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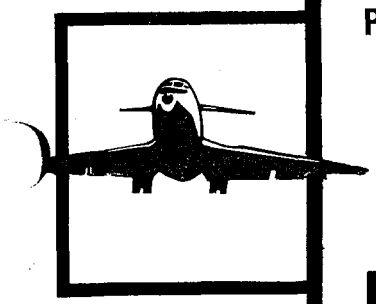

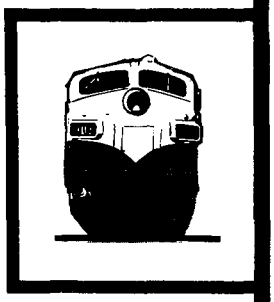

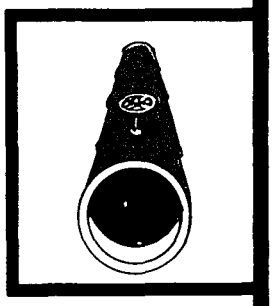

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

CENTRAL AIRLINES FLIGHT 27
HUGHES CHARTER AIR
GATES LEARJET MODEL 25 (N51CA)
NEWARK INTERNATIONAL AIRPORT
NEWARK, NEW JERSEY
MARCH 30, 1983

NTSB/AAR-84/11

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16. Abstract

About 0514, eastern standard time, on March 30, 1983, Central Airlines Flight 27, a Gates Learjet model 25 (N51CA), with two pilots aboard crashed at Newark International Airport, Newark, New Jersey, during a landing attempt on runway 4 right. The airplane was destroyed by impact, and the two pilots died as a result of the accident. The airplane came to rest in a drainage ditch at the airport perimeter. A ground fire erupted near the latter portion of the impact area.

The National Transportation Safety Board determines that the probable cause of this accident were (a) loss of control following ground contact, (b) an unstabilized approach, and (c) impairment of the flightcrew's judgment, decisionmaking, and flying abilities by a combination of physiological and psychological factors.

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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

Adopted: August 7, 1984

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MARCH 30, 1983

SYNOPSIS

About 0514, eastern standard time, on March 30, 1983, Central Airlines Flight 27, a Gates Learjet model 25 (N51CA), with two pilots aboard crashed at Newark International Airport, Newark, New Jersey, during a landing attempt on runway 4 right. The airplane was destroyed by impact and the two pilots died as a result of the accident. The airplane came to rest in a drainage ditch at the airport perimeter. A ground fire erupted near the latter portion of the impact area.

The National Transportation Safety Board determines that the probable causes of this accident were (a) loss of control following ground contact, (b) an unstabilized approach, and (c) impairment of the flightcrew's judgment, decisionmaking, and flying abilities by a combination of physiological and psychological factors.

1. FACTUAL INFORMATION

1.1 History of the Flight

On March 30, 1983, Central Airlines Flight 27, a Gates Learjet Model 25 (N51CA), was operating as a nonscheduled cargo flight (cancelled bank check courier) under 14 CFR Part 135 from Midway Airport, Chicago, Illinois, to Newark International Airport, Newark, New Jersey. Flight 27 departed Chicago at 0251 central standard time 1/ on an instrument flight rules flight plan; there were two pilots aboard. The purpose of the flight was to carry cancelled bank checks to Newark and then to continue to Hartford, Connecticut. According to air traffic control (ATC) recordings, the en route phase of the flight was routine. The cruise altitude was flight level (FL) 410. At 0456:11, the flight was cleared to descend, and the crew acknowledged the clearance. At 0458:20, the controller asked Flight 27 to "start your descent now, please." The crew acknowledged and the airplane began descending. The flight continued to receive clearances to descend and maneuvered until 0511:38 when Flight 27 advised ATC, ". . .approach control, twenty-seven, we got runway one one in sight now. I wonder if we can have a visual to one one?" The controller responded that runway 11 was "noise sensitive," and the crew responded, "Okay, we'll go to four then." The controller cleared Flight 27 for a visual approach to runway 4 right and added, ". . .not below two til on final. . . ." The crew acknowledged and contacted Newark Tower at 0512:15.

1/ All times contained herein are eastern standard time, unless otherwise indicated, and based on the 24-hour clock.

The Newark local controller cleared Flight 27 to land and gave the winds as 340° at 9 knots. The crew's acknowledgement of the landing clearance was the last transmission from N51CA. According to associates of the pilots (including the chief pilot) who reviewed the ATC tapes, the right-seat occupant (copilot) was making the radio calls. It is common practice that the pilot not flying the airplane make the radio calls.

The local controller stated that she first observed Flight 27's landing lights when the airplane was about 6 miles from the airport. She said that the approach appeared normal, "perhaps a little fast." She said she saw the airplane touchdown on the runway because the landing lights "jiggled" and the airplane made "a little bounce." The controller had looked away to log the flight's arrival on the flight strip, and when she looked back, she saw the airplane's lights roll to the right. She saw a fireball which extinguished in 10 to 15 seconds. The controller notified emergency crews about the accident, which she estimated had occurred at 0514.

A truckdriver, who holds a private pilot certificate, was driving southwest on the New Jersey Turnpike 2/ when Flight 27 crashed. His truck was positioned where he could see down runway 4R to the southwest when he saw the airplane coming toward him over the runway with its right wing down. He said that the right wingtip was nearly on the ground when he saw the right wing come up at what he believed to be the proper time to recover and land the airplane. He said the airplane landed and then came off the runway in a few seconds with the right wing down. The airplane leveled off again and touched down a second time on the runway. Then, the truckdriver said, "He (the pilot) pulled off in a pretty steep level climb of 30° or more." According to this witness, after the second touchdown, the airplane rose to about 30 feet, the right wing dropped swiftly to almost 90° right wing down, and then the airplane began turning to the right. The airplane was then headed toward the turnpike, almost directly at the witness. He saw the airplane burst into flames and come to rest. The witness said that there was moonlight and that the sky was beginning to "lighten up".

A second witness also was driving southwest on the turnpike when he first observed the accident airplane's landing light. He saw the right wing go down and the airplane appear to cartwheel.

Another witness, located on the airport nearly abeam of the landing area of runway 4 right, was about 2,600 feet northwest of the runway when he saw Flight 27. He said the approach appeared normal, "not fast, not slow." He said that when the airplane was about 10 feet above the runway, he saw it drop and bounce "pretty high" in a level attitude. He said that "it looked like a gust took him." He said that after the second touchdown, "he appeared to roll to the right, maintaining runway heading for a while, then he began to swerve off the runway." The witness stated that the airplane initially touched down near the "red and white shacks off the side of the runway" (about 500 feet from the approach end).

Two other witnesses were driving northeast on the turnpike. One said that the airplane made "a right wing-over from about 20 to 30 feet above the ground," and that it hit the ground and almost immediately burst into flames. The other witness described the airplane as "going sideways." He said the nose was facing to 10 or 11 o'clock, but the airplane was moving toward 1 o'clock with reference to the runway centerline. He said the tail was lower than the nose, and the engines "sounded like nothing was wrong." He said the tail hit the ground, and the airplane cartwheeled and caught fire.

2/ The turnpike parallels runway 4 right adjacent to the airport perimeter fence on the southeast side of the airport.

The pilot of another Learjet, operated by Jet Courier Services, Inc., and piloted by the check airman who had given the captain of N51CA his last proficiency check, was about 3 miles out on final approach when the accident occurred. The pilot said he had been cleared to follow N51CA and to land on runway 4 right.

He said that the approach of N51CA appeared normal and that the airplane was lined up with the runway. All he observed of the accident was a "sudden flame shooting about 45° to the right of the runway, then it [the airplane] hit something. . . a little like an 'Indy' car hitting a wall."

The airplane came to rest about 750 feet to the right of runway 4 right, about 1,500 feet from the point where it departed from the runway. (See figure 1.) The fuselage came to rest partially submerged in a canal alongside the New Jersey Turnpike. The wing section came to rest about 50 feet from the fuselage in the middle of the canal. The airport crash/fire/rescue crew extinguished the ground fire about 3 minutes after the accident. The accident occurred during dawn at location 40° 42' N and 74° 10' W.

1.2 Injuries to Persons

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

1.3 Damage to Aircraft

The airplane was destroyed by impact forces.

1.4 Other Damage

Ground damage was insignificant.

1.5 Personnel Information

The crew was properly certificated for the flight in accordance with appropriate Federal regulations. (See appendix B.) Both pilots were rated as "captain" for Learjet operations. The company practice was to have the pilot-in-command (captain) fly in the left seat. The pilot-in-command actually flew the airplane while the other pilot (copilot) operated the radio and performed as copilot. The pilots' previous flight experience together as a crew could not be determined, although they had known each other for several months while working for Jet Courier Services, Inc. The copilot's operating experience into Newark Airport was not established. The captain had received a route familiarization into Newark the day before the accident.

