CIVIL AERONAUTICS BOARD

ACCIDENT INVESTIGATION REPORT

Adopted: May 13, 1952 Released: May 16, 1952

UNITED AIR LINES, INC., NEAR DENVER, COLORADO, DECEMBER 4, 1951

THE ACCIDENT

At approximately 0725 MST[1] on December 4, 1951, a United Air Lines DC-3A N-17109, designated as United Trainer 16, crashed 8 4 miles northeast of Stapleton Air Field, Denver, Colorado, while on a training flight The accident was fatal to the three occupants—a flight instructor and two first officer trainees The aircraft was demolished by impact

HISTORY OF THE FLIGHT

United Air Lines operates a Flight Training Center at Denver, Colorado, to train applicants for first officer positions with the company The crew of United Trainer 16 consisted of Senior First Officer Jordan D Kocher, who had been designated by United Air Lines as captain and instructor, and Trainee First Officers Laurence G Wilson and Wayne C Moen.

The flight departed Stapleton Air Field at 0655, December 4, 1951 The 0628 weather conditions, upon which the crew had been briefed, were ceiling measured 15,000 feet, visibility 25 miles, and wind northwest 14 knots Ceiling and visibility were unlimited at the time of the accident, with the wind northwest 16 knots No radio contacts were made by United Trainer 16 after reporting departure time It was cleared for a training flight of four hours' duration within a 25-mile radius of Denver Captain Kocher occupied the left pilot's seat at takeoff Upon departure, the aircraft load, in addition to the crew, was 820 gallons of gasoline, full oil tanks, and 650 pounds of sand ballast tied down in the rear baggage pit The load was properly distributed with relation to the aircraft's center of gravity, and the 22,910-pound gross weight at takeoff was within allowable limits Witnesses reported that at between 0720 and 0725 the aircraft was seen to stall, enter a spin, and strike the ground in a diving attitude before recovery was effected.

INVESTIGATION

Trainees Wilson and Moen had progressed to the final stages of the flight curriculum and the flight was made for the purpose of a general review of items taught at the Denver Training Center Witnesses reported that when the aircraft was first observed, it was proceeding in a northwesterly direction. They heard one or more bursts of power, which were accompanied by a black puff of smoke from each engine The aircraft then stalled and entered a spin, making two or more revolutions before diving into the ground One of the eyewitnesses stated that the aircraft struck the ground while diving at an angle of about 60 degrees below the horizontal with the wings almost level.

Witness estimates concerning the altitude of the aircraft at the time it entered the spin varied from 500 to 3,000 feet. Because of this wide variance, United Air Lines conducted tests using an aircraft of the same type with four of the eyewitnesses located in the same ground positions they had occupied on the day of the crash Communications trucks were used for ground-to-air contact. Each phase of the test flight was discussed by ground observers and the pilots involved to obtain as accurate an estimate of the simulated flight path as possible. From this reconstruction of the last few moments of flight it appears that the altitude of the aircraft was approximately 8,200 feet above mean sea level, or 3,200 feet above the terrain Prior to entering the spin it appears that considerable altitude, perhaps as much as 800 feet, was lost after power had been applied and before the aircraft entered the spin.

All ground observers to the test flight (including CAA and company personnel) had

[1] All times referred to herein are Mountain Standard and based on the 24-hour clock

difficulty determining whether or not the gear was down, and it was impossible to determine flap position During several of the passes over the area, the landing gear was extended, one-quarter flaps was applied, and speed gradually reduced to 95 mph, at which point a power application was made. Full power application at 2,700 rpm was necessary to simulate the sound heard by the witnesses

Distribution of the wreckage was limited to a relatively small area, indicating that the aircraft struck the ground in a steep dive The fuselage forward of a point four feet behind the main cabin door was completely demolished. Aft of this point, it was severely distorted and crushed It was found that at impact the landing gear was extended and flaps were one-half down. All control systems were thoroughly checked but there was no evidence of malfunction or failure prior to impact

Due to the severity of impact and complete destruction of the cockpit, positions of the various controls could not be considered indicative of their positions prior to impact The throttles were found advanced one inch, propeller controls in full low pitch position, right and left ignition switches were on "both" magnetos, and the master ignition switch was on The left mixture control was found in the auto lean position, the right in emergency rich and broken off Both the left and right fuel selector valves were found on their respective auxiliary tanks. The wing flap and landing gear selector valves were in the neutral position Trim tab settings were normal, with the elevator indicating one degree nose up, aileron neutral, and rudder one degree nose right.

