, 1982, at 1155:28 eastern daylight time (edt), while in cruise flight on Airway J79-121 en route *to* Orlando, Florida, from Teterboro, New Jersey, the flightcrew of N100TA, an IBEX Corporation Gates Learjet 23, was cleared by the Jacksonville Air Route Traffic Control Center to descend from its altitude of Flight Level 410 to Flight Leue! 390. The flightcrew acknowledged the clearance, and air traffic control observed the radar target descend. About 2 minutes later, the airplane crashed into the Atlantic Ocean, from a steep, high-speed descent about 12 miles from Savannah, Georgia. The air traffic controller made several unsuccessful attempts to contact the airplane. The pilots had reported no difficulties in any of their radio transmissions. The pilot. copilot, and the two passengers on board were killed.

The Sational Transportation Safety Board determines that the probable cause of the accident was an uncontrolled descent from cruise altitude €or undetermined reasons: from which a recovery was *not* or could not be effected.

1. FACTUAL INFORMATION

11 *History* of the Flight

According to the president of the IBEX Corporation, the purpose of the flight was to transport business associates from Teterboro. Sew Jersey, to Orlando, Florida, for a business meeting. The airplane. N100TA, was based a? Morristown. The flight was originally scheduled for either May 3 or 4, 1982, but the regular copilot, who was contacted on May 4, was not available for the trip to Orlando. A substitute copilot was furnished on May 5 by L&R Services, Inc., an air **taxi** operator at Morristown, New Jersey, and assigned the flight. The substitute copilot had flown with the pilot once previocsly. Reportedly, the owner of L&R Services observed the pilot conduct the preflight on the evening of May 5.

At 0748 1/ on May 6, the pilot telephoned the Teterboro Flight Service Statio?. (FSS) and requested a weather briefing for a flight from Teterboro to Orlando. The specialist working the briefing position discussed the standard terminal arrival **(STAR)** procedures for Orlando and agreed with the pilot's observation *that* it was a good day for a flight, with no hazardous weather. He gave the pilot the 1400 winds aloft at Flight Level (FL) 390 and mentioned the chance of some clear air turbulence had been forecast for the **period** ending at 0300 o.1 May 6.

1/ All times herein are eastern daylight time, based on ?he 24-hour clock.

The flight plan filed was as follows: Instrument Flight Rules (IFR) to Orlando, Florida, at FL 410, true airspeed 440 knots, via the DIX 7 standard instrument departure, Kenton transition, J14 to Richmond, 5165 to Charleston, J79-121 to Orlando, time en route 2 hours with 3 hours 45 minutes of fuel on board.

The airplane was fueled with 300 gallons (150 gallons each wing) of Jet A containing Prist (anti-icing additive) at Aero Services, Morristown Municipal Airport, Morristown, New Jersey, and was then flown to Teterboro to pick up the passengers. Personnel at Teterboro Aircraft Service, Inc., refueled the airplane to its 817-gallon capacity with 331 gallons of Jet A containing Prist Line personnel observed two passengers and the pilots board the airplane and observed the pilot occupy the left cockpit seat.

The flight was cleared IFR, essentially as filed, and the airplane was taxied from the ramp about 1005. After some air traffic delay, the flight was cleared for takeoff at 1028. Following the routine clearance and takeoff, New York Air Route Traffic Control Center (ARTCC) cleared the flight to climb to FL 240, and at 1041, issued an expedited clearance to FL 410. The copilot, who was handling the radio communications, reported that they were almost at FL 240 and would continue climbing at 300 knots.

At 1131:33, the flight contacted the Jacksonville, Florida, Air Route Traffic Control Center (ARTCC) and reported level at FL 410. It continued routinely along Airway J 79-121 until 1155:28, when the ARTCC cleared the flight to "...descend and maintain flight level three nine zero." This instruction was acknowledged immediately, "...three nine oh one hundred tango alpha," but the airplane did not begin to descend until about 35 seconds later. At 1157, 1 minute 32 seconds later, the copilot hurriedly reported, "One hundred tango alpha's descending now." During this radio transmission, the sound of a warning horn was heard in the background, and according to ?he radar data, the airplane descended through FL 400. The controller did not understand the transmission and asked 3 seconds later, "...say again." There were no further radio transmissions from the airplane. At 1201:14, the controller reported, "one hundred tango alpha I've last your transponder sir. reset it again on code thirty-three twelve."

About 1200, a fishing boat crew observed a large water geyser on the surface of the water in the Atlantic Ocean about 12 miles southeast of Savannah, Georgia. On arrival at that location, the boat crew found floating debris from an airplane, later identified to be N100TA, which included pieces of fuselage skin and cabin interior material. The submerged wreckage was located on May 14, 1982, at a depth of 55 feet with the aid of underwater sonar equipment. This crash site was at 31°45.4' N latitude and 080°40.4' W longitude.

12 Injuries to Persons

Injuries	Crew	Passengers	Others	Total
Fatal	2	2	0	4
Serious	5	0	0	0
Minor/None	0	0	0	0
Total	2	2	0	4

1.3 Damage to Aircraft

The airplane was destroyed by impact forces.

1.4 Other Damage

None

1.5 Personnel Information

The flightcrew was properly certificated and was qualified to make this flight. (See appendix B.) The pilot held an Airline Transport Pilot (ATP) certificate with airplane single and multiengine land ratings, and commercial privileges for rotorcraft–helicopters. He held six different turbojet airplane type ratings According to FAA records, he reported having logged 25 hours in the Model 23 Learjet at the time of his type rating flight on June 30, 1981. His total flight time was believed to have been about 7,000 hours, of which 100 to 150 hours were reportedly accumulated in the Learjet. His logbook was not available, and the IBEX Corporation could not furnish the Safety Board with a record of his flight time. He also held a current second class medical certificate with no limitations.

The copilot held a Commercial Pilot certificate with airplane single and multiengine land and instrument ratings She did not hold any airplane type ratings She had received a 14 CFR 135 copilot proficiency check in the Model 23 Learjet on February 25, 1982. Reportedly, she had about 1,550 hours of total pilot time, of which about 125 hours were in the Learjet 23. She also held a current first class medical certificate with a limitation that the holder must wear glasses for distant vision while exercising the privileges of her certificate.

1.6 Aircraft Information

Gates Learjet 23, N100TA, Serial No. 23-045, was issued a standard airworthiness certificate on August 25, 1965, in accordance with Part 3 of the Civil Air Regulations of May 15, 1956. (See appendix C.) It was certificated for night to a maximum altitude of 41,000 feet m.s.l. 2/ and at a maximum operating speed (V_{mo}/M_{mo}) of 358 knots indicated airspeed (KIAS)/0.82 Mach numbers. Among other features, the airplane was equipped with General Electric CJ-610-4 powerplants, dual JET attitude direction indicators, Collins P/N 101 horizontal situation indicators, a JET FC-110 autopilot (4-5020 Flight Controller), dual Wilcox transponders, a Smith encoder altimeter end altitude alerter, a PRIMUS 40 radar, an AIM standby attitude gyro, and lead-acid batteries

Review of the history of ownership disclosed that Teterboro Aircraft Services, Inc., had owned and operated N100TA from September 1, 1976, until Panhandle Aircraft, Inc., purchased the airplane from Teterboro on January 8, 1981. Panhandle, in turn, sold it to Air Capital Aircraft Sales, Inc., of Wichita, Kansas, on June 23, 1981. The airplane apparently was operated from Teterboro, New Jersey, during this period of time. The IBEX Corporation purchased the airplane from Air Capital Aircraft Sales, Inc., through a time purchase agreement. The agreement, dated July 1981, required monthly payments and a final balloon payment in July 198%. According to the operator, he was in the process of negotiating a 6-month extension to the agreement when the accident occurred.

2/ All altitudes are above mean see level unless otherwise noted.

1.6.1 Maintenance

Review of the maintenance records indicated that the airplane had been maintained in accordance with Federal Air Regulations As a result of a previous incident 3/ involving the pitch axis of the FC–110 autopilot in 20 Series Learjets, an Airworthiness Directive (AD) 80–22–10 was issued October 23, 1980, to prevent a potential malfunction. (See appendix D.) According to the maintenance records for N100TA. this A 3 was performed by Teterboro Aircraft Services by installing the manufacturer's airplane modification kits AMK–80–3, change 4, and AMK 80-16B, change 2, in accordance with paragraph B of the AD. However, there was no entry in the logbook showing the date the AD was accomplished. The total time on the airframe at that time was 6,971 hours

The records showed that while being operated by the IBEX Corporation, from July 1981 to May 6, 1982, the airplane had been maintained in accordance with an inspection program approved under 14 CFR Part 91, Section 217(b)(4) -- a current inspection program recommended by the manufacturer. However, this program was no? on file with the local Federal Aviation Administration (FAA) General Aviation District Office, as required by 14 CFR Part 91, Subpart D. According io me operator, the pilot was given the responsibility to manage the required maintenance. The records further indicated that tne required-cycle of inspections had been performed ai the proper times and that compliance with all other applicable AD's was accomplished.

The operator further reported that the airplane was flown in conjunction with its business and that it had accumulated about 75 nours during his period of ownership. Because of the 'high–time" engines, the operator had considered the options of overhauling them, purchasing other used engines, or selling the airplane for a larger one. The operator said also that the interior of the cabin had been extensively refurbished.

X 150-hour inspection was performed on the airplane from October 21 to October 30, 1981. The total time on the airframe at that time was 7,064 hours. During the inspection, 105 maintenance discrepancies were recorded on tine customer work order. According to instructions given by the pilot, all but 19 of the 105 discrepancies were corrected. The remaining discrepancies, several of which were minor, were fisted as 'leave as is," or were noted that they would be corrected by the pilot at a later date. Two discrepancies of interest concerned (1) a low spot in the flexible lines of a pitot static defect correction module where water could collect and freeze, and (2) ?he resealing of the nose compartment door to prevent water from leaking into the Compartment. Among other avionics equipment, the autopilot computer was contained in this compartment. There was no maintenance record entry showing that these two outstanding discrepancies had been corrected. Also, during the 150-hour inspection, the standard nickel cadmium batteries were replaced with lead acid batteries in accordance with a Supplemental Type Certificate (No. SA103350). According to the regular copilot, he windshield on the right side would fog up when the airplane was operated in warm moist air. To get rid of the moisture buildup, the pilot reportedly made an unauthorized modification by drilling small holes in the imide windshield layer to permit the injection of nitrogen between the outer and inner layers where the moisture would collect. After the moisture was removed, the small holes were filled with plastic screws. This action was performed when the airplane was on the ground.

According to the pilot examiner who owned L&R Services and who trained the pilot in the Learjet, an autopilot pitchup problem which had occurred during cruise flight

3/ Aircraft Incident -- National Jet Industries, Gates Learjet 25, Butler, Missouri, October 3, 1980.

had been handled correctly by the pilot. The examiner stated the incident occurred either in June or July of 1981. Reportedly, it was determined that a short in a circuit board had caused the problem and that the malfunction had been repaired. Review of the maintenance records covering the period the airplane was operated by IBEX disclosed that no similar autopilot discrepancy or associated repair had been recorded. However, in October 2981, the autopilot was repaired On March 25, 1982, additional routine maintenance was performed on the airplane, at which time it had accumulated a total of 7,098 hours.

1.6.2 Weight and Balance Information

The maximum certificated takeoff gross weight of the Learjet 23 is 12,500 pounds with an allowable ramp weight of 12,750 pounds. The allowable center of gravity (c.g.) range et 12,500 pounds is 20.8 to 32.5 percent mean aerodynamic chord (MAC). N100TA was last weighed on October 29, 1981. The basic empty weight and c.g. at that time was 6,853.5 pounds and 31.5 percent MAC, respectively.

The exact weight and seating location of the two passengers were not established nor was the total weight of the luggage on board The following postaccident computations, using reasonable estimated passenger and luggage weights, were made to establish a probable weight and balance at the most adverse, aft c.g. condition possible, at takeoff, and et the time of the uncontrolled descent:

Takeoff

Item	Weight (lbs)	Moment (1,000)
Empty Aircraft	6,853.5	1.619.9
Pilot	190	17.5
Copilot	110	17.5
Passengers (2 Aft)	340	71.4
Baggage	150	37.8
Fuel (Jet A)	5,643	1,377.12
Burnoff (taxi fuel)	-300	-75.52
	12,986.5	3,065.7

Center of gravity 30.8 percent MAC.

Impact

Item	Weight (lbs)	Moment (1,000)
Empty Aircraft	6,853.5	1,619.9
Pilot	190	17.5
Copilot	110	17.5
Passengers (2 Aft)	340	71.4
Baggage	150	37.8
Fuel 4/	2,716	646.15
	10,359.5	2,410.25

Center of gravity 26.7 percent MAC.

4/ Fuel burnoff was calculated on nominal fuel burnoff as follows: start and taxi, 300 pounds; takeoff, 150 pounds; 8 minutes low altitude, 267 pounds; climb to FL 410, 620 pounds; normal cruise 1 hour 7 minutes, 1.510 pounds; descent, 80 pounds Remaining fuel was assumed to be full wing tanks (2,252 pounds) and 232 pounds in each tip tank.

Based on these calculations, the airplane was about 487.5 pounds overweight at takeoff. Both weight and balance were within the allowable limits at the time of the accident.

1.7 Meteorological Information

On May 6, 1982, the weather on the eastern seaboard was influenced by a large high pressure area centered over the North Carolina coast which extended north to Nova Scotia and south to Cuba. The two constant pressure weather charts pertaining to the upper atmospheric weather conditions relevant at the time of the eccident were: the 0800, 200-millibar chart (4 hours before the accident) and the 2000, 200-millibar chart (8 hours after the accident) (See appendix E.)

The 0800, 200-millibar chart showed a sharp ridge (high pressure! extending from the Gulf of Mexico into Canada. The ridge was oriented on a line from eastern Alabama through centrsl Kentucky to Lake Huron. The polar and subtropical jet streams entered the ridge cver Texas and split in two directions. One branch of the jet stream headed northward over Oklahoma and into Minnesota, and the other branch headed southeastward over the Gulf of Mexico to southern Florida and Cuba. At the leading edge of the ridge, there was a southerly moving jet stream with winds greater than 70 knots, blowing due south off the Atlantic Coast and joining the southern branch of the other jet stream over the western Antilles. The winds were northwesterly at 50 to 55 knots in the vicinity of the airplane's route of flight. The 2000, 200-millibar chart showed essentially the same upper atmospheric conditions; however, the ridge was displaced farther eastward and the winds were northwesterly at 30 knots in the vicinity of the airplane's route of flight

The nearest weather radar coverage of the accident site was the National Weather Service radar station located at Waycross, Georgia. During the period from 1600 on May 5, 1982, to 1600 on Nay 6, 1982, no thunderstorms or other significant meteorological activity were detected by this station.

Savannah, Georgia, was to the east of a line of high clouds extending from north Georgia to northeastern Florida as depicted by the May 6, 1201 infrared Geostationary Operational Environmental Satellite !GOES). The GOES 1231 visual light picture showed only thin broken clouds to the west of the accident site. There was no indication of convective activity.

Observed upper atmospheric data from soundings at five locations in the general area of the accident site were analyzed by the Safety Board's meteorologist. All significant atmospheric layers due to temperature differences at altitudes in the vicinity of the airplane's descent from its cruise flight level were investigated. The data disclosed that between 0800 and 2000 on the day of the accident, the tropopause was from 42,378 feet to 43,581 feet over Charleston, South Carolina, and Athens and Waycross, Georgia. At 0800, the tropopause was at 54,074 feet over Appalachicola, Florida, and 51,817 feet over Tampa, Florida. At 2000, it was at 48,177 feet over Appalachicola and 48,983 feet over Tampa "he temperature at the tropopause ranged from -83° F to -98° F during that period. A? 0800, there was a sharp altitude rise and apparent discontinuity in the tropopause between Waycross and Appalachicola. There was definite evidence of layering at the five locations Vertical wind shears across the discontinuity were 63 knots per 1,000 feet at Charleston, 7 knots per 1,000 feet at Waycross, 13 knots per 1,000 feet at Appalachicola, and 16.5 knots per 1,000 feet at Tampa. At 2000, there again was a sharp altitude rise and apparent discontinuity in the tropopause between Waycross and Appalachicola. An upper front was identified near the tropopause over Charleston

There was no identifiable discontinuity over Waycross. Vertical wind shears across the layer were insignificant at Charleston and Waycross, not available at Appalachicola, and 9.4 knots per 1,000 feet at Tampa.

The data from the two Waycross soundings were averaged from the surface to 45,000 feet in increments of 5,000 feet. A portion of the calculations is as follows:

Altitude (feet)	Temperature (degrees F)	Wind (degrees true/knots)	Difference from Standard Altitude (feet)
30,000	-31.6	303/24	+ 1,330
35,000	-57.4	308139	+ 1,460
40,000	-79.2	305142	+ 2,450
45,000	-87.3	306/50	+ 1,290

NOTE: The airplane should hnve been below the tropopause, but would have been within the region where tropopause associated turbulence is most likely to have occurred.

There were no recorded pilot reports of turbulence in the area of the accident *at* the airplane's flight level. The pilot of another Learjet (N44FE) over Savannah, Georgia, at FL 4.0 at about the time of the accident, reported that the weather 30 to 50 miles east of his position was cloudy with some moderate cumulus buildups He reported that his flight at FL 410 was smooth.