1.6 Aircraft Information

N51CA was owned by Chatham Corporation and was being operated by Hughes Charter Air, Inc., at the time of the accident. The airplane and engines were maintained under an inspection program recommended by the manufacturer and the airplane records indicated that the inspection program was being accomplished on schedule. The last 150-hour inspection was accomplished on March 22, 1983, at an airplane total time of 5,727 hours. The airplane had been flown about 28 hours since the last inspection.

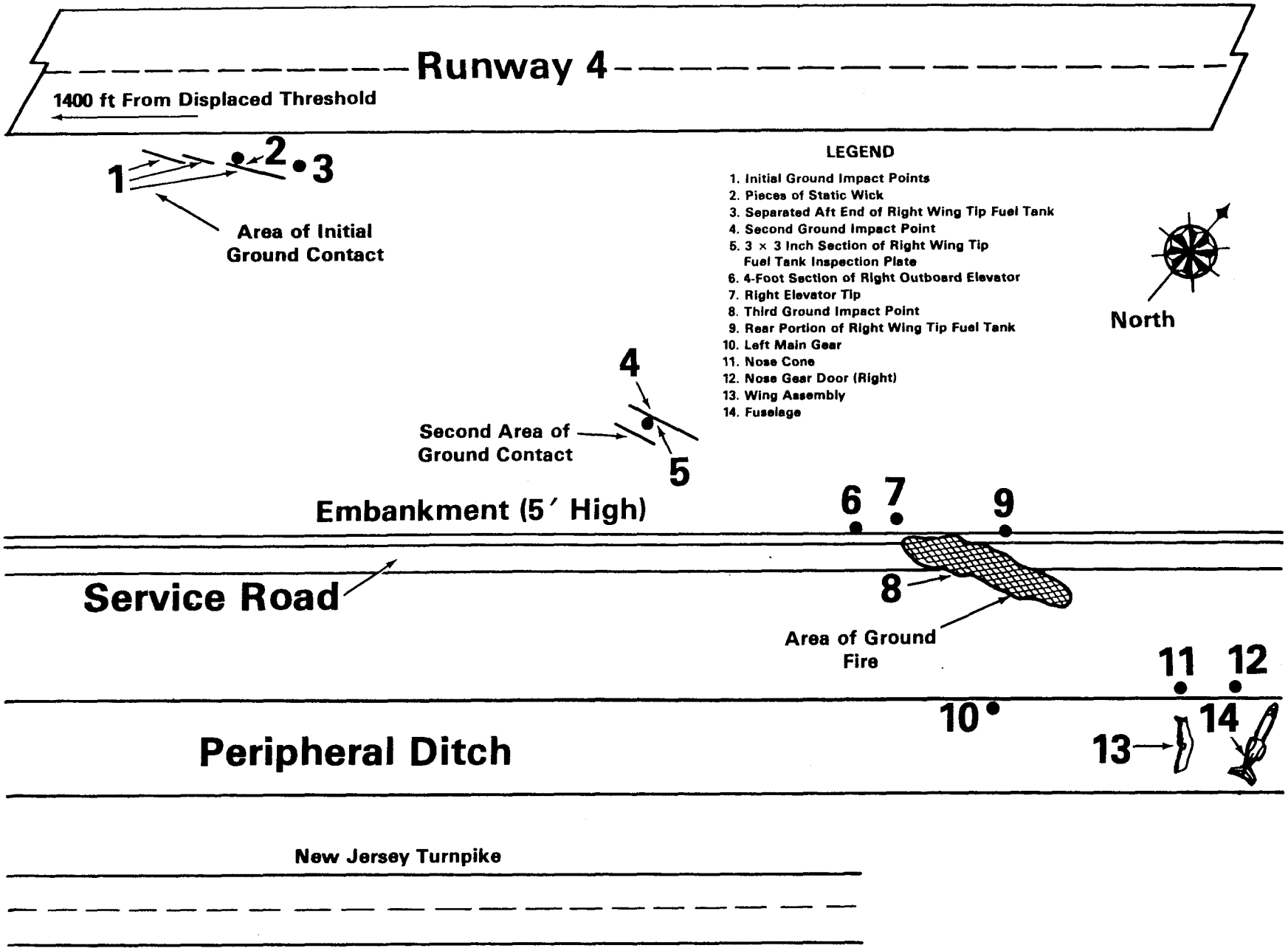

Figure 1.—Wreckage Diagram.

A review of maintenance records revealed that there had been repeated maintenance on the nosewheel steering system to resolve writeups for "nose wheel vibrations." The last action was taken on March 25, 1983, when the nosewheel steering servo was replaced. There were no reported problems with the steering after that date.

The maintenance records showed that N51CA was modified on January 26, 1977, with the installation of the Dee Howard Raisbeck Mark II modification kit, per Supplemental Type Certificate (STC)-SA-225 NW; Dee Howard Company thrust reverser kit, per STC-1670-SW; and main gear squat switches, per STC-2304-SW. A logbook entry, dated October 22, 1982, revealed that the stall warning transducer and vane had been replaced and the left and right stall warning systems had been calibrated per the Dee Howard maintenance manual. The stall warning system work required a flight test by a pilot qualified by Dee Howard Company; however, the records failed to indicate that this flight test was performed. The airplane had flown about 200 hours since that time and the chief pilot stated that he had flown it on numerous occasions, including at stickshaker airspeed, and he had not experienced control problems.

Completion of two applicable Airworthiness Directives (AD), 80-22-10 and 80-26-02 (which superseded 80-22-10), was not recorded in the logbooks. The AD's pertained to inspections and modification of the pitch trim system. A logbook entry, dated February 9, 1981, however, showed that the maintenance actions required by AD 80-26-02 had been accomplished.

The chief pilot for Hughes Charter Air, Inc., stated after the accident that N51CA's left engine had been consuming more fuel (about 25 pounds per hour) than the right engine. This condition required occasional crossfeeding of fuel to balance the lateral center of gravity. He said he had flown N51CA intermittently from January to March 1983. He claimed that during that period he often had transferred fuel from the fuselage tank forward to the wing tanks with no appreciable wing imbalance.

1.7 Meteorological Information

The sky was clear of clouds and visibility was greater than 7 miles. The 0450 weather sequence was:

> Sky clear, visibility — 15 miles, temperature — 29°, dewpoint -- 13°, wind — 330° at 12 knots, altimeter setting — 30.22 inHg.

A special observation taken at 0522 indicated that the sky was clear; that visibility was 15 miles; that the temperature was 29°, the dewpoint 13°, and the wind 330° at 9 knots; and that the altimeter setting was 30.23 inHg. The beginning of civil twilight was at 0517 and official sunrise was at 0545.

1.8 Aids to Navigation

There were no reported difficulties with aids to navigation.

1.9 Communications

There were no reported communications difficulties.

1.10 Aerodrome Information

Newark International Airport is located in both Essex and Union Counties. It is served by three runways: 11-29, 4L-22R, and 4R-22L. Runway 4R-22L is 9,800 feet long and 150 feet wide, and is paved with asphalt which is grooved for water runoff.

The runway is equipped with high intensity runwav lights centerline lights, and touchdown zone lights; all of which were operational at the time of the accident. Runway 4R has a displaced runway threshold for landing only, which is 1,200 feet from the approach end, leaving 8,600 feet usable for landing. The airport elevation is 18 feet above mean sea level; the touchdown zone is 11 feet above mean sea level. There was no visual approach slope indicator (VASI) light system provided on runway 4R.

1.11 Flight Records

No flight data or cockpit voice recorders were installed on N51CA, nor were they required.

1.12 Wreckage and Impact Information

The first identifiable marks on the ground made by N51CA were found about 18 feet to the right of the edge of runway 4R about 1,400 feet beyond the runway displaced threshold. No marks made by N51CA could be located on the runway surface where it presumably touched down. The initial impact area was an area of three ground scars made by the right wingtip fuel tank and the landing gear. The scars were aligned about 30° to the right of the runway heading. (See figure 1.) A second area of ground impact was located about 600 feet beyond the initial marks along a path oriented about 070°. These marks were gouges made by the right wing and right horizontal stabilizer/elevator.

Examination of the airplane fuel system components revealed that the right fuel crossflow valve was "open," the right standby fuel pump was operating at impact, the right standby fuel pump switch was "on", and the fuel crossflow valve was "open" at impact.

A third area of impact was located at the edge of an airport perimeter service road, about 600 feet beyond the second area. This area was about 86 feet long and 66 feet wide. Pieces of the cockpit windshield were embedded in the dirt along with numerous small pieces of debris from the cockpit. The main fuselage came to rest in a drainage ditch about 150 feet from the road surface. The fuselage was oriented in a northerly direction and was partially submerged in the water. The entire wing section, which had separated from the fuselage, came to rest partially submerged in the center of the ditch about 50 feet to the south of the fuselage.