Radio equipment was severely damaged. It was determined that the high frequency transceiver was set on Channel 8, 3322 5 kilocycles, the VHF transceiver was set on Channel 8, or 126 7 megacycles. A barograph was installed in N-17109 but no information could be obtained from the film which was exposed when the unit was broken by impact Examination of the electrical system revealed no evidence of overheating or fire

The bodies of the three pilots were thrown forward along the path of the wreckage, and their positions as they came to rest indicated that Captain Kocher was occupying the left seat, Trainee First Officer Moen was in the right seat, and Trainee First Officer Wilson was in the jump seat.

The left and right propellers were set at a position five degrees above the low pitch stops There was no evidence found of excessive heat or internal part failure in either engine, and both were developing power at impact.

Examination of the airframe failed to reveal any indication of malfunctioning or failure of any component Maintenance records were thoroughly reviewed and no discrepancies were noted. The aircraft was properly certificated and requirements of all applicable CAA airworthiness directives had been accomplished

Testimony of other trainees at the Denver Training Center reflected that it was uniform practice for the instructor to occupy the left seat with the two trainees occupying the right seat and the jump seat. It was also a general flight practice at the Center for the blind flying hood to be installed on the right side cockpit windows during all maneuvers Due to the severity of impact it could not definitely be determined whether the hood was in place. The hood in use at the time of this accident was a canvas type, secured in place by snap fasteners, this type is readily removable in the event of any emergency.

The training curriculum includes practice in approaches to a stalled condition but an aircraft is never actually to be stalled. The aircraft is slowed in level flight with reduced power until an approach to a stalled condition is indicated. All maneuvers of this nature were, at the time of the accident, to be performed between 8,000 and 9,000 feet MSL. Entry altitude was to be 9,000 feet MSL. These altitude stipulations were in conformance with a mutual agreement among all operators in the Denver area utilizing the practice area for instrument flight training

Prior to the accident ground instruction was not given to trainees in spin recovery on DC-3 type aircraft No flight instruction in spins can be given in the DC-3, since it is placarded against intentional spins. Investigation showed that the crew members of United Trainer 16 had acquired knowledge of standard spin recovery techniques in their previous training and experience.

Subsequent to the accident, students at the Center have received ground instruction on the spin characteristics and spin recovery techniques applicable to the DC-3 aircraft.

This addition to the curriculum has also been included in the courses for transition training on Douglas DC-4's, DC-6's and the Convair

During the investigation and public hearing, information was developed relative to the stall and spin characteristics of the DC-3 United Air Lines, in cooperation with the National Advisory Committee for Aeronautics, had previously conducted a series of flight tests on the stall characteristics of the DC-3 aircraft They were found to be normal, with ample warning of the approaching stall being given before control is lost. Stall warning was more pronounced with the flaps down and the landing gear extended With flaps and gear up the stall was more abrupt, with less warning, and there was a tendency for the aircraft to fall off on one wing

In 1944 the National Advisory Committee for Aeronautics released a report on "Free Spinning—Wind Tunnel Tests of the Douglas DC-3 Airplane." No actual spin tests on the DC-3 have been conducted by the manufacturer or the NACA, however, this report reflects that the chief pilot for an airline company had performed four intentional spins with the DC-3 Three spins were made with landing gear up and one gear down The aircraft weight was 22,000 pounds One two-turn spin was made with the engines developing 450 horsepower. The longest of the spins was three turns It was noted that considerable force was necessary to hold the ailerons in the neutral position and there was very marked buffeting of the tail surfaces The nose was well down in the spins, being not more than 15 degrees from the vertical Recovery was normal, with rotation stopped in less than one-half turn. The maximum indicated air speed in the spins was 150 miles per hour, with 200 miles per hour being attained upon recovery In making a three-turn spin, 3,000 feet of altitude was lost between spin entry and final recovery to level flight

The NACA report further reflects that in an inadvertent one-turn spin and recovery from the ensuing dive, one pilot reported that 3,000 feet altitude was lost. There have been other reports of intentional spin tests in the DC-3, the data being somewhat meager, however, they reflect essentially the same information

The following data were obtained from wind tunnel studies made by the NACA, using a DC-3 model and analyzing the aircraft's aerodynamic characteristics While the tests gave evidence that spin recovery is normal, an altitude loss of approximately 3,000 feet can be expected prior to a full recovery. Such altitude loss would be particularly true in the event a power-on spin was experienced. The spin would be steep with the nose down about 55 degrees from the horizontal, and the rate of descent would be about 10,500 feet per minute The force necessary to move the controls in a spin might be so high as to require the combined efforts of the pilot and copilot.

