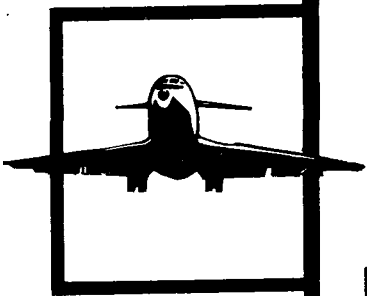
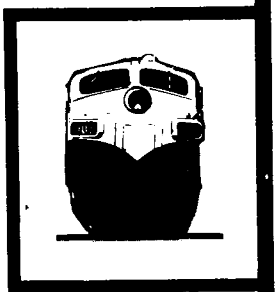
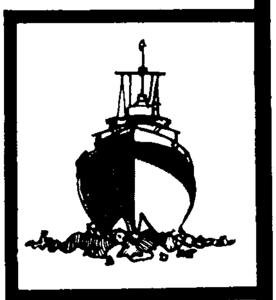


NATIONAL TRANSPORTATION SAFETY BOARD

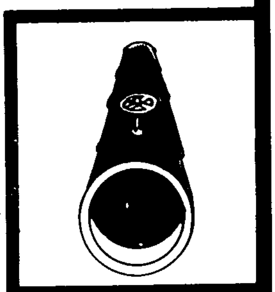


WASHINGTON, D.C. 20594

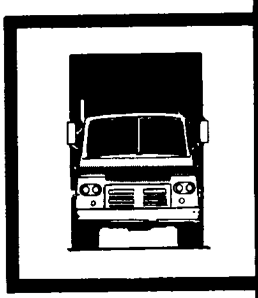


AIRCRAFT ACCIDENT REPORT

NORTHEAST JET COMPANY
GATES LEARJET 25D, N125NE
GULF OF MEXICO
MAY 19, 1980



NTSB-AAR-81-15



UNITED STATES GOVERNMENT

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
NTSB-AAR-81-15	PB81-910415	

4. Title and Subtitle Aircraft Accident Report-- Northeast Jet Company, Gates Learjet 25D, N125NE, Gulf of Mexico, May 19, 1980

5. Report Date
September 15, 1981

6. Performing Organization Code

7. Author(s)

8. Performing Organization Report No.

9. Performing Organization Name and Address
National Transportation Safety Board
Bureau of Accident Investigation
Washington, D.C. 20594

10. Work Unit No.
3352

11. Contract or Grant No.

12. Sponsoring Agency Name and Address

NATIONAL TRANSPORTATION SAFETY BOARD
Washington, D. C. 20594

13. Type of Report and Period Covered
Aircraft Accident Report
May 19, 1980

14. Sponsoring Agency Code

15. Supplementary Notes
The subject report was distributed to NTSB mailing lists: 1A, 8A and 8B.

16. Abstract At 1205 e.d.t., on May 19, 1980, Northeast Jet Company, Learjet 25D, N125NE crashed into the Gulf of Mexico while en route to New Orleans, Louisiana, from West Palm Beach, Florida. The pilot and copilot were on board the aircraft.

About 2 1/2 minutes after the aircraft was reported at Flight Level 430 in the vicinity of the Covia Intersection on Airway J58, the Jacksonville, Florida, Air Route Traffic Control Center received an unusual staccato sound transmission over the frequency, followed 18 seconds later by a report from the copilot, "Can't get it up . . . it's in a spin . . . ." About 33 seconds after the first staccato sounds, radio and radar contact with N125NE was lost about 104 miles west of Sarasota, Florida. Floating debris was located by a search aircraft and later recovered; the flightcrew was not found. There were no known witnesses to the crash.

The National Transportation Safety Board determines that the probable cause of this 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 envelope, all of which resulted in the aircraft exceeding its Mach limits and a progressive loss of control from which recovery was not possible. Contributing to the accident was the disconnection of the Mach overspeed warning horn with an unauthorized cut-out switch which resulted in the absence of an overspeed warning that probably delayed the crew's response to the turbulence encounter, and the inconsistencies in aircraft flight manuals and flightcrew training programs regarding the use of spoilers to regain control.

17. Key Words Clear air turbulence penetration, airplane response, pilot response, loss of control, overspeed, autopilot mistrim, disengagement, automatic flight control system, control stick puller, mach tuck, aileron buzz/"snatch", spoilers, nosedown pitching moment, uncoordinated roll maneuver, high speed dive.

18. Distribution Statement
This document is available to the public through the National Technical Information Service-Springfield, Virginia 22161
(Always refer to number listed in item 2)

19. Security Classification (of this report)	20. Security Classification (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	72	

NTSB Form 1765.2 (Rev. 9/74)

CONTENTS

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

Adopted: September 15, 1981

NORTHEAST JET COMPANY GATES LEARJET 25D, N125NE GULF OF MEXICO MAY 19, 1980

SYNOPSIS

At 1205 e.d.t., on May 19, 1980, Northeast Jet Company, Learjet 25D, N125NE crashed into the Gulf of Mexico while en route to New Orleans, Louisiana, from West Palm Beach, Florida. Only the pilot and copilot were on board the aircraft.

About 2 1/2 minutes after the aircraft was reported at Flight Level 430 in the vicinity of the Covia Intersection on Airway J58, the Jacksonville, Florida, Air Route Traffic Control Center received an unusual staccato sound transmission over the frequency, followed 18 seconds later by a report from the copilot, "Can't get it up . . . it's in a spin . . . ." About 33 seconds after the first staccato sounds, radio and radar contact with N125NE was lost about 104 miles west of Sarasota, Florida. Floating debris was located by a search aircraft and later recovered; the flightcrew was not found. There were no known witnesses to the crash.

The National Transportation Safety Board determines that the probable cause of this 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 envelope, all of which resulted in the aircraft exceeding its Mach limits and a progressive loss of control from which recovery was not possible. Contributing to the accident was the disconnection of the Mach overspeed warning horn with an unauthorized cut-out switch which resulted in the absence of an overspeed warning that probably delayed the crew's response to the turbulence encounter, and the inconsistencies in aircraft flight manuals and flightcrew training programs regarding the use of spoilers to regain control.

1. FACTUAL INFORMATION

1.1 History of the Flight

On May 14, 1980, N125NE was flown to West Palm Beach, Florida, on a business flight. The aircraft was fueled to near capacity and then hangared. According to the fixed-base operator, at West Palm Beach, the aircraft did not receive any further service.

About 2140 1/ on May 18, the flightcrew arrived in West Palm Beach by commercial aircraft, remained overnight in a company apartment, and arrived at the airport about 0930 on May 19. Their activities between the time of their arrival on May 18 and their arrival at the airport the following morning are not known.

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

At 0955:15, the flightcrew of Learjet N125NE contacted the International Flight Service Station, Miami, Florida, obtained a weather briefing, and filed three flight plans for a trip from West Palm Beach to Allentown, Pennsylvania, with en route stops at New Orleans, Louisiana, and Newark, New Jersey. The flightcrew was to deadhead to New Orleans and pick up a passenger for a charter flight to Newark, New Jersey, and then return to Allentown, the company headquarters. They planned to depart at 1230 with a route of flight to New Orleans on Airway J-58 at Flight Level (FL) 430 at a true airspeed of 440 knots. Time en route was to be 1 hour 30 minutes with 4 hours of fuel on board. There was no forecast of turbulence in the flightcrew's weather briefing.

The copilot of an unmodified Learjet 24D, N51J, stated that he saw the crew of N125NE arrive at the airport and he engaged in a conversation with them about a similiar portion of the route of flight. He said that the crew of N125NE did not have the New Orleans instrument approach chart and they had asked for and made copies of his chart. He said that when the crew boarded N125NE for departure, the pilot occupied the right seat and the copilot occupied the left seat.

At 1107:06, N125NE contacted Palm Beach Clearance Delivery and received the following clearance: ". . . cleared to the New Orleans Lake Front airport radar vectors Sarasota as filed maintain five thousand expect FL 430 10 minutes after departure, departure frequency will be 124.6, squawk 3712." At 1119:14, the flightcrew received taxi clearance to runway 9, and at 1121:07, the crew received clearance for an intersection takeoff; 3 seconds later, they reported rolling.

At 1122:46, the aircraft was cleared to climb and maintain 10,000 feet mean sea level (m.s.l.) 2/ and to turn left to a heading of 330°. Thirty-six seconds later, they were told to turn to 290°. At 1124:51, the aircraft was cleared direct to Sarasota and was cleared to climb to and maintain 17,000 feet. At 1126:49, N125NE contacted the Miami Air Route Traffic Control Center (ARTCC) and reported, ". . . out of fifteen, five climbing to one seven thousand," and was then cleared to climb to and maintain FL 230. At 1127:30, N125NE was cleared to climb to and maintain FL 430. At 1130:56, the crew reported out of FL 260, and at 1135:16, they reported out of FL 330. At 1145:16, the aircraft reported to the Miami Center, ". . . with you level uh out of four two zero for four three zero."

At 1201:42, the pilot contacted the Jacksonville ARTCC and reported level at FL 430. At 1203:56, an unusual staccato or vibration noise, was transmitted over the ARTCC frequency. The following transcript of the radio transmissions from N125NE was prepared by the Jacksonville ARTCC:

1203:56	-	(unusual sound on frequency, three distinct bursts)
1204:00	-	(put out the spoilers)
1204:03	-	(keyed microphone with static)
1204:13	-	(keyed microphone with static)
1204:14	-	Can't get it up (pause) it's in a spin (background) noise, voice talking in background)
1204:20	-	(sporadic sounds, keying and unkeying of a microphone)
1204:23	-	Oh jees (background noise)

2/ All altitudes are mean seal level unless otherwise noted.

1204:27		-	We're gonna
1204:30		-	(static)
1205:19	R-29	-	November One Two Five November Echo ah reset and squawk three seven one two normal
1208:19	R-29	-	November One Two Five November Echo JAX
1208:29	R-29	-	November One Two Five November Echo Jacksonville Center

At 1203:53, the Jacksonville ARTCC lost altitude information (mode C) from the aircraft and at 1204:29, the ARTCC lost radar contact with the aircraft on Airway J-58 in the vicinity of the Covia Intersection when the aircraft apparently made about a 90° left turn from the 290° radial, 104.5 miles west of the Sarasota (SRQ), Florida.

The aircraft crashed at latitude 27°54' N and longitude 84°46' W. The depth of the water is about 600 feet.

According to the copilot of N51J, he departed West Palm Beach about 16 minutes after N125NE. He and the pilot, who was flying the aircraft, received radar vectors over Lake Okeechobee during the climb-out, and about 30 miles south of Sarasota, they were cleared by the Miami ARTCC to fly direct to the Covia Intersection. The aircraft reached FL 430 well before the Covia Intersection and was cruised at Mach 0.77, indicating 210 to 220 knots with a true airspeed (TAS) of about 440 knots. The ram air temperature was -39° C. The gross weight of the aircraft was estimated at 12,000 pounds. He described the weather as essentially clear, with a very light haze at about FL 450, with some low clouds at about 2,000 feet and some cloud buildups southwest of their course. He did not note any change in ram air temperature.

N51J encountered some light to moderate "chop" which presented no problem, about 50 miles west of Sarasota. In the vicinity of the Covia Intersection, the aircraft pitched up about 5°, climbed about 300 to 400 feet, pitched down about 4°, lost about 700 to 800 feet of altitude, and then abruptly pitched up at which time the autopilot disengaged. The flightcrew reengaged the autopilot, and the same sequence occurred two more times. Following the third reengagement of the autopilot, no further turbulence disturbances occurred. The pilot of N51J, an experienced Learjet captain, gave the following account of the incident:

> I noticed that our Mach number suddenly rose from .77 to nearly .80 and simultaneously our altitude increased and I felt the most severe turbulence I have ever encountered in a Learjet. It disconnected our autopilot and, when I reengaged it for the last time, the altitude hold was inoperative and it had to be repaired later. I reduced power immediately.
>
> The turbulence continued for a certain time, which I cannot guess at now. Our altitude varied considerably during this interval.
>
> I did not check the path of the jet streams that day but I am fairly certain that we must have crossed a jet stream at a fairly sharp angle and this was the cause of the rise in Mach number and the turbulence.

The pilot further stated that he, "... had no great difficulty in maintaining control under these extreme conditions." He did not deploy the spoilers, nor did he unintentionally disengage the autopilot and yaw damper with the wheel master button during the encounter.

Shortly after 1100, a National Aeronautics and Space Administration (NASA) pilot departed the Johnson Space Center, Houston, Texas. He was flying a Northrup T-38 jet aircraft from Houston to Patrick Air Force Base (AFB) near the Kennedy Space Center, Florida. He stated that there were cloud buildups just to the south of New Orleans, with tops about FL 430. He stated that 40 to 50 miles east of New Orleans, the weather was clear and the air was smooth, with some scattered cloud layers below. He was cruising at Mach 0.89 at FL 430 on Airway J58 and attempting to attain Mach 0.90. The gross weight of the aircraft at the time was 10,500 lbs. His flight level was changed by the Jacksonville Center and he climbed to FL 450. Shortly thereafter, he overheard a keyed microphone and voices in the background which lasted about 10 seconds. He said he was not able to determine what was stated. The aircraft overflew the accident site about 19 minutes after the accident. The pilot further stated that he did not encounter any significant turbulence. He said that in the vicinity of Covia Intersection he requested to fly direct to Patrick AFB and that the air traffic control (ATC) kept him at FL 450 as long as they could before he received a descent clearance to land.

1.2 Injuries to Persons

Injuries	Crew	Passengers	Other	Total
Fatal	2	0	0	2
Serious	0	0	0	0
Minor/None	0	0	0	0

1.3 Damage to Aircraft

The aircraft was destroyed by impact forces.

1.4 Other Damage

None.

1.5 Personnel Information

The flightcrew was certificated and qualified for the flight. (See appendix B.) The pilot obtained type ratings in the Learjet 23 and 24 on August 16, 1966. He acquired his type rating in the model 25 on July 8, 1968. According to Northeast Jet, he had accumulated 15,740 flight-hours, of which 6,062 hours were in the Learjet.

The copilot was not rated in the Learjet. According to the company, he had accumulated 4,116 flight-hours, of which 65 hours were in the Learjet. He had also acquired 40 hours of Learjet 25 ground school. He was a former military pilot and had accumulated 2,476 flight-hours of high performance turbojet flight time before his employment with the company.

1.6 Aircraft Information

Gates Learjet Model 25D, N125NE, serial No. 271, was issued a standard airworthiness certificate on February 12, 1979. It was equipped with the manufacturer's Century III and Softflite performance modifications to improve the slow speed and stall characteristics of the aircraft. It was certificated for flight up to 51,000 feet. The aircraft was purchased by Northeast Jet Company on April 30, 1979. (See appendix C.)

The maintenance logs were on board the aircraft and were not recovered. A review of the company's available maintenance records did not provide an accurate evaluation of the maintenance status of the aircraft. However, the records indicated that the required maintenance checks under the company's Approved Aircraft Inspection Program had been conducted at the proper intervals.

Company records indicated that on May 29, 1979, the copilot's airspeed indicator was indicating 0.02 Mach higher than the pilot's; a ground check of the indicators showed both to be reading identically. The cabin altitude test horn was reported inoperative in August 1979; corrective action taken was, "slaved in aural warn control box. No help. Reinstalled plug on original box and system ops check okay." On December 26, 1979, a customer work record stated "Stick puller goes off at Mach .79 on captains a/s indicators." According to the maintenance facility that performed the 1,200-hour inspection on April 20, 1980, the Mach/overspeed warning and stick puller control systems had been tested and no discrepancies were noted. During the same inspection, the right engine oil pressure gage was indicating a below zero pressure and the left aileron cable was reported bad; no corrective actions were recorded. However, a Northeast Jet representative said that the right engine oil pressure discrepancy had been corrected and the left aileron cable had been replaced on May 6, 1980.

The maximum certificated takeoff gross weight of the Learjet 25D is 15,000 pounds and the center of gravity (c.g.) envelope at this weight is 17 to 30 percent mean aerodynamic chord (MAC). The total fuel capacity of N125NE was 6,144 pounds. The addition of 580 gallons of fuel on May 14 would have placed the fuel load on departure at 5,737 pounds.

Postaccident weight and balance computations of the aircraft before takeoff were:

Item	Weight (lbs)	Moment (X1000)
Zero Fuel Weight (Bow)*	8,709	3,256.000
Fuel Load		
wings and tip tanks	4,837	1,865.330
fuselage	900	341.720
Total Ramp Weight	14,446	5,463.050

The c.g. was 21.5 percent MAC.

*Basic operating weight

1.7 Meteorological Information

The 1000 West Palm Beach surface weather was: Scattered--2,000 feet and 30,000 feet; visibility--12 miles; temperature--82° F; dew point--74° F; wind 140° at 9 knots; altimeter--30.07.

Based upon radar observations from the National Weather Service (NWS) radar at Appalachicola, Florida, and photographs from the Geostationary Operational Environmental Satellite (GOES), there was no significant thunderstorm activity over the Gulf of Mexico in the vicinity of Covia Intersection. There was, however, thunderstorm activity to the north over northern Florida, Georgia, and Alabama.