There was evidence of fuel spillage and ground fire in the area of the road and up to the edge of the drainage ditch. Fire had damaged a small area on the left lower fuselage aft of the wing root attachment. The remainder of the airplane was not burned.

1.13 Medical and Pathological Information

Both pilots died as a result of injuries sustained in the accident. The captain died as the result of a massive skull fracture and other multiple injuries. The first officer died as the result of asphyxiation due to drowning associated with multiple injuries. The captain's body showed no evidence of bruising consistent with the use of a seatbelt or shoulder harness in a rapid deceleration.

Toxicological analyses were performed on the remains of the captain and the first officer at three laboratories. Tests were conducted at the New Jersey Medical Examiner's laboratory (NJ) as part of its responsibilities for handling accident victims.

Samples also were sent by the Safety Board to the FAA's toxicology laboratory in Oklahoma City, Oklahoma (CAMI). At the Safety Board's request additional confirmation tests were performed at the Armed Forces Institute of Pathology (AFIP). Following are the various tests and the results:

Captain

Blood	-	negative for alcohol and other drugs (CAMI, NJ)
	-	3% saturation of carbon monoxide in blood containing 7.7 gm% hemoglobin (CAMI)
	-	sample condition precluded AFIP tests
Urine	-	positive for cannabinoids by EMIT only. (NJ, CAMI)
	-	positive for cannabinoids by GC/MS (AFIP)
	--	positive for 197 mcg/L 3/ 11 - nor - delta-9-tetrahydrocannabinol-9- carboxylic acid (AFIP)
	-	positive for nicotine (CAMI)
Alcohol Swabs	-	positive for marijuana (CAMI)

Copilot

Blood	-	negative for alcohol and most drugs (CAMI, NJ)
	-	5% saturation of carbon monoxide in blood containing 18.8 gm% hemoglobin
	-	positive for 0.07 mg/L phenylpropanolamine (NJ)
	-	positive for 247 mEg/L glucose (NJ)
	-	sample condition precluded AFIP tests
Urine	-	negative for alcohol and most drugs (CAMI, NJ, AFIP)
	-	positive for 8.87 mg/L phenylpropanolamine (NJ)
	-	positive for nicotine (CAMI)
Alcohol Swabs	-	positive for marijuana (CAMI)

1.14 Fire

The ground fire was confined to a fan-shaped area about 200 feet long and 100 feet wide up to the edge of the drainage ditch where the airplane came to rest. The fire mostly self-extinguished within seconds, but was fully extinguished within 3 minutes of the accident by the airport fire department.

1.15 Survival Aspects

The survivability of the accident could not be assessed because the multidirectional forces and multiple impacts precluded a calculation of the g-forces sustained by the occupants. The occupiable area of the cockpit was partially compromised by the loss of the windshield and upper fuselage structure over the cockpit when the airplane hit the ground nearly inverted during the crash sequence.

3/ Mcg/L is equivalent to ng/ml (nanograms per milliliter).

The copilot's restraint system remained intact during the accident and his body had to be cut out of the cockpit. The instrument panel had moved downward and pinned his legs. The captain's seatbelt and shoulder harness were found unfastened and undamaged by impact forces. The captain was thrown from the cockpit during the impact, and he came to rest in the water near the airplane wreckage.

1.16 Tests and Research

Both engines were removed from the airplane and were examined by the Safety Board at the manufacturer's facility. No preimpact malfunctions or failures were found. The damage to the engine components indicated that they were operational and at or near idle thrust at the time of the major ground impact.

The left and right flap actuators were removed and examined by the Safety Board at the Dee Howard Company facility. Both actuators had been modified with the Dee Howard travel limiter stops to provide a 38° full flap position rather than a 40° position. No impact witness marks were found on the actuator cylinders, rods, or stop limiters.

The flap selector handle was examined and was found to have impact damage in the forward direction at the 20° detent position. The flap handle was free to move from the 38° (full flap) position to the 20° detent with only moderate force.

The right and left flap hydraulic actuators were found extended to a length which corresponded to a flap position of about 28°. The flap tracks and supporting mechanisms were damaged in a manner consistent with having been torn away between 19° and 28° extension for the right flap and about 37° for the left flap. Examination of the remainder of the flap system revealed no preimpact failure, and no positive evidence of the flap position at initial touchdown.

Numerous landing gear components were examined at the Safety Board metallurgical laboratory. Marks on the landing gear selector switch indicated that it had been struck sharply in an upward direction during impact. The selector detent mechanism was not damaged. The landing gear down control valve and the landing gear selector valve were examined and functionally checked. The tests indicated that a landing gear "down" position was selected at the time of the major ground impact, when the airplane's wings were torn from the fuselage. Evidence on the landing gear structure showed that the gear was extended at impact.

Examination of the spoiler control valve, the spoiler selector switch, and annunciator light revealed that the spoilers were selected down (stowed) at impact. The horizontal stabilizer actuator mechanisms showed no evidence of preimpact failure. The horizontal and lateral trim system components were tested functionally and found to operate normally. The autopilot pitch torque and roll servos were tested functionally at Gates Learjet Corporation. Both components were found to operate within specified limits. Both the primary and secondary yaw damper system servos were tested functionally and found to operate within normal ranges.

The left and right stall warning light bulb filaments were examined and found to have no evidence of stretch or distortion. The pilots' control column shaker assemblies were examined and functionally tested at Gates Learjet Corporation. Both motors were started and operated normally. There was no evidence of scrape marks inside the damaged housings to indicate that the weights were rotating at impact.

The left and right angle-of-attack sensor mechanisms were examined at the Dee Howard Company. Both sensors sustained severe impact damage so they could not be tested functionally. The potentiometer arms in both transducers were crushed near the low angle-of-attack stops.

The right static port was not recovered; the left static port had been damaged on impact. The skin surrounding the port was polished; the polished condition was not in accordance with the Dee Howard Company Information Letter No. IL1-82-1, dated July 30, 1982, which stated that the Gates Learjet directives regarding paint removal adjacent to the static ports were not applicable for the Mark II converted airplanes. It further stated that an alteration of the static ports may "adversely affect the airspeed calibration" (+ one knot).

The aileron trim tab was displaced 5° down, which would be the position to compensate for a right wing "heavy" condition. The airplane manufacturer could not calculate a possible fuel imbalance value for this trim condition. The standard procedure to cope with a fuel imbalance is for the pilot to add 10 knots to the calculated landing reference speed. The Hughes Charter Air chief pilot and test pilots for Dee Howard and Gates Learjet stated that the possible fuel imbalance to produce the 5° aileron trim indication should not be a problem in making a safe landing.

1.17 Additional Information

1.17.1 Aircraft Performance Information

The maximum certificated takeoff weight for N51CA was 15,000 pounds and the maximum certificated landing weight was 13,300 pounds. The airplane weight at the time of the accident was calculated to be 12,125 pounds.

The center-of-gravity (c.g.) limits for N51CA were 9 percent mean aerodynamic chord (M.A.C.) to 17 percent M.A.C. for the forward limit, depending on weight, and 30 percent M.A.C. for the aft limit. The c.g. at the time of the accident was calculated to be 29 percent M.A.C.

The computer-stored radar data from the New York TRACON was analyzed in order to reconstruct the final approach of N51CA. The calculated weight and balance information for the landing was used along with the airplane's aerodynamic data and meteorological data to derive performance data, flightpath, airspeed, and altitude information for N51CA. These derived values are not absolute, because of the low sampling rate of the radar data and the number of assumptions necessary.

The derived ground track of N51CA and analysis of the airplane's performance parameters during the descent and landing attempt revealed that the airplane made a high speed descent from cruise altitude to the point where it began the turn to final approach about 1,000 feet. Indicated airspeed was well above the legal limit of 250 knots during flight below 10,000 feet—exceeding the limit at times by at least 50 knots based on an average of the derived values. The average indicated airspeed did not diminish to 250 knots until the airplane descended to about 2,500 feet; less than 2 1/2 minutes before landing.

The airplane performance evaluation revealed that the airplane made a left turn from a southeasterly heading to the final approach course. The turn to final was completed only about 1 mile from the end of the intended landing runway at an altitude of about 700 feet. The average rate of descent during the turn was about 1,150 feet per minute (fpm) and the average indicated airspeed was about 180 knots. The average rate

of descent after the airplane was established on the final approach course was about 1,000 fpm with an average glidepath angle of about 5°. Average airspeed on final, although the trend indicated a slight decreasing airspeed, was about 140 knots (125 knots was the desired speed). Only 33 seconds elapsed from the time the airplane was aligned with the runway to the time of the touchdown.