The following is the 1200 aviation surface weather observation from the Savannah, Georgia, Municipal Airport; it is representative of other observations in the vicinity: clear; visibility -- 7 miles; temperature -- 78°F; dewpoint -- 53°F; wind -- 310° at 7 knots; altimeter --30.22 inHg.

The area forecast covering the Atlantic Coast south to the northern Georgia border, issued by the National Weather Service Office, Washington, D.C., and valid from 2100 on May 5 until 1500 on May 6, included a chance of moderate clear air turbulence over North Carolina, South Carolina, and the adjacent coastal waters until 0300 on May 6. The subsequent area forecast, valid from 0900 on May 6 to 0300 on Mag 7, forecast no turbulence over the coastal States This information was avrilable to the pilot before departure.

The High Level Significant Weather Prognosis Chart (23,000 to 60,000), available after 0450 on May 6, and valid untii 1400 on the same day, showed an area of moderate turbulence between 30,000 feet to 40,000 feet over the Atlantic coastal States from central Florida to southern Virginia. This chart is used primarily for briefing overseas flights, and it is not known whether the pilots obtained this information.

The National Weather Service Forecast Office in Miami, Florida, has responsibility for the Florida coastal area north to the South Carolina -- Georgia border. The Miami Forecast Office did not forecast any turbulence for the same time periods indicated in the aforementioned forecasts.

1.8 Ai& to Navigation

Not applicable.

1.9 Communications

There were no known communications difficulties.

1.10 Aerodrome Information

Not applicable.

1.11 Flight Recorders

Tne airplane was not equipped with a flight data recorder (FDR) or a cockpit voice recorder (CVR), nor was either required by regulation.

1.12 Wreckage and Impact Information

Although several pieces of the wreckage were recovered on the Ocean surface shortly after the crash, the submerged wreckage was not located until May 14, 1982, with the aid of underwater sonar equipment. The search began at 1600 on May 13 based on location information furnished by the U.S. Coast Guard. The wreckage was located the following day at 1700 after a 3-hour 45-minute search which covered 2.1 square nautical miles. The main wreckage was scattered over a 50- by 100-foot area 55 feet below the surface of the ocean. The wreckage recovery operation began May 18 and was concluded the following day. Visibility in the water was about 25 feet or iess

Only about half of the airplane structure was recovered. Pieces of the aft section of fuselage skin and frames that remained floating on the ocean several hours after the accident included the upper aft frame and skin structure between fuselage stations 18 and 22, the left aft window frame, and the emergency escape hatch frame. Pieces recovered from the Ocean floor included the lower portion of the cabin door about 1 foot above the bottom hinge line, with the hinge and a section of adjacent door frame attached. Pieces of the upper and lower door latch handles arid locks were also found, including one latch pin which was engaged in the lover door. About 7 feet of the cockpit wind-screen frame was recovered with pieces of the windscreen remaining within the frame. Both engines arid all three landing gear assemblies were recovered.

Pieces from both wings and tip tanks were recovered. Several structural pieces from the wing center section were generally bent upward in the spanwise direction. Several pieces of the flight controls remained attached to the wing structure, including the left aileron and spoiler and the right wing spoiler and flap. The majority of the wing spars were not recovered. The left aileron remained normally attached at the rear spar on all three hinge fittings. Also attached were the trim and balance tabs Only one of the spoiler actuators was recovered; it was found in the fully retracted position.

The largest portion of recovered wreckage was the empennage, which included the vertical stabilizer, a 35-inch piece of the left side of the horizontal stabilizer, an engine, and the fuselage tailcone. The base of the vertical stabilizer was bent to the right 60° to 70°, and the leading edge was crushed aft against the front spar. The rudder, with the trim tab attached, was separated from the vertical stabilizer and was recovered in one piece. The leading edge of the left side of the horizontal stabilizer was crushed aft against the spar. The right side of the horizontal stabilizer had separated in a rearward direction 5 inches outboard of the vertical stabilizer. The horizontal stabilizer trim actuator remained attached at the junction of the vertical and horizontal stabilizers The dual electric motors were bent slightly forward at their mounts. The jackscrew was slightly bent and showed an extension of 14 threads, which corresponded to a stabilizer leading edge down position of about -4.5°. The right elevator, which was broken into three pieces, had separated from the stabilizer at its hinge points. An inboard portion of the left elevator was recovered; it had separated from the stabilizer at the hinge point. There was no evidence of overtravel at the hinge points of either elevator.

Examination of the wing flaps, spoilers, and landing gear disclosed that they were in the retracted position at the time of impact with the water. Because of the extensive destruction of the airframe and the absence of many components, complete integrity of the flight control system could not be established. However, the separations of the control system components recovered were typical of overload failures.

Examination of the compressor and turbine sections of both engines disclosed evidence of rotation at impact. The fuel control assemblies were recovered intact. The anti-ice valves had separated from the engines. One bleed valve was open and the other was closed.

Examination of portions of cockpit instruments indicated that both attitude gyro indicators showed a 60° nosedown attitude. One gyro showed a 120° right bank and the other gyro a 140° left bank. The pitch trim selector switch was in the normal position, and the yaw damper switch was in the ON position. The left stall warning switch was destroyed, but the right switch was in the ON position. Both the left and right pitot heat and engine nacelle heat switches were in the ON position.

Both throttles were in the flight idle position. One exhaust gas temperature gauge showed 180°; the normal operating range is from 200° to 677°C. One rpm gauge showed a reading of 53 percent; the normal operating range is from 47 percent to 100 percent. The left and right engine oil pressure gauges showed 47 psi and 29 psi, respectively; the normal operating range is 5 to 60 psi. The a.c. inverter switches were in the MAIN position.

There was no evidence of preexisting structural or system failure or malfunction of the components of the wreckage recovered.

1.13 Medical and Pathological Information

Post-mortem examination showed that the pilot died as a result of multiple traumatic injuries Toxicological specimens disclosed negative drugs and carbon monoxide findings Tests for alcohol disclosed a 0.03 grams percent blood alcohol level. Because of the condition of the body at the time the samples were taken and because of the problem encountered in the preservation of the samples, it was determined that they were contaminated.

The extensive injuries to the pilot and the passengers prevented post-mortem and toxicological examinations Positive identification of the passengers and pilot was made. The copilot's body was not recovered.

1.14 Fire

There was no evidence found to indicate the occurrence of an in-flight fire or explosion-

1.15 Survival Aspects

The accident was not survivable.

1.16 Tests and Research

1.16.1 Airplane Components

Several components of the autopilot system, the Mach overspeed warning system, and the angle of attack transducer were examined by the Safety Board at the Gates Learjet Corp. facility in Wichita, Kansas. The yaw control servo and magnetic clutches and the d.c. torquer actuator (pitch axis servo), an item required to be installed by AD 80-22-10, were recovered but damaged to the extent that functional tests could not be performed. There was no evidence of preimpact malfunctions of these units. The lateral coupler, trim coupler, and the pitch servo amplifier circuit boards from the autopilot computer amplifier disclosed no evidence of overheating; but impact damage prevented functional testing. The trim coupler board was equipped with the improved silicone transistors as required by AD 80-22-10. Functional testing of the autopilot effort indicators and controller unit also could not be performed because of impact damage. No meaningful information could be derived from the damaged Mach overspeed warning system and angle of attack transducer.

The horizontal stabilizer actuator was placed in a test jig at the manufacturer's facility. Measurement of the jackscrew extension was 1.4 inches which corresponded to a -4.5° stabilizer leading edge down position. When installed, the stabilizer is rigged to move within a range of 6.5°, from a -0.5° to a -7° leading edge down position. The rigging tolerance is ± 0.5°. The -4.5° leading edge down position corresponds to an estimated trim speed of about Mach 0.48/143 KIAS to Mach 0.41/122 KIAS, or about 122 KIAS at 40,000 feet. Electrical power was applied to determine if the motors would operate. After several attempts, the primary motor would turn the jackscrew in either direction. Once the crushed cover to the secondary motor was removed, that motor also turned the jackscrew. 5/

The main fuel control units from both engines were recovered intact and examined under Safety Board supervision at the General Electric Company's engine facility. It was concluded that brinell marks on the 3D cams of both fuel controls indicated 60 percent rotor speeds and turbine inlet temperatures of 85°F at the time of impact.

1.16.2 Warning Horn Sound

The warning horn sound heard on the ARTCC tape of the last radio transmission from the airplane was examined on the Safety Board's Spectral Dynamics spectrum analyzer. The warning horn sound was an oscillating tone with a period of 0.6 seconds, and lasted for 1.5 seconds; this tone was heard in the background the entire time of the copilot's radio transmission which also lasted 1.5 seconds The tone began at a frequency of 1,900 Hz, rose to a frequency of about 2,300 Hz, returned instantaneously to 1,900 Hz, and rose again. The slope of the frequency increase was about that of the Mach

5/ When the electric trim (no manual trim is available) is used to reposition the horizontal stabilizer, either the primary or secondary motors will cause the trim to operate at rates of 0.394° and 0.185° per second, respectively. The autopilot uses the secondary motor to move the stabilizer. However, when operating, the autopilot causes the motor to position the stabilizer at 0.0267° per second.

overspeed warning tone. The normal Mach overspeed warning should begin at 1,900 ± 380 Hz and go to 3,000 ± 600 Hz in 1.5 ± 0.3 seconds. The only other similar warning tone is the cabin pressure warning horn. The norma? cabin pressure warning should begin at 2,100 ± 420 Hz and go to 2,900 ± 560 Hz within a period of 0.3 ± 0.06 seconds The warning tone heard in the background was within frequency tolerances for both warnings However, the period did not fit the characteristics of either the Mach overspeed or cabin pressure warnings.

In order to determine the reason the warning signal did not fit the characteristics of either the Mach overspeed or cabin pressure warning, the warning horn oscillator unit from another Model 23 Learjet was examined at the Gates Learjet Customer Service Center since the unit in the accident airplane was not recovered. Maintenance records disclosed that this oscillator was the same type as that installed in the accident airplane. A test *of* the surrogate unit disclosed that when the Mach overspeed warning horn was activated, its tone lasted the same 0.6-second period as the tone noted in the *last* radio transmission from the accident airplane but that it started at a frequency below the specified tolerances. The unit was determined to be defective though the reason was not pinpointed. As a trial, the resistor and zener transitor in the overspeed warning horn circuit were replaced with similar components known to be of the correct value. When activated again, the unit generated the correct signal period of 1.2 to 1.8 seconds. The test results showed that the characteristics of the zener transistor in the surrogate Mach overspeed warning oscillator had changed in service, which resulted in the shortening of the warning signal period, resulting in the same warning horn signal as that heard on the XTC tape.

The cabin pressurization warning horn circuit in the surrogate oscillator was then examined. Replacement of an existing . ˉistor, which was not of the specified design value, with one of the specified design value, resulted in a shorte ıed period when the unit was activated. When a leaky capacitor was simulated, the period could **be** lengthened to a limit of 1 second. According to the capacitor manufacturer, leakage of a capacitor of the type called for in the specifications was extremely rare, and normally such a device either functioned properly or failed completely.

Thus, while the warning sound heard on the ATC tape did not fit the characteristics for either ?he Mach overspeed warning or the cabin pressurization warning circuits, it was possible using the foregoing technique to replicate the sounds heard on the tape. Accordingly, a failure or an inadvertent substitution of components in either warning circuit oscillator could have led to their generating the warning sound heard on the XTC tape.

1.16.3 Radar information

Since the airplane was not equipped with a FDR, the Safety Board attempted to use recorded radar information to reconstruct the airplane's flightpath. **A** National Aeronautics and Space Administration **(NASA)** Ames Research Facility computer program was used to process radar information obtained from the FAA ARTCC and a U. **S.** Navy facility in Jacksonville, Florida. The last 6 minutes 37 seconds of the recorded radar data from the flight was reviewed. Calculations of the airplane's performance were made based on the radar information, the airplane's performance specifications, and meteorological dsta.

Because *of* the error tolerances inherent in the recorded radar ***data*** and the lack of accurate wind and temperature information, it could not be concluded that the airplane was actually performing precisely as depicted by the data. However, past comparisons of actual FDR date with radar data has shown that Zhe latter provides good trend information.

The FAA ARTCC and the Navy facility were tracking the airplane from the same radar antenna located at Jacksonville, Florida. The data from these facilities indicated that for 28 to 41 seconds after the copilot acknowledged the descent clearance, the airplane continued on course in level cruise night at 40,800 feet, averaging 0.77 M, or about 228 KIAS. At 1156:13, the airplane began a descent of 600 to 700 fpm. At 1157:00, 1 minute and 27 seconds after the airplane had already descended 1,000 feet, the copilot transmitted, "One hundred tango alpha's descending now." In the following 24 seconds, the airplane descended to 39,600 feet, climbed to 41,100 feet, then began two long period longitudinal oscillations that continued to the last recorded radar return at 1159:49, at an altitude of 4,200 feet. The airplane's track heading during the oscillations varied from 190' to 210°. The period of the oscillations was about 1 minute. Speed decreases and increases were consistent with the oscillations. The NASA program showed a speed decrease of 0.74 to 0.54 M from 1157:01 and an ensuing speed increase to 0.75 M at 1158:49. The computed angle of the airplane's flightpath began at 12°, became progressively steeper, and ended in a 68° descent angle. Beyond 1158:49, the program showed a gradual increase in indicated airspeed from 271 to 400 KIAS. The average rate of descent was 15,375 fpm based on the radar data using pressure altitude (mode C). The coordinates of the last radar return were 31°45'58" N latitude, 080" 41'04" W longitude. The distance from the point of the last radar return to the wreckage site was 3,162 feet on a magnetic bearing of 135°. (See appendix G.)

According to tine airplane manufacturer, the stabilizer trim position required to maintain a speed between 0.75 to 0.77 M at a c.g. of 27 percent MAC is -1.4° to about -1.2° leading edge down at 40,000 feet.

In an attempt to define further the conditions that would have Seen. required to generate :he first portion of the accident flightpath as depicted by the radar data, the manufacturer performed several flight tests with e Learjet 23 of similar configuration and gross weight as the accident airplane. These tests 'were conducted at an altitude of between 33,000 and 40,000 feet, and at an airspeed of about 0.75 M in level flight and in cruise descents. Two types of tests were conducted. The first type consisted of holding the control yoke in position whiie operating the primary trim noseup for various lengths of time from .75 to 3 seconds and then releasing the yoke. Also, the autopilot trim was operated without holding the control yoke. The second type consisted of pulsing the yoke once with a force strong enough to initiate an oscillation; the force of this pulse was not recorded.

The tests disclosed the natural period and amplitude of the longitudinal, long-period oscillation (phugoid) of the airplane under the test conditions. The data collected showed that the period for the natural phugoid for the airplane was 58 to 66 seconds. Engine thrust was not changed during the tests. The effects of different thrust settings on the flightpath of the test airplane were not measured.

As indicated previously, the radar data showed that the accident airplane made two longitudinal iong-period oscillations before and during the final descent. The first oscillation cycle, as depicted by the Navy radar readout from 1157:14 to 1158:12, showed a period of about 1 minute with an amplitude of about 3,900 feet (41,000 feet maximum altitude at 1157:26 minus 37,100 feet minimum altitude at 1158:02). The first oscillation occurred about a relatively horizontal axis starting at 39,700 feet and ending at 33,100 feet. The second oscillation occurred during the initial part of the final descent, and due to the large initial and final altitude differences, it could not be compared adequately to the oscillations recorded during the flight tests. The actions taken by the pilots to control the airplane during the oscillations are not known. Therefore, neither the thrust nor the flight control positions of the airplane could be determined.

1.17 Additional Information

1.17.1 Airplane Characteristics

Because the Model 23 Learjet was certificated under earlier regulations, a stick puller was not required to be installed in the accident airplane. (A stick puller is required in later model Learjets certificated under 14 CFR 25.) A stick puller system will cause the airplane to climb in the event of a Mach overspeed. When the airplane speed reaches 0.82 M, a Mach sensing switch activates the overspeed warning horn, and at the same time, sends a noseup signal to the autopilot elevator servo actuator (d.c. torquer), causing the airplane to climb until the overspeed condition is corrected.

Moreover, the Model 23 is not equipped with a force sensor in the autopilot system. A force sensor, subsequently installed in later Model Learjets, signals the autopilot computer to disengage the autopilot pitch trim once the pilot overrides the elevator with a force in excess of 6 to 8 pounds. A force sensor also disconnects any autopilot modes selected, such as heading, altitude, or speed, but will allow the autopilot to operate in the basic attitude hold mode once the control column pressure is decreased. In this condition, the autopilot will maintain the existing pitch attitude and will roll the wings level. In the absence of a force sensor, as in the case of the Model 23, the autopilot will trim in the direction opposite to the force applied to the control yoke by the pilot unless the pilot completely disengages the autopilot.

The manufacturer's Century III and Softflite wing modifications to improve the airplane's slow speed and stall characteristics have not been approved for the Model 23. The Dee Howard-Raisbeck, Mark II, a similar wing improvement modification, has been approved for the Model 23, but the accident airplane was not equipped with this modification. The airplane was equipped with a single yaw damper which is designed to prevent a coupled lateral-directional oscillation which is commonly referred to as a "dutch roll."