The 0800, 250 millibar (approximately 34,000 feet) map showed a trough extending south through the western plains States into western Texas. The jet stream wind maxima extended north-northeast from northeast Texas through West Virginia. The 0800, 100 millibar (approximately 53,000 feet) map showed a trough with no pronounced jet maxima.

The 0800 winds aloft observed at Bootheville, Louisiana, Appalachicola, and Tampa, Florida, were as follows:

Altitude (feet above sea level)	Direction (degrees true)	Speed (knots)
Bootheville - 42,797	263	69
Appalachicola - 42,988	261	49
Tampa - 43,138	256	9

The maximum vertical wind shears at the approximate altitude of N125NE at Boothville, Appalachicola, and Tampa were 9.2, 14.6, and 6.5 knots per 1,000 feet, respectively. The maximum horizontal wind shear between Appalachicola and Tampa (a line nearly normal to the wind direction) was 37 knots per 150 miles. The parameters used by the NWS for forecasting clear air turbulence based on wind shear include: vertical wind shears exceeding 6 knots per 1,000 feet and/or horizontal wind shears exceeding 18 knots per 150 miles for moderate turbulence, and vertical wind shears exceeding 6 knots per 1,000 feet and horizontal wind shears exceeding 40 knots per 150 miles for severe turbulence.

In addition to the wind shears, a shallow temperature inversion layer, possibly an upper front, was reported at Bootheville, Appalachicola, and Tampa near the flight level of N125NE. Such an inversion layer, or upper front, is often considered an indication of clear air turbulence.

There were no forecasts for clear air turbulence included in the 0900 area forecasts issued by the Forecast Offices at Miami and New Orleans. There were no convective SIGMETS or AIRMETS pertinent to the area of the accident.

The following pilot report was made by N51J at 1230: Location--270° 160 miles from St. Petersburg, Florida; altitude--43,000 feet; type of aircraft--Learjet 24; turbulence--severe clear air turbulence (cat).

1.8 Aids to Navigation

Not applicable.

1.9 Communications

There were no known communication difficulties before the last transmission from N125NE.

1.10 Aerodrome Information

Not applicable.

1.11 Flight Recorders

The aircraft was not equipped with a flight data recorder or a cockpit voice recorder, nor was either required by regulation.

1.12 Wreckage and Impact Information

Recovered aircraft wreckage from N125NE consisted of a 40-inch section of fuselage from the aft pressure bulkhead forward (frames 18 through 22), which contained the baggage compartment; a 1.5- by 3.0-foot piece of cockpit floor structure; a landing gear emergency air bottle; an oxygen bottle; a spare wheel; a ram air duct; the right wing fuel tip tank nose section, from the forward closure bulkhead to the second bulkhead (station 46); the front section of the right engine pylon; and miscellaneous cabin interior items. Examination of the debris was concentrated on the baggage compartment floor structure and fuselage skin, the right engine pylon, and the portion of the right wing fuel tip tank.

- On the left side of the fuselage section, the frames and stringers remained attached to the baggage compartment floor structure. The floor structure was undamaged. The Nos. 5 and 8 wing spar to fuselage attachment fittings were broken. The fasteners of the wing fitting at the No. 7 spar attachment failed in shear, leaving the wing fitting attached to the fuselage fitting.

  On the right side of the fuselage section, the No. 7 wing spar fitting was broken and the remaining portion was connected to the fuselage fitting which was bent rearward. The No. 8 fuselage fitting was broken and bent rearward and outboard. The skin on the right side of the fuselage section was concaved in the open bays between the frames and stringers.

  The air conditioner evaporator and blower assembly, anti-ice tubing, electrical wiring, and conduits were attached to the fuselage top skin. Two diagonal buckles were located below the level of the baggage floor at frame 21 on the left side of the structure and progressed upward and forward to frame 19.

- The housing for the recognition light, located forward of the closure bulkhead of the right wing tank was intact. The light bulb and nose cone fairing were not recovered. All of the fastener holes for the nose cone fairing were elongated in the forward direction. Glass particles remained inside the light bulb retainer ring. The aft bulkhead fastener holes were elongated forward around the top surface and rearward around the bottom surface of the nose section of the tank. The tank was slightly compressed and exhibited a secondary compression buckle in the bottom surface of the tank.

- The forward portion of the right engine pylon, which was separated from its engine and fuselage attachment, included the upper and lower skin, the leading edge air inlet, and the inboard and outboard attachment flanges. All inboard attachments to the fuselage were sheared. All screws common to outboard flange attachment to the engine nacelle were pulled through. The upper skin surface exhibited diagonal buckles between the pylon box structure which indicated downward loading of the pylon.

1.13 Medical and Pathological Information

A review of the flightcrew's flight physical examination records disclosed no history of disqualifying medical problems.

1.14 Fire

There was no evidence of fire damage to the recovered wreckage.

1.15 Survival Aspects

The accident was not survivable.

1.15.1 Wreckage Search

The flightcrew of a Fairchild F27, N172C, on a company flight from Houston, Texas, to Tampa, overheard the Jacksonville ARTCC calling N125NE. N172C was at FL 190. The ARTCC advised the flightcrew that contact with N125NE was lost and asked them if they would attempt to contact the aircraft and search the water en route to Tampa.

The captain of N172C stated that the weather was clear and smooth. He obtained clearance from the ARTCC to descend to 8,000 feet for a closer look and circled a 20-mile area in the vicinity where radar contact with N125NE was lost. The captain spotted white floating debris around an oil slick on the 290° radial, 104.5 miles from Sarasota. At 1249, the aircraft made a low pass and determined that the debris was white styrofoam and what appeared to be an overhead liner and a nose cone portion of a tip tank. The flightcrew of N172C did not see the flightcrew of N125E.

The captain stayed at the scene until a Coast Guard C-130 arrived at 1345. The C-130 flightcrew located the accident site, using a Litton 72 inertial navigation system, and contacted and directed a fishing vessel to the debris.

By the time a Coast Guard helicopter from St. Petersburg arrived on-scene at about 1424, the debris and oil slick had drifted on a heading of 160° true. Except for a section of fuselage, the debris had drifted beyond the oil slick. The helicopter crew reported the weather on-scene as clear with 15 miles visibility, wind--120° at 10 knots, and sea condition--3 feet from 220°.

The fishing vessel recovered the debris and transported it to St. Petersburg.

The Safety Board in coordination with the Gates Learjet Corporation, the Federal Aviation Administration (FAA), and Perry Oceanographics, Inc., of Kiveiera, Florida, participated in a two-phase effort to recover the remainder of the wreckage. The first phase was conducted between May 29 and June 8, 1980, using side scanning sonar and Loran "C" navigation equipment. The sonar returns defined potential crash site locations in the area where the floating debris was recovered and added credibility to the belief that the crash site area had been correctly identified.

The second phase was conducted from June 21 to July 2, and an attempt was made to identify the sonar returns, using underwater video equipment transported by a tethered remote control vehicle. The video search proved negative as all of the sonar returns observed were from dead coral formations and lumps of mud. Further attempts to recover the wreckage were suspended.

1.16 Tests and Research

1.16.1 Aircraft Performance

The two-engine climb schedule for the Learjet Model 25 is based on a climb speed profile of 300 knots indicated airspeed (KIAS) to 24,500 feet, Mach 0.70 indicated (M_I) to 45,000 feet and $0.72M_I$ above FL 450. It is more common to fly the aircraft at 270 KIAS until reaching $0.70M_I$ (about 30,000 feet.) At a start climb weight of 14,000 pounds, the climb schedule chart[1] shows that the aircraft was not climb limited to FL 430 at standard atmospheric conditions (ISA). The temperature was about 10° warmer (ISA + 10°) than standard from FL 360 to FL 400, but from FL 410 to FL 430, the temperature was about standard. The amount of fuel used for taxi, takeoff, and to the top of the climb was about 1,200 pounds, an amount that would normally be burned from the tip tanks before a fuel transfer from the fuselage tank would be accomplished. At this point, the aircraft's weight would have been 13,246 pounds with a c.g. of about the 20.2 percent MAC.

The following airspeed limits and turbulent air penetration procedures were extracted from the Learjet 25D and 25F aircraft flight manual (AFM):

	Limitations KIAS	Limitations KCAS
MAXIMUM OPERATING SPEED V_{MO}/M_{MO}		
These speeds shall not be deliberately	V_{MO} S.L. to 14,000 feet	
exceeded in any flight condition except	306	300
where specifically authorized for flight	V_{MO} above 14,000 feet	
test or pilot training operations or in	359	350
approved emergency procedures. If	M_{MO} .82 M_I	.81M
*V_{MO} or M_{MO} is inadvertently exceeded.	AFC/SS Inoperative	
1. Thrust Lever - Idle	0.78 M_I	0.77M
2. Rotate nose up not to exceed 1.5 g's		
3. Level wings if required		

NOTE: No aerodynamic changes are apparent at either V_{MO} or M_{MO} and the aircraft will respond normally to control movements.
*Means maximum operating limit speed.

TURBULENT AIR PENETRATION

Flight through severe turbulence should be avoided if possible. When flying at 30,000 feet or higher, it is not advisable to avoid a turbulent area by climbing over it unless it is obvious that it can be overflown well in the clear. For turbulence of the same intensity, greater buffet margins are achieved by flying the recommended speeds at reduced altitudes.

A. AFC/SS - If severe turbulence is penetrated with the AFC/SS on, the altitude hold mode should be off. With AFC/SS off, yaw damper should be engaged. Remember, controllability of the aircraft in turbulence becomes more difficult with the yaw damper off. Rudder should be centered before engaging yaw damper.

B. Airspeed - Approximately 255 KIAS. Severe turbulence will cause large and often rapid variations in indicated airspeed. DO NOT CHASE THE AIRSPEED.

C. Attitude - Maintain wings level and the desired pitch attitude. Use attitude indicator as the primary instrument. In extreme drafts, large altitude changes may occur. DO NOT USE SUDDEN LARGE CONTROL MOVEMENTS.

D. Stabilizer - Maintain control of the airplane with the elevators. After establishing the trim setting for penetration speed, DO NOT CHANGE STABILIZER TRIM.

E. Altitude - Allow altitude to vary. Large altitude variations are possible in severe turbulence. Sacrifice altitude in order to maintain the desired attitude and airspeed. DO NOT CHASE ALTIMETER.

F. Thrust - Engine ignition should be set to ON (refer to IGNITION SYSTEM OPERATION, this Section). Make an initial thrust setting for the target airspeed. CHANGE THRUST ONLY IN CASE OF EXTREME AIRSPEED VARIATION.

Buffet Boundaries--All aircraft in high speed flight are subject to airframe buffet caused by shock wave induced airflow separations from the aircraft's lifting surfaces. The formation of a shock wave begins as the local airflow over the wing airfoil shape reaches sonic speed. The onset of high speed buffet is influenced by the speed of the aircraft and sudden changes in its angle of attack. Usually, airframe buffet also occurs at low speeds when high angles of attack (stall) are approached because of separation of the airflow from the airfoil surfaces. The difference between the high airspeed which produces Mach buffet and the low airspeed which produces stall buffet decreases as altitude increases. At very high altitudes, the difference is substantially reduced in subsonic aircraft. Since Mach buffet and stall buffet are also dependent on the load factors produced by the wing, the aircraft's maneuverability margins at high altitudes are correspondingly reduced. The Learjet does not possess sufficient inherent prestall buffet characteristics at low speeds to provide a pilot with a clear warning that the aircraft is stalled before it enters a flight condition from which a normal recovery can not be accomplished. 3/ Therefore, the aircraft was equipped with a stall warning stickshaker/pusher system to artificially provide the needed stall warning.

According to the AFM, the low speed buffet boundary for an aircraft with a gross weight of 13,000 pounds, at FL 430, and 1.5g's is 192 KIAS (.71M_I). The AFM does not depict the high speed buffet boundary. According to Gates Learjet, however, at 12,500 pounds and in 1-g flight, the buffet free Mach number range for the accident aircraft would have been from 0.57M_I (155 KIAS) to beyond red line of 0.82M_I (233 KIAS). "Beyond the red line, and beginning with a barely perceptible airframe buffet at about .82M, the buffet and aileron activity increase with increasing Mach No. to .86M, which is as fast as has been tested."

3/ FAA special condition CAR 3.120.

Radar Information--ARTCC recorded radar information for N125E was available from the Jacksonville Center, the Miami Center, and the Cross City radar facility north of Tampa. The radar points from the three radars were averaged into one probable ground track. (See appendix D.)

Calculations of the aircraft's performance were made based on the radar data, aircraft specifications, and meteorological data. The calculations included the period between the latter part of the climb to FL 430 and the time of the last altitude encoded radar return from the Jacksonville radar. Because of data tolerances, the Safety Board could not conclude that the aircraft was performing precisely as calculated at each point in time that the calculations were made. The general range and trend of these calculations, however, are representative of the aircraft's performance during the period of the flight examined.

The radar data showed that the aircraft was cruising on assigned altitude and on course within a minute before radar information was lost. The radar information also showed that the aircraft's track turned to the right nearly 90° and the aircraft began a descent during the final minute of information. During this turn, altitude information was lost from all three radars. However, the ground position coordinates, which continued to be recorded, showed that the aircraft's ground track made a final turn of about 90° to the left.

Once an aircraft exceeds a rate of descent of 20,000 feet per minute, the radar computer no longer displays the altitude information from the aircraft's transponder, and when this happens, a specific code is recorded in the computer memory. If the altitude information from the aircraft's transponder is not received by the radar, then a different code is recorded in the computer memory. A readout of the recorded radar information from the accident aircraft showed that the altitude information was lost because it was not being received by the ground radar, and not because the aircraft had exceeded the 20,000 feet per minute rate of descent parameter. A special flight check of the primary radar coverage in the vicinity of the Covia Intersection showed satisfactory coverage from FL 430 to a minimum altitude of FL 190.

N125NE climbed to its cruising altitude of FL 430 between 220 and 250 KIAS, or between 0.75 and 0.82 Mach (M_I). Between 1157:41 and 1202:41, the altitude was stabilized at FL 431 and the average speed was Mach 0.77. During the next 48 seconds, between 1202:41 and 1203:29, the aircraft's altitude and vertical speed deviations were within tolerances. At 1203:46, Jacksonville radar showed the aircraft had lost 300 feet which resulted in a rate of descent of 1,500 feet per minute. At 1203:45, Cross City radar showed the aircraft had lost 800 feet which computed to about 4,000 feet per minute. No further altitude information was received by Jacksonville nor Cross City. Between 1203:29 and 1204:14, the aircraft made a right turn of nearly 90° followed by a left turn of about 90° in 7 seconds. Radar information was lost 8 seconds later at 1204:29.

Learjet N51J departed West Palm Beach 16.5 minutes after N125NE and flew the same flight route in the same direction. N51J's route of flight was displaced about 12 miles south of N125NE's route of flight. Also, the NASA T-38 flew on the same airway in the opposite direction as N125NE and overflew the vicinity of the accident site about 18.5 minutes after Jacksonville Center received the last radar return from N125NE. Learjet N51J was cruising at FL 430 "well before Covia Intersection" according to the pilot.

The NASA T-38 was first recorded on radar, climbing from FL 430 to 450, about 120 miles west of the vicinity of the accident. According to the pilots, the NASA T-38 was cruising at Mach 0.89 and the Learjet was cruising at 0.77, indicating 210 to

220 knots with TAS of 440 knots, with an indicated outside air temperature of -39° C (-28° F). The calculated ram temperature rise at Mach 0.77 and -39° C indicated is about 20.5° C. This would give an outside air temperature of -59.5° C.

1.16.2 ATC Tape of Communications

An ATC tape of communications with N125NE was examined in the Safety Board's audio laboratory. The FAA ATC transcript was expanded in the area of the occurrence. (See appendix E.) Reception was marginal because of the distance between N125NE and the receiving station. If N125NE had been maneuvering, it is possible for the reception to have been intermittent even though the transmitter remained keyed. The unusual, very low volume signals, which were heard following the cessation of the last decipherable transmission at 1204:27, may have been bleed-through through the receiver transistor controlling the squelch circuitry. The possibility that the low volume signals were coming from N125NE is supported by the fact that the normal transmitter ON/OFF signature was absent from the transmission, which suggests that the aircraft's transmitter remained ON. The receiver squelch circuitry could have been responsible for the low amplitude signals. The low signals were weak voices; however, the words could not be deciphered.

The "staccatto sound" (similar to the stall warning signal as noted in the transcript) had a frequency of 18 to 19 heavy beats per second. In some cases, the heavy beat was followed by a light beat about 20 milliseconds later. In general, the individual staccatto beats took a finite time (approximately 16 milliseconds) to build to a maximum and then drop off. The signal level between the beats did not drop to the normal quiescent (no signal) voltage level but remained up at some value until the beginning of the next cycle, which indicated that the carrier was continuing or that the receiver squelch was keeping the ATC receiver on.