The computer-stored radar data for a Boeing 737 which immediately preceded N51CA to runway 4R also was plotted to calculate the landing distance/time separation of the two airplanes. The comparison of the two tracks showed that the accident airplane crossed over the arrival end of runway 4R about 4 minutes after the Boeing 737.

1.17.2 The Pharmacology, Methods of Detection, and Behaviorial Effects of Marijuana

Cannabis, a crude material from the CANNABIS SATIVA plant contains hundreds of chemicals. The resin contains the active principal ingredients, of which there are 30 derivatives, all known as cannabinoids. One cannabinoid, technically defined as delta-9-tetrahydrocannabinol (THC), produces almost all the characteristic-specific pharmacological effects of the complex crude cannabis mixture. 4/ The predominate method of use is by smoking, although marijuana can be taken by eating and is absorbed into the body by digestion.

When the smoke of the burning cannabis plant is inhaled, the drug reaches the brain with relatively little time for metabolism or dilution. The psychological and cardiovascular effects are evident within a few seconds and peak effects occur about the time smoking is completed. When smoked, THC is rapidly absorbed by the blood in the lung. Once in the blood, the levels of THC fall rapidly (into the tissues) for the first 30 minutes. Having an independent rate of elimination, the metabolites of THC have a varied life in the blood. The cannabinoids are lipid soluble and dissolve in fats and fat solvents. Therefore, there is a long-term retention of THC in the fatty tissues of the body. In the body, some cannabinoids are reabsorbed and some diffuse back through the kidneys. Thus, the cannabinoids are only slowly eliminated from the body. Because of all these factors, marijuana may be active in the nervous system long after it is no longer detectable in the blood. In this way, marijuana differs fundamentally from drugs such as alcohol, nicotine, and caffeine which are rapidly metabolized and eliminated from the body.

Several methods exist for testing for the presence of marijuana in the human body. The reliability or validity of a particular test depends on its specificity and sensitivity. Some tests are qualitative only (indicating presence), while other are quantitative.

Swabs of the mucous membranes can be tested for marijuana by the Duquenois test or other similar colorimetric tests. The tests are considered qualitatively reliable and indicative of recent use or short-term exposure to marijuana. According to an FAA toxicologist, these findings indicate exposure to marijuana, in general, in the previous 24 hours. Another source indicates recency of use within 12 hours based on the mucus membrane swab tests. Some literature discusses the possibility of positive qualitative tests as the result of "passive" inhalation of marijuana smoke by a person in the immediate vicinity of other users. No definitive research has been found which confirms this possibility.

4/ Marijuana and Health. Report of a Study by a Committee of the Institute of Medicine, Division of Health Sciences Policy. National Academy Press, Washington, D.C., 1982.

Urine can be tested for the presence of marijuana by products by several methods. There are immunological tests, such as the EMIT or radioimmunoassay (both qualitative only) which are rapid and easy to use on large numbers of specimens. Because these are immunochemical tests, there is the potential for noncannabinoid -related substances to cross-react with assay reagents and produce a false positive result. Marijuana presence in the urine can be confirmed by other tests. Because 11-nor-delta-9-tetrahydrocannabinol-9-carboxylic acid (THC-carboxylic acid) has been shown to be the major urine metabolite of THC, most confirmation procedures have been developed to detect this metabolite. These procedures are gas chromatography (GC) and mass spectrometry (MS). In the GC procedure, the THC metabolite is identified by retention time. In the MS procedure, the compound's identification is based on its mass spectrum. GC/MS analyses for THC and its metabolites are considered highly reliable and sufficiently sensitive methods of testing, and they produce quantitative results.

Quantification of THC-carboxylic acid in the urine by means of the GC/MS method is generally reported in ng/ml units. Conclusions regarding quantification of THC-carboxylic acid in the urine and correlation to the recency of use must account for the variability of urine concentration based on an individual's liquid intake/elimination volumes. However, research reveals that values above 100 ng/ml THC-carboxylic acid found in the urine of casual and chronic users of marijuana is indicative of use within the previous 24 to 48 hours. 5/ Detection of and quantification of THC and its metabolites in blood are much more difficult and require extremely sensitive equipment. If quantification in blood is accomplished, more definitive assessments of recency of use of marijuana can be made.

As a general rule, simple and well practiced skills are less susceptible to the effects of marijuana than are novel or complex tasks. There is experimental evidence that marijuana seriously impairs psychomotor performance, such as reaction time and tracking. The acute effects on perceptual and psychomotor functions begin to be seen at 0.050 to 0.150 mg/kg 6/ used doses 7/ of THC. There is an impairment of motor coordination and tracking behavior (4.5 mg by smoking) 8/ in both naive and chronic users. This disruption in tracking performance can last for 4 to 8 hours. Also, significant decrements in performance on signal detection tasks are found at 2 to 3 mg doses. At moderate doses of marijuana, short-term memory is impaired and subjects perceive events as lasting longer than actual elapsed time. Low to moderate doses of marijuana impair oral communication, especially the "clarity of sequential dialogue with another person." The attentional mechanism (the ability to retain attention to a task) appears to be most susceptible to marijuana effects. Tasks or task components involving continuous attention are most likely to be affected and effects on memory are most significant in phases dependent on attention.

Most automobile simulator studies show an impairment of driving skills following 10 to 15 mg doses of marijuana. These impairments have been reported in both perceptual functions as well as car control motor skills. On a closed course, car handling skills were also reduced by this dosage of marijuana. And in street driving, 5 to 40 mg THC impairs judgment and concentration as well as car handling skills.

5/ Testimony by Dr. Michael Peat, Associate Director, Center for Human Toxicology, University of Utah, at NTSB Public Hearing, Denver, Colorado, June 7, 1984.
6/ This measurement refers to milligrams of THC per kilogram of subject body weight.
7/ Doses in this context refer to measured doses of intake, that is the amount of marijuana smoked; not the amount found in the blood or urine analysis.
8/ This measurement refers to total dose in milligrams.

In a flight simulator, smoking marijuana cigarettes with 0.09 mg/kg THC doses resulted in significant impairment of short-term memory. Subjects were unable to recall where they were in the execution of a task. They tended to forget where they were in a given flight sequence.

Regarding marijuana's presence in automobile accidents, using a culpability index 9/ model, 10/ researchers calculated that drivers with cannabinoids present in their urine were found to have a culpability index of 1.7. This is the same culpability level found for the presence of alcohol in automobile accidents, suggesting an excess of THC positive drivers in the category responsible for accidents. Furthermore, surveys of marijuana users report that they receive a higher-than-average number of tickets for driving violations and that they are involved in a higher-than-average number of accidents.

The acute clinical effects of marijuana seem to occur on a continuum from mild dysphoria (disorientation) to acute brain syndrome depending on individual differences and the extent of use. And, marijuana appears to have a sedative effect.

The Safety Board was unable to find comprehensive data which correlates postmortem toxicological blood/urine analyses findings with operator behavioral degradation from marijuana use.

1.17.3 Human Performance Factors

The Pilot in Command (Captain)

Previous Activities.—The captain's family and associates were interviewed to determine his activities in the 4 days preceding the accident. Interviews revealed the following:

On Saturday, March 26, he stayed "around the house" and retired at 2200. On Sunday, he and the copilot bowled with some associates in the afternoon. In the evening, he studied for an oral examination that was scheduled for the next day. According to his wife, he ate "regular meals" and "slept well" on both days.

On Monday, the captain arose about 6 a.m. and ate breakfast. He left shortly after breakfast for the airport where he was given an oral examination by an FAA inspector on the subject of Hughes Charter Air's procedures and operations specifications . According to the FAA inspector, the captain passed the examination and appeared normal in every respect. He called his wife from the airport about 1300, and arrived home about 1400. According to his wife, he slept until 2100, ate dinner, and left for the airport. The captain's wife stated that her husband had not indicated that he was overworked or that he was not getting adequate rest.

The captain reported for duty at the Combs Gates hanger, Stapleton Airport, Denver, Colorado, at 2300 mountain standard time (m.s.t.). The flight departed at 2343 m.s.t. en route to Bradley International Airport, Windsor Locks, Connecticut, via Newark, landing at Bradley Airport 0550 on March 29, 1983. After performing postflight

9/ A culpability index compares the frequency that a drug is found in drivers assigned responsibility for causing a collision with the frequency in individuals from the same sample who had not caused an accident.