According to the FAA-approved airplane flight manual (AFM), the Model 23 can be flown up to 0.82 M without the use of the autopilot, whereas use of the autopilot above 0.78 M is required for later model Learjets. A master button, located below the four-way trim switch on the outboard horn of the pilot's control wheel will, among other features, stop all pitch, roll, and yaw trim runaway and will completely disconnect the autopilot.

At low speeds, the Model 23 does not possess sufficient inherent prestall buffet characteristics to provide the pilot with a clear warning before it enters a flight condition from which a normal recovery cannot be accomplished. 6/ Therefore, the airplane is equipped with an artificial stall warning system which incorporates a stickshaker and stickpusher to provide a prestall warning in order to prevent an abrupt wing rolloff when stalled. The system includes a stall vane on each side of the nose of the airplane, two angle of attack indicators, two stall warning lights, and a computer. As the critical angle of attack is approached at a point near the stall, $1.07V_s$, the computer activates the stickshaker which induces a mild vibration of the control column and causes the red stall warning lights to flash. If the angle of attack is further increased, an additional signal from the computer actuates the stickpusher (d.c. torquer) and forces the

6/ FAA Special Condition, CAR 3.120.

control wheel forward with a force of 60 to 80 pounds This force diminishes as the angle of attack decreases and can be physically overridden by the pilot at any time. The system automatically disengages when it has decreased the angle of attack to a point less than that at which the pusher was set to actuate. 7/ Acy signals from the autopilot are canceled when the pusher activates. The Model 23 stall warning system, however, is not programmed to operate at a speed higher than 1.07 V_s when at altitudes above 22,500 feet as is the case in later models, such as the 24 E/F and 25 D/F, and all Century III modified Learjets. In these later models, the stall warning system has been programmed to operate at speeds higher than 1.07 V_s to guard against engine flameouts

Airspeed Limitations—The following airspeed limits were extracted from the limitations section of the Model 23 AFM:

AIRSPEED LIMITATIONS	LIMITATIONS KIXS	KCAS
MAXIMUM OPERATING SPEED V_{MO}/M_{MO}		
These speeds shall *not* be deliberately exceeded in any flight condition except where higher speed is specifically authorized for flight tests or pilot training operation or in approved emergency procedures. If either V_{MO} or M_{MO} is inadvertently exceeded, reduce airspeed by reducing thrust to idle and rotating aircraft nose up not io exceed 1.5 g's.	358 .82 M_I	300 .81 M

NOTE

No aerodynamic changes are apparent at either V_{MO} or M_{MO} and the aircraft will respond normally to control movements.

The following temporary AFM change, dated October 1, 1980, was found entered in the AFM recovered from the wreckage of N100TA:

The MAXIMUM OPERATING SPEED V_{MO}/M_{MO} paragraph is hereby deleted and the following added.

AIRSPEED LIMITATIONS	LIMITATIONS KIAS	KCAS
MAXIMUM OPERATING SPEED V_{MO}/M_{MO}	358 .82 M_I	350 .81 M
These speeds shall not be deliberately exceeded in any flight condition except where higher speed is specifically authorized for flight tests or pilot training or in approved emergency procedures		

Do not extend spoilers, or operate with spoilers deployed, at speeds above V_{MO}/M_{MO} due to significant nose down pitching moment associated with spoiler deployment.

7/ FAA Order 8110.6, Review Case So. 38.

Excerpts from the AFM emergency procedures section concerning a Pitch Axis Malfunction, Pitch Upset (noseup or nosedown), Recovery from Inadvertent Overspeed, and Runaway Trim are contained in appendix F. The recommended procedures for Inadvertent Overspeed are contained in a temporary AFM change dated February 5, 1982. The charge recommended lowering the landing gear in the event that Mach numberlairspeed and/or pitch/roll attitude become severe. The temporary AFM change was nos entered in the AFM recovered from the wreckage.

Buffet Boundaries.--All subsonic airplanes in high altitude and high speed flight are subject to airframe buffet caused by shock–wave–induced airflow separations from the airplanes' lifting surfaces An important factor in understanding the characteristics of high speed airflow is a knowiedge of the existence of various anomalies at the speed of sound. At the speed of sound, small pressure disturbances will be propagated through the air as shock waves, the progagation speed being a function of static air temperature. It is not necessary for an airplane to reach the speed of sound to produce a shock wave. The aerodynamic shape of airfoils will cause local flow velocities on the surfaces to be greater than the speed of the airplane. Thus, an airplane will experierce the formation of a shock wave as tine local airflow over the wing reaches supersonic speed, and this can occur at flight speeds less than the speed of sound. This regime of flight is termed the transonic region and is defined as occurring from about Mach number 0.75 to 1.20. (The relationship between airspeed and the speed of sound is termed Mach number.) In this region, mixed subsonic and supersonic airflows over the airplane are encountered. The highest flight speed possible without supersonic flow is termed the critical Mach number of an airplane. Shock waves and buffet and airflow separation take place above the critical Mach number for the airplane. Significant pressure disturbances and changes in air density occur ahead of and behind the shock wave. These changes produce what are termed compressibility effects, which result in trim and stability changes, buffet of control surfaces, and a decrease in their effectiveness Additionally, the onset of high speed buffet is also influenced by the resulting su. ien changes in the angle of attack of the wing. 8/

Airframe buffet also occurs at fow speed because of airflow separation (stall) when high angles of attack are approached. The margin between the high speed buffet and low indicated airspeed which produces stall buffet, decreases as altitude increases Since high speed buffet and stall buffet ere also dependent on the load factors produced on the wing, the airplane's maneuverability margins at high altitudes are correspondingly reduced.

The AFM buffet boundary chart for the accident airplane indicates that the low speed buffet boundary for the Model 23 airplane at a gross weight of 10,500 pounds at FL 400 and 1.5 g's is 159 KIAS. The chart does not depict the high speed buffet boundary. However, a ncte on the chart states that the high speed buffet at 1.5 g's does not occur until the speed is in excess of M_{MO} (0.82 M).

1.17.2 Pilot Operational Practices

According to the FAA pilot examiner, the pilot and copilot normally flew with oxygen masks in a ready position for quick donning and, therefore, probably would not heve been wearing them. 9/ He stated that the copilot was aware of the recent

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8/ Aerodynamics for Naval Aviators, by H. H. Hurt, Jr.

9/ Federal Regulations do not require the use of supplemental oxygen by pilots of a pressurized airplane provided the cabin pressure altitude does not exceed 14,000 feet m.s.l at flight altitudes of 41,000 feet and below, and provided that both pilots of an airplane requiring two pilots are at the controls and have quick-donning-type masks available.

change regarding the use of the landing gear and not the spoilers as a last resort in the event of an overspeed and loss of control. He further stated that the pilots routinely flew at a cruise speed of 0.76 to 0.78 M using the autopilot. He said a descent would have been initiated by retrimming the airplane with the switch on the autopilot controller which disconnected the altitude-hold feature and by reducing thrust to maintain the cruise speed and cabin pressurization within limits. He said that if the pilot had encountered any significant turbulence he would have flown the airplane manually.

According to the regular copilot, the airplane was routinely flown in cruise flight between 0.76 to 0.77 M at FL 410 using the autopilot. He stated that he had not experienced a mach overspeed warning in the airplane. He said that he and the pilot were watchful of an overspeed condition and a loss of cabin pressurization. However, he further stated that he had never discussed with the pilot the effects of an overspeed condition and the use of spoilers or the landing gear as corrective measures. He added that he had flown with the pilot to Florida about 15 times, and on a few occasions the pilot had left his seat during the flight to talk with one of the passengers involved in the accident.

1.17.3 Gates Learjet Service News Letter

Gates Learjet Service News Letter 49, dated May 1980, and issued immediately after a previous high altitude loss of control type accident, 10/ requested that operators review their emergency procedures regarding potential overspeed conditions. The manufacturer specifically urged careful review of procedures relating to emergency descent, inadvertently exceeding V_{MO}/M_{MO}, pitch axis malfunction, and normal or primary pitch trim system runaway.

Regarding the overspeed condition, the letter, in part, states:

> At Mach No.'s in excess of M_{mo}, aileron activity could be encountered, and this activity increases in amplitude as Mach No. is increased. This activity has been described as aileron "buzz" or aileron "snatch" and is a random frequency and amplitude movement of the ailerons and control wheel. Pulling "g's" in that regime of flight increases the aileron activity, so one must not pull abruptly on the elevator control to slow the aircraft, but must apply a steady force of the magnitude necessary to produce as much "g" force as possible without losing roll control. Exceeding V_{mo} in the lower Mach No. regime produces higher recovery elevator control forces, but no aileron activity. Another phenomenon which occurs at Mach No.'s beyond the red line is "Mach Tuck." This phenomenon is caused by aft movement of the wing center of pressure and results in a nose-down pitching moment. The stick puller is provided as a device to ensure no excursion beyond M_{mo}. It should never be turned off during normal operation of the aircraft. If, for any reason, there is a malfunction that requires turning off the stick puller, the aircraft should be operated at speeds well below M_{mo} as prescribed in the applicable Flight Manual procedures. As in any airplane, speeds beyond the red line must be avoided by maintaining the desired attitude with appropriate flight controls and by decreasing thrust while executing the prescribed Emergency Procedures.

10/ NTSB Aircraft Accident Report—"Northeast Jet Company, Gates Learjet 25D, N125NE, Gulf of Mexico, May 19, 1980, (NTSB-AAR-81-15).

NOTE: IF M_{MO} IS INADVERTENTLY EXCEEDED TO THE POINT WHERE THE AIRPLANE SEEMS TO BE OUT OF CONTROL, LOWER THE LANDING GEAR. The landing gear doors may be lost or damaged, but the main concern is to facilitate recovery by using the extended gear to slow the forward speed of the airplane. . . .

Spoilers

The use of the spoilers is not prescribed in Pitch Axis Malfunction and Runaway Trim Emergency Procedures. The reason is that the nose down pitch change which the spoilers produce may aggravate pitch down problems

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1.17.4 Special Certification Review of the Learjet

As a result of other Learjet accidents (see appendix H), the FAA undertook a special certification review (SCR) of the Learjet which addressed primarily items suspected of being potential factors in the accidents. This review was conducted only of the 14 CFR 25 certification and, therefore, did not include a review of the Learjet Model 23 certification. The first Learjet certificated under 14 CFR 25 was the Model 24. However, since the Model 23 is very similar to the Model 24, the AD's resulting from this review were extended to the Model 23. The following excerpts regarding specific problem areas discussed in the interim SCR report were made available to the Safety Board on May 8, 1981:

> This interim report will generally establish that the Learjet airplanes do possess certain critical flight characteristics, which require compensation by complex systems to insure an adequate level of safety. Records review indicates that approvals of these compensating systems were based on possible inadequate rules, extensive rationalization rather than actual demonstration of adequacy, early "state-of-the-art" engineering judgment, equivalent safety determinations, and apparently inadequate system analysis. It appears that most of the reported problem areas involve a system(s) whose proper functioning is critically required to provide an acceptable level of safety for the airplane; and these installed systems are possibly inadequate to perform their intended function. 11/

1) High Speed Characteristics

a. M_{MO} (0.81) is limited by longitudinal stability characteristics

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11/ As a result of its preliminary findings, the FAA issued AD 85-16-06 on August 4, 1980, which was superseded by AD 80-19-11 on September 4, 1980.

b. Mach tuck (nose down pitch divergence caused by aft movement of center of pressure due to compressibility) begins prior to M_{MO}. 12/

c. Extension of the spoilers at high speed causes a large nose down pitching moment. For the Lear 25 D/F Models, stick force required to hold airspeed with spoiler extension at V_{MO} varies from 46 lbs. at aft c.g. to 84 lbs. at forward c.g.

d. Aileron "buzz" onset occurs just above M_{MO}; at higher Mach numbers and/or higher load factors, aileron "snatch" (rapid, large deflection aileron motion) occurs. Loose (misrigged) aileron cables could increase the amplitude and lower the onset Mach number, since the major factor which damps this motion is control system friction.

e. The Mach overspeed warning and stick puller systems operate only from the copilot's Pitot-static system. If an error in the copilot's system results in a low Mach reading for any reason, the overspeed warning will occur beyond M_{MO}.

f. During STC approvals on three different aircraft (one Model 25D and two Model 35's), it was noted in a dive to M_{DF} with a separate trailing cone calibrated static system that the pilot's Machmeter stopped increasing at approximately 0.80-.81 Mach number and remained at this reading out to a true Mach number of 0.86.

On the recovery, the pilot's Mach indicator began working again at .805 Mach. Changing the Machmeter did not eliminate this characteristic. The copilot's Machmeter indicated correctly on the Model 25D, but both Model 35 copilots' Machmeters read less than the correct Mach number.

The majority of the problem was traced to a production static system calibration error in a dive using a production indicator. This was not detected during original prototype testing with a sensitive Machmeter and a trailing cone.

In addition, part of the problem was possibly caused by the static sources not being flush with the surface after the airplanes were painted. The end result of the airspeed problem was that the production airplanes were actually going .01 to .015 Mach faster than expected.

12/ Maximum Operating Limit Speed - "V_{mo}/M_{mo} must be established so that it is not greater than the design cruising speed V_c and so that it is sufficiently below V_D/M_D, or V_{DF}/M_{DF}, to make it highly improbable that the latter speeds will be inadvertently exceeded in operations." V_D/M_D means design diving speed and V_{DF}/M_{DF} means demonstrated flight diving speed.

g. Lear 25 TIR [Type Inspection Report] data shows that the speed increase after an upset was lass if the spoilers were not used, because the heavy nose down trim change made it harder to get the nose up to 1.5 g's for recovery. The AFM specifies spoiler deployment as the **first** action in an overspeed condition.

If a pitch upset occurs near M_{MO}, the airplane can accelerate rapidly into a region where the flying qualities are unacceptable. Consider, for example, any type of nose down pitch axis malfunction (such as trim runaway, pusher hardover, autopilot hardover, etc.). In this case, if the pilot restrains the control coiumn, the pull force can go as high as 50-60 lbs. (80 lbs. for pusher malfunction.) Because of pilot reaction time (3 seconds according to 8110.10), 13/ the speed will have increased beyond the limit Mach number. If the pilot follows the AFM procedure for overspeed and deploys the spoilers (which is instinctive), the required pull force will increase an additional 50-80 lbs. Also, because of the pitch instability due to Mach tuck, the pull force will continue to increase as speed increases. Adding the maneuvering stick force required to pull 1.5 g, the total pilot force required for recovery can be as high *as* 150-200 lbs.

The stick puller was installed to prevent Mach overspeed, but in the event of a nose down pitch axis malfunction, and/or deployment of the spoilers, its 18 lb. pull becomes insignificant.

At some Mach number beyond M_{DF}, the elevator effectiveness will decrease due to shock wave formation. Additionally, stretch in the longitudinal control system at very high control forces can negate any further elevator deflection in the recovery direction.

At the same time these extreme pitch forces are being generated, the pilot csn have a severe roll control problem due to aileron "buzz" and "snatch." An active pitch axis malfunction is not required for this scenario to take place. A passive failure on the ground to the 0.81 Mach warning/puller switch allows the system to test properly on preflight, yet be totally inopezative. In this case, an inadvertent overspeed due to *gust* upset, unannunciated autopilot softover, pitot static system error, pilot inattention, fuel burnoff, flying into a colder airmass, etc., can put the airplane into an overspeed condition with no warning.

If, after the pilot notices the overspeed, he deploys the spoilers, or if aileron "snatch" rolls the airplane to an excessive bank angle, it may **become** impossible to recover.

13/ **FAA** Notice 8110.10 *of* September 22, 1972, concerning trim malfunctions.

Model 24

2) Learjet Model 24 and 25 unmodified (straight wing) airplanes have speed margins between pusher actuation and aerodynamic stall that may be inadequate to compensate for the many airplane and system variables that affect these margins. Since 3 KIAS was previously found to be minimum margin for (alpha dot) 14/ equipped Century III airplanes, it is logical to conclude that the margins should be even greater on the non-equipped (straight wing) airplanes

3) Learjet unmodified (straight wing) airplanes nave stall characteristics such that the artificial stall warning (shaker) and *stall* deterrent (pusher) systems must perform their intended functions in all reasonably foreseeable operating conditions This would include reasonable pilot abuse and imperfect maintenance practices Service experience indicates that the systems ar– not preventing aerodynamic stall encounters.

4) A pilot would instinctively momentarily resist or overpower an unexpected pusher actuation. With inadequate pusher/stall margins this could lead to aerodynamic stall encounter and uncontrollable rolloff. In close proximity to the ground, such loss of lateral control could result in loss of the airplane and may be a factor in Learjet landing and takeoff accidents.

5) The mainte..ance of aircraft and system components affecting the pusher/stall speed margins is quite critical on all Learjets Current maintenance manual procedures are not mandatory and could result in the above margins not being maintained in service. Additionally, the manual does not adequately define the qualifications of the pilot required to flight test the airplane after certain maintenance is performed. The criticality of the airplane and systems relative to the pusher/stall speed margin-, and the precise flight test techniques and adjustments required, dictate that the "qualified" pilot be an FAA Approved production flight test pilot.

6) Stall characteristics at high altitude were not evaluated on unmodified (straight wing) Learjets.

7) Pusher malfunction tests have not taken info consideration a possible unannunciated fault in the 1/2g limiter.