1.16.3 Aileron Buffet

The Gates Learjet Corporation investigated the staccato-type sound by comparing the frequency of primary flight control vibration with the frequency of the unusual sound. The natural frequency of the ailerons is 11.5 Hz. The same frequency was picked up when the vibration was recorded in the cockpit. When the sound was recorded through the radio in the cockpit, a frequency of 19 Hz was identified. The vibration of the stickshaker was also recorded. It revealed a frequency of 30 Hz without the radio and 31 Hz with the use of the radio as a medium. Based on the results of the tests, the manufacturer was not able to reach any conclusions about the source of the staccato sounds heard on the tape.

1.17 Additional Information

1.17.1 Automatic Flight Control Stability System (AFC/SS)

The AFC/SS primarily consists of the autopilot pitch axis which includes a force sensor in combination with a control stick puller and an aural overspeed Mach warning horn. Longitudinal stability of the aircraft is dependent on operation of the autopilot pitch axis when operating beyond Mach 0.78 (M_I); when the autopilot is not in use, speed is restricted to 0.78 M_I. When this limit is reached, a sensing switch in the copilot's pitot static system energizes the 0.78 M_I speed warning.

The force sensor will signal the autopilot computer to disengaged the autopilot pitch trim once the pilot overrides the elevator with a force in excess of 6 to 8 pounds. The force sensor also disconnects any autopilot modes selected, such as heading, altitude, or speed, and causes the autopilot to operate in the basic altitude hold mode. Once the control column pressure is decreased, the autopilot will maintain the existing pitch attitude and will roll the wings level.

The control stick puller is incorporated into the flight control system to automatically prevent the aircraft from exceeding M_{mo}. The puller is powered or armed by the left stall warning switch. When the aircraft reaches Mach 0.82 (M_I), another sensing switch will sound the Mach warning horn and feed a nose-up signal to the autopilot elevator servo clutch. This will cause the aircraft to climb until the overspeed condition is corrected. The stick puller exerts a force of 18 pounds. It is an M_{mo} function only and will not work below 30,000 feet. The aircraft is not to be flown beyond 0.74 M_I if the puller is inoperative.

1.17.2 Stall Warning Stickshaker/ Pusher System

Because of the stall characteristics of the Learjet, an artifical stall warning system incorporating a stickshaker and stickpusher was installed to provide a prestall warning to prevent an abrupt wing rolloff. The system includes a stall vane on each side of the nose of the aircraft, two angle of attack indicators, two stall warning lights, and a computer. In flight, the stall vanes align with the local direction of the airstream. As the angle of attack of the aircraft changes, the realigned vanes signal the computer and the corresponding angle of attack is depicted on the cockpit indicators. As the critical angle of attack is approached at a point near the stall, 1.07 V_s, the computer actuates the stickshaker which induces a mild vibration of the control column while causing 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 clutch) and forces the control wheel forward with a force of 60 to 80 pounds. This applied force diminishes as the angle of attack decreases and can be overridden by the pilot. 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. 4/ Any signals from the autopilot are cancelled when the pusher activates. The computer also modulates the signals to compensate for various wing flap positions. In conjunction with an altitude pressure switch, the angle of attack for the shaker/pusher operation is reduced above altitudes of about 22,500 feet. This causes the system to operate at a higher speed than it does at lower altitudes. This feature is incorporated in only the models 24 E/R, 25 D/F, and all Century III modified airplanes.

The Century III modification incorporated an electronic computer circuit in the stall warning system. The circuit, identified as the alpha dot system, uses the rate of change of the angle of attack sensor vane to automatically raise the stall warning stickshaker/pusher speeds to compensate for accelerated entry to the stall. The circuit permits the stickpusher activation speed to be set within 1 knot of the unaccelerated stall speed/wing rolloff. Theoretically, the computer raises the stickshaker/pusher speeds at about the same rate that the stall speed increases under accelerated stall conditions. During an FAA special investigation of the Learjet, in cooperation with the Safety Board's study of modified Learjets, 5/ it was determined that the 1-knot speed margin between

4/ FAA Order 8110.6, Review Case No. 38
5/ "Study of Selected Performance Characteristics of Modified Learjet Aircraft," February 1979.

activation and aerodynamic stall was inadequate. This condition was corrected by Airworthiness Directive (AD) 79-12-05, dated June 18, 1979, which increased the pusher margin to about 3 knots and increased the AFM stall and landing approach speeds. However, with the development of the Softflite modification, the aircraft rolloff characteristics at the stall were enhanced significantly and permitted resetting of the stickpusher operation within 1 to 2 knots of the stall speed.

1.17.3 Wheel Master Button

The wheel master button is located below the four-way trim switch on the left side of the pilot's control wheel. (See figure 1.) In the Learjet model 25D, when depressed, it will, among other features, disconnect the autopilot and yaw damper, and interrupt any primary pitch trim.

The yaw damper system is designed to prevent a coupled lateral-directional oscillation which is commonly referred to as a "dutch roll." Without the yaw damper operating, "dutch roll" can occur in the Learjet at altitude and high Mach number but is most severe in the landing configuration.

1.17.4 Overspeed Warning Horn Cut-out Switch

N125NE was equipped with an overspeed warning horn cut-out switch, an unauthorized modification. (See figure 2.) The Northeast Jet Company reported the existence of the switch when a similiar one was located under the pilot's instrument panel in the company's other Learjet 25D, N911MG.

An operational ground check of the switch installation in N911MG using battery power disclosed that when the switch was activated the maximum operating speed V_{mo}/M_{mo}, cabin altitude, and landing gear warning horn was inhibited. The stall warning, stick shaker/pusher system, and stickpuller were not affected because the switch was installed between the aural warning control box output and the horn. With the switch in the normal position (ON), signals from the aural warning control box would activate the horn. In the OFF position, the horn was inhibited.

An aneroid type pressure switch is installed in the copilot's pitot-static system to activate the overspeed warning horn if the 306-KIAS limit is exceeded between sea level and 14,000 feet. The speed restriction was imposed because of the windshield bird strike criteria of 14 CFR 25.775. 6/ The Learjet Model 23, the first model produced, was certificated on May 15, 1956, in accordance with Part 3 of the Civil Air Regulations; windshield bird strike criteria were not required. As a result, the Learjet 23 was approved to cruise up to its maximum operating speed of 358 KIAS between sea level and FL 239 without a structural speed restriction. Later Learjet models were certificated in accordance with FAR Part 25 and were required to meet the windshield bird strike criteria. A redesigned windshield was able to withstand the impact of a 4-pound bird at 300 knots. The Learjet models 24 through 24E were limited to 306 KIAS between sea level and FL 310 and the Learjet model 24F and later models were restricted to 306 KIAS until passing 14,000 feet, and to 359 KIAS above 14,000 feet. This procedure was consistent with an earlier FAA decision involving the certification of another type of turbojet.

6/ The windshield panes and supporting structure directly in front of the pilots must withstand, without penetration, the impact of a 4-pound bird when the velocity of the aircraft (relative to the bird along the aircraft's flightpath) is equal to the value of its cruise velocity at sea level.

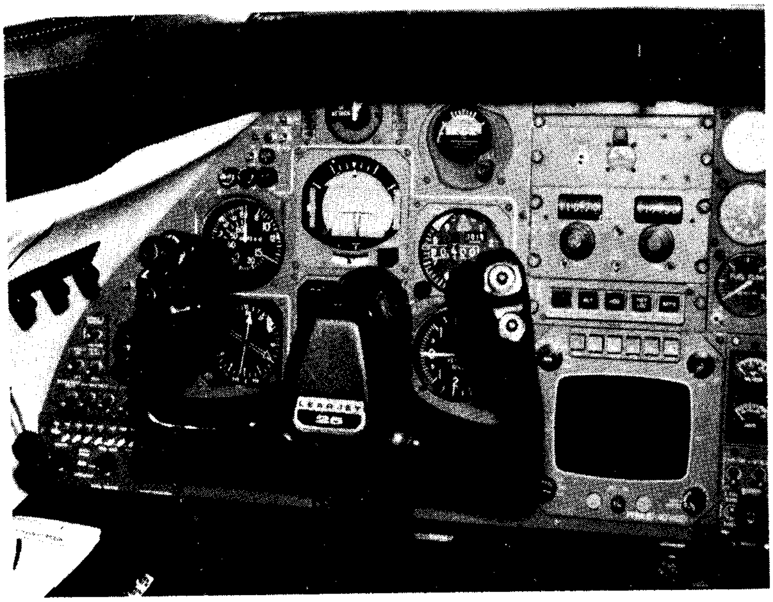


Figure 1.--Wheel master button on pilot's control wheel. The microphone switch is located on the front side of the wheel, opposite the wheel master button.

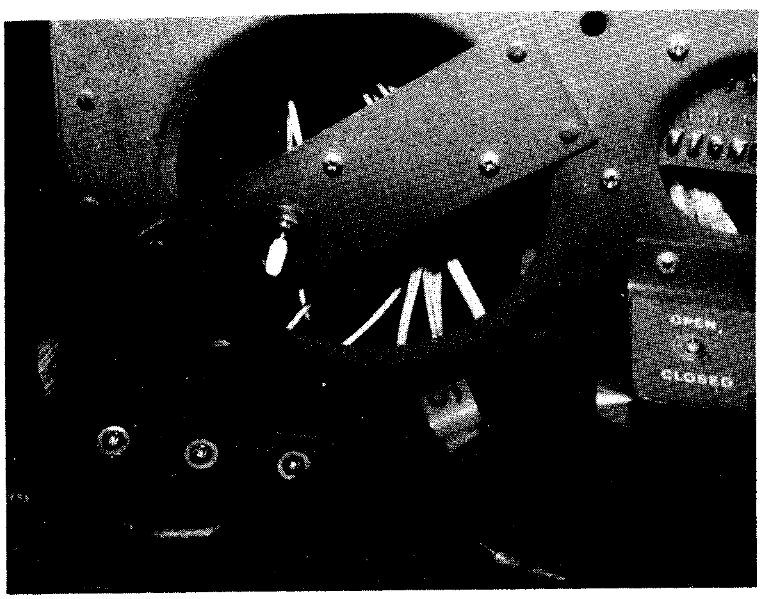


Figure 2.--The unauthorized overspeed warning horn cut-out switch is identified within the circle.

Shortly after the accident, the FAA issued a general notice alerting its field offices of the unauthorized switch installation. A special airworthiness alert was issued later which alerted all air carrier and general aviation operators of the unauthorized switch installation. The FAA expressed concern that all flightcrews and operators might not be aware of the existence of such a switch and that operators should have their aircraft inspected and have the switch removed, if installed.

Northeast Jet Company did not disclose its reason for installing the overspeed warning cut-out switch.

1.17.5 Gates Learjet Service News Letter

Gates Learjet Service News Letter 49, dated May 1980, and issued immediately after the accident, 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 states, in part:

> 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.
>
> **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.

Certification flight tests of the aircraft's high speed flight characteristics were conducted to determine compliance with the criteria set forth in FAR Part 25.253 (February 1, 1965). In accordance with Advisory Circular (AC) 25.253-1, dated November 24, 1965, on high speed flight characteristic testing, as a means of compliance, only a 1.5 g recovery procedure is used.

1.17.6 Special Certification Review of the Learjet

As a result of several other Learjet accidents (see appendix F), the FAA undertook a special certification review (SCR) of the Learjet which addressed primarily several items suspected of being potential factors in the accidents. The following extracts of three 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 approval 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 apparent 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. 7/

1) High Speed Characteristics

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

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

c. Gates Learjet states in the Model 25 Type Inspection Report (TIR) that if a FAR 25.1505 8/ upset occurs at M_{MO}, the aircraft will exceed M_{DF}. This characteristic is the reason for the stick puller. If the puller is inoperative, M_{MO} is limited to 0.74 Indicated Mach Number.

7/ As a result of the preliminary findings, the FAA issued AD 80-16-06 on August 4, 1980, which was superseded by AD 80-19-11 on September 4, 1980. (See appendix G.)

8/ 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.

d. 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.

e. 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.

f. 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}.

g. During STC approvals on three different aircraft (one Model 25D and two Model 35s), 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.

h. Lear 25 TIR data shows that the speed increase after an upset was less 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 column, 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), 9/ 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 can 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 inoperative. 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.

2) Pitch Trim System

a. The control wheel primary pitch trim interrupt switch installed on the control wheel of all 30 series and Century III 20 series Learjets is not a quick-disconnect switch as inferred in almost all Learjet TIRs and design documents. The pitch trim interrupt switch must be held until the pitch trim selector/disengage switch is turned off. None of the control wheel switches, with the exception of pitch trim and lateral trim, are labeled as to their function. Because of these differences from model to model, different emergency procedures are applicable. In the event of an actual pitch axis malfunction, the pilot cannot always immediately determine the cause of the malfunctions since it could be caused by any of the following: stick pusher, stick puller, autopilot, secondary pitch trim or primary pitch trim. In addition, no single action by the pilot can immediately

9/ FAA Notice of September 22, 1972 concerning trim malfunctions.

eliminate all pitch axis faults. In order to totally isolate all potential pitch axis faults, the pitch trim selector must be turned off, the autopilot turned off, both stall warnings turned off, and the AFCS pitch circuit breaker pulled.

3) Autopilot AFC/SS Characteristics

a. On the 45,000 foot Model 24E/F and 25D/F autopilot malfunctions were conducted at low altitudes only with maximum specification torques on all axes. Autopilot performance was demonstrated at low altitudes only with minimum servo torques. No autopilot pitch trim runaways were conducted.

b. On the 51,000 foot Model 24E/F and 25D/F autopilot functional tests were conducted at 51,000 ft utilizing minimum specification torques on all axes. Malfunction tests were not conducted, but instead were "rationalized" from data obtained at 41,000 to 45,000 ft on various straight wing models of the 24, 25, and 36.

c. FAA Review Case No. 57 (dated September 16, 1965) on the DC-8, on which the Learjet 24/25 AFC/SS (Mach trim) system was patterned, required the following specific items to be added to the existing DC-8 autopilot before it could be used as a stability device:

- o Aural warning upon any autopilot disconnect in the clean configuration.
- o Adding the autopilot disconnect light to the master warning light.
- o Restriction of the airplane nose-down pitch command authority of the autopilot to approximately 10° (degrees).
- o Addition of a stabilizer-in-motion aural warning.

The items in subparagraph c were not required on the Learjet AFC/SS.

d. The Mach trim function of the FC-110 AFC/SS as originally evaluated on the Model 24, required a stick force-disengage function on the pitch axis to "preclude any out-of-trim problems." During required collision avoidance maneuvers, the Mach trim function was automatically disengaged with 6 lb. stick force. This force disengage function is included on all Model 24 and 25 AFC/SS systems. The function was, however, deleted on the Model 35/36 and 28/29 models where an independent Mach trim unit is provided.

2. ANALYSIS

2.1 The Flightcrew

The flightcrew was certificated and qualified to operate the aircraft. The pilot, an experienced Learjet captain, occupied the right seat. The copilot, who occupied the left seat, was not rated in the Learjet and had limited flight time in this aircraft. It is believed that the copilot was flying the aircraft when a loss of control occurred. There was no evidence of previous medical problems of either pilot which would have had an effect on the accident.

2.2 Aircraft Airworthiness

The unavailability of the entire wreckage and most of the maintenance records for examination precluded the Safety Board from making a total assessment of the aircraft's airworthiness at the time of the accident. According to Northeast Jet, the previous discrepancy concerning the right engine oil pressure had been corrected. The December 26, 1979, remark, "stick puller goes off at Mach .79 on captain's a/s indicators," infers that the indicator was faulty because the Mach overspeed warning and stick puller system operates from the sensing switch (Mach switch) in the copilot's pitot-static system. The inference is somewhat supported by the May 29, 1979, remark that the copilot's indicator was believed more accurate than the pilot's, which read 0.02 Mach lower. The difference between the indicators was within tolerance; however, the pilot's indicator would have been 0.01 Mach out of tolerance with respect to the actuation of the stick puller if it operated at the prescribed speed of $0.82M_I$. Assuming the existence of a 0.02 Mach difference between indicators, the copilot's indicator would have been reading $0.81M_I$ when the puller activated, and this indication was also within tolerance. The Safety Board could not conclude with certainty, however, that the copilot's Mach indicator was accurate based entirely on the actuation of the puller because it was not known if the Mach switch setting was within tolerances. Erroneously low airspeed indications could have been a critical factor in the accident because the aircraft would have been nearer its Mach buffet boundary and would have had less margin for maneuvering. The low airspeed indications were noted as an item of concern in the SCR interim report.

The inoperative cabin altitude test horn reported in August 1979 may have been due, in part, to the installation of the overspeed warning cut-out switch. However, the Safety Board was not able to verify that possibility.

According to Northeast Jet, the left aileron cable had been replaced 13 days before the accident. Proper maintenance of the aileron system is a critical item in the Learjet because, as noted in the SCR interim report, control system friction is a major factor in damping initial Mach buffeting of the control surfaces.