10/ As a control condition, aspirin had a culpability index of 1.0, i.e., it was found more frequently in individuals assigned responsibility for a collision than in those who were not.

activities and dispatching checks to the banks, the crew checked into a motel and had breakfast at 0700. After breakfast, the captain was called back to the airport to arrange for a bag of checks that should have been offloaded at Newark to be sent back to Newark on a commercial airline. While at the airport, he visited with the check airman for Jet Courier Service, Inc., who was a good friend. According to the friend, they discussed the events of the last month and the new company. The captain returned to the motel about 1300 and presumably slept or rested in his room. About 1900, the flightcrew went to a local steak house for supper. They returned to the motel at 2100 for a nap. At 2300 they left for the airport. At 0021, the flight departed Bradley and arrived at Chicago Midway at 0114 central standard time (c.s.t.). At Midway, the aircraft was refueled with 1,200 lbs. of fuel, and the captain filed a flight plan to Newark. He reportedly drank three cups of coffee during that time.

Habit Patterns.—Several of the captain's associates reported that he had smoked cigarettes heavily until about 2 years before the accident and that he recently started smoking again. One associate said that it was because of the "new company thing and other pressures." His wife and several associates stated that he had smoked marijuana, but had stopped about 2 years before the accident about the same time he stopped smoking cigarettes. Regarding flying while under the influence of marijuana, one associate stated that the captain had stated that "he would never do it, but if he did, he said that I would never know." The captain's wife and other associates denied any knowledge that the pilot had smoked marijuana recently.

Life Events.—In the past month, the captain left his job with Jet Courier Services, Inc., and had begun flying for Hughes Charter Air amid much controversy, including that fact that both pilots (as well as others) had been terminated by Jet Courier Services, Inc. 11/ In addition, he had just bought a house and his wife was expecting a baby. One associate said that he was nervous about the new company because of the competition between companies and concerns about future job stability. However, his wife said that he was excited about the expected baby, the new house, and the professional atmosphere of the new job.

The Copilot

Previous Activities.—The copilot's two roommates (one of whom was a pilot) and associates were interviewed to determine his activities. Interviews revealed the following:

On Saturday, March 26, the copilot went to the airport and read through the operations manual of Hughes Charter Air, Inc. Later that evening, he and friends ate at a Mexican restaurant and drank margaritas. Afterwards, he went to a friend's apartment and played cards. He returned home about 0030 or 0100. On Sunday, March 27, the copilot slept until about 1000. He went bowling about noon with friends. The copilot had a hot dog and two bloody marys. After bowling, the copilot returned to his apartment with a friend and had a pizza delivered to the apartment. The copilot went to bed early because of an early appointment for an oral examination before an FAA inspector the following morning on the company's procedures and operations specifications.

11/ According to some statements and a document obtained from Jet Courier Services, Inc., the pilots along with other employees were "fired" when Jet Courier Services management learned that they were contemplating accepting employment with American Check Transport, Inc.

On Monday, March 28, the copilot got up about 0600 and at 0800 met with the Director of Operations — Hughes Charter Air — and two FAA inspectors at the airport. After the oral examination, the copilot, the pilot, and a mutual friend went to a restaurant where they ordered hamburgers; they were unable to finish them, however, because they were too raw. After lunch, the copilot went to a 1400 appointment for an examination for a first-class medical certificate. He returned to his apartment about 1600, and then left with a friend until about 2200. About 2200, the copilot went to the airport where he was given a proficiency check. It is not known when he returned to his apartment. On Tuesday, March 29, about 0830, one of the roommates awakened the copilot to get into the apartment; the copilot then went back to bed. He got up at noon to take his other roommate to the airport; at 1800 or 1830 this roommate called from the airport for a ride back to the apartment. After returning to the apartment, the copilot visited with the friend. At 2200, he left for the airport with a roommate who was also a pilot. This roommate said that "during the drive, he was in a good mood, he was in good spirits, and his actions were normal." He watched the copilot conduct some of his preflight duties between 2300 and 2315 m.s.t. According to the roommate, "He (the copilot) was getting the clearance and computing the aircraft numbers in the cockpit of the Learjet he was to fly to Midway."

The copilot left Denver on flight 24FF. The captain of this flight remembers that the copilot reported to the airport about 2245, about 15 minutes late. He was cheerful, but he said that he had not had much sleep that day. The captain said, "I asked him if he felt fit to fly, and he said that he wasn't that tired and there was no problem at all." The copilot flew the first leg to Des Moines, on which he performed normally. "The copilot flew a perfectly good approach with a good landing." This captain said he did not know the copilot very well, and that this was their first flight together. ". . .I didn't notice any lack of performance, and as far as I knew, the copilot was alert and his normal usual self all the way to Midway where he boarded Learjet N51CA (flight 27), and I waved him goodbye."

Habit Patterns.—The captain of Flight 24FF said that the copilot smoked little European type cigars. The copilot was not known to be a marijuana smoker, except one person stated that he smoked marijuana "socially" on occasion at parties.

Operational Performance of Flightcrew

According to a pilot who had flown often with the captain, he was a good pilot who exhibited command authority when necessary. "Even though I was a captain, if I did something he didn't like, he would testily tell me about it. Later we would discuss it on the ground." The check airman for Jet Courier Services, Inc., who had given the pilot his proficiency check on January 19, 1983, said that he did an excellent job during the check ride.

A company ground instructor of Hughes Charter Air who recently had provided initial company indoctrination training and portions of recurrent Learjet training to the captain and copilot said that both pilots performed satisfactorily on a written test and demonstrated good knowledge of the pertinent contents. Also, both had demonstrated satisfactory knowledge during oral examination on Learjet systems and procedures including normal, abnormal, and emergency procedures. The instructor said, "Throughout all my dealings with these two pilots, I found no abnormalities in their behavior or ability to function as competent pilots."

1.17.4 Corporate Structure - Hughes Charter Air

The pilots of N51CA had been employed by Jet Courier Services, Inc., Cinncinnati, Ohio, until about 1 month before the accident. Jet Courier Services, Inc., had been transporting cancelled bank checks under contract to banks throughout the country. About 1 month before the accident, a former executive of Jet Courier Services, Inc., formed a new company called American Check Transport, Inc., for the purpose of transporting cancelled checks. The president of American Check Transport, Inc., said that his company was a subsidiary of Central Air Charter of Kansas City, Kansas. The president of Central Air Charter was the Chairman of the Board of American Check Transport, Inc. The newly formed company expected to do business as (DBA) a 14 CFR Part 135 operator under the operating certificate of Central Air Lines; DBA Central Air Charter; DBA American Check Transport. Central Air Charter, a 14 CFR Part 135 operator of light twin-engine airplanes, planned to apply to the FAA for certification to fly Learjet-type airplanes. Because this process would take about 6 weeks and was not completed at the time the contract to carry checks was made, American Check Transport, Inc., made arrangements with Hughes Charter Air of Denver, Colorado, to transport the cancelled checks during the interim period under its 14 CFR Part 135 certificate. Hughes Charter Air leased N51CA from Chatam Corporation of the same address as Hughes Charter Air, Denver, Colorado, to provide the contracted service.

The pilots of N51CA, and seven other pilots, had resigned, or were fired, from Jet Courier Services, Inc., about a month before the accident to accept positions with American Check Transport, Inc. According to the president of American Check Transport, Inc., the pilots were employees of Hughes Charter Air. The president of Central Air Charter, Inc., stated that the pilots were employees of Central Air Charter, but were assigned to Hughes Charter Air, Inc.

1.17.5 Bank Check Courier Operations

Bank check courier operations require timely transportation of cancelled checks generally at night between banks in various cities. The checks are transported by air and by surface within a network of operators under contract to the banks or subcontractors. Air operations are conducted under Part 135 Air Taxi rules. Competition between operators is intense and contracts are based on efficient and accurate exchange of the checks. On some routes, direct competition exists (as was the case with Jet Courier Services, Inc. and Hughes Charter Air, Inc.) between Chicago and New Haven, and contracts are "won or lost" sometimes based on which company gets the checks to the destination first with the least number of "late" deliveries. Many contracts are written short-term for only 60 to 90 days and renegotiation of the contracts are based a great deal on the on-time performance of a particular company.

2. ANALYSIS

2.1 General

The flightcrew was properly certificated and qualified in accordance with existing regulations. They were adequately trained and had sufficient overall and recent experience in the Learjet airplane. The pilots had received the required off-duty time for rest before reporting for duty, however, the quality of their rest is questionable.

Weather was not a factor in this accident. There was no evidence of wind shear or gusts which could have caused the accident. The nearly 4-minute time lapse between the attempted landing and the preceding landing of the Boeing 737 airplane discounts the possibility of wingtip vortices from the heavier airplane causing control problems for N51CA.