1.18 Useful a Effective Investigative Techniques

None.

14/ The rate of change of the wing angle of attack.

2. ANALYSIS

2.1 General

The flightcrew was certificated and qualified to operate the airplane in accordance with Federal regulations. Based on the number of type ratings held and the reported total flight time of 7,000 hours, the pilot was an experienced airman in turbojet airplanes. The copilot, who was a much less experienced pilot with 1,550 hours of flight time, had accumulated about the same number of hours in the Learjet (100-150 hours). Each received their Learjet training from the same FAA-designated pilot examiner, who was experienced in the Model 23. The training they received from him apparently did not include any formal ground school or flight training, and there were no training records available from which the Safety Board could verify the extent and completeness of the flightcrew's training in the Model 23. Consequently, the Safety Board could not determine whether or not the flightcrew's experience and training, or lack thereof, in the Model 23 contributed to either the loss of control or the failure to recover.

There was no known evidence of previous medical factors affecting either the pilot or the copilot which would have prevented them from performing their required flight duties. Post-mortem examination of the pilot disclosed no evidence of preexisting disease. Toxicological tests were negative for drugs and carbon monoxide. Because of the contamination of the blood samples from the pilot, the positive blood alcohol content of 0.03 was not considered a valid result. The copilot's body, as noted, was not recovered so no tests could be made.

Because of the total destruction of the airplane and the lack of CVR and FDR information, the Safety Board was not able to determine precisely the circumstances or causal factors related to the accident. However, the accident was similar to other Learjet accidents which involved a loss of control at high altitudes and from which the flightcrews were unable to recover the airplane. Accordingly, the Safety Board relied on the maintenance history, meteorological information, radar data, portions of the wreckage, the FAA's SCR report, and knowledge gained from previous Learjet investigations in its analysis of this accident.

2.2 Airworthiness

According to the maintenance records, scheduled maintenance had been performed in accordance with Federal regulatory requirements. However, 19 of the discrepancies uncovered during the 150-hour inspection performed on the airplane during October 21 to October 31, 1981, had not been corrected. Although most were minor, the water leak in the nose compartment and the low spot in the pitot static correction module lines could have resulted in potential problems. Since the autopilot computer was installed in the nose compartment, water could have leaked into the compartment and into the components of the computer and might have caused electrical shorts and spurious signals, resulting in autopilot malfunctions. The freezing of water in the pitot static correction system could have resulted in pitot static system errors and false airspeed indications.

Examination of the autopilot computer circuit boards disclosed no distinguishable preimpact damage or discrepancies such as thermal runaway or electrical shorts. However, impact damage precluded any meaningful functional tests, and examination of other damaged autopilot system components provided no useful information. Although there was no clear evidence to indicate that an autopilot malfunction had occurred, the possibility of one could not be eliminated because (1) most of the system either was not recovered or was destroyed by impact forces, (2) in several previous Series 20 Learjet accidents and incidents the autopilot was considered to be a possible factor, and (3) the FAA issued AD'S requiring modification of the pitch axis of the autopilot as a result of its SCR.

An in-flight fire or explosion was also considered as a possible cause or factor in the accident. However, there was no soot or fire damage on any of the components recovered. Although the airplane was extensively damaged by impact forces, its extremeties were recovered. Consequently, since these components usually separate during a substantial in-flight breakup, an in-flight explosion was discounted. The right aileron was not found, but it may not have been located because of the severe destruction of the airplane during impact and because of the difficulties encountered in locating wreckage in an underwater recovery. However, because of the circumstances of the accident, the possibility of an in-flight separation of the aileron could not be ruled out.

2.3 Weather

The area in which the airplane was flying just before its descent from FL 410 was between converging polar and subtropical jet streams and was on the leading edge of a sharp upper ridge moving eastward at a speed of about 20 knots. An analysis of the vertical structure of the atmosphere showed an apparent upper front in the area near FL 410. This structure was sufficiently well defined and contained adequate wind shear to have developed moderate or possibly severe clear air turbulence. Although there should have been some continuity between the high level weather depiction chart prepared by the National Meteorological Center and the charts from the National Weather Service Forecast Offices at Washington and Miami, it is likely that the turbulence forecast in the 2100 Area Forecast was not included in the 0900 Area Forecast from Washington, and was not included in either the 2100 or 0900 Area Forecasts from Miami, because of the lack of pilot reports to confirm any turbulence. Further, the weather situation before and at the time of the accident did not meet the normal National Weather Service criteria for the existence of clear air turbulence. Consequently, the forecasters at the two forecast offices apparently followed accepted procedures in not forecasting turbulence where none had been reported. The Safety Board's weather analysis shows that a potential for clear air turbulence existed. Even though the existence of clear air turbulence cannot be conclusively determined without an observation, such as a pilot report, the conditions conducive to clear air turbulence which existed in this accident and in other loss of control accidents from high altitude involving the Series 20 Learjets, leads the Safety Board to believe that the possibility of a turbulence encounter severe enough to upset the airplane and precipitate a loss of control cannot be excluded. Consequently, the Board will reemphasize to the NWS the importance of expediting an early solution to the clear air turbulence analysts and forecasting problem.

2.4 Loss of Control

Analysis of the radar data showed that the airplane was in straight and level flight at FL 410 for at least 2 minutes 16 seconds before the Air Traffic Control (ATC) clearance was given to the pilots to descend and maintain FL 390. Also, radar and meteorological data indicated that the airplane probably was flying at a conservative cruise speed of about 0.77 M. The copilot immediately acknowledged the descent clearance, but the airplane did not descend until 28 to 41 seconds later. The copilot may have believed it necessary to inform ATC of the delay, which could explain her report 1 minute 27 seconds later, at 1157:00, "One hundred Tango Alpha descending now."

However, the airplane had already descended 1,000 feet when the report was made, which may indicate that the crew had Seen or was distracted by some ether event. The radar data indicated that the airplane descended to 39,600 feet at 1157:13. The next radar signal received, at 1157:25, indicated that the airplane had climbed back to 41,000 feet. From this position, the airplane began a meneuver which consisted of two iong-period longitudinal oscillations and descended to an altitude of 4,200 feet, where radar contact with the airplane was lost. The radar data indicated that the airplane's track during the descent varied *but* stayed within 10° of its course.

Based on the relationship between the last radar contact and the accident site, the airplane apparently maintained about the same engle of descent, about 68°, from 12,000 feet until impact with the ocean. The data showed that the airplane's track was 245° magnetic, but the wreckage site was in the direction of 135° magnetic from the last radar contact. Assuming the radar data to be accurate, it is therefore probable that the airplane was in a right spiral at the time it struck the water. This is supported by the wreckage examination which disclosed that the airplane was in a steep nosedown, right wing down attitude at the time of impact.

Examination of the flight profile derived from the radar data indicateti that several obvious anomalies occurred. First. the airplane climbed Sack to FL 410 when it should have leveled at FL 390, indicating a pitchup problem. Second. after returning to FL 410, the airplane entered an uncontrotied descent. In order io explain these anomalies, several hypotheses were considered. These hypotheses included a flight control malfunction, a cabin depressurization, a turbulence upset. a low speed buffet excursion, end a high speed buffet excursion.

While a pitchup problem in the autopilot 'led occurred several months after the AD, which had been issued to prevent en *autopilot* pitch *axis* malfunction, had Seen accomplished *on* the airplane. the autopilot reportedly had been corrected. Since it was reported that the pilots normally used ?he autopilot in cruise flight and since there were no other known outstanding discrepancies with the device, it is reasonable to believe that it 'was used during cruise flight and the initial part of the descent to FL 390. However, since all of the autopilot components were not recovered. and impact damage precluded a functional test of those which were recovered. *a* malfunction of the autopilot system after the descent was initiated cannot be excluded as a possible factor in the accident.

The postaccident position of the stabilizer actuator (-4.5° leading edge down) was inconsictent with the required trim for cruise flight at FL 410 and for the initial shallow descent made by the airplane from that altitude. For the foregoing conditions, the stabilizer should have been positioned from about a -1.4° to a -1.2° leading edge down in order for the airplane to have Seen within trim. Otherwise, the pilots would have had to push on the control yoke with a substantial amount of force in order to fly the airplane in *level* flight. This suggests that the stabilizer was moved following the initial descent to FL 390. The normal time required for the autopil*o* change the stabilizer position from a *cruise trim setting* to a -4.5° leading edge down position is about 2 minutes. If a malfunction occurred in either the primary or secondary trim systems however, the time required for the stabilizer to be moved the same number *of* degrees would have Seen 8 or 18 seconds, respectively.

The degree to which a loss of control. could develop from an autopilot malfunction would depend upon **the** crew's recognition and response to the problem. The pilots had the means available to stop an autopilot malfunction had it occurred. If the autopilot malfunction was caused by a "hardover" signal, causing airplane noseup elevator movement, the crew should have Seen able to recognize the problem immediately and should have been able to overpower the autopilot action and disconnect it. Given a 3-second recognition time and 1 to 2 seconds to respond, either pilot should have been able to stop the unwanted elevator input within 5 seconds by using the wheel master button on the control yoke. If the operation of the pitch axis could not have been stopped with the wheel master button, it would have been necessary to turn off the stall warning system and pull the autopilot pitch control circuit breaker to remove all electricai power to the autopilot system. Coordination between the pilot and copilot would have been required to perform this procedure. The copilot would have had to have pushed on the control yoke to counter the noseup pitch force while the pilct deactivated the system. Had a subtle failure occurred involving only stabilizer movement, the slow rate of trim change may not have been immediately recognizable without a stabilizer trim-in-motion warning, particularly if the pilots did not have their hands on the control ydce -- a normal situation when using the autopilot However, since the radar data showed that the airplane pitched up and climbed from 39,600 feet to 41,000 feet in 12 seconds, it is not likely that a subtle failure of the autopilot occurred because of the apparent rapid pitchup maneuver of the airplane compared to the slow trim rate associated with this type of malfunction Therefore, a subtle failure in the pitch axis of the autopilot probably was not involved. However, it is believed that an autopilot "hardover" malfunction cannot be ruled out as a possible factor in the loss of control, even though it does not explain satisfactorily how the stabilizer was positioned to -4.5° leading edge down.

A runaway pitch trim malfunction in the primary pitch trim system could have moved the stabilizer to its postaccident position during the initial pitchup maneuver. However, the pilots would probably have detected quickly a runaway trim condition of the primary trim system because of its relatively rapid rate of operation-

The radar-depicted flight profile indicated that the airplane did not gain as much altitude as the manufacturer's test airplane did with noseup primary trim input under similar flight conditions In fact, the test airplane decelerated to 150 KIAS, the low *speed* buffet boundary; the test maneuver was stopped and corrective action ... taken. However, the Safety Board could not reach any firm conclusions from comparisons with these tests because neither the thrust setting of the accident airplane during the pitch oscillations nor the extent to which the pilots may have attempted to control the airplane during the oscillations are known. Either of these factors would have affected the pattern of the oscillations If they had been alert, the pilots would have attempted to control the airplane in reaction to the pitchup, and they would not have allowed the control yoke to move freely as was permitted in the test maneuvers. Nevertheless, because of 'pilot distraction or attempts to correct the malfunction, the airplane might have stalled from the initial pitchup maneuver, and could have rolled off and entered a steep nosedown, high speed descent. Consequently, it is possible that the stabilizer intentionally was positioned to the -4.5° leading *edge* down during attempts by the pilots to recover from a steep, uncontrolled descent.

The possibility that the warning horn sound was that of the cabin 'altitude warning horn is based on the fact that decompression of the cabin could have caused or contributed to the accident by incapacitating the crew. This suggestion was supported by the unexplained sudden termination of any further radio transmissions from the crew. Any decompression which occurs in less than 0.5 seconds is considered by most authorities to be an explosive decompression, and this type of decompression would probably have included a substantial rupture in the pressure vessel Such a rupture would have created considerable noise in the cabin from air flowing past the rupture. Further, such a rupture would have created conditions 15/ which make speaking very difficult. According to the manufacturer, the holes drilled—into the inner layer of the windshield should not have caused or contributed to a decompression because the 'outer layer of the windshield maintains the integrity of the pressure vessel.

Assuming that an explosive or rapid decompression of the cabin occurred during the initial portion of the descent to FL 390, the copilot would not have been able to make the last radio transmission clearly. Except for that it appeared to be a hurried transmission, there was no distortion associated with the effects of decompression in the copilot's voice nor was there any noise associated with a rupture of the cabin. Additionally, the warning horn was heard in the background at 1157:01. Consequently, the safety Board concludes that a rapid decompression had not occurred at or before that time

The possibility of a disabling rapid or explosive decompression having occurred after the copilot's last radio transrnission to Jacksonville Center cannot be excluded. For example, it is possible that a two-stage decompression occurred; that is, a small rupture, which permitted the cabin altitude to increase to 10,000 feet and activate the pressurization warning horn, followed by a rapid enlargement of the rupture and a rapid decrease in cabin pressure to the ambient pressure. This would explain the lack of any response to tine ATC controller's request ". , .to say again" and the absence of any further radio transmissions from N100TA.

The Safety Board, however, could not determine. conclusively whether the warning horn heard during the copilot's last transmission was generated by the cabin pressurization warning or the Mach overspeed warning oscillators. Tests disclosed that a failure of either the resistor and the zener transistor in the Mach overspeed warning circuit or the capacitor in the cabin pressure warning system could have resulted in the abnormal warning sound heard on the ATC tape. Consequently, a rapid decompression shortly after the copilot's last transmission remains a possibility. However, such a condition has not been known to have occurred in a Learjet because of a system or structural failure. Furthermore, during a I-minute period following the copilot's last transmission, the airplane remained within 600 feet of its last assigned cruising altitude of FL 390. Moreover, it oscillated within 2,000 feet of this altitude until 1158:25, at which time the airplane's rate of descent increased. The Safety Board believes that the altitude variations between FL 410 and FL 370 could have been the result of the pilots' attempts to control the airplane thus negating a rapid decompression. However, for unknown reasons, they were not able to arrest the descent. If the pilots had perceived the warning sound as a cabin altitude warning, they may have at some point initiated an emergency descent. On the other hand, if they perceived it as the mach overspeed warning, they may have reduced engine thrust and raised the nose of the airplane to bleed off the excessive speed, which could account for the climb to FL 410.

Discounting an explosive or rapid decompression, in the event of a substantial loss of cabin pressurization, the pilots should have had sufficient time to take corrective action even before becoming incapacitated due to hypoxia. In the event of a decompression, which could not have been controlled by management of the environmental systems, an emergency descent could have been executed. AFM emergency procedures require an emergency descent to 30,000 feet or below in the event cabin pressurization becomes above 15,000 feet. The procedure requires, first the

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15/ At an altitude of 40,000 feet, the time of useful consciousness is 15 to 20 seconds without supplemental oxygen. Consequently, the very first actions of a flightcrew under explosive decompression conditions at 40,000 feet should be to don an oxygen mask.

donning the oxygen mask and then reducing thrust: then extention of the spoilers, the lowering of the landing gear: and descent at a speed of 0.82 M or *263* KIAS. Switching the transponder to the emergency code of 7700 is also required in order to alert ATC. However, wreckage examination showed that the spoilers and landing gear were retracted at impact. Also, tie transponder had not been switched to the emergency code.

With regard to the possibility of a turbulence encounter leading to an upset, two past high altitude loss of control accidents involving Series 20 Learjets were attributed to clear air turbulence encounters In one of the accidents, the Northeast Jet Company Learjet 25D accident cited previously, a clear air turbulence encounter was verified, and it led to an overspeed condition and loss of control. Altnough turbulence was no: reported by another Learjet transiting the area at the tine of N100TA's accident, analysis of the meteorological conditions disclosed *the* potential for moderate to severe clear ai? turbulence. Based on the Safety Board's analysis, the upper atmospheric structure was similar to, but not as well defined as, *the* upper atmospheric structure which existed in the Northeast Jet Company accident. .An encounter with clear air turbulence could have resulted in either a high speed departure or low speed departure from descending cruise flight. If **the** pilots had reacted to a turbulence upset with a suddtn maneuver which increased the load factor, the airplane may have decelerated into the low speed buffet boundary and entered an uncontrollable wing roll-off a steep nosedown split "S" type maneuver, and a high speed dive. Recovery from a maneuver of this type could be difficult and perhaps impossible because of the high nosedown pitching moments associated with flight beyond M_{MO}.

With respect to a high speed **buffet** excursion or overspeed condition, it would have been very easy for the airplane to have accelerated 0.05 Mach to M_{MO} (0.82 M) during the initial descent from FL 410. The airplane descended at a rate of about 700 feet per minute in the 47- to 59-second interval between the time it left FL 410 and the time of the copilot's last transmission. Control difficulties could have resulted if the crew had allowed tie airplane *to* accelerate beyond M_{MO} into an overspeed condition because ***of*** the nosedown pitching moments associated with speeds in excess of the critical Mach number for the airplane. Considering the potential conditions for moderate to severe clear air turbulence, a gust upset of sufficient intensity could also have resulted in an overspeed. According to the FAA's SCR report, a production error in the copilot's pitot static system, an error resulting in the static sources not being flush with the fuselage, or a malfunction of the system could be contributing factors leading to an overspeed. As previously reported **in** other high altitude loss of control accidents, abnormal pitch forces and a severe roll control problem could have Seen encountered without warning if such conditions had existed. The outcome of an overspeed condition is greatly dependent upon the pilot's reactions. An abrupt noseup elevator control input is slow the airplane from a descending overspeed would aggravate the condition by increasing the local Mach effects on the wing ("aileron buzz") and could have resulted in the loss of roll control Such control inputs might also cause separation of an aileron. Furthermore, if the pilots had deployed the spoilers in an attempted recovery and had failed to reduce engine thrust *and retrim* the *airplane*, the control column puli forces would have increased and the speed instability and roll control could have progressed to the pcint where it would have become impossible to recover the airplane. An overspeed encounter could explain the apparent rushed delivery of the copilot'; last transmission, the warning horn sound, and the crew's failure to respond to subsequent calls by ATC.