Because the Learjet has characteristics which could lead to critical control problems in the high Mach regime of flight and which might not be recognized by the inadequately trained or unwary pilot, complex compensating features were incorporated into the flight control system to comply with current Federal aviation regulations and to provide an appropriate level of safety. In view of the integral nature of the compensating features in the aircraft, an unauthorized modification, such as an overspeed warning horn cut-out switch, could be detrimental to safety. The switch also would have inhibited the cabin altitude and landing gear warning horns. This unauthorized modification, therefore, could have insidious consequences. In some earlier Model 24 Learjets, pilots were required, according to AFM limitations, to maintain 306 KIAS between 10,000 feet and FL 310, and in some later Model 24 Learjets, pilots were required to slow to 306 KIAS at

14,000 feet during a descent to avoid actuation of the overspeed warning horn. The Learjet Model 25D was exempt from the 306 KIAS speed restriction above 14,000 feet, but the use of the cut-out switch would have permitted abuse of the speed restriction below 14,000 feet, during climbouts and descents, without activation of overspeed warning horn. Because the overspeed warning also provides a vital safety function at high Mach numbers, the Safety Board concludes that installation and use of the cut-out switch made the accident aircraft unairworthy.

A preflight test of the other Northeast Jet Company Learjet disclosed that the cut-out switch did not affect the operation of the stick puller system. Based on the test and statements made by company personnel, the Safety Board concludes that the cut-out switch also would not have affected the operation of the stick puller in N125NE.

2.3 Loss of Control

Recorded comments of the flightcrew on the ATC tape indicated that control of the aircraft was lost shortly after it was leveled at FL 430. The limited portions of the recovered wreckage prevented determining whether the aircraft was intact when it struck the water. Although no firm conclusions could be made regarding the aircraft's attitude at impact, the nature of the damage suggested that the impact was severe. The separations of the wing attachment fittings indicated that the right wing rotated aft and the left wing rotated forward at breakup. The top crown skin and the sidewall skin attached to the baggage floor were concaved which suggested that the aircraft struck the water inverted. However, diagonal buckles on the left side wall skin which extended from below the baggage floor at frame 21 to near the top of frame 19, suggested that the aircraft may have struck the water with empennage first, in an upright, nose-high attitude. The elongation of the right wing tip tank nose section fastener holes indicated that it separated in an upward direction.

Since the complete wreckage was not available for examination, the Safety Board considered several possibilities which could have caused the loss of control of the aircraft, based on the knowledge gained from previous Learjet investigations, the FAA's SCR interim report, ATC radar and tape of communications, meteorological data, and information from other pilots who were in the vicinity when the accident occurred. The Safety Board identified the following areas for evaluation:

- Flight characteristics
- Flight control system and compensating features
- Engine performance
- Turbulence
- Pilots' actions

Flight Characteristics.--The flight characteristics which most probably contributed to the accident were the speed instability due to "Mach Tuck"; the minimal speed margin between M_{MO} and M_{DF}, resulting in the requirement for a stick puller; the high nosedown pitching moment with spoiler extension at high speed; the aileron "buzz/snatch" phenomenon which occurs slightly above M_{MO} and which is aggravated with increased speed and load factor; and the decreased elevator effectiveness due to shock wave formation at Mach numbers beyond M_{DF}.

Flight Control System and Compensating Features.--With regard to the flight control system, control difficulty was considered because of the malfunction history of the electromagnetic clutches. However, because the accident aircraft was equipped with improved d.c. torquer clutches, the Safety Board concludes that a malfunction in this unit was not likely.

The possibility of a transistor failure in the autopilot computer which could have caused a trim runaway in either the noseup or nosedown direction and flight control difficulty was considered because it is not known whether the aircraft was equipped with the Delco or non-Delco germanium transistors. According to Gates Learjet, Delco transistors are more resistant to thermal runaway failures than germanium transistors built by other manufacturers; also, the transistors on the accident aircraft were likely to have been non-Delco. Their reliability, therefore, is questionable. However, in consideration of a transistor failure, a failure could cause a runaway trim in either the noseup or nosedown direction. The control wheel pressure needed to compensate for runaway trim condition could have been low or high (10 to 80 pounds) depending on when the pitch trim monitor may have disconnected the autopilot. The Safety Board cannot rule out the possibility of a failure or malfunction of an autopilot computer transistor; however, when considered with all the available evidence, we believe that a failure or malfunction of a transitor was not likely.

Engine Performance.--Engine flameout leading to a loss of control was also reviewed. The service history disclosed that engine flameout primarily concerned the CJ610-6 engine and not the -8A engine which has an improved compressor stall margin. Also, there was no evidence on the ATC tape indicating that the flightcrew was confronted with an engine power loss, and loss of thrust would not have caused or necessarily have contributed to either a low speed or high speed loss of control situation. Therefore, the Safety Board concludes that it is not likely that an engine flameout caused the loss of control.

Turbulence.--The Safety Board's examination of the weather conditions showed no active thunderstorms in the immediate vicinity where the aircraft departed its flight level. The wind in the vicinity would have been from 270° at 50 knots ($\pm$10° and 5 knots), and the temperature would have been -59° C ($\pm$2°). This temperature corresponds almost exactly with the corrected ram air temperature reported by the crew of N51J. Based on the soundings which indicated the existence of a shallow temperature inversion layer, an upper front was present. Such a frontal system is known to be conducive to the formation of clear air turbulence. Since the NWS defines a horizontal wind shear of 40 knots over 150 miles as a severe clear air turbulence condition, the Safety Board concludes that moderate to severe clear air turbulence existed at FL 430 in the vicinity of the Covia Intersection when the accident aircraft entered the area.

The pilot's report from Learjet N51J, minutes after the accident, and his subsequent statements further confirm the existence of clear air turbulence. The Safety Board believes that the accident aircraft encountered essentially the same phenomenon as described by the pilot of N51J, and we conclude that this phenomenon initiated the accident sequence of events. Furthermore, the flight characteristics of the aircraft, and the actions of the crew in response to the encounter led to the loss of control from which the flightcrew was not able to recover.

An adequate range usually exists at all altitudes and weight conditions between the onset of high speed buffet and low speed buffet, or the speed at which the stickshaker would activate in 1-g flight. Increased load factors caused by manuevering, such as pull-ups or level banked turns, however, reduce the buffet-free speed range. The aircraft's operational envelope, therefore, becomes restricted under conditions of high altitude flight because of the buffet boundary limitations. This narrow area of operation is commonly referred to as "coffin corner." For these reasons, the buffet boundaries of an aircraft become extremely important to a pilot since they dictate the limiting margins within which the aircraft can be operated safely. A sharp, unexpected turbulence encounter can easily cause an aircraft to exceed these margins.

Since the aircraft was operating in a relatively narrow area of its flight envelope, the Safety Board considered the possibilities of a loss of control from transient conditions which might have placed the aircraft either below its low speed buffet boundary or above its high speed buffet boundary. The aircraft's 1-g low speed buffet boundary was $0.57 M_I$ and its 1-g high speed boundary was about $0.82 M_I$, a 0.25 M_I margin equating to about 78 knots. A load factor increase of about 1.5 g's would have reduced the margin to between 30 and 40 knots. However, an adequate margin appears to have existed.

Pilots' Actions.--According to the ATC tape of communications, the first indication of difficulty began at 1203:40.1 (appendix E) with a short burst of static associated with a keyed microphone. The sound came from the accident aircraft since it compared with the transmitter key's signature from previous transmissions. Also, according to the probable radar ground track plot, the first sign of significant flightpath deviation occurred about 1203:41, coincident with the keyed microphone sound, when the aircraft began turning to the right and descending from FL 431.

Eight seconds after the burst of static, the calculated speed of the aircraft was Mach 0.81, a 0.04 Mach increase over that which the aircraft had been averaging about 4 seconds earlier. At 1203:56.7 (appendix E), the unusual staccato sound occurred. The Safety Board believes that the staccato sound was transmitted when the copilot keyed the microphone inadvertently because of his firm grip on the control wheel. It was noted that the signal level between the low frequency beats did not drop to the normal quiescent voltage level, but remained at the same value until the next frequency cycle began. The evidence supports the contention that the copilot had keyed the microphone continuously which resulted in the inadvertent transmissions. Immediately after the cessation of the staccato sound, at 1204:00.7, the pilot stated, "put-out the spoilers." His statement sounded weak, as if it was in the background, possibly due to his statements being amplified through the copilot's headset microphone. At 1204:13.3, 12.6 seconds later, the copilot stated, "Can't get it up . . . its in a spin." Four seconds later, the aircraft made about a 90° deviation to the left in its ground track.

Based on information from the closest radar site, Cross City, the aircraft's calculated rate of descent at 1203:46 was about 4,000 feet per minute. The evidence indicates that the aircraft began to descend rapidly, and its speed began to increase shortly (8 to 10 seconds) before the first staccato sounds were recorded. The high rate of descent is further supported by the radar returns which were progressively closer together during the final 30 seconds of radar contact. The returns support a conclusion that the aircraft was diving at high speed and at a progressively steeper angle. The speed of the aircraft and the short radius of the 90° left deviation in its ground track indicates that the aircraft could not have made either a steady coordinated turn or a turn resulting from a loss of control from its low speed buffet boundary to arrive at the location of the last radar return at 1204:29. Therefore, the Safety Board concludes that the weight of evidence indicates that the aircraft made a high speed descent from FL 431.

The Safety Board's evaluation of the staccato sound disclosed a heavy beat frequency of 18 to 19 Hz. Extensive tests by the aircraft manufacturer also showed that ground vibrations of the ailerons at their natural frequency produced a frequency of 19 Hz when recorded through the radio in the cockpit. The vibrations produced by aileron buffet could be felt throughout the entire aircraft. Recording of the stickshaker with or without the use of the aircraft radio as a medium, produced essentially the same frequencies, but the shaker vibration cannot be felt throughout the aircraft. Therefore, the Safety Board concludes that the staccato sound probably was associated with aileron buffeting at high Mach numbers and that this buffeting was transmitted through the airframe and through the open radio transmitter which resulted in the recorded frequency of 18 to 19 Hz, rather than the natural frequency of 11 Hz.

Because the flightcrew was not alerted to the possibility of encountering clear air turbulence in the weather briefing, the altitude hold mode of the autopilot was probably engaged when the aircraft penetrated the turbulence near the Covia Intersection. According to the AFM, the flightcrew should have had this feature disengaged during penetration of known turbulence to prevent the possibility of a mistrim condition.

In a sudden upset, a pilot would reactively grab the control wheel in an attempt to maintain control of the aircraft. Under these circumstances, it would have been easy for the copilot to inadvertently key the microphone. Further, with the copilot holding the control wheel, the turbulence could have caused the force sensor to disconnect the altitude and heading hold functions of the autopilot, or he could have easily disengaged the pitch trim function with 6 to 8 pounds of force applied to the control column. Either type of disengagement would not have been readily apparent to the flightcrew because there are no associated artifical warnings. As a result, the copilot could have been confronted with a mistrim condition and a need to exert a significant amount of pull force to maintain level flight because of the possible nosedown trim the autopilot may have used to counteract the increased airspeed caused by the turbulence. The necessary pull force would have continued to increase with an increase in speed because of the "Mach Tuck" tendency. Additionally, since the wheel master button was inside the copilot's left hand grip, opposite the microphone switch, it is probable that he could have accidentally disengaged the autopilot and yaw damper. The absence of these critical items under these conditions would have significantly contributed to the copilot's difficulty in controlling the aircraft.

The lack of the Mach overspeed warning sound on the ATC tape probably indicates that the warning horn was disabled because of the cut-out switch. Not until 20.4 seconds after the burst of static is there recorded evidence that the flightcrew took action to correct the overspeed condition when the pilot gave the command to use the spoilers. However, his statement was made 12 seconds after the aircraft had already reached $0.81M_I$. Considering the computed rate of the aircraft's speed increase, the aircraft probably had substantially exceeded M_{MO} before the spoilers were extended. Consequently, extension of the spoilers would have further aggravated the situation by significantly increasing the pull force needed to restore the aircraft to level flight.

The stick puller should have functioned once the overspeed occurred. However, since it exerts a relatively light force of 18 pounds against the control column, its operation could have been easily overcome and could have gone unrecognized by the flightcrew, particularly if the copilot had abruptly pushed forward on the control wheel in response to any pitchup caused by the turbulence. The lack of an overspeed warning system would have contributed to such a reaction and to the flightcrew's failure to recognize that the stick puller was functioning.

It is not known whether the crew was aware that the cut-out switch was on. According to the company, the pilot was aware of the switch installation, and its position before the flight could have been determined by following the preflight checklist. Therefore, since it would not have been easy to inadvertently move the switch to the ON position, because of its position underneath the instrument panel, it is believed that the crew should have been aware of the position of the switch. Nevertheless, the turbulence encounter was sudden and unexpected, and the Mach warning would have been essential in alerting the crew to the overspeed condition before the overspeed limit was substantially exceeded.

Since the aircraft's reactions would have appeared very similar in either a turbulence encounter or a control malfunction occurrence, the upset could have been perceived as a control malfunction. The pilot's statement at 1204:23.6, (appendix E) "pull the circuit breaker," supports this possibility. It is believed that the pilot was referring to the AFC/SS circuit breaker which must be pulled to insure that all pitch trim operation is stopped-- a prescribed emergency procedure. This possible inaccurate perception of the sudden upset also could have delayed the crew's correct response to the upset.

The copilot was military trained with experience in turbojet fighter and attack mission aircraft and would have been accustomed to abrupt control movements and high "g" maneuvers. Consequently, since he lacked experience in the Learjet, the copilot may have been more aggressive in his response to the upset and to a nosedown high speed departure. As indicated in the FAA's SCR report and Gates Learjet Service Letter 49, if an overspeed condition occurs, aileron "buzz" would be the first indication of encountering a high speed Mach buffet condition. The letter further states, "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 airplane but must apply a steady force of the magnitude necessary to produce as much "g" force as possible without losing roll control." During certification flight tests, this recovery "g" force was limited to 1.5 g's. The ailerons in the Learjet are sensitive to buffeting at speeds beyond M_{mo} and increased "g" loads. Therefore, it is conceivable that the copilot could have increased the onset and the intensity of Mach buffet by exerting more than 1.5 g's on the aircraft. Consequently, his attempts to recover the aircraft by pulling on the control wheel probably resulted in a loss of roll control. The Safety Board concludes that the copilot's comment, "Can't get it up...its in a spin," indicates that he was attempting to pull on the control wheel to recover the aircraft but that it was in an uncoordinated roll manuever from which a recovery may not have been possible.

Action by the pilot to deploy the spoilers could have been a natural reaction to an overspeed since he had been trained initially to use such a procedure in the Learjet Model 24, and the early Model 24 AFMs specified the use of spoilers in an overspeed situation. However, the procedures for the Model 25D/F AFM do not provide for the use of spoilers in this situation, but require the reduction of thrust, leveling of the wings, and a slight positive "g" recovery.

The ability of one flightcrew to recover from the turbulence upset and the failure of another flightcrew to recover may be due to differences in the severity of the turbulence encountered; differences, such as the rigging of the flight controls, between the two aircraft; or to the attentiveness of the flightcrews and their perception of the upset. The pilot of N51J made an immediate thrust reduction, did not disengage the autopilot or yaw damper, and did not deploy the spoilers. It is believed that the primary reasons for the accident flightcrew's failure to recover were the lack of a timely thrust reduction, an inadvertent disengagement of the autopilot and yaw damper, and an inability to counteract the significant nosedown pitch forces caused by deployment of the spoilers.

Further, it is our opinion that the inconsistencies regarding the use of spoilers in training for an overspeed condition may have been responsible for the different response to the upset.

More emphasis should be placed in training on turbulence upset procedures. Since this type of training may not be practical in the aircraft, it could be effectively accomplished in a simulator. The training should instill in a Learjet flightcrew a greater appreciation for how quickly the aircraft can exceed its operating envelope, and how quickly they must respond correctly to insure a successful recovery. It should also teach a crew how to recognize and avoid situations which may lead to a loss of control.

The Safety Board recognizes that in a high altitude environment a pilot might make only a small reduction in thrust because of its affect on cabin pressurization. However, considering the marginal controllability characteristics of the aircraft at speeds beyond M_{mo} and the marginal "g" limits allowed for recovery, a pilot is confronted with a very critical situation and thrust must be reduced immediately to recover the aircraft.

The Safety Board investigated three accidents in which the overspeed warning horn was heard before the loss of control occurred. (See appendix F.) In at least two of the accidents, and possibly the third, the spoilers were used in an unsuccessful attempt to decelerate the aircraft. In all three accidents, deployment of the spoilers probably would have aggravated the situations and prevented recovery of the aircraft.