2.2 The Approach and Attempted Landing

The evidence suggests that the flight was routine until the airplane began its descent into the Newark area. The radar data indicate that, during the descent into the Newark area, the airplane's indicated airspeed exceeded the 250-knot limit below 10,000 feet by as much as 50 knots. Also, the turn to final approach was relatively close to the runway, and it was flown at a speed higher than recommended for the approach flap setting which left little time for the captain to prepare for the landing. The rate of descent on final approach exceeded 1,000 feet per minute and the glide path of 5° obviously exceeded the "normal" 3°. Consequently, the approach to runway 4 flown by N51CA was "unstabilized." A "stabilized" approach generally involves positioning the airplane at a point aligned with the final approach course such that a 2 1/2° to 3° glide-path can be flown at the desired reference speed with the airplane landing gear and flaps configured for landing. The airspeed and descent rate should be stabilized, as well as course alignment, to preclude the need for abrupt or excessive control inputs. For an instrument approach, these conditions should be met at the final approach fix, generally 4 to 6 miles from the runway and more than 1,000 feet above the landing altitude. For a visual approach, these conditions could be met closer to the runway and at a slightly lower altitude, but at least 1 mile from the runway and above 500 feet.

Because of the unstabilized approach, the approach path angle would not have been consistent with that normally experienced by the pilots. The excess airspeed would have precluded the pilots from establishing landing flap settings until just before reaching the runway threshold. The higher-than-normal rate of descent and the higher-than-normal airspeed would have precluded the pilot at the controls (captain) from establishing a normal elevator trim setting for landing. A precise flare and touchdown would have been more difficult under these circumstances as compared to a normal stabilized approach. These factors probably resulted in the captain's flying the airplane onto the runway before the high vertical speed was arrested.

The primary reason for a stabilized approach path is to allow a pilot sufficient time to configure the airplane flap setting, landing gear, trim setting, descent rate, and airspeed for the critical flare phase of landing. A stabilized approach provides a margin of error should a destabilizing event occur, such as turbulence, and it sets the stage for a more precise flare and touchdown. Since the captain of N51CA did not fly a stabilized approach, he did not have as much margin for error as would be available during a stabilized approach.

The loss of control was precipitated by bounces, (according to witnesses the airplane bounced twice) from which the pilot failed to recover. The number and severity of the bounce(s) and the location(s) on the runway where the bounce(s) occurred were not determined, however, the witness observations and the point of departure from the runway suggest that the initial touchdown occurred in the normal touchdown zone, probably about 500 feet from the displaced threshold. The unstabilized approach probably contributed to both the initial bounce and to the loss of control following the bounce(s), because the airplane was not configured (trimmed) and the captain was not prepared to cope with any abnormal events because of insufficient time to react.

Before concluding that the unstabilized approach contributed to the initial bounce and loss of control, the Safety Board examined several possible reasons for the initial bounce and the subsequent loss of control — flight control and airframe systems, airplane lateral center of gravity, Learjet stall characteristics, and Learjet landing characteristics.

Examination of the flight control and other airframe systems related to airplane controllability revealed no conditions which could explain the reason for the accident.

One airworthiness factor which was considered by the Board involved the airplane's lateral center of gravity. The fuel crossflow valve was found in the "open" position, the right standby fuel pump was operating at impact, the right standby fuel pump switch was selected on, and the reported history that the left engine of N51CA burned more fuel than the right, all suggest that the pilots may have encountered a fuel imbalance which made the right wing heavier than the left and that they were correcting the problem by crossfeeding fuel. Also, the 5° aileron trim tab down indicates that the pilot had trimmed the airplane for a slightly right wing "heavy" condition. However, at the estimated speed of touchdown this factor would not have been sufficient to cause the bounce. It may have had a slight destabilizing effect, but certainly not sufficient to be considered a cause of the initial bounce. However, the minor lateral center of gravity problem, as well as a bounce, are the type of destabilizing factors for which the stabilized approach procedure is designed and intended to compensate. Also, the final approach airspeed was at or above the recommended 10 knots to be added for a fuel imbalance condition. Therefore, although the Safety Board does not consider the lateral center of gravity problem a cause for accident initiation, it could not rule out the possibility that the lateral center of gravity imbalance may have been a factor in the captain's failure to recover from the bounce.

The Safety Board also examined the possibility that the stall characteristics of N51CA precipitated the loss of control. Since the required test flight following stall warning system maintenance was not accomplished, the Board was not able to establish the airplane's low speed flight characteristics. The Safety Board believes that this aspect probably was not causal because the airplane had been flown successfully for about 200 hours since the maintenance and it was not reported to have abnormal low speed handling characteristics. Also, the accident sequence began with a bounce at a speed well above stall. Similarly, the improperly polished static ports, which could have caused an airspeed reading discrepancy of about ± 1 knot, did not cause the bounce. However, the Safety Board could not rule out the possibility that these factors may have contributed to the failure of the captain to recover from the bounce(s). The absence of definitive airplane performance information from a flight data recorder during the latter portions of the flight precludes the Safety Board from determining the precise reason(s) for the failure of the captain to recover from the bounce(s).

One explanation for the loss of control following the bounce(s) could be the fact that the captain did not have his restraint system fastened. The fact that he was not restrained could have caused him to move about uncontrollably after the initial bounce, and therefore be unable to control the airplane, or he could have made unintentional control inputs while trying to restrain himself from moving about in the airplane. Consequently, this factor is a strong possibility for the loss of control after touchdown.

The Safety Board also considered the possibility that the wingdrop and loss of control exhibited by N51CA may have resulted from an attempted go-around. In two previous accidents investigated by the Safety Board, 12/ 13/ it was determined that the

12/ Aircraft Accident Report: "Massey-Ferguson, Inc., Gates Learjet 25D, N137GL, Detroit, Michigan, January 19, 1979" (NTSB-AAR-80-4).
13/ Aircraft Accident Report: "Kennedy Flight Center, Gates Learjet 23, N86655, Byrd International Airport, Richmond, Virginia, May 6, 1980" (NTSB-AAR-80-12).

accident airplanes may have crashed during go-around attempts because of pilot-induced roll reversals during power addition following a wingdrop in the landing flare. The maneuver can result in a nose-high low speed condition near the ground and subsequent loss of control due to pilot-induced overcontrol.

Although this accident is similar in some respects to the earlier accidents, it is not sufficiently similar to conclude that a go-around attempt was the cause of this accident. First, no witnesses recalled hearing the sound of increased engine power which would indicate go-around thrust being applied. Secondly, the examination of the engines revealed that they were operating at idle at major impact, suggesting that the pilot(s) had not applied go-around thrust. Also, witnesses did not observe roll reversals, other than the right wingdrop, and one witness reported an abnormal pitchup. Lastly, the previous accidents occurred at normal touchdown speeds or below, not at the speed flown by N51CA. Therefore, the Safety Board concludes that this accident sequence was not initiated by the low-speed handling characteristics of the Learjet. Following the bounce or bounces, however, the airplane's airspeed could have been dissipated to a point where the low-speed handling characteristics may have contributed to the failure to recover.

2.3 Physiological/Psychological Factors

The absence of evidence pointing to airworthiness and environmental reasons for this accident strongly suggests that actions by one or both of the pilots were the primary cause of the accident. Notwithstanding the unstabilized approach flown in this case, a properly trained and experienced pilot, who is vigilant and alert, should have been able to land the airplane successfully. Both pilots were trained properly and had sufficient experience to prepare them to complete a safe landing following an unstabilized approach; however, there were several physiological and psychological factors present which could have affected adversely the pilots' flying ability, decisionmaking and judgment, and which could have led to the accident.

The Safety Board examined in-depth the question of whether the effects of the use of marijuana by the pilots was a factor in the accident. The results of the nose swab toxicological tests indicate recent use or inhalation of marijuana by both pilots in the 12 to 24 hours before the accident.

According to his friends, the copilot was not a known "user" of marijuana, but he reportedly did smoke it on occasion "socially" at parties. Analyses of the copilot's urine did not reveal the byproducts of marijuana. Therefore, in the absence of a confirmation test to support the qualitative nose swab test, it is possible that the copilot had been exposed to marijuana smoke within the 24 hours before the accident and did not actually smoke it himself. Information about the copilot's activities during the 24 hours before the accident did not eliminate, or point to, the possibility that he smoked or was exposed to marijuana before reporting for flying duties in Denver. Investigation of the two pilots' recent activities revealed that they were not together in the previous 24 hours before arriving at Midway Airport on separate flights. While at the airport, they were not alone together until departure for Newark. Therefore, smoking marijuana during the accident flight is a possibility and could account for the nose swab toxicological findings. Similarly, the copilot could have used, or been exposed to, marijuana at some other time, and the captain used it at another time. The investigation did not reveal evidence which would lead to a conclusion on this matter.