However, the radar and meteorological data are not fully consistent with an overspeed condition, nor is the postoccident noseup trim position of the stabilizer actuator jackscrew. it appears that the airplane made a significant reduction in speed from about 238 KIAS/0.80 M at 1155:25 to about 220 KIAS/0.74 M at 1156:13, when the airplane began the descent. The speed appears to have stabilized during the next 48 seconds until a further speed redaction to about 207 KIAS/0.69 M at 1157:13. This apparently was the speed of the airplane before it climbed back to 41,100 feet. The data contradict, to some degree, a possible overspeed encounter and a conclusion that the warning horn sound was that of the Mach overspeed warning- This of course is predicated on the assumption that the Mach overspeed warning was properly calibrated. However, witnout other supportive evidence, it is difficult to conclude with certainty that an overspeed condition did not exist, became the accuracy of the derived indicated airspeeds and Mach numbers are dependent on accurate wind and temperature information and accurate radar data points.

For the foregoing reasons, the Safety Board was not able to determine the probable cause of the accident. The lack of CVR and FDR data prevented a direct determination of the problems the pilots' might have encountered, and the airplane's flightpath and speed. Because the airplane was destroyed and critical flight control system components were either destroyed or not recovered, the possibility of a control system malfunction could not be eliminated. Also, without more definitive information, the Safety Board could not rule out the possibility of a cabin decompression. The Safety Board believes that the potential for moderate to severe clear air turbulence existed at tine time of the accident. However: the Safety Board could not determine if the airplane encountered this phenomenon. If such an encounter occurred, it could have been either a causal or contributing factor in an upset and failure to recover. Under any of the possible circumstances discussed, had the airplane accelerated to an overspeed condition, the flightcrew should have been able to regain control of the airplane by reducing engine thrust and extending the landing gear. Since the copilot was the only one reportedly aware of the procedure to lower the landing gear if the overspeed could not be otherwise controlled, it may have been forgotten during other attempts to control the airplane.

2.5 Flight Recorders

This accident again illustrates tine need for flight data recorders and cockpit voice recorders in multiengine turbine-powered aircraft. Unless the probable cause of an accident or the factors Contributing to an accident can be definitively established, proper corrective action cannot be taker.. Recorders have greatly enhanced the aviation community's ability to improve flying safety and to prevent accidents through the invaluable investigative data recorders have provided concerning those airplanes for which they are required.

As occurred in this accident, ATC radar can provide data on altitude (assuming the altitude encoding transponder is operational and the airplane signal reaches the ground-based antenna), position, and ground speed; however, such data are very limited in their usefulness. Data points are not sampled frequently enough, nor is the data precise enough to derive more than trend information regarding the flight.

The Safety Board realizes that currently available air carrier type recording systems are generally unsuitable for the smaller turbine-powered aircraft comprising much of the fleet not already covered by requirements for recorders Therefore, the Safety Board continues to support the development of smaller, lighter, lower cost recorders using state-of-the-art technology.

Several recorder manufacturers have indicated that such recorders have been under development for some time and could be produced and marketed within 7 to 12 months after a technical standard order (TSO) covering them is issued by the FAA, Anticipated prices appear compatible with other general aviation equipment and should be acceptable to industry. The Safety Board strongly urges the FAA to adopt standards and requirements for the installation of these recorders in complex, high performance aircraft. Without such requirements, the Board can oniy continue to urge manufacturers and operators of these aircraft to voluntarily install such recorders

2.6 Pilot Training

Although the Safety Board could not determine in this accident whether or not the loss of control or failure to recover the airplane was due to a lack of thorough pilot training, it has previously concluded as a result of its investigation of other similar Series *20 Learjet accidents that* inadequate pilot *training **and*** proficiency in *Learjets were* factors in the accidents. The Board emphasized in its report on the Sky Train Air Inc., Learjet 24 accident at Felt, Oklahoma, on October 1, 1981, that, although 14 CFR 61.63(d) does not require flight training in a type airplane for which an applicant is seeking a rating, good judgment would dictate obtaining thorough flight training in type and acquiring some knowledge about the environment in which the airplane will be operated before the applicant attempts to obtain his type rating flight check. The Board believes it essential that pilots obtain such training before operating a high performance turbojet, such as a Learjet, as pilot in command. In the Sky Train report, the Board recognized that 14 CFK **61.63** (d) may be sufficient in providing general guidelines to an applicant about the training needed for a type rating. However, in the Board's opinion, in the case ***of*** high performance airplanes appropriate and effective training and type rating flight checks of an applicant will depend, in part, upon a thorough evaluation of the airplane made concurrentiy with tine original type certification by FAA speciaiists assigned to the Flight Operations Evaluation Board (FOEB). Their evaiuaiion should determine initially whether a type rating is necessary, what the type racing flight check should consist of. and what areas should be emphasized in training. These areas must *include* a *careful* review of *the* unique *qualities of the airplane* and any anticipated problems that might be expected with it in service. The results of this review must be used in developing the required training program for a particular airplane. Additionally, this training and flight test information should be given widespread distribution. The Flight Standardization Board (FSB) in the exercise of its responsibility should review recommendations by the FOE3 and develop the minimum standards and qualifications for designated pilot examiners, flight instructors, and pilots. The FSB should also distribute the information to all FAA Regions. In turn, this information must be made available to all FAA Field Offices, its inspectors, and the aviation community to provide for the standardization of pilot training and qualifications in high performance airplanes.

Safety Recomnendati~~s' X-82-123 through A-82-129, aimed at improving initial training, type-rating flight checks, and recurrent training in turbojet airpianes. were issued to the FAA on September 27, 1982. (See appendix I.)

3. CONCLUSIONS

3.1 Findings

1. The pilots were certificated **and** current. in accordance with Federal regulations

2. There was no evidence of preexisting medical factors affecting either of the **pilots** which would have caused or contributed to the accident.

3. The airplane had been maintained in accordance with Federal regulations.

4. There was no forecast for clear air turbulence in the area in which the airplane was flying at the time of the accident; however, analysis developed that there was the potential for moderate to severe clear air turbulence in the area.

5. The airplane was in a cruise descent to its last assigned flight level and it suddenly pitched up when within 600 feet of that altitude and climbed.

6. The pitchup was followed by two pitch oscillations which were then followed by an uncontrolled descent at progressively steeper angles until impact

7. The pilots did not or were not able to arrest the uncontrolled descent for unknown reasons.

8. The reason for the apparent loss of control could not be determined.

9. The wing spoilers, flaps, and landing gear were retracted at the time of impact.

10. It could not be determined if the crew extended the wing spoilers or lowered the landing gear at any time during the descent.

11. The pilots probably reduced engine thrust at some time during the descent because the engines were determined to have been near an idle thrust setting at the time of impact

12. The horizontal stabilizer actuator jackscrew was in a large noseup trim position (-4.5°) at the time of impact.

13. The airplane struck the water in a steep nosedown, right wing down attitude at high speed.

14. The AFM recovered from the wreckage did not contain the latest revision regarding overspeed recovery procedures; however, the copilot was reportedly aware of the revision.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was an uncontrolled descent from cruise altitude for undetermined reasons, from which a recovery was not or could not be effected.

4. RECOMMENDATIONS

As a result of similar accidents involving the Series 20 Learjet, in which the Safety Board found it difficult or was unable to determine the probable cause due to a lack of conclusive evidence, it issued several Safety Recommendations to the FAA directed at improving flight recorder standards and requiring their use in complex general aviation aircraft. It has also issued to the FAA and to the aviation industry recommendations aimed at upgrading initial and recurrent pilot training. (See appendix L.)

5. APPENDIXES

APPENDIX A

INVESTIGATION AND HEARING

1. Investigation

The Safety Board was notified of the accident at 1330 on May 6, 1982. A team of three investigators was dispatched from Washington, D.C. to the scene the same day. Investigative groups were established for the areas of operations, structures, and systems. Additional support was later provided by the Safety Board's Headquarters staff in the areas of weather, airplane performance, ATC tape analysis, and maintenance records.

Parties to the investigation included the Federal Aviation Administration and the Gates Learjet Corporation.

2. Public Hearing

No public hearing or deposition proceeding was held in this investigation.

APPENDIX B

CREW INFORMATION

Pilot George R. Morton

Pilot George Richard Morton, age 38, held Airline Transport Pilot (ATP) Certificate No. 1656268, with airplane single and multiengine land ratings and commercial privileges for rotorcraft-helicopter. He held type ratings for DA-20, IA-Jet, L-18, L-B34, CV-A340, CV-A440, CY-880, CV-990, and LR-Jet. His pilot logbook was not found; however, he indicated that he had accumulated 25 hours in the Learjet at the time of his rating ride on June 30, 1981. Others, including the aircraft owner and a principal copilot, estimate that he might have accumulated a total of approximately 100-150 hours in the Learjet at the time of the accident. The most reliable source of his total time (FAA Medical Form dated June 17, 1981) was 7,000 hours.

He held Mechanic Certificate No. 2178794, with Airframe and Powerplant ratings and e valid Inspection Authorization issued March 5, 1982. His Flight Instructor Certificate No. 1656268CFI, with ratings for airplane single and multiengine land and instrument airplane, expired on October 31, 1979.

He was cited for flight violations twice which resulted in a 90-day suspension of his pilot license from January 24, 1972 through April 22, 1972. The first occurrence involved violation of 14 CFR 91.79(b) and 91.73(a), in that he operated his aircraft: (1) over a congested area below an altitude of 1,000 feet above the highest obstacle within a horizontal radius of 2,000 feet, and (2) during the period from sunset to sunrise without lighted position lights. The second violation involved 14 CFR 91.71(a), 91.71(d), and 91.9. These violations involved acrobatic flight over e congested area, below 1,500 feet above the surface in a careless or reckless manner so as to endanger the life or property of another.

He failed the initial flight check for his ATP on March 27, 1974, at which time he had logged 2,300 hours flight time, but subsequently passed the flight check on March 30, 1974. Similarly, he failed the initial type rating flight check in the Jet Commander on June 26, 1974, but passed it on July 28, 1974. All other ratings and certificates were obtained on the first attempt, as follows:

Type Rating	Date
CV-A340, CV-A440	3/30/77
DA-20	10/22/77
CV-880, CV-990	5/6/78
LR-Jet	6/30/81

He held a valid FAA second class medical certificate issued June 17, 1981, with no limitations.

Copilot Sherri D. Dav

Copilot Sherri D. Day, age 24, held Commercial Pilot Certificate No. 147560814, with airplane single and multiengine land and instrument airplane ratings. As a function of her employment by L&R Services, Inc. (a Part 135 Air Taxi Operator of a Learjet 23 unrelated to the accident), she received a copilot proficiency check in e

Learjet 23 on February 25, 1982. This check was administered by her father, and observed by an FAA Operations Inspector. Based on information provided by her father and others, it is estimated tnat she had accumulated approximately 1,550 total flying hours, including approximately 125 hours in tine Learjet 23.

She had a valid FAA first class medical certificate dated February 2, 1982, with a limitation that the holder must wear glasses for distant vision while exercising the privileges of her certificate.

FAA Designated Pilot Examiner Mr. Lou Neubarth

Mr. Lou Neubarth, a FAA designated pilot examiner, trained both the pilot and copilot in the Learjet 23. He described flight training of the pilot as some local '%ounce" hops, two executive trips to Florida, in which Mr. Morion did sll the flying, and a few more local flights. He estimated that Mr. Morton had approximately 15 hours in type when he received his type rating ride. He described him as very astute with books, wiring diagrams, etc. and described an incident in which there was an autopilot pitchup in cruise. Mr. Morton reacted immediately and overcame the situation.

Mr. Neubarth, the owner of L&R Services and the father of Mrs. Sherri Day, gave her trainin; in his Learjet 23, and she flew as copilot for his company. He estimated that she had accumulated 100 hours in his aircraft, and indicated that she had flown "essentially as captain" on the last few trips. He felt she still had some minor trouble with strong crosswinds, but she had passed the written portion of the airline Transport Pilot examination, and he expected her to get a type rating in tie Learjet in about 6 months. He stated that this was the second time that Mr. Morton and Mrs. Day had operated together as a crew on N100TA. Because the regular copilot, (approximately 6-7 months) was unable to get the days off and make this trip, Mrs. Day substituted.

APPENDIX C

AIRCRAFT INFORMATION

FAA certification of the Gates Learjet Model 23 was approved July 31, 1964, under Part 3 of the Civil Air Regulations of May 15, 1956, with Special Conditions and an exemption for ground operation at a maximum weight of 12,750 lbs. It was certificated for flight up to a maximum altitude of 41,000 feet and at a maximum operating speed (V_{mo}/M_{mo}) of 358 KIAS/0.82 M_I.

Gates Learjet 23, N100TA, serial No. 23-045, was issued a standard airworthiness certificate on August 25, 1965. Maintenance records indicated that the airplane had last been inspected in accordance with a maintenance program recommended by the manufacturer and approved under 14 CFR 91.217(b)(4). The last routine maintenance was performed on March 25, 1982 at which time the airplane had accumulated a total of 7,098 hours. It was not equipped with the manufacturer's Century III or Softlite modifications to improve its slow speed and stall characteristics. The airplane was equipped with lead acid batteries in accordance with Supplemental Type Certificate (STC) SA103350 instead of the standard nickel cadmium batteries.

The aircraft was equipped with two General Electric, CJ610-4 engines The following times and cycles are as of March 25, 1982:

	Left	Right
Serial Number	241-074	241-031
Time Since New	4655.1 hrs.	6926.1 hrs.
Time Since Overhaul	2901.1 hrs.	2501.1 hrs.
Cycles Since New	N/A 1/	N/A
Cycles Since Overhaul	N/A	N/A
Time Since Last Inspection	35.1 hrs.	34.0 hrs.
Date Installed	1-6-81	N/A
Time Since Last Hot Section Inspection	35.1 hrs.	259.2 hrs.

The maintenance records kept on board the airplane were not recovered.

1/ Not available.

APPENDIX D

G/.TES LEARJET AIRWORTHINESS DIRECTIVE
VOLUMES I AND II

GATES LEARJET

Airworthiness Directive

Volumes I & II

80-22-10 GATES LEARJET: Letter issued October 23, 1980. Applies to 23, 24, 25, 28 and 29 series airplanes certified in all categories.

COMPLIANCE: Required as indicated, unless previously accomplished.

A) Before further flight:

1. Deactivate the pitch function of the FC-110 Automatic Flight Control System (AFCS) or Automatic Flight Control Stability System (AFC/SS), as indicated below, by pulling the AFCS Pitch DC Circuit Breaker to the off position, banding it to prevent use of this function and checking to assure this function is the only deactivated circuit or control:

SERIES	SERIAL NUMBERS	LOCATION
23	003 thru 014	Pilot's Switch Panel
	015 thru 099	Pilot's Sub Panel
24	100 thru 139 (except 131, 132 & 134)	Pilot's Sub Panel
	731, 132 & 13U	Pilot's circuit breaker panel
	140 thru 229	Autopilot computer rack
	230 and up	(under pilot's seat)
25	003 thru 069 (except 032)	Pilot's circuit breaker panel
	032	Autopilot computer rack (under pilot's seat)
	070 and up	Pilot's Sub Panel
		Pilot's circuit breaker panel
28	001 and up	Pilot's circuit breaker panel
29	001 and up	Pilot's circuit breaker panel

2. Install a locally fabricated placard on or near the autopilot control head in clear view of the crew, using letters at least 3/32 inch high, which reads:

·AUTOPILOT PITCH AXIS INOPERATIVE

OBSERVE APPROPRIATE AFY AIRSPEED LIMSTATXONS
FOR INOPERATIVE AUTOPILOT

and operate the airplane in accordance with this placard.

3. Insert in the appropriate section of the existing Airplane Flight Manual (AFM) the FAA approved temporary Airplane Flight Manual Change dated October 22, 1980, pertaining to emergency procedures for pitch axis malfunction.

B) On or before January 1, 1981, accomplish all of the following at a Gates Learjet authorized service center holding appropriate FAA repair station ratings (see attached list):

1. Visually inspect the elevator control system to assure that Pitch Axis Servo (D.C. Torquer), P/N 6600163-( ) is installed.

a) If installed, modify the airplane by' incorporating autopilot pitch trim monitor test switch in accorddnce with Gates Learjet Airplane Hcdification Kit AMK 80-16.

b) Sf not installed, modify the airplane by replacing the pitch servo actuator and capstan and incorporating autopilot pitch trim monitor test switch in accordance with Gates Learjet Airplane Modification Kits AMK 80-3 and AMK 80-16, respectively.