Company records reflected that in addition to the aircraft, the company and crew were properly certificated. Each crew member had an adequate rest period prior to the flight

ANALYSIS

Testimony of eyewitnesses indicates conclusively that the aircraft entered a spin approximately 3,200 feet above the terrain Inasmuch as United's Denver Training Center curriculum prohibits spins and aircraft are not brought to a full stall, and since examination of the wreckage revealed no evidence of failure or malfunctioning of the aircraft or any of its components, it must be concluded that this spin was entered inadvertently. The fact that partial recovery was effected before impact is further substantiation that there was no failure or malfunctioning of the aircraft.

From the results of spin studies made by the NACA on this type of aircraft, which indicate that an altitude loss of approximately 3,000 feet will occur before full recovery can be effected, it is apparent that the spin in this instance was entered at an altitude too low to permit recovery from the dive, although rotation was stopped.

It appears that United Air Lines was lax in not giving trainees ground instruction on spin characteristics and spin recovery techniques prior to this accident This situation has been remedied, however, by inclusion of such instruction in the training center curriculum.

FINDINGS

On the basis of all available evidence, the Board finds that

1. The company, the aircraft, and the crew were properly certificated.

2. The load was properly distributed within approved center of gravity limits and the

aircraft was lightly loaded, carrying only the crew in addition to the fuel, oil and ballast.

3. No malfunctioning of the aircraft or its components was reported prior to the accident, and no evidence of malfunctioning or failure was indicated by examination of the wreckage.

4. The aircraft stalled at an altitude of approximately 8,200 feet MSL (about 3,200 feet above the ground), entered a spin, and crashed before recovery could be effected.

5. Power was being developed by both engines upon impact

—39514

PROBABLE CAUSE

The Board finds that the probable cause of this accident was an inadvertent spin at an altitude too low for recovery.

BY THE CIVIL AERONAUTICS BOARD

/s/ DONALD W. NYROP

/s/ JOSEPH P. ADAMS

/s/ CHAN GURNEY

Oswald Ryan, Vice Chairman, and Josh Lee, Member, did not participate in the adoption of this report.

Supplemental Data

INVESTIGATION AND HEARING

The Civil Aeronautics Board was notified of this accident at 0820, December 4, 1951 An investigation was immediately initiated in accordance with the provisions of Section 702(a)(2) of the Civil Aeronautics Act of 1938, as amended. A public hearing was ordered by the Board and was held in Denver, Colorado, on December 18, 1951.

AIR CARRIER

United Air Lines, Inc., is a Delaware corporation, with its general offices at 5959 South Cicero Avenue, Chicago, Illinois. The company is engaged in the transportation of persons, property, and mail under certificates of public convenience and necessity issued by the Civil Aeronautics Board It also possesses an air carrier operating certificate issued by the Civil Aeronautics Administration for operations over its various routes. The company maintains a Flight Training Center for its personnel at Denver, Colorado

FLIGHT PERSONNEL

Captain Jordan D Kocher, instructor, age 37, was employed by United Air Lines on July 28, 1944. He held a valid airman certificate with an air transport rating for single and multi-engine land aircraft. Captain Kocher had a total of 5,793 flying hours, of which 2,404 were in DC-3 equipment, and 93 hours of instrument flying time. Captain Kocher received a CAA physical examination on May 28, 1951, and his last company physical examination was accomplished on October 30, 1951 He was temporarily assigned as a flight instructor at the Flight Training Center at Denver on October 24, 1951.

Trainee First Officer Laurence G. Wilson was employed by United Air Lines on September 28, 1951. He was the holder of a valid airman certificate with a commercial pilot rating for single and multi-engine land aircraft. He had a total of 1,250 flying hours, of which 100 were instrument Mr. Wilson had received eight hours and 41 minutes of flight instruction in DC-3 aircraft at the time of the accident. His last physical examination was accomplished on September 1, 1951.

Trainee First Officer Wayne C Moen was employed by United Air Lines on September 28, 1951 He held a valid airman certificate with a commercial rating for single-engine land aircraft Mr Moen had received ten hours and eight minutes of flight instruction in DC-3 aircraft at the time of the accident. He had a total of 990 flying hours, of which 25 were instrument. His last physical examination was accomplished on July 5, 1951.

THE AIRCRAFT

N-17109, a Douglas DC-3A. Serial No. 4999, was owned and operated by United Air Lines, Inc It had a total of 15,041 flying hours and was currently certificated by the Civil Aeronautics Administration. It was equipped with two Pratt & Whitney R-1830 engines, and Hamilton Standard propellers