The Safety Board is aware of the FAA's efforts in response to our previous recommendations to review the certification of the aircraft and of its recent issue of Airworthiness Directive 81-16-08 to correct some of the high altitude, high speed control deficiencies. We are also aware of the SCR team's recommendation that the spoiler system be redesigned to reduce the nosedown pitching moment so that deployment of the spoilers at V_{MO}/M_{MO} will not require more than 50 pounds of control force to counter. Earlier this year, this recommendation was considered resolved with the required pitch axis modifications and the changes in the AFM and training procedures. However, the Safety Board believes that changes in the AFM and training procedures will not necessarily remedy this potential problem as evidenced by the events in this accident. Currently, the spoiler system is used primarily as a speed brake and not necessarily a spoiler. Also, the aircraft's emergency descent performance is dependent upon the use of the spoiler as a drag device. It is apparent that a thorough retraining exercise must be conducted to insure that pilots do not use the spoilers at an inappropriate time. In response to a Safety Board recommendation, the FAA stated that it had established a team to "review the adequacy and effectiveness of Learjet crew training." 10/ As of this date, we have not received any information about its progress. Therefore, we encourage the FAA to take immediate action to expedite its review of training to resolve this potential problem.

3. CONCLUSIONS

3.1 Findings

1. The pilots were certificated and qualified for the flight.

2. There was no evidence of physical impairment or incapacitation of the pilots.

10/ FAA letter dated September 25, 1980 (see appendix I.)

3. The aircraft was certificated and maintained according to approved procedures.

4. There were no thunderstorms in the immediate vicinity of the accident.

5. Although no severe clear air turbulence was forecast, there was moderate to severe clear air turbulence in the area where the aircraft abruptly departed its flight level.

6. The aircraft was at a conservative cruise speed when it encountered moderate to severe clear air turbulence which required immediate pilot action to maintain control of the aircraft.

7. The copilot, who was flying the aircraft, may have initiated abrupt control movements during the turbulence encounter in an attempt to control the aircraft.

8. The copilot may have accidentally disengaged the autopilot and yaw damper which would have significantly hampered recovery, or a partial disengagement could have occurred which also could have adversely affected recovery.

9. The airplane exceeded its high speed Mach buffet boundary and its M_{MO} limitations.

10. The lack of an overspeed warning probably delayed the flightcrew's response to correct an overspeed condition.

11. There was no conclusive evidence of a failure or malfunction of the aircraft's systems. However, unauthorized installation of the overspeed warning horn cut-out switch rendered the aircraft unairworthy.

12. The increased speed and attempts by the flightcrew to regain control of the aircraft by deploying the spoilers, failing to retrim, and pulling on the control wheel with excessive force resulted in the loss of pitch and roll control from which a recovery was not possible.

13. The marginal controllability characteristics of the aircraft at and beyond M_{mo} contributed to the flightcrew's difficulty in executing a recovery, and the extension of the spoilers probably prevented a successful recovery.

14. The inconsistencies in the AFMs and in training probably contributed to the flightcrew's use of the incorrect procedure for recovery from an overspeed condition.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of this 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 envelope, all of which resulted in the aircraft exceeding its Mach limits and a progressive loss of control from which recovery was not possible. Contributing to the accident was the disconnection of the Mach overspeed warning horn with an unauthorized cut-out switch which resulted in the absence of an overspeed warning that probably delayed the crew's response to the turbulence encounter, and the inconsistencies in aircraft flight manuals and flightcrew training programs regarding the use of spoilers to regain control.

4. RECOMMENDATIONS

As a result of this investigation, the Safety Board issued the following recommendation to the National Oceanic and Atmospheric Administration:

> Define the relationship between clear air turbulence and upper fronts as analyzed by soundings and develop forecasting techniques to utilize the information to improve clear air turbulence forecasts. (Class II, Priority Action) (A-81-103)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JAMES B. KING
Chairman

/s/ ELWOOD T. DRIVER
Vice Chairman

/s/ PATRICIA A. GOLDMAN
Member

/s/ G. H. PATRICK BURSLEY
Member

FRANCIS H. McADAMS, Member, did not participate.

September 15, 1981

5. APPENDIXES

APPENDIX A

INVESTIGATION AND HEARING

1. Investigation

The Safety Board was notified of the accident about 1600 on May 19, 1980, and investigators were dispatched to St. Petersburg, Florida, and Jacksonville, Florida, to conduct an investigation.

Parties to the investigation were the Federal Aviation Administration, Gates Learjet Corporation, and Northeast Jet Company.

2. Public Hearing

No public hearing was held, and no depositions were taken.

APPENDIX B

CREW INFORMATION

Pilot James T. Cheek

Pilot Cheek, 59, held Airline Transport Pilot (ATP) Certificate No. 245834, with an aircraft multiengine land rating and type ratings in the Lockheed Jet Star L-1329, the Desault Falcon DA-20, and the Gate Learjet Models 23, 24, and 25. He also held a certificate, issued on January 17, 1976, for commercial privileges in single engine land sea airplanes and rotorcraft-helicopters. He had held a flight instructor certificate, which expired on December 31, 1979, for single and multiengine aircraft and rotorcraft-helicopters.

Pilot Cheek held a first-class medical certificate, issued February 11, 1980, with the limitation that he shall possess correcting eye glasses for near vision while exercising the privileges of the airman certificate. His application for this medical certificate showed that his uncorrected near vision in both eyes was 20/100, corrected to 20/20. His uncorrected distant vision was 20/20.

Pilot Cheek had been employed as a captain by Northeast Jet on October 8, 1978. He reported on his application that he had 14,810 hours of flight time, of which 11,790 hours were in multiengine aircraft. He also reported a total multiengine charter time of 1,750 hours in the Learjet and 390 hours in the Falcon. On a resume attached to his employment application, he reported 6,869 hours of turbojet pilot-in-command time, of which 5,898 hours were in the Learjet. His total flight time reported by the company as of May 19, 1980, was 15,740 hours, of which 6,062 hours were in the Learjet.

According to the company's records pilot Cheek had flown 165 hours in the 90 days preceding the accident Between April 22 and May 17, 1980, he had flown 41 hours -- 13 hours in N125NE from May 5 to May 8 and 28 hours in N911MG, the company's other Learjet 25D. Sixteen hours were flown in N911MG between May 14 and May 17. He did not fly on May 18.

Pilot Cheek's last proficiency check was a 6-month IFR flight on April 1, 1980, conducted by the chief pilot.

Pilot Cheek had obtained his ATP certificate January 16, 1963. He had obtained type ratings in the Learjet 23 and 24 on August 16, 1966, after having accumulated a total of 568.9 hours in the Learjet. He had obtained a Learjet 25 rating on July 8, 1968. He had completed a pilot recurrent training course in the Learjet models 24D/E/F and 25B/C/D/F with Flight Safety International, Wichita, Kansas, between July 31, 1978, and August 4, 1978. The course included 16 hours of ground instruction and 14 hours of simulator instruction. He received 8 hours of initial ground training October 4, 1978, and 16 hours of recurrent training on August 24, 1979, with Northeast Jet.

Copilot Francis J. Donnelly

Copilot Donnelly, 32, held ATP Certificate No. 1840270 with aircraft multiengine, instrument, and helicopter ratings and type ratings in the Cessna 500 Citation and Sikorsky S-58. He also held a certificate, issued on February 2, 1980, for commercial privileges in single engine land aircraft and rotorcraft-helicopters. This certificate was issued on February 2, 1980. He held a first class medical certificate issued December 7, 1979, with no limitations.

Copilot Donnelly had been employed by Northeast Jet on April 11, 1980. On a resume, attached to his employment application he reported 4,051 hours of flight time, of which 2,850 hours were in single and multiengine turbojet aircraft. His total flight time reported by the company as of May 19, 1980, was 4,116 hours of which 65 hours were in the Learjet.

According to company records, copilot Donnelly had flown 65 hours in the 90 days preceeding the accident. Between April 19 and May 13, 1980, he had flown 60.6 hours -- 33.1 hours in N125NE and 27.5 hours in N911MG. On April 21, 1980, he received an annual proficiency/qualification check of 0.6 hour duration from an FAA Principal Operations Inspector

At the time of the accident, copilot Donnelly was a Major and a Naval Aviator in the United States Marine Corps. He had been serving as Executive Officer of Marine Aircraft Group 49, Naval Air Station, Willow Grove, Pennsylvania. He had been scheduled to be released from active duty July 1, 1980, and had obtained a May 1 release date. He entered Naval Flight School November 7, 1966, and flew both airplanes and helicopters while on active duty. The major portion of his flight experience was obtained flying helicopters (Boeing CH-46, 755 hours) in Vietnam and in the following turbojet airplanes: 1,250 hours in North American T-2's (instructor pilot); 800 hours in Douglas A-4's; 76 hours in Hawker-Siddley AV-8; 350 hours in Douglas DC-9B. He also accumulated 101 hours in a reciprocating twin engine airplane.

Copilot Donnelly had obtained his commercial pilot certificate through a military competence examination on April 17, 1968, at which time he had been issued the following ratings: airplane single engine land, rotorcraft-helicopter, and instrument including helicopter. On January 21, 1970, he had obtained an aircraft multiengine land rating, limited to centerline thrust, and on February 15, 1980, he had obtained his ATP certificate and a standard multiengine land rating with a type rating in the Cessna 500 Citation. He had 6.5 hours in the Citation at the time of his flight check.

Between April 14 and April 18, copilot Donnelly obtained 40 hours of Learjet 25 ground school from Executive Jet Aviation, Inc., Columbus, Ohio. He also received 5 hours of instruction concerning flight safety items on March 19, and 8 hours of an indoctrination course on March 20 from Northeast Jet. He flew a 1.1-hour training flight on April 19 and a 1.2-hour training flight on April 20 before his 0.6-hour check flight the following day. He subsequently received 22 hours of instruction while on various charter and ferry flights and accumulated a total of 27.2 hours of pilot in command time in the Learjet.

APPENDIX C

AIRCRAFT INFORMATION

FAA certification of the Learjet 25D was approved May 20, 1976, under 14 CFR Part 25, effective February 1, 1965, with the addition of Special Conditions.

Gates Learjet 25D, N125NE, serial number 25-271, was issued an airworthiness certificate on February 12, 1979. It was certificated for flight up to 51,000 feet. The aircraft was equipped with the manufacturer's Century III and Soft-Flite performance improvement modifications. It was also equipped with two General Electric CJ610-8A turbojet engines, an FCS-110 standard autopilot with a GLC S231-2 indicator, and a Collins FD-108 primary flight director.

The Century III modification was designed to improve the slow speed performance of the aircraft and to permit operation within shorter field lengths. It involved increasing the radius of the wing leading edge forward of the 6 percent chord station. The new contour was kept constant from the wing root to the wing tip, in contrast to the original leading edge, and contained a change in chamber and an increase in thickness from about midspan outward to the tip. This change in the shape of the leading edge lowered the stall speed of the wing by several knots. A strake was added to the juncture of the wing tip and the tip tank to improve the effectiveness of the aileron, particularly at high angles of attack. In the cockpit, the angle of attack indicators were revised with colored segments reflecting safe, caution (shaker), and danger (pusher) flight regimes.

The "Softflite" modification, which became effective in July 1979, was developed to further improve the aircraft's stall characteristics. The aerodynamic improvements included full chord wing fences, stall strips, and an extension of the gap seals at the leading edge of the ailerons to further control airflow between the upper and lower surfaces of the wing in the vicinity of the ailerons. In addition, the improvement required removal of the vortex generators on top of the wing in front of the ailerons and replacement with boundary layer energizers (small ridge devices installed at right angles to the airflow to energize the boundary layer flow in order to delay the onset of compressibility).

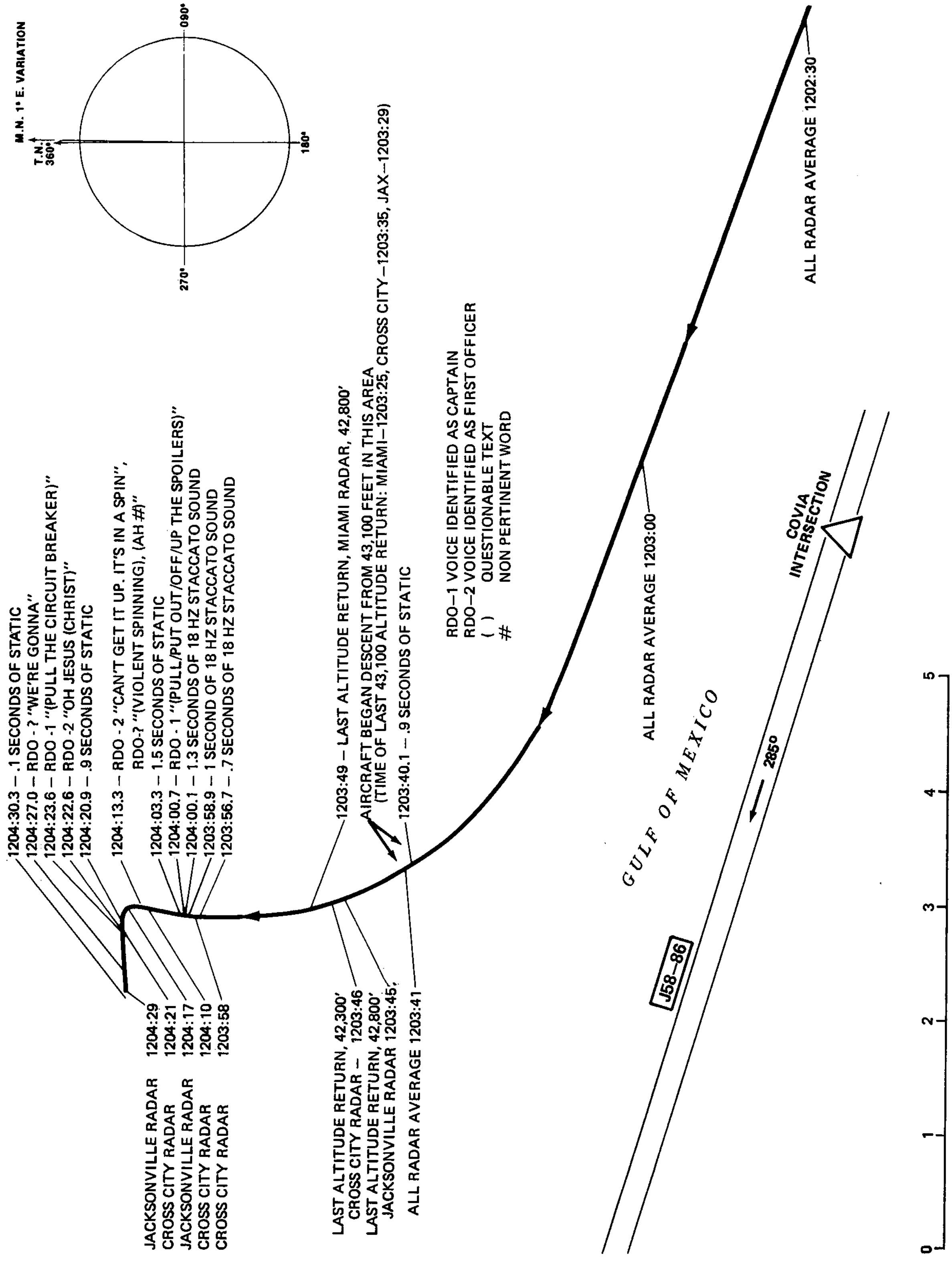
The aircraft had been flown slightly over 1,200 hours at the time of the accident.

The engine serial numbers were:

Position	Serial No.
Left	GE-E211-100A
Right	GE-211-079A

APPENDIX D

PROBABLE GROUND TRACK



APPENDIX E

NTSB EXPANDED TRANSCRIPT OF AN ARTC CENTER TAPE R29 POSITION REEL 79/12 TRACK 27B, MAY 29, 1980

LEGEND

CAM	Cockpit area microphone voice or sound source
RDO	Radio transmission from accident aircraft
-1	Voice identified as Captain
-2	Voice identified as First Officer
-?	Voice unidentified
*	Unintelligible word
#	Nonpertinent word
%	Break in continuity
( )	Questionable text
(( ))	Editorial insertion

AIR-GROUND COMMUNICATIONS

TIME & SOURCE	CONTENT
1201:42 RDO-1	Jacksonville Center Lear one two five november echo with you four three oh
1201:46 CTR	Lear one two five november echo Jax Center roger flight level four three zero
	((Intercom))
	((Intercom))
	((Intercom))
CTR	Republic four ninety six, contact Atlanta Center one three two point eight five
496	Four ninety six roger, good day
CTR	Good day ((intercom))
CTR	NASA nine sixty two Jax

TIME & SOURCE	CONTENT
NASA	Yeah Jax NASA nine ah six two is at four three zero
CTR	Roger, it's gonna be necessary to move you either to forty five or, ah, forty one, what's your preference?
	((Intercom))
NASA	Let me try to get up to forty five if I might
CTR	NASA nine sixty two roger, maintain flight level four five zero
NASA	Nine six two to four five zero
1203:40.1 RDO	((Short burst of static starts and continues until 1203:41.0))
1203:56.7 RDO	((Initial sound of stacatto beats on radio approximately 18 Hz, continues until 1203:57.4))
1203:58.9 RDO	((Second sound of stacatto beats on radio approximately 18 Hz, continues until 1203:59.9))
1204:00.1 RDO	((Third sound of stacatto beats on radio approximately 18 Hz, continuing until 1204:01.4 and including a voice saying))
1204:00.7 RDO-1	(Pull/put out/off/up the spoilers)
	((The word "stalls" was heard by one person, most heard the word "spoilers"))
1204:03.3 RDO	((Burst of static, no particular structure involved, continues until 1204:04.8))
1204:13.3 RDO	((Sound similar to cockpit background noise followed by the voice of the copilot saying))
RDO-2	Can't get it up
RDO-2	It's in a spin
RDO-?	(Violent spinning) (ah #)
1204:20.9 RDO	((Sound of static, continues until 1204:21.8))

TIME & SOURCE	CONTENT
1204:22.6 RDO-2	Oh Jesus (Christ)
1204:23.6 RDO-1	(Pull off the circuit breaker) ((or))
	(Pull off the breaker) ((or))
	(Pull off the *) ((or))
	(Pull the # engine)
1204:27.0 RDO-?	We're gonna ((conversation ends at 1204:27.8))
1204:30.3 RDO	((Sound of static, continues until 1204:30.4))

APPENDIX F

LEARJET ACCIDENT AND INCIDENT HISTORY

Some 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 before and after the Northeast Jet accident. The relevance of these accidents, incidents, and corrective actions to the Northeast Jet accident is discussed in the analysis of this report.