2. Insert in the appropriate sections of the existing Airplane Flight Manual (AFM) the FAA approved temporary Airplane Flight Manual changes dated October 21, 1980, for autopilot trim monitor.

C) When paragraph B of this AD has been accomplished, the requirements of paragraphs A)1. and 2. of this AD are no longer applicable.

D) Airplanes may be flown in accordance with FAR 21.197 to a location where the requirements of this AD can be accomplished provided the autopilot Is not operative during that flight.

E) Any equivalent method of compliance with this AD must be approved by the Chief, Aircraft Certification Program, FAA, Central Region, Room 238, Terminal Building No. 2299, Mid-Continent Airport, Wichita, Kansas 67209.

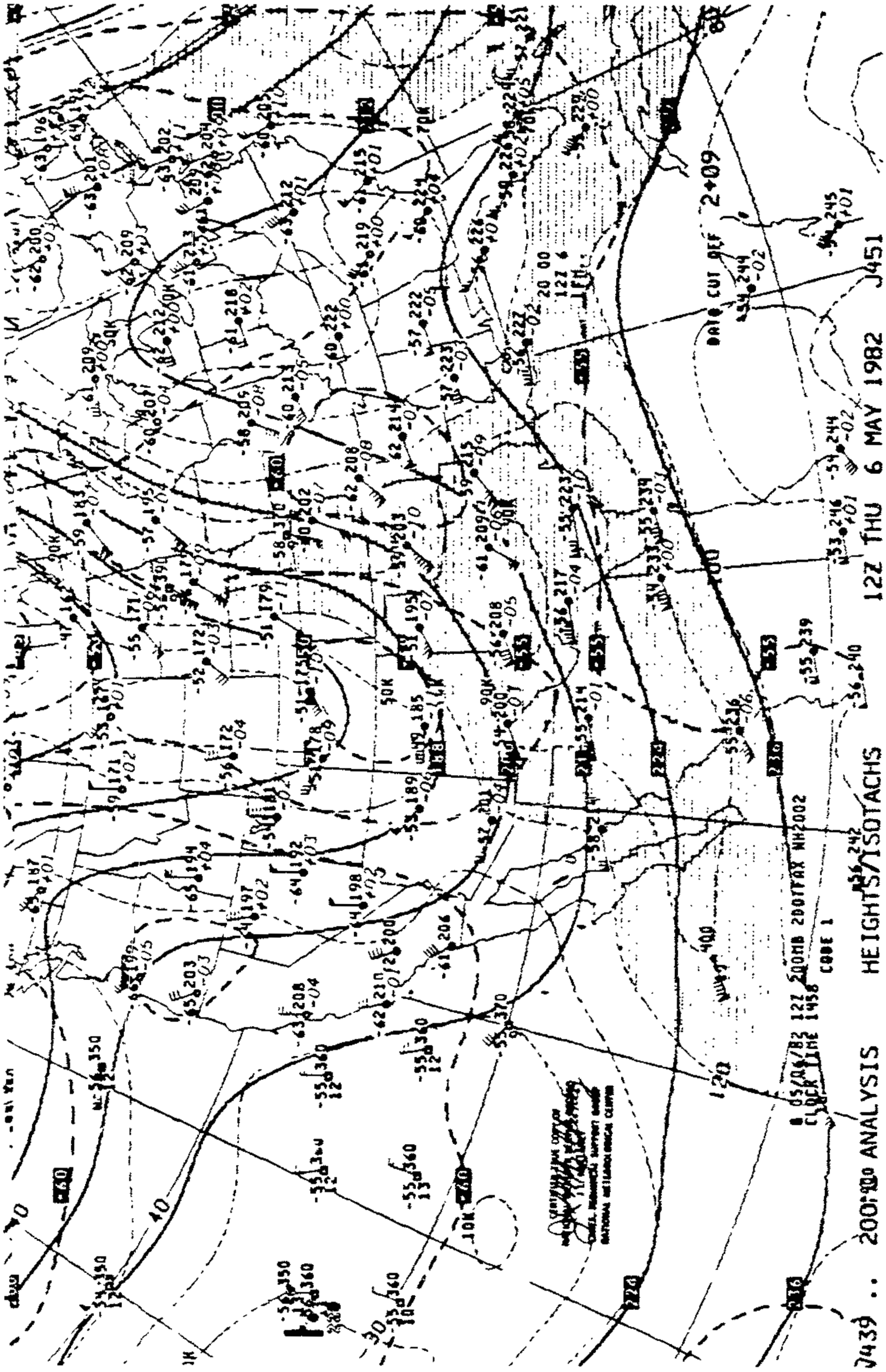
This Airworthiness Directive becomes effective upon receipt.

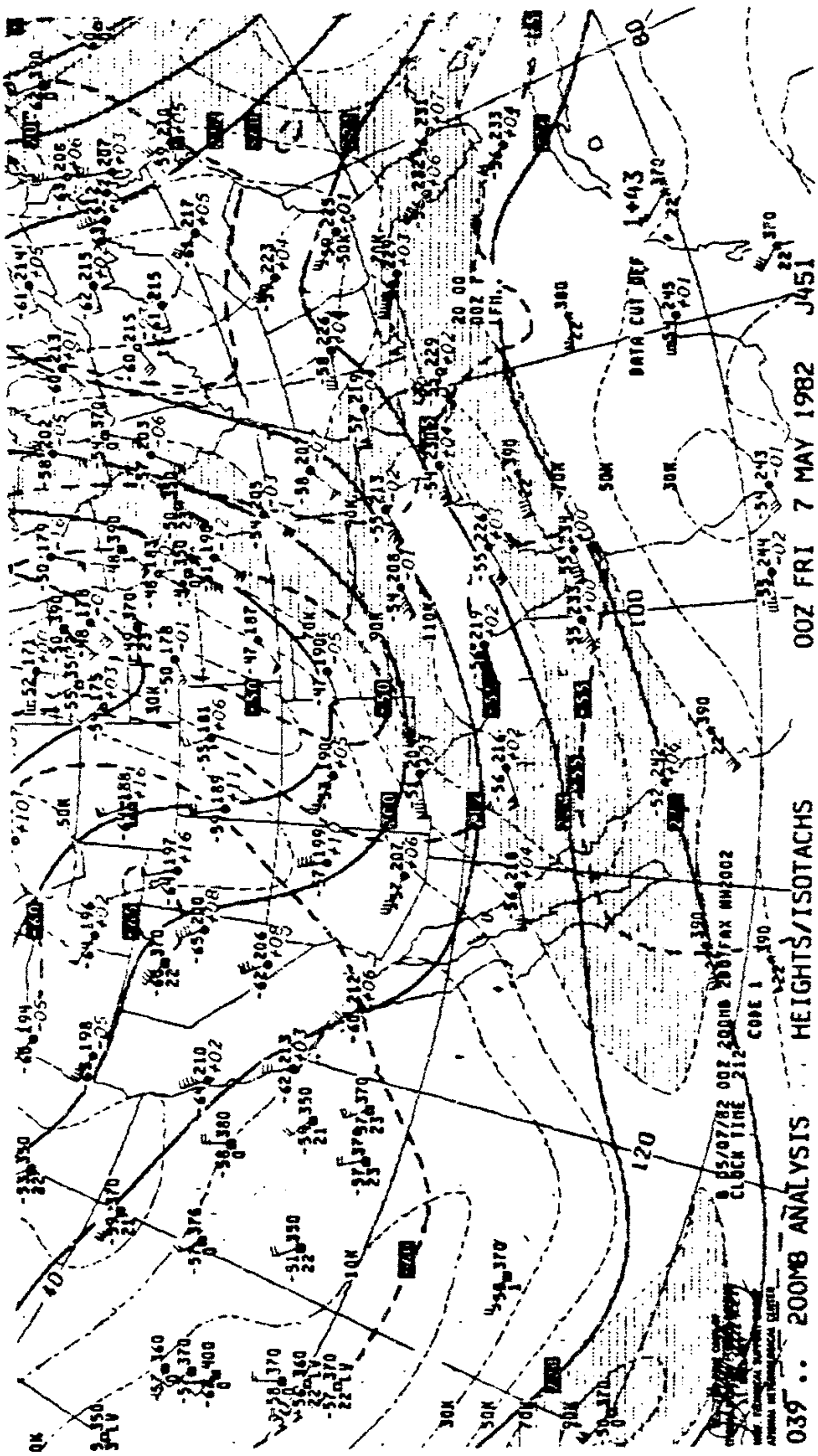
FOR FURTHER INFORMATION CONTACT:

Larry Malir, Aircraft Certification Program, Systems and Equipment Section, Federal Aviation Administration, Room 238, Terminal Building 2299, Hid-Continent Airport, Wichita, Kansas 67209; Telephone (316) 992-8281.

APPENDIX E

CONSTANT PRESSURE CHARTS

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Complete Stall Warning System Failure

If both left and right stall warning systems fail, the angle-of-attack indicator will also become inoperative and stall may be avoided by reference to the airspeed indicator only. In this event:

A. Maintain airspeed at least 30 knots above stall speeds shown in Section IV. Normal landing approach speed may be maintained on final approach in the landing configuration.
B. Limit bank angles to 30° maximum.

Yaw Damper Failure

Should the yaw damper fail at high altitude and high Mach No., the aircraft will demonstrate a moderate "Dutch Roll" although this *is easily* controlled in smooth air or in light turbulence, it could become difficult to control in moderate or severe turbulence especially during *instrument conditions*. Caution should be exercised to prevent overcontrolling. Should this malfunction occur, the following procedure should be adhered to:

A. Select secondary gyro. If on secondary, select primary.
B. If failure still exists, turn yaw damper switch off.
C. Pull AUTOPILOT YAW circuit breaker.
D. Avoid flight into areas of moderate/severe turbulence.
E. *Land as soon as possible.*
F. Do not attempt further flight until trouble has been located and corrected.

Pitch Axis Malfunction

A pitch axis malfunction is indicated by unwanted control column movement or elevator control system binding. *In the event of a pitch axis malfunction:*

A. Elevator Control - As required to maintain aircraft control.
B. *Cutoff* Button (Pilot's or Copilot's control wheel) - Depress.

Note

> This will disengage the autopilot and correct the problem if the autopilot was the cause of the malfunction. Cutoff button may then be released.

Pitch Axis Malfunction (CONT)

IF CONTROL FORCE CONTINUES:

C. Both STALL WARNING Switches - OFF.
D. AUTOPILOT PITCH Circuit Breaker (Pilot's Subpanel or Switch Panel) - Pull.
E. If Flight Conditions Permit:
   1. *STALL WARNING Switches - ON*, one at a time, to isolate the malfunctioning system.
   2. AUTOPILOT PITCH Circuit Breaker - Reset, if desired.
F. If both STALL WARNING Switches are OFF:
   1. Maintain airspeed at least 30 knots above stall speeds shown in Section IV. Normal landing approach speed may be maintained on final approach in the landing configuration.
   2. Limit bank angles to 30° maximum.

TEMPORARY FLIGHT MANUAL CHANGE

Aircraft Affected: Gates Learjet Model 23.

Description of Change: Add PITCH UPSET (NOSE-UP or NOSE-DOWN) Emergency Procedure.

Filing Instructions: Insert this page adjacent to page 3-11 in your Model 23 AFM and retain until further notice.

Add the following PITCH UPSET (NOSE-UP or NOSE-DOWN) as follows:

PITCH UPSET (NOSE-UP OR NOSE-DOWN)

A nose-up pitch axis malfunction or nose-up pitch trim system runaway can result in extremely high pitch attitudes, heavy airframe buffet, and require control forces in excess of 75 pounds for recovery.

A nose-down pitch axis malfunction, nose-down pitch trim system runaway, or nose-down overspeed can result in extremely high airspeeds and require control forces in excess of 75 pounds for recovery.

WARNING Do not extend spoilers on any nose-down pitch upset at any speed due to a significant nose-down pitching moment associated with spoiler deployment.

NOTE Control pressures may be heavy. Copilot assistance is recommended with this procedure.

FAA APPROVED DATE 10/1/80

for CHIEF, AIRCRAFT CERTIFICATION PROGRAM
FAA CENTRAL REGION
WICHITA, KANSAS

TEMPORARY FLIGHT MANUAL CHANGE (CONT)

IMMEDIATELY:

A. Attitude Control - As required to maintain aircraft control.
- If in nose-up attitude, roll into bank or maintain existing bank until the aircraft nose passes through the horizon.
- If in nose-down attitude, level the wings before pulling the nose up.

B. Thrust Levers - As required. (If in nose-down attitude, immediately reduce thrust levers to IDLE position).

C. Control Wheel Cutoff Button - Depress and hold until step G is accomplished.

D. PITCH TRIM Selector Switch (switch panel) - OFF.

E. On aircraft 23-003 thru 23-014, NORMAL PITCH TRIM Switch (switch panel) - OFF.

F. Stall Warning Switches - OFF.

WARNING On any speed excursions beyond M_{MO}, the elevator control must be smoothly and steadily applied to prevent encountering excessive aileron activity and airframe buffet. Beyond .85 M_I, a 1.5 g pull-up may be sufficient to excite aileron activity and the g level must be limited to that required to maintain lateral control.

AFTER AIRCRAFT CONTROL IS REGAINED:

G. Spoilers - Check retracted.

H. AUTOPILOT PITCH Circuit Breaker (pilot's subpanel or switch panel) - Pull.

I. If control force continues, select other trim system and retrim the aircraft.

J. Isolate malfunctioning system by switching system ON one at a time. Pause between activating each system to determine the defective system.

TEMPORARY FLIGHT MANUAL CHANGE

Publication Affected:

1. Gates Learjet Model 23 AFM.
2. Gates Learjet Model 23-015 AFM.
3. Gates Learjet Model 23 With Jet Pump Fuel System AFM.
4. Gates Learjet Model 24 AFM
5. Gates Learjet Model 24A AFM.
6. Gates Learjet Model 24B AFM
7. Gates Learjet Model 24 ECR 736 AFM
8. Gates Learjet Model 24D AFM.
9. Gates Learjet Model 24E AFM.
10. Gates Learjet Model 24F AFM.

Description of Change: Delete RECOVERY FROM OVERSPEED procedure and add RECOVERY FROM INADVERTENT OVERSPEED procedure.

Filing Instructions: This Temporary Change supersedes previous (RECOVERY FROM OVERSPEED) Temporary Changes dated 10-1-80 against the following AFM's. Remove superseded Temporary Change from appropriate AFM. Insert this page as follows and retain until further notice.

1. **23 AFM — Insert adjacent to page 3-11.**
2. 23-015 — Insert adjacent to page 3-9A.
3. 23 w/Jet Pumps AFM — Insert adjacent to page 3-11.
4. 24 AFM — Insert adjacent to page 3-10.
5. 24A AFM — Insert adjacent to page 3-12.
6. 24B AFM — Insert adjacent to page 3-11.
7. 24 ECR 736 AFM — Insert adjacent to page 3-13A.
8. 24D AFM — Insert adjacent to page 3-15.
9. 24E AFM — Insert adjacent to page 3-16.
10. 24F AFM — Insert adjacent to page 3-17.

Add RECOVERY FROM INADVERTENT OVERSPEED procedure as shown on attached page.

FAA APPROVED [signature] DATE 2/5/82

for CHIEF, AIRCRAFT CERTIFICATION PROGRAM
FAA CENTRAL REGION
WICHITA, KANSAS

RECOVERY FROM INADVERTENT OVERSPEED

If V_{MO} or M_{MO} is inadvertently exceeded:

WARNING

Do not extend the spoilers, or operate with the spoilers deployed, at speeds above V_{MO}/M_{MO} due to significant nose-down pitching moment associated with spoiler deployment.

1. Thrust Levers — IDLE.
2. Identify aircraft pitch and roll attitude.

NOTE

- In any aircraft, altitude (particularly roll attitude) may be difficult to identify from visual and instrument references in an extreme nosedown condition.
- Do not apply elevator force until bank angle is reduced to less than 90°. A pull elevator force when the bank angle is greater than 90° will increase the nose-down attitude.

3. Level wings.
4. Elevator and pitch trim — As required to raise the nose.

WARNING

On any speed excursions beyond M_{MO}, the elevator control must be smoothly and steadily applied to prevent encountering excessive aileron activity and airframe buffet. Beyond 0.85 M_I, a 1.5 g pullup may be sufficient to excite aileron activity and the g level must be limited to that required to maintain lateral control.

If Mach or airspeed is severe or if pitch and/or roll attitude is extreme or unknown:

5. Landing Gear Switch — Down. Lowering the landing gear at high speed will increase drag and cause a moderate nose-up pitching moment which is easily controllable, but should be anticipated.

   Extending the landing gear has been flight tested to 0.85 M_I and 320 KIAS. Analysis of flight test data indicates that this procedure is applicable at higher speeds.

CAUTION

Minor damage to the landing gear doors may be experienced when the gear is lowered at very high speed. **Do not retract landing gear for remainder of flight.** After landing, a thorough inspection of the landing gear and doors for condition must be made.

-41-

AP PBD F

Runaway Trim

The normal trim systems are provided with a cutoff button located on both the pilot's and copilot's control wheel below the normal pitch/roll trim switches. This is the same switch used to activate the low priority nose wheel steering system. Procedures to be followed during various phases of runaway trim conditions are as follows:

A. Rudder Trim Runaway
1. Engage cutoff button
2. Pull YAW circuit breaker on the copilot's circuit breaker panel and release cutoff button.
3. Continue flight but do not re-engage rudder trim until trouble is located and corrected.