In order to determine whether marijuana had been smoked recently aboard N51CA by the crew, or for that matter, anyone recently, the Safety Board took samples from the interior of the airplane for chemical analyses to detect the presence of

marijuana byproducts. The findings were negative; however, since the airplane was submerged after the accident and washed before the samples were taken, these tests are considered inconclusive. Therefore, the Safety Board could not draw a conclusion about whether marijuana was smoked on the airplane recently, nor could the Board determine the source of the marijuana for the positive nose swab test for the copilot.

Urine analyses indicated that the captain definitely had used marijuana recently. The captain's peers reported that he had smoked marijuana heavily until about 2 years before the accident. He reportedly had stopped when he married. He also reportedly had stopped smoking cigarettes about the same time. However, according to his associates, the captain had very recently begun smoking cigarettes, reportedly because of the pressures and stress of changing jobs and because of family matters. Although tests indicated that he had used marijuana recently, his family and associates were not aware of it.

The Board's investigation of the captain's recent activities did not reveal when or where he last smoked marijuana, or the amount. He was in the presence of associates at times and was alone at times in the previous 24 hours. His associates denied knowledge of his smoking marijuana in their presence. Nevertheless, the Safety Board believes that the toxicological evidence is conclusive that the captain had used marijuana and probably smoked it in the 24 hours before the accident. The absence of definitive blood analyses for marijuana precludes the Safety Board from determining whether the captain used it within 4 to 8 hours before the accident — the generally accepted time frame in which there are measurable behavioral effects.

The human performance effects of the use of marijuana are of particular concern to the Safety Board in aircraft operations. The documented behavioral effects of marijuana include impaired judgment and concentration, impaired perceptual and motor skills, and reduced short-term memory. Although the Safety Board could not establish in this case whether either pilot was under the influence of marijuana, the circumstances of the accident scenario strongly suggest poor pilot judgment and skills. Pilot judgment was substandard as evidenced by the high speed descent and the unstabilized approach to the airport and runway. Pilot's performance was substandard as evidenced by the bounce(s) and the failure to recover. Additionally, the evidence that the captain did not have his seatbelt and shoulder harness fastened during the landing attempt indicates abnormal pilot behavior. The Safety Board has found many cases in the past in which pilots did not use shoulder harnesses; however, the non-use of a seatbelt is quite unusual. While all of the foregoing anomalies can be explained by factors other than by the effects of marijuana use, such as inexperience, poor training, or casual, careless and reckless attitudes; both pilots were experienced and well trained and neither pilot had displayed such behavior or characteristics in the past.

Both pilots had low levels of carbon monoxide in their blood, presumably from smoking cigarettes. The effects, even of such low levels (3 percent and 5 percent), raise a pilot's effective physiological altitude 14/ to about 7,000 or 8,000 feet. During cruise, the airplane cabin altitude would be about 8,000 to 9,000 feet, and during the descent, it would gradually decrease until about 8,000 feet, where the cabin altitude would equal the actual flight altitude. The hypoxic effects of carbon monoxide and altitude are additive. The effect of a given increase in carboxyhemoglobin is about the same as that of an equal

14/ Effective Physiological Altitude is the altitude equivalent to a body's reduced blood-oxygen saturation (or oxygen - carrying capacity of the blood) due to various hypoxic factors such as carbon monoxide.

loss of arterial oxygen saturation due to high altitude. Consequently, during cruise and part of the descent, the combination of elevated cabin altitude and the effects of carbon monoxide would raise the pilots' effective physiological altitude to about 12,000 feet. Minor degradation of human performance, including reduced night vision and visual processes, begin to occur about 5,000 feet. About 10,000 feet and above memory, decisionmaking, and attention are impaired.

The hypoxic effect can be synergistic with various factors including drugs and diet. Therefore, the combined effects of possible marijuana use and hypoxia could have exacerbated the adverse effect on pilot performance.

The drug phenylpropanolamine found in the copilot's urine is indicative of the use of cold or allergy type medicine, or diet control pills. The use of such drugs generally is contraindicated for use by pilots because of the drugs' action in causing nervousness, wakefulness, and errors in judgment. In fact, the FAA has stated in its procedures for Aviation Medical Examiners that any airman who is undergoing continuous treatment with an antihistamine drug must be denied medical certification and that during those periods when the drug is being used for the treatment of acute illnesses, an airman is obligated not to pilot an aircraft. Consequently, the copilot's abilities could have been impaired by this drug, especially when combined with the elevated effective physiological altitude, the possible effects of marijuana use, and possible fatigue or sleepiness.

Although both pilots had been given sufficient time off to rest, the quality of the rest is questionable. The captain had opportunity for rest of about 8 hours (6 hours at one time and 2 hours at another) while in New Haven in the afternoon and evening. The copilot had opportunity for several hours of rest during the day previous to the accident. However, the off-duty and rest periods were interrupted by business and personal affairs which could have detracted from their ability to get adequate rest and the times available for rest were not necessarily at night when "normal" rest is acquired. Additionally, the time of the accident coincides with the "low" time in a person's circadian rhythm cycle (biological clock) when the normal biological functions induce reduced human performance. Furthermore, after several hours, the combination of carbon monoxide and elevated cabin pressure altitude would lead to fatigue. Consequently, the pilots probably were experiencing the effects of fatigue from several sources, which would have reduced further their performance.

Both pilots on the accident airplane were aware of the competition between their company and the other company whose flight was immediately behind them during the flight to Newark. Time is a critical factor in the check courier business. Although normal air traffic control procedures would prevent one airplane from passing another in flight because they were on similar routing and at similar airspeed, if the flight behind N51CA had been able to land first, for instance, if N51CA had executed a go-around for some reason, or if the Jet Courier Services, Inc. jet had been able to make a faster ground turn-around for the last flight to New Haven, ultimately there could be adverse consequences for Hughes Charter Air, Inc. Consequently, both pilots' decisionmaking would have been affected by such factors and could have caused them to make the rapid descent and short turn onto final approach. Also, under these circumstances, the captain of N51CA would be less likely to execute a go-around if the approach was not necessarily as he desired. Moreover, the day before the accident, the captain had inadvertently left checks behind which had to be rerouted at a later time. Such errors are costly and, if repeated, or added to late arrivals, could cause the company to lose its contract.

Human performance research 15/ 16/ into critical life events (death of a spouse, job change, major purchase, relocation, etc.) indicates that such factors create psychological and physiological stress. The stress in turn can cause degradation of human performance. The captain of N51CA had experienced several critical life events in the recent weeks before the accident. He had changed jobs, purchased a new house, moved, and his wife was expecting a baby. Any one of these could create manageable stress; however, the combination of them could be significantly stressful. Evidence of the adverse effects of these stresses was indicated in conversations with his close friend and by his return to the use of tobacco. These factors also could account for his recent use of marijuana. Although correlation of these factors directly to the cause of this accident is impossible, they could definitely affect the captain's state of mind and consequently, his judgment and decisionmaking.

In summary, several physiological/psychological factors existed in this accident scenario, no one of which might necessarily have been sufficient to degrade the pilots' performance to the point that it would cause the accident. However, when they are considered in combination, along with the accident circumstances and the pilots' experience level and past behavior, the evidence leads to the conclusion that these factors probably were underlying reasons for the accident. Consequently, the Safety Board believes that both pilots' judgment, decisionmaking, and flying skills were affected adversely by this combination of factors to cause the accident—both the initial bounce and the failure to recover.

The use of both licit and illicit drugs by pilots is a major concern in aviation safety because of the critical skills required of pilots and the adverse effects of such drugs. Similarly, the physiological and/or psychological effects on pilot performance of such drugs are not clearly defined and are not well publicized to the flying community. Although some research has been conducted in this area, the need exists to collate available data and to institute additional research in drug involvement in aircraft accidents and the potential effects of such drugs on pilot performance. The Safety Board's difficulty during this investigation in obtaining definitive data, both quantitative and qualitative, regarding toxicological analyses and the resultant behavioral effects of such drugs indicates a need for research to develop scientific data on this subject. From such data, the potential for drug problems in aviation could be assessed.

The Safety Board believes that information on the effects of various drugs should also be collected for application in the aviation mode because of the critical nature of pilot performance requirements and task complexity. The information that is collected should be used to develop guidelines and cautionary material for pilots on the use of both licit and illicit drugs before and during flight operations.

The apparent widespread use of illicit drugs, especially marijuana, among the general population suggests that some percentage of pilots in both private and commercial aircraft operations are using such drugs. Moreover, the effects of the use of licit drugs and the contraindications for such use in flying have not been disseminated effectively to pilots. Existing guidelines, including FAA Advisory Circular AC 91.11-1, "Guide to Drug Hazards in Aviation Medicine," published in 1962, are outdated and incomplete.