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 was 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 aircraft's cockpit voice recorder (CVR). Apparently, 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, it is believed the instructor stated "runaway trim" and the 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, it is believed the instructor stated, "can't pick up . . . pull." A witness estimated that the aircraft was in a 45° dive angle. 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 flight 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 VOR. About 6 minutes into the flight, 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; then a final, but louder, "Pull it out" was received at 1033:20. It was determined that the altitude alert had sounded at 1032:32, and 4 seconds later, the overspeed warning horn had sounded. Witnesses 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. As a part of the Safety Board's May 1979 Study of Selected Performance Characteristics of Modified Learjet Aircraft," flight tests 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 noted in flight tests 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) The use of spoilers in a high speed recovery;

(3) The flightcrew's background and qualifications; and

(4) The flight control system--pitch servo clutch assemblies, autopilot/automatic 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 24B, serial No. 209, operated by the Syntek Corporation, reported a longitudinal control problem while en route from Greensboro, North Carolina, to Nashville, Tennessee, at FL 350. 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 electrical power is removed.

Examination of the electromagnetic clutch of the Syntek aircraft revealed that the ferrous powder was packed without the presence 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 without the presence 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 type installed in the Kelco Aircraft Learjet. The Greensboro, North Carolina, incident prompted concern that magnetic clutches may have been a factor in the Vickery, Ohio, accident. As a result of the incident and 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. (See appendix H.)

In its investigation of the Vickery, Ohio, 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 could not be determined.

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 it 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 24,000 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 11/ 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 could have caused the control difficulty in the incident, the possibility could not be verified during ground tests of the servo unit, but the lack of success in a ground test verification 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 the investigation, the FAA issued Emergency AD-80-22-10 (see appendix G) 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) along with certain other changes. 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 a 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.

In regard to the transistors in the trim coupler board in the autopilot computer of the National Jet Industries Learjet, tests for faults were negative. The transistors installed were Delco germanium which are believed to be more resistant to thermal runaway failures than the germanium transistors built by other manufacturers. Such a failure could cause a disturbance in the pitch axis of the aircraft. According to the manufacturer, this situation 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. In an attempt 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.

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

---

11/ 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.

a lot of background noise. It was apparent that the flight was in difficulty, and that the pilot attempted to identify himself and asked for a lower altitude, but did not make any further discernable 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, the trim monitor test feature was incorporated into the autopilot system as required by AD 80-22-10, which was later superseded by AD-80-26-02.

In response to a Safety Board letter requesting flight test data 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 these accidents and incidents, the Safety Board issued recommendations A-80-53 through -55 to the FAA on June 27, 1980. (See appendix H.)

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." (See appendix I.)

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 40,000 feet while the aircraft was climbing to FL 430 northeast of Childress, Texas. The engines were air started passing through 25,000 feet, and a 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 a result of its investigation of this incident, the Safety Board issued recommendation A-81-69 to the FAA on June 29, 1981. (See appendix H.)

APPENDIX G

AIRWORTHINESS DIRECTIVES

GATES LEARJET

Airworthiness Directive

Letter

Volume I & II

80-19-11 GATES LEARJET: Letter issued September 9, 1980. Applies to the following models and serial number airplanes, unless noted:

MODELS	SERIAL NUMBERS
23	23-003 through 23-099
24, 24A	24-100 through 24-180
24B, 24B-A	24-181 through 24-217 24-219 through 24-229
24C, 24D, 24D-A	24-218, 24-230 through 24-328
24E, 24F, 24F-A	24-329 and subsequent
25, 25A	25-003 through 25-060
25B, 25C	25-061, 25-067 through 25-201, 25-204, 25-205
25D, 25F	25-206 and subsequent
28, 29	28-001 and subsequent, 29-001 and subsequent
35, 36, 35A, 36A	35-001 and subsequent, 36-001 and subsequent

COMPLIANCE: Required as indicated, unless previously accomplished.

A) Before further flight, insert the following information in the FAA Approved Airplane Flight Manual and operate the airplane in accordance with these insertions:

1. In Section, 1, LIMITATIONS, adjacent to AIRSPEED LIMITS, MAXIMUM OPERATING SPEED VMO/MMO:

a. Delete any procedures relative to exceeding VMO or MMO.

b. Add the following limitation:

WARNING: Do not extend the spoilers, or operate with the spoilers deployed, at speeds above VMO/MMO due to the significant nose down pitching moment associated with spoiler deployment.

2. In Section 1, LIMITATIONS, add a new limitation:
TRIM SYSTEMS

a. To assure proper trim systems operation, the BEFORE STARTING ENGINES trim system checks must be successfully completed before each flight.

• WARNING: Failure to conduct a complete pitch trim preflight check prior to each flight increases the probability of an undetected system failure. An additional single failure in the trim system could result in a runaway. In certain critical flight conditions an unrestrained runaway could result in high speeds, severe buffet, wing roll off, loads in excess of structural limit and extremely high forces necessary for recovery.

2

b. Pitch trim system runaway training that actually involves running the trim in flight to simulate malfunctions is prohibited.

3. In Section 1, LIMITATIONS, adjacent to STALL WARNING SYSTEM, add the following:

On Models 23, 24, 24A, 24B, 24B-A, 24D, 24D-A, 25, 25A, 25B, and 25C with unmodified wings, and the same models with Howard/Raisbeck Mark II wings:

WARNING: Do not intentionally fly the airplane slower than initial stall warning (shaker) onset.

4. In Section 1, LIMITATIONS, adjacent to YAW DAMPER:

a. Delete any references to disengaging the yaw damper before landing, or landing with the yaw damper engaged.

b. Add the following yaw damper requirements:

On landing, the following yaw damper disengage procedures shall apply:

(1) The airplane shall be configured for landing at least 500 ft. AGL for normal landing:

(2) The yaw damper shall be disengaged during the landing flare.

CAUTION: If landings are attempted in turbulent air conditions with the yaw damper OFF, the airplane may exhibit undesirable lateral-directional (Dutch-Roll) characteristics. These characteristics are improved as the wing/tip fuel is consumed. The pilot shall observe the NOTE relative to turbulence contained in the BEFORE LANDING section of Section II of the Airplane Flight Manual and increase airspeed as required.

5. In Section II, NORMAL OPERATION PROCEDURES, adjacent to BEFORE STARTING ENGINES Procedures:

a. Delete current preflight procedures on all trim systems.

b. Add the following new trim system preflight checks:

NOTE: Some early Model 23, 24 airplanes incorporate a cutoff button that interrupts pitch, roll and yaw axes.

(1) Pitch Trim Selector Switch -- EMER (or SEC).

(2) Operate EMERGENCY (or SEC) pitch trim switch NOSE UP and NOSE DOWN and check for stabilizer movement. Stabilizer movement will be approximately one-half of the rate of primary trim.

(3) Either Control Wheel Trim Switch - Operate NOSE UP and NOSE DOWN. Trim motion shall not occur.

(4) Pitch Trim Selector Switch - OFF.

(5) Actuate pilot's and copilot's Control Wheel Trim and Trim Arming Switches (if applicable) and pedestal EMERGENCY (or SEC) Pitch Trim Switch. Trim motion shall not occur.

(6) Pitch Trim Selector Switch - NORM (or PRI)

(7) EMERGENCY (or SEC) Pitch Trim Switch Operate NOSE UP and NOSE DOWN. Trim motion shall not occur.

NOTE: On all Model 23 airplanes and Model 24 (Serial Number 24-100 through 24-169) airplanes, except for those incorporating Accessory Kit AAK70-3, trim motion will occur.

(8) Pilot's Control Wheel Trim Switch - Without depressing arming button (if applicable), move switch to LWD, RWD, NOSE UP, and NOSE DOWN; trim motion shall not occur. Depress arming button (if applicable); trim motion shall not occur. Then depress arming button (if applicable) and move switch to LWD, RWD, NOSE UP and NOSE DOWN; trim motion shall occur.

(9) Repeat Step (8) for Copilot's Control Wheel Trim Switch.

(10) Trim by positioning Copilot's Control Wheel Trim Switch in one direction; then trim in opposite direction using the Pilot's Control Wheel Trim Switch. Pilot's trim shall override the Copilot's trim. Repeat for all lateral and pitch trim positions.

(11) Pilot's Control Wheel Trim Switch - NOSE UP. While trimming, depress Control Wheel Master Switch (if applicable) or Cutoff Button (if applicable); trim motion shall stop when the Control Wheel Master Switch is held. Repeat procedure for NOSE DN condition; trim motion shall stop. Repeat procedure for LWD & RWD lateral trim on airplanes equipped with Cutoff Button. (The procedures in this paragraph are not applicable to Model 25, S.N. 25-003 through 25-205 and Model 24, S.N. 24-170 through 24-328, except those airplanes modified by AAK76-4A).

(12) Repeat Step (11) using copilot's Control Wheel Trim Switch, and Control Wheel Master Switch (if applicable), or Cutoff Button (if applicable).

(13) YAW TRIM Switch - Operate each half separately (if installed); trim motion shall not occur.

(14) YAW TRIM Switch - Operate both halves simultaneously; trim motion shall occur. On aircraft with Cutoff Button, check that the Cutoff Button stops the trim.

(15) Trim - Set all axes for takeoff.

6. In Section III, EMERGENCY PROCEDURES, add a new PITCH UPSET (NOSE-UP or NOSE-DOWN) Emergency Procedure:

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 significant nose-down pitching moment associated with spoiler deployment.

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

IMMEDIATELY:

a. Attitude Control - As required to maintain aircraft control.

4

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

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

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 Master Switch or Cutoff Button - Depress and hold until step g. is accomplished.

d. PITCH TRIM Selector Switch - OFF.

e. STALL WARNING Switches - OFF.

WARNING: On any speed excursions beyond MMO, the elevator control must be smoothly and steadily applied to prevent encountering excessive aileron activity and airframe buffet. Beyond .85 M1, 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:

f. Spoilers - Check retracted.

g. Autopilot's Pitch Circuit Breaker - Pull.

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

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

7. In Section IV, PERFORMANCE DATA, adjacent to the appropriate takeoff charts, add the following:

Increase all Chart V1, VR and V2 speeds by:

a. Model 23, 24, 24A, 24B, 24B-A, 24D, 24D-A, 25, 25A, 25B, 25C, with unmodified wings, plus 5 KNOTS Indicated Airspeed.

b. Model 23, 24, 24A, 24B, 24B-A, 24D, 24D-A, 25, 25A, 25B, 25C, with Howard/Raisbeck Mark II wings, plus 5 KNOTS Indicated Airspeed. (Increase applies to FLAP 10 and FLAP 20 charts, and is not applicable to FLAP 10 OVERSPEED chart.)

8. In Section IV, PERFORMANCE DATA, adjacent to each TAKEOFF DISTANCE CHART, add the following:

Increase all chart takeoff distances by:

a. Model 23, 24, 24A, 24B, 24B-A, 24D, 24D-A, 25, 25A, 25B, 25C, with unmodified wings, plus 10%.

5

weight is above 14,500 lbs. For takeoff weights above 14,000 lbs. and below 14,500 lbs., reduce the weight to 14,000 lbs. Takeoff weight reduction not applicable to FLAP 10 OVERSPEED.

10. In Section IV, PERFORMANCE DATA, adjacent to LANDING APPROACH SPEEDS chart, add the following:

Increase all chart Landing Approach Speeds by:

a. Model 23, 24, 24A, with unmodified wings, plus 8 KNOTS Indicated Airspeed.

b. Model 23, 24, 24A with ECR 736 (CJ610-6 engines and increased gross weight), and Model 24B, 24B-A, 24D, 24D-A, with unmodified wings, plus 4 KNOTS Indicated Airspeed.

c. Model 25, 25A, with unmodified wings, plus 3 KNOTS Indicated Airspeed.

d. Model 25, 25A, with unmodified wings with ECR 936 (AAK 70-5), plus 5 KNOTS Indicated Airspeed.

e. Model 25B, 25C, with unmodified wings, plus 5 KNOTS Indicated Airspeed.

f. Model 23, 24, 24A, 24B, 24B-A, 24D, 24D-A, 25, 25A, 25B, 25C, with Howard/Raisbeck Mark II wings, plus 5 KNOTS Indicated Airspeed.

11. In Section IV, PERFORMANCE DATA, adjacent to each LANDING DISTANCE CHART, add the following: Increase all chart landing distances by:

a. Model 23, 24 and 24A, with unmodified wings, plus 10%.

b. Model 23, 24, 24A with ECR 736 (CJ610-6 engines and increased gross weight) and Model 24B, 24B-A, 24D, 24D-A, with unmodified wings, plus 5%.

c. Model 25, 25A, with unmodified wings, plus 4%.

d. Model 25, 25A, with unmodified wings with ECR 936, (AAK70-5) plus 7%.

e. Model 25B, 25C, with unmodified wings, plus 7%.

f. Model 23, 24, 24A, 24B, 24B-A, 24D, 24D-A, 25, 25A, 25B, 25C, with Howard/Raisbeck Mark II wings, plus 7%.

12. In Section IV, PERFORMANCE DATA, adjacent to the LANDING WEIGHT LIMITS CHART, add the following:

Reduce the Limiting Weight-Brake Energy landing weights as follows:

a. Model 23, 24, 24A, with unmodified wings, 800 lbs.

b. Model 23, 24, 24A, with ECR 736 (CJ610-6 engines and increased gross weight), and Model 24B, 24B-A, 24D; 24D-A with unmodified wings, 400 lbs.

c. Model 25, 25A, with unmodified wings, 300 lbs.

d. Model 25, 25A, with unmodified wings with ECR 936 (AAK70-5), 500 lbs.

e. Model 25B, 25C, with unmodified wings, 500 lbs.

f. Model 23, 24, 24A, 24B, 24B-A, 24D, 24D-A, 25, 25A, 25B, 25C, with Howard/Raisbeck Mark II wings, 500 lbs.

NOTE: In order to comply with the requirements of paragraph A of this Airworthiness Directive, this AD, or a duplicate thereof, may be used as a temporary amendment to the

6

Airplane Flight Manual and carried in the aircraft as part of the Airplane Flight Manual until replaced by the identical revisions to the Airplane Flight Manual provided by the manufacturer and approved by the FAA. The temporary Airplane Flight Manual Changes required by paragraph A) of this AD may be accomplished by the holder of at least a private pilot certificate issued under Part 61 of the Federal Aviation Regulations on any airplane owned or operated by that person who must make the prescribed entry in the Airplane Maintenance Records indicating compliance with paragraph A) of this AD.

B) Except for the roll axis of the FC-200 autopilot installed on Model 35, 35A, 36 and 36A airplanes, within the next 75 flight hours, conduct the following inspections to assure capability of manually overriding the Automatic Flight Control Systems:

1. Energize the airplane electrical system by applying 28 VDC electrical power.

2. <u>Roll Axis</u>

a. On airplanes equipped with FC-110 autopilot, remove the electrical power from the FC-110 Autopilot Computer. Open the computer and identify the Roll Calibration Board. On the Roll Calibration Board, temporarily install, in parallel with R18 (82 ohm) resistor, a 39 ohm, one watt resistor. Restore the electrical power and engage the Autopilot with the control wheel centered and verify that the roll slip clutch breakaway occurs by rotating the control wheel briskly (45 degrees per second) in both directions. If slippage is not verified, remove the capstan and adjust to proper torque per the appropriate Gates Learjet Service Manual. Return Autopilot Computer to original configuration and accomplish a functional check of the autopilot.

3. <u>Yaw Axis</u>

a. Effective on all models:

(1) Check and adjust the yaw capstan slip clutch torque (primary and secondary where applicable) in accordance with the appropriate Gates Learjet Service Manual.