B. Aileron Trim Runaway
1. Engage cutoff button
2. Pull ROLL circuit breaker on the copilot's circuit breaker panel and release cutoff button.
3. Continue flight but do not re-engage aileron trim until trouble is located and corrected.
4. Use caution when changing airspeeds or configuration as aileron force required to maintain wings level will vary.

C. Pitch Trim Runaway (with autopilot engaged)

The autopilot pitch trim system utilizes the secondary emergency motor contained in the horizontal stabilizer actuator. This system is protected by two circuit breakers.

1. Disengage autopilot with cutoff button provided automatic disengage did not function.

CAUTION

Be prepared for aircraft out-of-trim condition when autopilot is disengaged.

2. PITCH TRIM NORM/EMER Switch - OFF
3. Pull autopilot PITCH circuit breaker. This deenergizes the autopilot pitch trim motor only.
4. PITCH TRIM NORM/EMER Switch - EMER and check for proper operation. Use caution since fault may be *in the emergency trim motor circuit and runaway* trim may continue. If this condition exists, proceed as under Pitch Trim Runaway - Emergency System.

Runaway Trim (CON'T)

5. If emergency trim system operates normally, set PITCH TRIM NORM/EMER switch to NORM and check for proper trim operation.
6. If normal trim system also operates properly, the autopilot circuit is faulty. Continue flight but do not engage autopilot until trouble is located and corrected.

D. Pitch Trim Runaway - Normal System
1. Engage trim cutoff button
2. PITCH TRIM NORM/EMER Switch - EMER
3. Release cutoff button
4. All trim functions in pitch axis can be performed with the EMERGENCY switch on the aft end of the pedestal. The trim rate in the emergency system is approximately half of the normal.
5. Flight may be continued but land as soon as possible as no backup system now exists.

E. Pitch Trim Runaway - Emergency System
1. PITCH TRIM NORM/EMER Switch - OFF

Note

The trim cutoff button will not deactivate the emergency pitch trim motor.

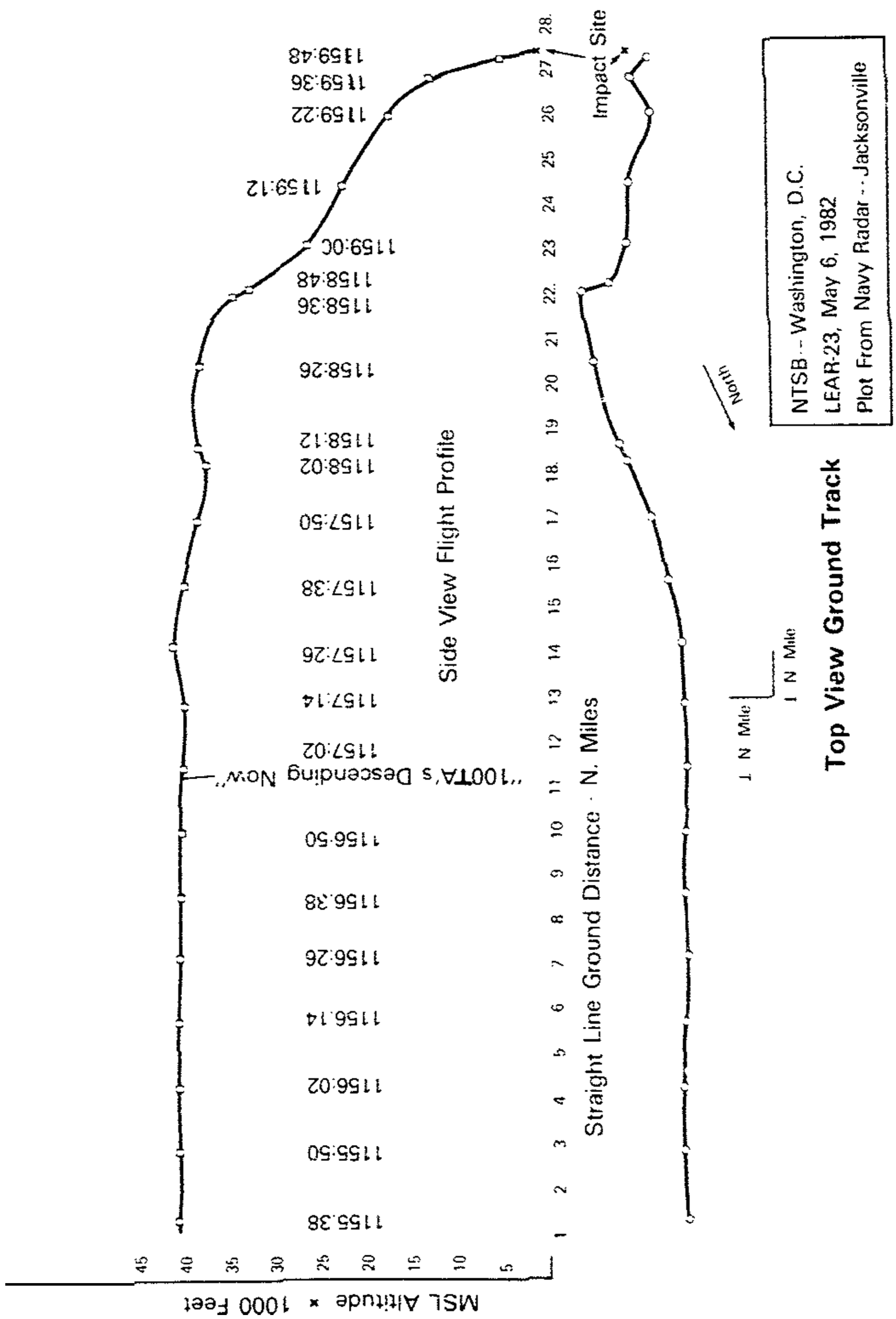
2. Land as soon as possible.
3. Use caution in adjusting thrust or airspeed as the stick forces required to maintain desired angle of attack will vary with thrust and/or airspeed.

Note

In the event a malfunction of any trim system should occur, no further flights should be attempted until all trouble has been located and corrected.

APPENDIX G

FLIGHTPATH CHART



APPENDIX H

LEARJET ACCIDENT AND INCIDENT HISTORY

Some relatively recent incidents and accidents involving Learjet aircraft are discussed herein to present the background and the development of the corrective actions which have been taken by the FAA before the October 1, 1981, accident in Felt, Oklahoma.

On August 31, 1974, a Colorado Flying Academy Learjet 25B, serial No. 151, crashed near Briggsdale, Colorado. The airplane departed Denver at 1331 m.d.t. on a training flight en route to Cheyenne, Wyoming, with two passengers aboard. The last radio contact with the flight wes at 1336 when the aircraft was at 17,400 feet. The Sky was clear with about 40 miles visibility.

The Safety Board retrieved information from the cockpit voice recorder (CVR), which was installed in the aircraft as an owner's option. Based on this information, it appeared that the instructor pilot, in the right seat, decided to introduce a runaway trim emergency to the student pilot who was on his fourth lesson for his type rating. The runaway trim maneuver followed an unusual attitude. About 1348:39, the instructor is understood to have stated, "runaway trim," and tne student stated 2 seconds later, "okay turn it off." Three seconds later, the student stated, "the. . . spoilers," and 3 seconds later, the instructor stated, "spoilers can't do that." Three seconds later, at 1348:50, the landing gear and the overspeed warning horns sounded; the overspeed horn warning continued to the end of the recording at 1349:15. At 1348:56, a voice identified as the instructor's stated, "can't pick up.. . pull." A witness on the ground estimated that the aircraft was in a 45° dive angle before impact. The aircraft struck the ground in a wings level, 20° to 40° nosedown attitude.

The instructor held ratings in the Learjet Models 23, 24, and 25. He had 9,323 hours of flight time. His total Learjet fliiht time was not known. He had flown the Learjet 130 hours in the past 90 days and had accumulated 161 hours in the Learjet Model 25. The student's flight experience was not known.

Examination of the wreckage disclosed that the landing gear, wing flaps, and spoilers were retracted at the time of ground impact. The horizontal stabilizer jackscrew was found in the full nosedown position.

On October 20, 1978, a Kelco Aircraft Company Learjet 25, serial No. 019, crashed 1.5 miles southeast of Vickery, Ohio. The aircraft departed the Cleveland–Hopkins Airport at 1019 e.d.t. with a pilot, copilot, and an FAA Operations Inspector on board for the purpose of giving the copilot an "airtaxi" flight check. The flight check was to consist of some "high work" maneuvers, such as slow flight, stalls (approach to shaker), steep turns, possible simulated emergencies, such as a runaway pitch trim, an engine fire, and an emergency descent; and "low work," such as landings, go–arounds, and simulated engine-out maneuvers. The flight climbed to 16,500 feet, and at 1027, the crew advised the Cleveland ARTCC that they would be operating in the area of the Sandusky YOR. About 6 minutes into the fiight, at 1032:49, a sound similar to a keyed microphone was received by the ARTCC, followed by five statements of "Pull up" in rapid sequence; a final, but louder "Pull it out" was received at 1033:20. It was determined that the altitude alert had sounded et 1032:32, and 4 seconds later, the overspeed warning horn had sounded. Witnesses on the ground reported observing the aircraft in about a 60° dive angle, and they stated they did not see any smoke, fire, or pieces of the aircraft separate before ground impact.

Both pilots held a type rating in the Learjet. The pilot had 150 hours and the copilot had 230 hours in the Learjet.

Examination of the wreckage revealed that the wing flaps and the spoilers were retracted at impact. The position of the landing gear could not be confirmed. The horizontal stabilizer trim actuator was positioned to a minus 2.69°. This position equated to a cruise speed of 276 KIAS, at the estimated gross weight and c.g. of the accident aircraft. It was also determined that the aircraft accelerated to 306 KIAS (V_{mo}) in 6 to 7 seconds. Flight tests, made as a part of the Safety Board's May 1979 Study of Selected Performance Characteristics of Modified Learjet Aircraft, showed it would have required a negative "g" maneuver to achieve such acceleration. Simulated nosedown runaway trim conditions could not duplicate this condition. It was also noted that, "...extension of the spoilers is not a viable procedure to prevent acceleration in a nosedown trim runaway condition. Extension of the spoilers at V_{mo} with full nosedown trim required an elevator force estimated at 120 to 140 pounds to maintain level flight. At 250 knots, the elevator force was measured at 98 pounds with full nosedown trim and spoilers extended."

The investigation of these accidents prompted research related to the following key areas:

(1) Runaway pitch trim training techniques;
(2) Use of spoilers in a high speed recovery;
(3) Flightcrew backgrounds and qualifications; and
(4) Operation of the flight control system--pitch servo clutch assemblies, autopilotlautomatic flight control system, stall warning system, and the effectiveness of the control cables, ailerons and stabilizer/elevator system at high speeds

On March 2, 1979, the pilot of a Learjet Model 248, serial No. 209, operated by the Syntek Corporation, reported a longitudinal control problem at FL 350 while en route from Greensboro, North Carolins, to Nashville, Tennessee. The pilot stated that the stickshaker came on four times, and he responded by turning the two stall warning switches off one at a time. Each time he turned them back on, the aircraft would abruptly pitch nosedown, and the associated stall warning switch circuit breakers would pop. By deactivating the stall warning system, he was able to isolate the problem. However, in spite of his action, he had difficulty with pitch control during the landing but was able to make a safe landing following four attempts at Greensboro. The pilot made a 10° flap landing at a higher than normal airspeed and used the stabilizer trim for pitch control.

The longitudinal control problem was traced to the pitch axis servo drive unit (electromagnetic clutch). The clutch contains ferrous powder which normally coagulates or packs into a solid mass when a magnetic field is introduced electrically by signals from the autopilot or stall warning stickshaker/stickpusher system. The energized clutch then transmits torque to the elevator control system in the appropriate direction. The powder normally decoagulates and the clutch rotates freely when the magnetic field is removed.

Examination of the electromagnetic clutch of the Syntek aircraft revealed that the ferrous powder was packed even in the absence of electrical power. Such a condition could produce a nosedown pitching moment with normal operation of the autopilot which would require as much as 80 pounds of pull force on the control column to counter. Even without electrical power, the jammed clutch would affect the breakout force and the force gradient of the longitudinal control system before the elevator could be moved. Gates Learjet personnel theorized that moisture contamination caused the ferrous powder to pack and jam the clutch. During previous overhauls, Gates Learjet personnel have found various degrees of moisture contamination

The Safety Board examined the clutch in its metallurgical laboratory and found no foreign substances in the ferrous powder. However, some of the particles of the powder continued to pack into small hard lumps. The reason for this peculiarity was not determined, but it was believed that some undetermined property in the material was causing the clutch to jam even in the absence of a magnetic field.

Although the Safety Board noted that Gates Learjet had discontinued use of the electromagnetic clutch which was manufactured by Jet Electronics (part No. 2380066), in new aircraft, 220 Learjets were equipped with the clutch unit at that time, and it was a mandatory item for flight. The clutch unit was the Same as the type installed in the Kelco Aircraft Learjet. The Syntec incident prompted concern that magnetic clutches may have been a factor in the Kelco accident. In its investigation of this accident, the Safety Board identified only two servo clutches which were the primary yaw units. These servo clutch units were corroded, but the source of the corrosion could not be identified. Of the remaining eight servo clutch units installed in the aircraft, six exhibited no evidence of packing, one was destroyed, and the other was not located. Therefore, the condition of the pitch axis electromagnetic clutch units in the Kelco aircraft could not be determined. As a result of the Syntec incident and the foregoing accidents and in view of the potential catastrophic results of control difficulties caused by jammed electromagnetic clutches, the Safety Board issued safety recommendations A-79-21 through -23 to the FAA on April 18, 1979.

As a result of the Syntek Corporation incident investigation, several actions were taken by the FAA and the Gates Learjet Corporation to correct the magnetic clutch problem. A temporary AFM supplement was issued prescribing specific emergency procedures to follow in the event of a pitch axis malfunction. Copies of the Safety Board's recommendations were widely distributed and two operations bulletins describing the problem were issued to all FAA field offices In its response of July 16, 1979, to the Safety Board's recommendations, the FAA stated that it believed it was not necessary to restrict the operations of Learjets equipped with the electromagnetic clutches because of the temporary AFM change. However, these procedures only proved to be interim measures with respect to the clutch servo unit problem.

Between 0330 and 0400, on October 3, 1980, a National Jet Industries Learjet 25, serial No. 010, experienced an upset while in cruise flight at FL 450 over Butler, Missouri. The crew was on an air taxi cargo flight from Columbus, Ohio, to Pueblo, Colorado. With the autopilot and altitude hold engaged, the aircraft smoothly but suddenly pitched up, and gained more than 300 feet before the copilot pushed the primary trim switch to the nosedown position which disengaged the autopilot; the aircraft continued to deviate in a noseup attitude. Stall buffet was encountered and the left engine flamed out. Both pilots pushed full forward on the control column and the copilot selected secondary trim and also turned off the stall warning switches in an attempt to lower the nose, but to no avail. About 37,000 feet, the right engine flamed out. The aircraft began to respond to control movements about 32,000 feet, and the engines were restarted between 24.900 and 28,000 feet. The crew diverted to Wichita, Kansas, where they landed successfully.

The Safety Board's meteorological examination of the weather conditions existing in the area of the flight disclosed the existence of an upper front with wind shears greater than 10 knots per 1,000 feet. The Safety Board believes that this condition provided the potential for gravity waves 1/ and/or turbulence at the aircraft's flight level. The wave action or turbulence would have existed in a shallow layer, probably less than 1,000 feet thick. Based on the crew's statements of the incident, it was considered possible that the aircraft encountered the vertical component of a gravity wave.

Inspection of the aircraft by the FAA and the Gates Learjet Corporation disclosed that although the possibility of packed ferrous powder in the aircraft's electromagnetic clutch causing the control difficulty in the incident could not be excluded, the possibility could not be verified during ground tests of the servo unit--an inconclusive ground test is not unusual. It was noted that the amount of powder and the amount of lubricant were not in accordance with specifications Subsequent flight tests and analysis of the findings caused engineers to conclude that the control difficulty could have been cause by a packed pitch axis electromagnetic clutch.

At the conclusion of its investigation, the FAA issued Emergency AD-80-22-1G on October 23, 1980, which required deactivation of the pitch function in the FC-110 autopilot AFCS or AFC/SS until the electromagnetic clutches had been replaced with the improved, in-production d.c. torquer clutches (motor driven) and certain other changes had been made. The d.c. torquer clutches have continuously been installed since the model 25B, serial no. 067. Other changes required by the AD involved inspection of the autopilot trim coupler circuit board to assure that proper transistors were installed, and incorporation of 4 pitch trim monitor preflight test switch along with appropriate changes to the AFM. Upon accomplishment of these items, the autopilot pitch axis function could be restored. Operators were given until April 1, 1981, to make the changes

A failure of the transistors in the trim coupler board in the autopilot computer could cause a disturbance in the pitch axis of the aircraft. It was learned that Delco germanium transistors were believed to be more resistant to thermal runaway failures than the germanium transistors built by other manufacturers Hence,, the reason for the inspection. According to the manufacturer, a failure would normally be preceded by spurious autopilot disconnects because the trim monitor would sense an incorrect electrical phase relationship between stabilizer and elevator trim positions In other words, the trim coupler would have disconnected the autopilot if an unwanted trim motion of the stabilizer occurred. The control force required to maintain the desired flight attitude at the time of a disconnect under this condition might range anywhere between 10 and 80 pounds However, a pilot would still retain elevator control, but it could be limited depending on the amount of stabilizer mistrim present at the time of the disconnect. Therefore, a pilot may receive some kind of warning of a potential significant disturbance in the autopilot before control difficulty would become substantial. To prevent this type of failure from recurring, the FAA ordered compliance with the appropriate Jet Electronics Service Bulletins SB 4-2020-30, -32, -33, or -34, which are a part of Gates Learjet's aircraft modification kit, AMK 80-16B, mentioned in the airworthiness directive. The transistors installed in the trim coupler board of *the* National Jet Industries Learjet were Delco germanium and tests for faults were negative.