Many toxicology laboratories, including FAA's laboratory (CAMI), do not necessarily test for presence of therapeutic levels of licit drugs unless a specific request is made based on the finding of a prescription bottle or other indication of use of a

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15/ Alkov, R.A., Life Changes and Accident Behavior, Approach Magazine, February 1975.

16/ Rahe, R. H., Life Crisis and Health Change, Report No. 67-4, Naval Medical Neuropsychiatric Research Unit, San Diego, California.

particular drug by a pilot. Drug screens generally are designed only to detect abnormal (lethal or incapacitating) levels of licit drugs, and only the presence of illicit drugs. Additionally, the facilitative effects of therapeutic levels of licit drugs with other factors associated with aviation are not well established and should be examined with a view toward providing guidelines to pilots and improving toxicological test procedures. Also, little data exist which can be used to correlate postmortem toxicological findings to pilot performance.

2.4 Flight Recorders

Additionally, this accident investigation again illustrates the importance of the cockpit voice recorder (CVR). A CVR on N51CA could have provided more information and data to aid investigators to better understand the circumstances leading to the accident. The Safety Board has made several recommendations regarding the importance of CVR installation on aircraft in which they currently are not required. Certainly, CVR information is never used in isolation to determine the cause of an accident. However, in the human performance area, the cockpit voice recorder can provide critical insight into many issues in the an accident scenario, including the judgment and decisionmaking of a flightcrew. A better understanding of these issues would not only aid in the understanding of this accident, but would also provide guidance in developing principles for enhancing aviation safety. The Safety Board examined several airworthiness factors which could have led to the pilot's subsequent loss of control, including lateral center of gravity imbalance, stall characteristics, and improperly polished static ports. However, the absence of definitive airplane performance information during the latter portions of the flight precluded a conclusive determination. The presence of a flight data recorder would have provided such data. This accident demonstrates, again, the significance of the installation of the cockpit voice and flight data recorders. Therefore, the Safety Board reiterates Safety Recommendations A-82-106 through A-82-111 which were issued to the FAA on August 31, 1982.

A-82-106

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

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

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

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

(Class I, Urgent Action)

A-82-107

Require that all multiengine, turbine-powered, fixed-wing aircraft certificated to carry six or more passengers manufactured on or after a specified date, in any type of operation not currently required by 14 CFR 121.343, 121.359, and 135.151 to have a cockpit voice recorder and/or a flight data recorder, be prewired to accept a "general aviation" cockpit voice recorder (if also certificated for two-pilot operation) with at least one channel for voice communications transmitted from or received in the aircraft by radio, and one channel for audio signals from a cockpit area microphone, and a "general aviation" flight data recorder to record sufficient data parameters to determine the information in Table I (attached) as a function of time. (Class II, Priority Action)

A-82-108

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

A-82-109

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

A-82-110

Require that "general aviation" cockpit voice recorders be installed as soon as they are commercially available in all multiengine turbine-powered aircraft (both airplanes and rotorcraft), which are currently in service, which are certificated to carry six or more passengers and which are required by their certificate to have two pilots, in any type of operation not currently required by 14 CFR 121.359, 135.151, and 127.127 to have a cockpit voice recorder. The cockpit voice recorders should have at least one channel reserved for voice communications transmitted from or received in the aircraft by radio, and one channel reserved for audio signals from a cockpit area microphone. (Class II, Priority Action)

A-82-111

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

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

(Class III, Longer Term Action)

3. CONCLUSIONS

3.1 Findings

1. The flightcrew was properly certificated and qualified to conduct the flight.

2. The flightcrew was trained adequately and had sufficient overall and recent experience in the Learjet airplane.

3. Both pilots had received the required off-duty time for rest; however, the quality of their rest is questionable because of interruptions and off-duty personal activities.

4. The descent into the Newark area and the approach for landing were flown at an abnormally high but manageable airspeed.

5. The final approach was unstabilized — the average rate of descent, once the airplane was established on final approach was 1,000 fpm on a 5° glide path and the average airspeed was about 15 knots above the desired approach speed.

6. The loss of control followed the bounces from which the pilot at the controls failed to recover.

7. Airworthiness factors probably were not causal in this accident, although the possibility that a lateral center of gravity imbalance may have been a factor in the pilot's failure to recover from the bounce(s) could not be ruled out.

8. The low-speed handling characteristics of the Learjet probably were not causal in this accident, although they may have contributed to the pilot's failure to recover from the bounce(s).

9. Several physiological and psychological factors may have affected adversely both pilots' judgment, decisionmaking and flying abilities, including potential fatigue, stress, drugs, and possible hypoxia.

10. Tests for marijuana indicated that the captain had used marijuana in the past 24 hours.

11. Tests for marijuana indicated that the copilot had used or had been exposed to marijuana in the past 24 hours.

12. Both pilots had low levels of carbon monoxide in their blood, presumably from smoking tobacco.

13. The accident circumstances and human performance findings strongly suggest impaired pilot judgment, decisionmaking, and flying abilities.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable causes of this accident were (a) loss of control following ground contact, (b) an unstabilized approach, and (c) impairment of the flightcrew's judgment, decisionmaking, and flying abilities by a combination of physiological and psychological factors.

4. RECOMMENDATIONS

As a result of this investigation the Safety Board recommended that:

—the Federal Aviation Administration:

Establish at the Civil Aeromedical Institute the capability to perform state-of-the-art toxicological tests on the blood, urine, and tissue of pilots involved in fatal accidents to determine the levels of both licit and illicit drugs at both therapeutic and abnormal levels. (Class II, Priority Action) (A-84-93)

Review the research and literature on the potential effects on pilot performance of both licit and illicit drugs, in both therapeutic and abnormal levels, and use that to develop and actively disseminate to pilots usable guidelines on potential drug interactions with piloting ability. (Class II, Priority Action) (A-84-94).

In coordination with the Office of the Secretary, U.S. Department of Transportation, institute appropriate research to further the understanding of potential effects on pilot performance of both licit and illicit drugs, in both therapeutic and abnormal levels, and actively disseminate those findings. (Class II, Longer Term Action) (A-84-95)

--the Department of Transportation:

Review the existing research and literature in this area and institute research to: (1) determine the potential effects of both licit and illicit drugs, especially marijuana, in both therapeutic and abnormal levels, on human performance; (2) obtain correlations between toxicological findings of drug levels in blood, urine, and other specimens and various behavioral measurements; and (3) assess the effects of various drugs on the specific tasks performed by the operator in all transportation modes. (Class III, Longer-Term Action) (A-84-96)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JIM BURNETT
Chairman

/s/ PATRICIA A. GOLDMAN
Vice Chairman

/s/ G.H. PATRICK BURSLEY
Member

/s/ VERNON L. GROSE
Member

August 7, 1984

5. APPENDIXES

APPENDIX A
INVESTIGATION AND HEARING

1. The Safety Board was notified of the accident at 0600 on March 30, 1983. A team of five investigators was dispatched from Washington, D.C., to the scene the same day. Investigative groups were established for operations, structures, and systems. Additional support was later provided in the areas of weather, aircraft performance, and human performance.

Parties to the investigation included the Federal Aviation Administration, Gates Learjet Corporation, General Electric Corporation, Dee Howard Corporation, Hughes Charter Air, Inc., and the Newark Airport Authority.

2. Public Hearing

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

APPENDIX B
CREW INFORMATION

The captain, Mr. Barnhart, age 26, held an airline transport pilot certificate with a Learjet type rating and an airplane multiengine land rating. He possessed a first-class medical certificate, dated January 13, 1983, with no limitations or waivers. He had accumulated about 5,100 hours total flight time with about 1,600 hours in the Learjet. He had flown about 180 hours in the last 90 days, all in the Learjet. He had logged 4.4 hours in the previous 24 hours before the accident.

Mr. Barnhart was hired by Central Air Charter on March 11, 1983. He had taken a proficiency check on January 19, 1983. He received recurrent ground training on March 14, 1983; recurrent flight training on March 15, 1983; and 2 hours of procedures training in Hughes Charter Air, Inc.'s procedures on March 13, 1983. He also received an oral examination on Hughes Charter Air, Inc., procedures given by an FAA inspector on March 28, 1983.

The copilot, Mr. Hogberg, age 25, held an airline transport pilot certificate with a Learjet type rating and an airplane multiengine land rating. He was also a certified flight instructor--land. He possessed a first-class medical certificate, dated March 28, 1983, with no waivers or limitations. Mr. Hogberg had accumulated about 4,112 hours total flight time with about 1,488 hours in the Learjet. He had logged 318 hours in the previous 90 days, all in the Learjet. He had logged 4.4 hours in the 24 hours before the accident.

Mr. Hogberg was hired by Central Air Charter on March 11, 1983. He had taken a proficiency check on March 28, 1983. He received recurrent ground training on March 14, 1983, and recurrent flight training on March 16, 1983.

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