4. <u>Pitch Axis</u>

a. Effective on Models 24D, 24D-A, 24E, 24F, 24F-A, 25B, 25C, 25D, 25F, 28, 29, 35, 35A, 36 and 36A airplanes and airplanes incorporating Gates Learjet Kits AAK71-12 or AMK80-3 (torquers):

(1) With the Autopilot disengaged, turn on both stall warning switches and move the control wheel forward and aft at a rapid rate (one second - stop to stop). Note the drag associated with control movement. Turn off the stall warning switches and repeat the rapid fore and aft movement. Note the decrease in drag, which is an indication that the electric disconnect clutch functions properly by disconnecting the drag of the pitch servo (torquer) from the control system.

b. Effective on Models 23, 24, 24B, 24B-A, 24C, 25 and 25A airplanes except airplanes incorporating Gates Learjet Kits AAK71-12 or AMK80-3:

(1) Check and adjust the pitch capstan slip clutch for proper torque in accordance with the appropriate Gates Learjet Service Manual.

C) On airplane Models 35, 35A, 36 and 36A, within the next 150 flight hours conduct the following inspection of the FC-200 autopilot roll axis to assure capability of manually overriding that axis of Automatic Flight Control Systems:

1. Energize the airplane electrical system by applying 28 VDC electrical power.

2. Check and adjust the roll capstan slip clutch for proper torque in accordance with the appropriate Gates Learjet Service Manual.

D) Submit a written report of any out of tolerance of roll, yaw, or pitch axis capstan slip torque to the Federal Aviation Administration, Aircraft Certification Program, Room 238, Terminal Building 2299, Mid-Continent Airport, Wichita, Kansas 67209. (Reporting approved by the Office of Management and Budget Order OMB No. 04-R0174.)

E) To assure proper operation of the Stall Warning Accelerometer Unit, perform, within the next 25 flight hours, inspection of the Stall Warning Accelerometer in accordance with appropriate Gates Learjet Service Bulletin SB 23, 24, 25-301A, SB 28, 29-27-3A, or SB 35, 36-27-12A. Submit a written report on any discrepancy discovered during this inspection to Federal Aviation Administration, Aircraft Certification Program, Room 238, Terminal Building 2299, Mid-Continent Airport, Wichita, Kansas 67209. (Reporting approved by Office of Management and Budget Order OMB No. 04-R0174.)

NOTE: The owner/operator is responsible for submitting reports required by this AD.

F) Airplanes may be flown in accordance with FAR 21.197 to a location where alterations and inspections required by this directive can be accomplished.

G) Any equivalent method of compliance with this AD must be approved by the Chief, Aircraft Certification Program, FAA, Central Region.

This Emergency Airworthiness Directive (AD) letter supersedes the Emergency AD letter dated August 4, 1980, AD 80-16-06, on this same subject.

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, Mid-Continent Airport, Wichita, Kansas 67209, telephone (316) 942-4281.

GATES LEARJET

Airworthiness Directive

Final Copy of Letter

Volumes I & II

80-26-02 GATES LEARJET: Amendment 39-4015. Applies to 23, 24, 25, 28 and 29 series airplanes certificated in all categories.

COMPLIANCE: Required as indicated, unless previously accomplished in accordance with AD 80-22-10.

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
	131, 132 & 134	Pilot's circuit breaker panel
	140 thru 229	Autopilot computer rack (under pilot's seat)
	230 and up	Pilot's circuit breaker panel
25	003 thru 069 (except 032)	Autopilot computer rack (under pilot's seat)
	032	Pilot's Sub Panel
	070 and up	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 AFM AIRSPEED LIMITATIONS
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.

2

B) On or before April 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 accordance with Gates Learjet Airplane Modification Kit AMK 80-16B, Change 2.

b) If 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, Change 4, and AMK 80-16B, Change 2, respectively.

2. Insert in the appropriate sections of the existing Airplane Flight Manual (AFM) the FAA approved temporary Airplane Flight Manual changes dated October 22, 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 AD supersedes AD 80-22-10.

This amendment becomes effective on January 15, 1981, to all persons except those to whom it has already been made effective by an airmail letter from the FAA dated December 11, 1980, and is identified as AD 80-26-02.

FOR FURTHER INFORMATION CONTACT:

Larry Malir, ACE-213, Aircraft Certification Program, FAA, Room 238, Terminal Building No. 2299, Mid-Continent Airport, Wichita, Kansas 67209; telephone (316) 942-4281.

EMERGENCY AIRWORTHINESS DIRECTIVE

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

FLIGHT STANDARDS NATIONAL FIELD OFFICE
P.O. BOX 25082
OKLAHOMA CITY, OKLAHOMA 73125

December 11, 1980

Our records indicate you are the owner of one or more Gates Learjet 23, 24, 25, 28 and 29 series airplanes. An emergency Airworthiness Directive (AD) letter, AD 80-22-10, dated October 23, 1980, was mailed by the FAA to registered owners of the aforementioned Gates Learjet series airplanes. The AD required, prior to further flight, deactivation of the FC-110 autopilot pitch axis and compelled the crew to observe appropriate Airplane Flight Manual (AFM) limitations for an inoperative autopilot and emergency procedures for pitch axis malfunction. The AD further required on or before January 1, 1981, modification of the airplane by requiring (1) replacement of the existing pitch axis servo and capstan with a D.C. torquer, (2) inspection of the autopilot trim coupler board to assure that the proper transistors are installed and (3) incorporation of a trim monitor preflight test switch. Upon accomplishment of these three requirements, and an addition to the AFM describing the function and use of the trim monitor, the autopilot pitch axis may be reactivated. Immediate adoption and effectiveness of AD 80-22-10 was necessary to reduce the hazard created by a possible pitch axis malfunction which, if not detected, could result in a hazardous flight attitude.

Subsequent to the issuance of AD 80-22-10, the manufacturer revised Airplane Modification Kits AMK 80-3 and AMK 80-16. AMK 80-3 referred to in paragraph B)1.b) of the AD has been revised to include Change 4. This change incorporates a revised Jet Electronics and Technology, Inc. (J.E.T.) Service Bulletin, a Parts Required List clarification, and footnotes to the kit instructions. AMK 80-16 referenced in paragraph B)1.a) and b) of the AD has been reidentified as AMK 80-16B, Change 2. Revision B added a relay assembly to the trim preflight test circuitry and Change 2 specified an operational check of the Autopilot Pitch Trim System plus parts list changes. The temporary Airplane Flight Manual referenced in paragraph B)2 of the AD bears the date of October 21, 1980. This date is incorrect. It should reflect the date of October 22, 1980. Numerous operators and other interested persons have objected to the compliance date of January 1, 1981, referenced in paragraph B) of the AD. The basis for these objections is the insufficiency of time and work facilities for the nine service centers listed in the AD to accomplish the required modifications. The FAA has investigated the situation and has verified the accuracy of these objections. Consequently, the compliance time is being extended to April 1, 1981. Concurrently, six additional service centers are being added that are authorized to accomplish the modifications. This action will prevent an undue hardship which would be caused if operators are forced to terminate operations because of service center workload and will not adversely compromise the safe operation of unmodified airplanes.

Since the condition described herein is likely to exist or develop in other aircraft of the same type design, an emergency AD is being issued, superseding AD 80-22-10. This new AD will reiterate the substance of AD 80-22-10 and, at the same time, incorporate the changes mentioned herein. The superseding AD will not require repetition of those requirements previously accomplished by AD 80-22-10.

Pursuant to the authority of the Federal Aviation Act of 1958, as amended, delegated to me by the Administrator, the following Airworthiness Directive (AD) is effective immediately on receipt of this letter and reads as follows:

80-26-02 GATES LEARJET: Letter issued December 11, 1980. Applies to 23, 24, 25, 28 and 29 series airplanes certificated in all categories.

COMPLIANCE: Required as indicated, unless previously accomplished in accordance with AD 80-22-10.

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
	131, 132 & 134	Pilot's circuit breaker panel
	140 thru 229	Autopilot computer rack (under pilot's seat)
	230 and up	Pilot's circuit breaker panel
25	003 thru 069 (except 032)	Autopilot computer rack (under pilot's seat)
	032	Pilot's Sub Panel
	070 and up	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 AFM AIRSPEED LIMITATIONS
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 April 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 accordance with Gates Learjet Airplane Modification Kit AMK 80-16B, Change 2.

b) If 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, Change 4, and AMK 80-16B, Change 2, respectively.

2. Insert in the appropriate sections of the existing Airplane Flight Manual (AFM) the FAA approved temporary Airplane Flight Manual changes dated October 22, 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 emergency AD supersedes AD 80-22-10 and is effective upon receipt.

FOR FURTHER INFORMATION CONTACT:

Larry Malir, Aircraft Certification Program, Systems and Equipment Section, Federal Aviation Administration, Room 238, Terminal Building 2299, Mid-Continent Airport, Wichita, Kansas 67209; Telephone (316) 942-4281.

GATES LEARJET

Airworthiness Directive

Volume I & II

81-16-08 GATES LEARJET: Amendment 39-4184. Applies to the following models and serial number airplanes certificated in any category:

MODELS	SERIAL NUMBERS	LEARJET AFM DESIGNATION
24E, 24F	350, 352, 353, 354, 356, and subsequent	24-350, 24-352, 24-353, 24-354, 24-356 and subsequent
25D, 25F	206 thru 336 338 thru 341	25-206 thru 25-336, 25-338 thru 25-341

COMPLIANCE: Required as indicated, unless previously accomplished.

To assure that the crew is provided with limitations for the safe operation of the airplane and to reduce the possibility of an unsafe condition resulting from a system's malfunction, accomplish the following:

A) Before further flight, insert the following information in the FAA Approved Airplane Flight Manual and operate the airplane in accordance with these limitations:

1. In Section 1, LIMITATIONS, adjacent to MAXIMUM OPERATING ALTITUDE:

a. Delete any procedures relative to maximum operation altitudes of 51,000 feet.

b. Add the following limitation for Model 25D/F:

Aircraft 25-230 and subsequent:

"The maximum operating altitude is 45,000 feet. This is the highest altitude for which acceptable flight characteristics and systems operation have been demonstrated."

c. Add the following limitation for Model 24E:

Aircraft 24-350, 24-352 and subsequent, except 24-355:

"The maximum operating altitude is 45,000 feet. This is the highest altitude for which acceptable flight characteristics and systems operation have been demonstrated."

d. Add the following limitation for Model 24F:

Aircraft 24-350 and subsequent when CJ610-8A engines are installed:

"The maximum operating altitude is 45,000 feet. This is the highest altitude for which acceptable flight characteristics and systems operation have been demonstrated."

B) In order to comply with the requirements of paragraph A) of this Airworthiness Directive, this AD, or a duplicate thereof, may be used as a temporary amendment to the Airplane Flight Manual and carried in the aircraft as part of the Airplane Flight Manual until replaced by revisions to the Airplane Flight Manual provided by the manufacturer and approved by the FAA. The Airplane Flight Manual changes required by paragraph A) of this AD may be accomplished by the holder of at least a private pilot certificate issued under Part 61 of the Federal Aviation Regulations on any airplane owned or operated by that person who must make the prescribed entry in the Airplane Maintenance Records indicating compliance with paragraph A) of this AD.

C) Prior to accomplishing the modification required by paragraph D) of this AD, contact the FAA office noted in paragraph F) if any modification or alteration has been performed on the affected airplane for further instruction relative to the compatibility of the modification of this AD.

D) On or before February 28, 1982, accomplish the following at an FAA certificated maintenance repair agency utilizing qualified technicians who must have recent accessory overhaul experience performing the overhaul test of the Gates Learjet Horizontal Stabilizer Trim Actuator with the necessary shop equipment (Attachment I hereto) as referenced in Learjet Repair Manual Number 1711-9, or the equivalent equipment, in accprdance with modification, inspection and installation instruction of the following Learjet Modification Kits, AMK 81-7, Change 1, AMK 81-8 and AMK 80-13, Change 3.

1. Modify Learjet Model 25D and 25F flight control systems, stall warning system and control wheel in accordance with Gates Learjet Airplane Modification Kits AMK 81-7, Change 1, AMK 81-8 and AMK 80-13, Change 3, respectively.

2. Insert in the appropriate sections of the existing Airplane Flight Manual (AFM) the FAA-approved temporary Airplane Flight Manual Change dated June 8, 1981, pertaining to procedures required as a result of the modification of flight control system in accordance with Airplane Modification Kit AMK 81-7, Change 1.

E) Airplanes may be flown in accordance with FAR 21.197 to a location where modifications required by this AD can be accomplished.

F) 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 amendment becomes effective on July 31, 1981.

FOR FURTHER INFORMATION CONTACT:

Larry Malir, ACE-213, Aircraft Certification Program, FAA, Room 238, Terminal Building No. 2299, Mid-Continent Airport, Wichita, Kansas 67209; telephone (316) 942-4281.

AD 81-16-08

ATTACHMENT I

The stabilizer actuator test stand (P/N ST-00463) is used to functionally test the stabilizer actuator after overhaul. The physical structure of the test stand must be capable of withstanding a minimum load of 2500 lbs. without any bending or deformation.

The stabilizer actuator is vertically mounted on the test stand with one end stationary and the other end movable through a hydraulic actuator. The test stand consists of the following components:

a. Hydraulic Actuator - The hydraulic actuator is capable of applying a regulated load of 0 to 2500 lbs. on the stabilizer actuator during the entire extend or retract cycles.

b. Hydraulic Pressure Regulator - The pressure regulator is used to select hydraulic pressures applied to the stabilizer actuator during the functional test.

c. Hydraulic Pressure Gauge - The hydraulic pressure gauge is used to monitor hydraulic pressure applied to the stabilizer actuator. The gauge must be certified at least monthly.

d. Digital Position Readout - The digital position readout indicator is used to monitor the travel of the stabilizer actuator. Signals to the indicator are picked up from a rigid mounted linear potentiometer and movable wiper attached to the hydraulic actuator. The digital readout is accurate to 1/1000th of an inch.

e. Linear Scale - A linear scale, graduated in 100th of an inch, is permanently mounted on the test stand to verify the digital readout. A tool of known length is used to verify the linear scale and digital readout before the stabilizer actuator functional test is performed. The tool length must be certified at least yearly.

f. Lapse Timer - A lapse timer is coupled to the control switches and the stabilizer actuator to monitor travel time during the extend and retract cycles. The lapse timer must measure seconds and be accurate to 1/100th of a second.

g. Trim Controller - The trim controller is used to simulate two-speed input to the stabilizer actuator primary motor. The trim controller part number is EM 2079-6.

h. Pre-Select Timer - The pre-select timer is used to check stabilizer actuator travel vs. time, voltage and amperage inputs in accordance with the functional test.

i. Power Supply - The power supply is variable through 0-30 volts DC and 0-30 amperes DC.

j. DC Voltmeter - The DC voltmeter must be capable of measuring 0-30 volts DC and must be certified at least yearly. The voltmeter is used to monitor the voltage inputs to the stabilizer actuator in accordance with the functional test.

k. DC Ammeter - The DC ammeter must be capable of measuring 0-30 amperes DC and must be certified at least yearly. The ammeter is used to monitor the amperes inputs to the stabilizer actuator in accordance with the functional test.

l. Millivolt Meter - The millivolt meter is used to monitor the stabilizer actuator linear potentiometer for a smooth and steady signal output. The meter is 0-50 volts graduated in 100 mv increments.

m. Switches - Necessary switches installed to operate the stabilizer actuator primary and secondary motors to extend or retract.

n. A digital or Simpson 260 meter, not a part of the test stand, is used to verify the resistance of the stabilizer actuator linear potentiometer. The digital or Simpson 260 meter must be certified at least every 90 working days.

APPENDIX H

NTSB SAFETY RECOMMENDATIONS

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

ISSUED: April 18, 1979

Forwarded to:

Honorable Langhorne M. Bond
Administrator
Federal Aviation Administration
Washington, D.C. 20591

SAFETY RECOMMENDATION(S)

A-79-21 through -24

The National Transportation Safety Board has recently investigated an incident which caused concern about the continued safe operation of certain Learjet aircraft.

The pilot of a Learjet Model 24B, N14BC, reported longitudinal control problems on March 9, 1979, while en route from Greensboro, North Carolina, to Nashville, Tennessee. While cruising at altitude, the aircraft abruptly pitched nosedown. The pilot regained control and deactivated the aircraft's stall warning system and automatic flight control system. After the aircraft was configured for landing, during an instrument approach to Nashville, it became longitudinally unstable. The pilot, who was unable to control the pitching oscillation, aborted the approach. As airspeed was increased, the aircraft became controllable. The pilot declared an emergency and returned to Greensboro where better weather existed. Similar problems were encountered while attempting to land at Greensboro. Three approaches were aborted before the aircraft was landed. The fourth approach was conducted without flaps, at a higher-than-normal airspeed, and with stabilizer trim for pitch control.

Postflight examination of the aircraft disclosed a resistance to motion of the longitudinal control system which was traced to the pitch axis servo drive unit. The unit was replaced and the aircraft was test flown without the control problems.