On April 11, 1980, Thunderbird Airways, Inc., Learjet 25B, serial No. 196, was on a return flight from Vernal, Utah, to Houston, Texas, at FL 410, after having completed an air taxi cargo flight. About 1716 c.s.t, the Albuquerque, New Mexico, ARTCC heard the sounds of a keyed microphone and a Mach overspeed warning horn with a lot of background noise. it was apparent that the flight was in difficulty, and that the

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1/ Atmospheric gravity waves are a disturbance in which bouyancy (or reduced gravity) acts as the restoring force on parcels of air displaced from hydrostatic equilibrium pilot attempted to identify himself and asked for a lower altitude, but did not make any further audible transmissions. The aircraft entered what was believed to be a steep, high speed descent and impacted 6 miles west of Conlon, Texas.

Investigation of this accident disclosed a relatively high probability of clear air turbulence in the area at the altitude the aircraft was transiting. It was determined that at the time of impact, the landing gear and flaps were retracted, the spoilers were extended, and the stabilizer actuator jackscrew was in the full nosedown position. The aircraft was equipped with d.c. torquer clutches, rather than electromagnetic clutches in the autopilot system. The aircraft's autopilot computer was equipped with the non-Delco germanium transistors. The transistors were destroyed and tests for the possibility of their failing could not be performed. As a result of this possible type of failure, this accident, and the National Jet Industries incident, AD-80-22-10 was promulgated to require that a trim monitor test feature be incorporated into the autopilot system (this was later superseded by AD-80-26-02).

On May 19, 1980, a Northeast Jet Company, Learjet 25D, N125NE was on a dead head flight from West Palm Beach, Florida to New Orleans, Louisiana. only the pilot and copilot were aboard. About 2 1/2 minutes after the aircraft reported at FL 430 at 1201:42 in the vicinity of the Covia Intersection on Airway J58, the Jacksonville, Floride, ARTCC received an unusual staccato sound transmission over the frequency, followed 4 seconds later by a transmission from the pilot stating "put out the spoilers" Fourteen seconds later, the copilot states, "Can't get it up...it's in a spin..." Fifteen seconds later, radio and radar contact with the aircraft was lost at about 104 miles west of Sarasota, Florida. Floating debris fron the aircraft was located at the 290° radial, 104.5 miles from Sarasota, in the Gulf of Mexico and was later recovered. The flightcrew was not found and there were no known witnesses to the accident.

The Safety Board determined that the probable cause of the accident was an unexpected encounter with moderate to severe clear air turbulence, the flightcrew's improper response to the encounter, and the aircraft's marginal controllability characteristics when flown at and beyond the boundary of its high altitude speed enveiope, all of which resulted in the aircraft exceeding its Mach limits and a progressive loss of control fron which recovery was not possible. Contributing to the accident was the disconnection of the Mach overspeed warning horn with an unauthorized cut-out switch. The absence of an overspeed warning probably delayed the crew's response to the turbulence encounter. Also contributing to the accident were the inconsistencies in aircraft flight manuals and flightcrew training programs regarding the use of spoilers to regain control.

The Safety Board was concerned about the manner in which certain flights were conducted. In response to the Board's letter requesting flight test date for the nosedown trim runaway condition, Gates Learjet reported in a letter dated December 15, 1980:

> The enclosed data was recorded. . . on a Model 25B (with the FAA aboard) on February 27, 1975. Stabilizer load flight test data is not available. Note that the runaway was stopped after three seconds; not allowed to run to the stop. In the one case at 300 KIAS, the trim was run to the stop and required an 85 pound pull to hold the airspeed. There is no Model 25B flight test data available to directly correlate the computer scenario of running the trim to the stop with a three second delay in any action by the pilot. In the flight test when the trim was run to the stop, the test pilot did have his hands on the wheel

As a result of the foregoing accidents and incidents, the Safety Board issued these recommendations to the FAA on June 27, 1980.

> Convene a Multiple Opinion Team to evaluate the flight characteristics and handling qualities of Series 20 Learjet aircraft: with and without slow flight modification, at both low- and high-speed extremes of the operational flight envelope under the most critical conditions of weight and balance (and other variable factors) and to establish the acceptability of the control and airspeed margins of the aircraft at these extremes. (Class I, Urgent Action) (A-80-53)
>
> Advise all Learjet operators of the circumstances of recent accidents and emphasize the prudence of rigid adherence to the operational limits and recommended operational procedures. (Class I, Urgent Action) (A-80-54)
>
> Evaluate information contained in the Gates Learjet Service New Letter 49 dated May 1980 pertaining to procedures to be followed if the aircraft inadvertently exceeds V_{mo}/V_{mo} and, based on this evaluation, require appropriate revisions to the aircraft flight manual. (Class I, Urgent Action) (A-80-55)

In its response dated September 25, 1980, the FAA stated that with regard to recommendation A-80-53, part of an evaluation had already been accomplished in conjunction with the Safety Board's February 1979 "Study of Selected Performance Characteristics of Modified Learjet Aircraft." The FAA stated that a separate investigation was initiated on June 17, 1980, to accomplish a certification review of the Learjet. In addition, they stated that their Office of Flight Operations had established a separate team to "review the adequacy and effectiveness of Learjet crew training."

On October 1, 1980, a Sky Train Air, Inc., Learjet 24, N44CJ, was on a return flight to McAllen, Texas from Casper, Wyoming at FL 450. Only the flightcrew and one other company pilot were aboard. About 1 minute after the crew made initial contact with the Albuquerque, New Mexico ARTCC, they failed to respond to a radio frequency change instruction and the airplane's transponder code was lost. The controller made several attempts to contact the airplane but to no avail. Witnesses at Felt, Oklahoma, heard an airplane overhead, at a very high speed; one witness who saw the airplane momentarily, stated it was in a descent angle of about 45° before it struck the ground. Investigation disclosed that the airplane impacted level terrain in a steep nosedown, left wing down altitude at very high speed, 2.8 miles southwest of Felt.

The Safety Board determined that the probable cause of the accident was a loss of control, possibly initiated by an unexpected encounter with moderate to severe clear air turbulence, which caused the aircraft to depart the narrow flight envelope boundaries in which it was operating and from which recovery was not effected, the flightcrew's lack of adequate training and experience in the Learjet, and the aircraft's marginal controllability characteristics near and beyond the boundaries of its flight envelope. Contributing to the accident was the flightcrew's probable extension of the spoilers in an overspeed situation, a procedure that had been prescribed in the approved aircraft flight manual until 1 year before the accident.

On December 7, 1980, the flightcrew of Learjet 25, serial No. 054, operated by Continental Oil Company, experienced a simultaneous flameout of both engines at about 40,003 feet while the aircraft was climbing to FL 430 northeast of Childress, Texas The engines were air started passing through 25,000 feet, and e precautionary landing was made at Childress. Extensive examination and testing of the CJ610-6 engines by General Electric disclosed that the flameouts were caused by reduced engine stall margin due to excessive blade tip clearance and excessive compressor case runout. As e result of its investigation of this incident, the Safety Board issued recommendation X-81-69 to the FAA on June 29, 1981.

APPENDIX I

SAFETY RECOMMENDATIONS

On September 9, 1982, the National Transportation Safety Board issued the following recommendations to manufacturers of multiengine turbine-powered airplanes and rotorcraft:

> Prewire all newly manufactured multiengine, turbine-powered fixed-wing aircraft certificated to carry six or more passengers in any type of operation not currently required by 14 CFR 121.343, 121.359, and 135.151 to have a cockpit voice recorder and/or a flight data recorder, to accept a "general aviation" cockpit voice recorder (if certificated for two-pilot operation) with at least one channel for voice communications transmitted from or received in the aircraft by radio, and one channel for audio signals from a cockpit area microphone, and a "general aviation" flight data recorder to record sufficient data parameters to determine the information in Table I (attached) as a function of time. (Class II, Priority Action) (A-82-101)
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> Prewire all newly manufactured multiengine, turbine-powered rotorcraft certificated to carry six or more passengers in any type of operation not currently required by 14 CFR 127.127 to have a cockpit voice recorder and/or a flight data recorder, to accept a "general aviation" cockpit voice recorder (if certificated for two-pilot operation) with at least one channel for voice communications transmitted from or received in the aircraft by radio, and one channel for audio signals from a cockpit area microphone, and a "general aviation" flight data recorder to record sufficient data parameters to determine the information in Table II (attached) as a function of time. (Class II, Priority Action) (A-82-102)
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> Install "general aviation:' cockpit voice recorders (on aircraft certificated for two-pilot operation) and flight data recorders when they become commercially available as standard equipment in all newly manufactured multiengine, turbine-powered fixed wing aircraft and rotorcraft certificated to carry six or more passengers in any type of operation not currently required by 14 CFR 121.343, 121.359, 133.151, and 127.127 to have a cockpit voice recorder and/or a flight data recorder. (Class III, Longer Term Action) (A-82-103)

On September 9, 1982, the Safety Board also issued the following recommendations to users of multiengine turbine-powered airplanes and rotorcraft:

> Encourage your members who own or operate multiengine, turbine-powered aircraft (both airplanes and rotorcraft) certificated for two-pilot operation to carry six or more passengers, in any type of operation not currently required by 14 CFR 121.359, 135.151, and 127.127 to have a cockpit voice recorder, to install "general aviation" cockpit voice recorders, and urge that they record voice communications transmitted from or received in the aircraft by radio on one channel, and audio signals from a cockpit area microphone on a separate channel (Class II, Priority Action) (A-82-104)

Encourage your members who own or operate multiengine, turbojet airplanes certificated to carry six or more passengers, in any type of operation not currently required by 14 CFR 121.343 to have a flight data recorder, to install "general aviation" flight data recorders as soon as they are commercially available, and urge that they provide for recording sufficient parameters to determine the following information as a function of time (see Table I (attached) for ranges, accuracies, etc):

altitude
indicated airspeed
magnetic heading
radio transmitter keying
pitch attitude
roll attitude
vertical acceleration
longitudinal acceleration
stabilizer trim position
or pitch control position.

(Class III, Longer Term Action) (A-82-105)

On August 31, 1982, the Safety Board issued the following recommemdations to the Federal Aviation Administration:

Encourage timely adoption of the Society of Automotive Engineers (SAE) standard for "general aviation" flight recorders (intended for installation in multiengine, turbine-powered fixed-wing aircraft and rotorcraft in any type of operation not currently required by 14 CFR 121.343, 121.359, 135.151, and 127.127 to have a cockpit voice recorder and/or a flight data recorder), and issue a Technical Standard Order (TSO) covering such recorders immediately after the SAE document is approved. Include in the TSO requirements that:

a) specify a cockpit voice recorder (CVR) of high enough audio quality to render intelligible recorded data on each of two channels which reserves one channel for voice communications transmitted fron or received in the aircraft by radio, and one channel fer audio signals from a cockpit area microphone;

b) specify all flight data recorder (FDR) parameters, ranges, accuracies, and sampling intervals cited in Tables I and II (attached);

c) specify crash and fire survivability standards for CVRs and FDRs which are at least as stringent as those of TSO-C51a for Type I (nonejectable) end Type III (ejectable) recorders as appropriate.

(Class I, Urgent Action) (A-82-106)

Require that all multiengine, turbine-powered, fixed-wing aircraft certificated to carry six or more passengers manufactured on or after a specified date, in any type of operation not currently required by 14 CFR

121.343, 121.359, and 135.151 to have a cockpit voice recorder and/or a flight data recorder, be prewired to accept a "general aviation" cockpit voice iecorder (if also certificated for two-pilot operation) with at least one channel for voice communications transmitted from or received in the aircraft by radio, and one channel for audio signals from a cockpit area microphone, and a "general aviarion" flight data recorder to record sufficient data parameters to determine the information in Table I (attached) as a function of time. (Class II, Priority Action) **(A-82-10?)**

Require that all multiengine, turbine-powered rotorcraft certificated to carry six or more passengers manufactured on or after a specified date, in any type of operation not currently required by 14 CFR 127.127 to have a cockpit voice recorder and/or a flight data recorder, be prewired to accept a "general aviation" cockpit voice recorder (if also certificated for two-pilot operation) with at least one channel for voice communications transmitted from or received in the aircraft by radio, and one channel for audio signals from a cockpit area microphone, and a "general aviation" Right data recorder to record sufficient data parameters to determine the information in Table II (attached) as a function of time. (Class II, Priority Action) **(A-82-108)**

Require that "general aviation" cockpit voice recorders (on aircraft certificated for two-pilot operation) and flight data recorders be installed when they become commercially available as standard equipment in all multiengine, turbine-powered fixed-wing aircraft and rotorcraft certificated to carry six or more passengers manufactured on or after a specified date, in any type of operation not currently required by 14 CFR 121.343, 121.359, 135.151, and 127.127 to have a cockpit voice recorder and/or a flight deta recorder. (Class III, Longer Term Action) **(A-82-109)**

Require that "general aviation" cockpit voice recorders be installed as soon as they are commercially available in all multiengine, turbine-powered aircraft (both airplanes ana rotoreraft), which are currently in service, which are certificated to carry six or more passengers and which are required by their certificate to have two pilots, in any type of operation not currently required by 14 CFR 122.359, 135.151, and 127.127 to have a cockpit voice recorder. The cockpit voice recorders should have at least one channei reserved far voice communications transmitted from or received in the aircraft by radio, and one channei reserved for audio signals from a cockpit area microphone. (Class II, Priority Action) **(A-82-110)**

Require that "general aviation" Right data recorders be installed as soon as they are commercially available in all multiengine, turbojet airplanes which are currently in service, which are certificated to carry six or more passengers in any type of operation not currently required by 14 CFR 121.343 to have a flight data recorder. Require recording of sufficient parameters to determine the following information as a function of time (see Table I (attached) for ranges, accuracies, etc):

altitude
indicated airspeed
magnetic heading
radio transmitter keying
pitch attitude
roil attitude
vertical acceleration
longitudinal acceleration
stabilizer trim position
or pitch control position.

(Class III, Longer Term Action) (A-82-111)

On September 27, 1982, the Safety Board recommended that the Federal Aviation Administration in conjunction with the activities of the Flight Operations Evaluation and the Flight Standardization Boards:

> Establish a requirement that manufacturers provide, as part of the initial certification of a new general aviation turbojet airplane, a training guide for piiot transition into the airplane. The training guide should encompass the entire flight envelope in which the airplane will be operating and any unique aspects of its systems design, handling characteristics, and performance including the hazards of exceeding the flight envelope. The training guide should be an approved manual for use by appropriate inspectors, pilot schools, flight instructors, and pilot examiners. (Class II, Priority Action) (A-82-123)
>
> Establish a requirement that manufacturers provide a training guide for pilot transition into currently certificated general aviation turbojet airplanes The training guide should encompass the entire flight envelope in which the airplane will be operating and any unique aspects of its systems design, handling characteristics, and performance. The training guide should be an approved manual fer use by appropriate inspectors, pilot schools, flight instructors, and pilot examiners (Class II, Priority Action) (A-82-124)
>
> Review the criteria currently prescribed for evaluating the type-rating requirement for successive models of turbojet airplanes built by the same manufacturer evolving from an original design, to determine if they are sufficient to provide adequate consideration of performance differences, operating environments, unique operational normal and emergency procedures, and systems design. If the criteria are found to be inadequate, revise them appropriately, and review existent type-rating requirements under the new criteria. (Class II, Priority Action) (A-82-125)

The Safety Board further recommended that the Federal Aviation Administration:

> Upon approval of each specific training guide for general aviation turbojet airplanes require that the criteria used by inspectors and pilot examiners in conducting type-rating flight checks include full consideration of the material provided in the training guides (Class II, Priority Action) (A-82-126)

Establish a minimum training curriculum to be used at pilot schools which covers special considerations involved in a pilot's initial transition into general aviation turbojet airplanes, including the aerodynamic, meteorological and physiological aspects of high performance, high altitude flight- (Class II, Priority Action) (A-82-127)

Require that pilot applicants for an initial type-rating in a general aviation turbojet airplane complete a minimum training curriculum at an approved pilot school or an equivalent military training program for turbojet airplanes (Class II, Priority Action) (A-82-128)

Require that type-rating flight checks in general aviation turbojet airplanes include actual demonstration of pilot competency in handling characteristics in high altitude flight at speed ranges compatible with the specified flight envelope of the airplane. (Class II, Priority Action) (A-82-129)