2631

The National Transportation Safety Board took custody of the malfunctioning servo drive unit, and it was examined at the Gates Learjet plant in Wichita, Kansas. This unit consists of an electric motor which runs continuously in one direction when either the automatic pilot or the stall warning stickpusher system is energized. The output shaft of the motor drives a pair of electromagnetic friction drive clutches. These clutches rotate in opposite directions and their output shafts are connected to a common output, which in turn drives the elevator control surface. The clutches contain ferrous powder. Normally, this ferrous powder coagulates into a solid mass only when a magnetic field is introduced electrically by inputs from the autopilot or stall warning stickpusher system. The clutch, which is energized, will transmit torque to the elevator control system in the appropriate direction. The powder normally decoagulates and the clutch rotates freely when electrical power is removed.

Examination of the servo drive unit removed from N14BC revealed that the ferrous powder in the clutch which transmitted motion in the elevator trailing edge down direction was solid, although there was no electrical input. With the aircraft's autopilot or stall warning system activated, this condition would produce a nosedown pitching moment which could require as much as 80 pounds force on the control wheel to counter. With power removed from the servo motor, the jammed clutch would still affect the breakout force and force gradient of the longitudinal control system.

The other clutch of the servo was examined and it was free to rotate.

Gates Learjet personnel theorized that the powder coagulated and caused the clutch to jam because of moisture contamination. Reportedly, various degrees of moisture contamination and clutch engagement have been found on other servos that have been overhauled at Gates Learjet in the past.

The ferrous material of both clutches of the servo was later examined at the Safety Board's metallurgical laboratories; no foreign substance was found. The material in both clutches was determined to be of the same approximate chemical composition. However, some of the particles of the ferrous powder from the jammed clutch continued to coagulate into small hard lumps. The reason for this is unknown and indicates that some undetermined property of the ferrous clutch material is causing the clutch to jam without the magnetic field.

The Safety Board was informed by the operator that the same aircraft experienced a lateral control problem on March 29, 1979. This time the aileron servo drive unit, identical to the pitch servo, was found to have a defective clutch. This unit has not yet been disassembled for detailed examination.

The Safety Board is aware that Gates Learjet has discontinued the use of this JET Electronic's part No. 2380066 in new aircraft. However, we have been informed that there are approximately 220 Learjet aircraft equipped with these servo drive units in operation. Furthermore, the pitch servo drive unit is a mandatory item for flight since it is an integral part of the stall warning stick pusher system which was required by the certification of the aircraft.

Two recent fatal accidents involved loss of control of Learjet model 25 aircraft which were equipped with the same type of servo drive units. These accidents are still under investigation. Additionally, a review of our accident files indicates to us that 10 other accidents since 1964 involving Learjet aircraft, which we believe were equipped with these servo drive units, may have been caused by control problems. However, the lack of postaccident evidence precluded identification of such a problem. Our investigation into this matter is continuing.

In view of the potential catastrophic results of control difficulties caused by jammed servo drive unit clutches, the Safety Board is extremely concerned and believes expedited action is justified. Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

> Initiate a program immediately to expedite the determination of cause for the clutch malfunction in JET Electronic part No. 2380066, servo drive unit, devise a means to detect potential problems, and define corrective action. (Class I--Urgent Action) (A-79-21)
>
> If defining and implementing the corrective action described above will require prolonged effort, restrict the operation of all Learjet aircraft equipped with this servo drive unit. (Class I--Urgent Action) (A-79-22)

Issue immediately an Operations Alert Bulletin to FAA inspectors and notify operators of Learjet aircraft equipped with this type of servo drive unit to advise the pilots of these aircraft of the possible control difficulties which can be encountered as a result of clutch malfunction. (Class I--Urgent Action) (A-79-23)

Determine whether other model aircraft use the same servo drive unit clutches and take appropriate action to advise the operators of those aircraft of the potential problem. (Class I--Urgent Action) (A-79-24)

KING, Chairman, DRIVER, Vice Chairman, McADAMS, and HOGUE, Members, concurred in the above recommendations.

By: James B. King
Chairman

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

ISSUED: June 27, 1980

Forwarded to:

Honorable Langhorne M. Bond
Administrator
Federal Aviation Administration
Washington, D.C. 20591

SAFETY RECOMMENDATION(S)

A-80-53 through -55

On May 6, 1980, a Learjet model 23 aircraft crashed while attempting a night landing on runway 33 at Byrd Field, Richmond, Virginia. The skies were clear, visibility was 10 mi, and the wind was calm. Although the Learjet was slightly high on the approach, it descended normally in a landing attitude. But before touching down, the aircraft yawed and rolled, and first the right wingtip fuel tank and then the left tiptank struck the runway. Thereafter, the nose of the aircraft pitched up, the engine thrust increased, the aircraft rolled to the right, and it crashed in a nearly inverted attitude. A fire erupted after impact, and both pilots, the only persons aboard, were killed. The aircraft had been manufactured in 1964. Available optional slow-flight modifications installed on many Learjets had not been installed on this aircraft.

During the past 2 years, the Safety Board has investigated several Learjet accidents in which the aircraft while on the landing approach exhibited similar roll and yaw maneuvers followed by a loss of control and a crash. The other Learjets involved were models 24, and 25 aircraft, with the Century III and Raisbeck slow-flight modifications. The investigation revealed that in each landing accident, the aircraft apparently was flown, as specified, with the yaw damper disengaged, although the altitude at which the yaw damper was disengaged could not be verified. The accident records indicate that turbulence, crosswinds, wing icing, pilot technique, or other conditions had disturbed the aircraft's equilibrium during a flare or go-around maneuver and that erratic roll and yaw maneuvers and a loss of aircraft control ensued. Subsequent flight tests indicated that an increase in engine thrust during an attempt to recover the aircraft may cause roll oscillations to become more pronounced and may reduce the likelihood of recovery.

In February 1979, the National Transportation Safety Board, the Federal Aviation Administration, the Gates Learjet Corporation, the National Aeronautics and Space Administration, and other interested parties participated in a "Study of Selected Performance Characteristics of Modified Learjet Aircraft." The objectives of the study were to examine the operation of the stall warning system, to determine the most probable effect of small amounts of ice on stall characteristics, and to study the low-speed handling qualities of the modified aircraft in a landing configuration. The study found some limitations in the effectiveness of the anti-ice system and potential problems with premature ice-induced stalls.

Although icing conditions and turbulence were not evident in the Richmond accident, the influences of turbulence and ground effect may have been significant factors in some of the Learjet accidents. Since the accident history of the aircraft indicates that the flight behavior may be unpredictable under certain conditions and loss of control may occur unexpectedly, the Safety Board is concerned that the 1979 study may not have identified all of the factors which can lead to erratic rolling of the Learjet in the landing phase. We also believe that the reasons for the ensuing loss of control have not yet been fully explored.

The Safety Board is also investigating three Learjet accidents which have involved loss of control at high altitude and which terminated in high-speed descents into the ground. One aircraft was on a training flight at 17,000 ft, and another aircraft was cruising en route at 41,000 ft. Both aircraft departed from level flight and entered steep descents from which the crews did not recover. The descents apparently were unexpected and occurred without warning. In the training accident, we believe that the pilots may have been practicing an emergency procedure for runaway stabilizer trim when the aircraft became uncontrollable. In the third accident, which occurred on May 19, 1980, a Learjet crashed into the Gulf of Mexico following an unplanned departure and high-speed descent from the aircraft's cruise altitude of 43,000 ft. The preliminary investigation of this accident disclosed that a cutout switch had been installed which could be used to silence the Mach overspeed warning horn. Similar horn warning cutout switch installations were found in other Learjet aircraft during inspections required following the May 19, 1980, accident.

In the high altitude loss of control situations, the possibilities under consideration are that a malfunction in the flight control system, turbulence, aerodynamic characteristics, or flightcrew action could lead to an upset and further loss of control. Accident records indicate that once high speeds and steep descents have been established, complete loss of control may result and recovery may be impossible.

For the foregoing reasons, we believe that the the flight characteristics of the Learjet aircraft in both the low-speed landing environment and the high-speed, high-altitude cruise environment should be thoroughly examined to gain a better understanding of the aerodynamic factors associated with these accidents. Without this information, we believe that measures to assure safe flight cannot be developed.

In addition, the Board is aware that Gates Learjet Service issued News Letter 49 dated May 1980 pertaining to procedures to be followed if the aircraft inadvertently exceeds V_{mo}/M_{mo}. These procedures specify that the spoilers should not be extended if a pitch axis malfunction or a runaway trim situation is apparent. The reason stated is that the nosedown pitch change that the spoilers produce may aggravate a nosedown pitch problem. The Board is concerned that this information is not included in the aircraft flight manual and that operators may not be aware of the consequences of spoiler extension in these situations. Furthermore, the procedures for slowing the aircraft from excess speed, as specified in the newsletter, include the extension of the landing gear. It is the Board's understanding that this procedure has not been evaluated during actual flight conditions. The Board believes that it would be appropriate for the FAA to evaluate these procedures and if they are deemed to be effective they should be incorporated immediately in the aircraft flight manual.

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

> Convene a Multiple Expert 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 specified operational limits and recommended operational procedures. (Class I, Urgent Action) (A-80-54)
>
> Evaluate information contained in the Gates Learjet Service News Letter 49 dated May 1980 pertaining to procedures to be followed if the aircraft inadvertently exceeds V_{mo}/M_{mo} and, based on this evaluation, require appropriate revisions to the aircraft flight manual. (Class I, Urgent Action) (A-80-55)

KING, Chairman, DRIVER, Vice Chairman, McADAMS and BURSLEY, Members, concurred in these recommendations. GOLDMAN, Member, did not participate.

By: James B. King
Chairman

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

ISSUED: June 29, 1981

Forwarded to:

Honorable J. Lynn Helms
Administrator
Federal Aviation Administration
Washington, D. C. 20591

SAFETY RECOMMENDATION(S)

A-81-69

On December 7, 1980, both engines of a Continental Oil Company Lear Model 25 flamed out at about 40,000 feet while the aircraft was climbing to 43,000 feet northwest of Childress, Texas. An emergency descent was made through heavy rain, turbulence, and lightning, during which airstart attempts were not successful. However, after passing through 25,000 feet, the engines were restarted and the aircraft made a precautionary landing at Childress. No one was injured, and the aircraft was not damaged.

An investigation into the cause of the flameouts was conducted by the Safety Board with the assistance and cooperation of the Federal Aviation Administration's New England Region Engineering and Manufacturing Branch and the General Electric Co., the engine manufacturer.

Extensive testing and a teardown examination of the General Electric CJ610-6 engines determined that the flameouts were caused by reduced engine stall margin due to excessive compressor blade tip clearance and excessive compressor case runout. Although both engines had been overhauled shortly before the incident, no evidence was found to confirm that the problem could have originated at overhaul. The manufacturer could not explain the cause of the case runout and tip rub that led to increased clearances.

A review of the service history between 1976 and 1980 of General Electric CJ610-6 engine-equipped Lear aircraft revealed at least 30 other instances of engine flameout at altitude, although the December 7, 1980, incident was the only reported instance of the loss of both engines. Sixteen of the reported flameouts were attributed to excessive compressor clearances. Nearly all of the flameouts occurred at altitudes near or above 40,000 feet. Some other aircraft are equipped with CJ610-6 engines, but those aircraft are generally operated at lower altitudes than the Lear aircraft. The service history of those aircraft has been reviewed and only two incidents of flameout were reported during the same period.

-2-

The Safety Board is aware that the engine and aircraft manufacturers are conducting a test and research program to develop a solution to the loss of engine stall margin. However, we are concerned that until a method is developed for recovering or preventing reduction of stall margin, the potential for an accident exists. Because the engine maintenance and overhaul manuals provide a method for determining loss of stall margin, the Safety Board believes it should be used periodically to check engines for decreased stall margin and that appropriate operating restrictions should be applied to those engines so identified.

The manufacturer has proposed a one-time altitude stall and acceleration check to identify engines for which a stall margin recovery fix would be necessary. However, those engines which pass this check may later develop a reduced altitude stall margin. For this reason, the Safety Board believes the check should be required periodically to identify engines which might be susceptible to altitude flameout.

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

> Issue an Airworthiness Directive to: (1) require, at appropriate periodic intervals, the performance of the altitude acceleration and stall check procedure defined in the CJ610-6 overhaul manual on Lear aircraft with General Electric CJ610-6 engines installed; and (2) restrict the maximum operating altitude of those engines shown by the test procedure to have a reduced altitude stall margin until the manufacturer has developed a satisfactory method for recovering stall margin and it is incorporated in those engines. (Class II, Priority Action) (A-81-69)

KING, Chairman, DRIVER, Vice Chairman, McADAMS, GOLDMAN, and BURSLEY, Members, concurred in this recommendation.

By: James B. King
Chairman

APPENDIX I

FAA RESPONSE LETTER

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

WASHINGTON, D.C. 20591

OFFICE OF THE ADMINISTRATOR

September 25, 1980

The Honorable James B. King
Chairman, National Transportation
Safety Board
800 Independence Avenue
Washington, D.C. 20594

Dear Mr. Chairman:

This acknowledges receipt of NTSB Safety Recommendations A-80-53 through 55, delivered by the Board on Friday, June 27, 1980, at 5:40 p.m., after close of official business. These recommendations were based on the Board's investigations of accidents involving Series 20 Learjet aircraft in the low-speed landing configuration and high-speed, high-altitude cruise environment.

The Federal Aviation Administration (FAA) is aware of the facts cited by the Board in its June 27 transmittal letter and has aggressively pursued corrective actions relative to these problems. A review of the accident data pertaining to these aircraft was initiated immediately following the May 6 accident at Richmond. On June 9, 1980, the Safety Analysis Division, Office of Aviation Safety submitted an analysis of Learjet accidents and Service Difficulty Reports to the Air Transportation Division, Office of Flight Operations. The analysis indicated a need for reevaluation of Learjet systems and subsystems concerning stick pusher and shaker, autopilot pitch and roll, elevator, aileron and throttle cables.

The analysis determined that aircraft control was involved in approximately 30 percent of the 49 accidents used in the analysis. Aircraft control involved overshoot, undershoot, runway alignment, and flying speed; but pilot flight-hour experience did not appear to be a factor. Based upon the analysis and the information presently available through the accident investigation, we have initiated actions which address the subject of the recommendations as follows.

A-80-53. Convene a Multiple Expert 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.

Comment. This recommendation has already been encompassed in an earlier investigation involving all Learjets, including the Series 20. This investigation was a followup to the February 1979 "Study of Selected Performance Characteristics of Modified Lear Jet Aircraft" in

2

which the NTSB, FAA, Learjet Corporation, National Aeronautics and Space Administration, and other interested parties participated. As a result of the investigation, Airworthiness Directive (AD) 79-12-05 was issued (copy enclosed). Also, a separate investigation was initiated by the FAA on June 17, 1980, to accomplish a certification review which will also include other areas not specifically addressed in the Board's recommendations. Although this review is still in its initial stages, preliminary information developed as a result of joint FAA and Gates Learjet Corporation flight evaluations has evidenced characteristics at the limits of their operating envelope which in combination with presently approved operating procedures could adversely affect safety of flight. In light of the foregoing, on August 1, the FAA Central Region issued by airmail letter an emergency airworthiness directive (copy enclosed) to Learjet aircraft owners. Since our investigation and review is incomplete, we will make our findings available to the Board when we complete our research.

A-80-54. Advise all Learjet operators of the circumstances of recent accidents and emphasize the prudence of rigid adherence to the specified operational limits and recommended operational procedures.

Comment. Immediately upon receipt of NTSB Safety Recommendation A-80-54, a notice, which included the Board's entire transmission (copy enclosed), was sent to all Learjet operators. In addition, a GENOT was telegraphed to all FAA General Aviation District Offices (GADO's), Flight Standards District Offices (FSDO's) and Air Carrier District Offices (ACDO's), directing that all Learjet Part 91, 121, and 135 operators be contacted to verify that the operators received the notice and were fully aware of the contents of NTSB Safety Recommendation A-80-54.

A-80-55. Evaluate information contained in the Gates Learjet Service News Letter 49 dated May 1980 pertaining to procedures to be followed if the aircraft inadvertently exceeds V_{mo}/M_{mo} and, based on this evaluation, require appropriate revisions to the aircraft flight manual.

Comment. This recommendation is included in FAA's investigation described above in our comments relative to NTSB Safety Recommendation A-80-53. Also, FAA's Office of Flight Operations has established a separate team to review the adequacy and effectiveness of Learjet crew training.

In addition to these actions which are being taken in direct response to NTSB Safety Recommendations A-80-53 through 55, a GENOT (copy enclosed) was also distributed on May 22, 1980, to all GADO's, FSDO's, and ACDO's. This GENOT requested the immediate inspection of all Learjet aircraft for installation of mach warning cut-out switches. To date we have noted seven instances of aircraft with unapproved cut-out switch installations, and these all have now been removed.

3

Finally, on June 2, 1980, a special issue of General Aviation Airworthiness Alerts was published (copy enclosed). This alert addressed the subject of unapproved alterations of speed warning systems in both air carrier and general aviation aircraft.

We will continue to keep the Board informed of our findings as the investigation progresses.

Sincerely,

Langhorne Bond
Administrator

4 Enclosures

*U.S. GOVERNMENT PRINTING OFFICE: 1981-0-361-828/82