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CIVIL AERONAUTICS BOARD

ACCIDENT INVESTIGATION REPORT

Adopted: September 30, 1955 Released: October 4, 1955

UNITED AIR LINES, INC., MacARTHUR FIELD, ISLIP, NEW YORK, APRIL 4, 1955

The Accident

A United Air Lines DC-6, N 37512, crashed on MacArthur Field at 1550,1/ April 4, 1955, shortly after becoming airborne. The occupants, two UAL captains and a UAL flight manager, were killed. The aircraft was destroyed by impact and ground fire.

History of the Flight

N 37512, under the command of Captain S. C. Hoyt, UAL New York area flight manager, departed New York International Airport at 1428 on a Visual Flight Rules flight plan for an estimated two-hour flight in the vicinity of MacArthur Field, Islip. The aircraft was properly dispatched on a routine check flight, and Captains V. H. Webb and H. M. Dozier were aboard for the purpose of receiving their periodic instrument proficiency check. Upon completion of the checks, the flight was scheduled to return to LaGuardia Airport.

At 1501 the flight reported to the company by radio that they were "doing air work around Hempstead." Another message was received by the company at 1527 reporting that the flight was going to make an ILS (Instrument Landing System) approach at Islip (MacArthur Field). Shortly thereafter, the flight contacted the MacArthur tower, requesting approval for an ILS approach and landing. Permission was granted by the tower, and a normal landing was made on runway 32. The aircraft was taxied to the intersection of runways 28 and 32 and the crew prepared for takeoff.

The 1532 MacArthur weather observation showed scattered clouds at 20,000 feet, broken clouds at 25,000; visibility over 15 miles; temperature 53; dewpoint 30; wind NNW at 20 knots, gusts to 30 knots. When the flight departed New York International Airport, weather was approximately the same and the forecast for the New York area indicated that it would be similar over the area for the duration of the flight.

At 1548, the MacArthur controller cleared the flight to take position on runway 32 and take off. The aircraft took position on the runway but did not

1/ All times referred to herein are eastern standard and are based on the 24-hour clock.

immediately take off, hence a second takeoff clearance was transmitted at 1550.2/

The gross weight of the aircraft at takeoff from MacArthur Field was approximately 61,050 pounds, which was well below the maximum allowable. The load was correctly distributed with respect to center of gravity limits.

The aircraft became airborne approximately 1,500 to 1,800 feet down the runway. The takeoff appeared normal, as did the initial portion of the climb, and the aircraft remained on the runway heading. When about 50 feet high, the right wing lowered and the aircraft started turning to the right, at which time the landing gear was retracting. The aircraft continued a climbing turn and the degree of bank increased to approximately vertical by the time the heading changed about 90 degrees and the aircraft had attained an estimated altitude of 150 feet. The nose dropped sharply and the aircraft dived into the ground, striking on the right wing and nose. It then cartwheeled and came to rest right side up. An intense fire started and consumed a large portion of the wreckage in spite of the prompt arrival of fire fighting equipment on the field.

Investigation

The wreckage was quite localized. The main portion was 173 feet from the east edge of runway 32 and 321 feet from the north edge of runway 24, about 1,300 feet from where it became airborne. Forward of the front cabin bulkhead, the fuselage structure was destroyed, but the seat belts held. It was ascertained that Captain Dozier was occupying the left seat, Captain Webb the flight engineer's seat, and Captain Hoyt the copilot's seat.

Early in the investigation, the general integrity of the fuselage, wing, and control surfaces was the subject of careful examination to determine if any malfunction or failure occurred during takeoff. No malfunction or failure was indicated by these examinations. The landing gear was retracted at impact and the flaps were extended 15 to 20 degrees (normal for takeoff). The automatic pilot was disengaged. All trim tabs were in place on their hinges and no evidence of failure or malfunctioning was noted. The gust lock was disengaged, and all mixture controls were found in auto rich; these positions were normal for takeoff. No evidence of malfunction or failure in any of the flight control systems was found.

All four engines were severely damaged by impact and fire. No evidence of failure in operation was found in any of the engine wreckage. Examination of the propellers indicated that each engine was developing power at impact, though the degree of power output could not be ascertained.

2/ It is the custom of UAL pilots on check flights to make a final check of significant items after taking position, before starting a simulated instrument takeoff.

The propeller governors were positioned for takeoff r. p. m. No. 4 propeller was rotating in its normal direction at impact but in reverse pitch. The No. 4 propeller shim plates showed that it was in full reverse pitch, or minus eight degrees. Nos. 1, 2, and 3 propellers were found at 34 degrees positive pitch, normal for takeoff. Examination of all four propellers disclosed no evidence of faulty operation.

Examination of all electrical units concerned with control of No. 4 propeller disclosed no evidence of operational malfunction or failure. Examination of additional items of the aircraft's electrical system failed to disclose any system malfunction. All damage observed was determined to have been caused by impact and fire after impact.

The propellers of the DC-6 airplane may be used to provide reverse thrust for braking while the aircraft is on the ground. Propeller reversal is initiated by retarding the throttles aft of the forward idle position at which time an electrical control system is activated causing the blades of the propellers to rotate within their hubs to a position wherein reverse thrust is developed. The extent of engine power and reverse thrust developed is in proportion to the extent of rearward throttle movement. The propellers are unreversed and forward thrust is restored by returning the throttles to the forward idle position or beyond.

While the aircraft is airborne a throttle latch mechanism prevents inadvertent throttle movement aft of the forward idle position and thus prevents unwanted reversal. Operation of the throttle latch is controlled by switches, on the landing gear struts, that close when the aircraft's weight is on the landing gear. This action energizes a solenoid which in turn releases the throttle latch. At the same time the reverse warning flag swings up into view on the control pedestal to show that the latch is out of the way. Mechanically linked to the solenoid, this red metal flag may be raised manually by the crew to operate the latch should the solenoid fail to operate.

When the aircraft becomes airborne the strut switches open and the solenoid becomes de-energized. The latch returns to the locked position and the flag swings down out of sight.

Approximately three years ago United Air Lines, concerned over the possibility of an unwanted inflight propeller reversal due to an electrical malfunction, modified the propeller control circuits of its DC-6 fleet. This modification results in the automatic removal of electrical power from the circuits controlling propeller reversal whenever the aircraft is airborne. Electrical power is restored to these circuits when the aircraft is on the ground. Removal and restoration of electrical power is accomplished automatically through the addition of a relay (known as the H-relay) controlled by switches which are in turn actuated by the throttle latch solenoid. The propeller control circuit of the subject aircraft had been so modified.

Investigation disclosed that once a propeller starts into reverse position it need not cycle completely but can be unreversed from any negative blade angle. Should the propeller become reversed due to movement of the throttle rearward past the forward idle position, while the aircraft is on the takeoff run and, should the aircraft then become airborne in this configuration, the propeller may be unreversed by (1) feathering or (2) lifting the reverse warning flag and advancing the throttle. Raising the flag serves the same function as the landing gear switch when the aircraft is on the ground; i.e. the reverse control system of the propeller is again energized permitting unreversal to take place. If the flag is not lifted when the throttle is moved forward the blades will remain in reverse pitch and the amount of reverse thrust developed will depend upon the amount of throttle applied.

Over the years during which propeller reversing systems have been in use on air transport aircraft, UAL has conducted numerous tests to determine aircraft flight characteristics with various combinations of forward and reverse propeller thrusts. For the most part, these earlier tests were conducted at cruise airspeeds and with cruise power settings, since the greater interest was associated with the effect of an unwanted propeller reversal on the aircraft performance and controllability while in level flight. These flight tests were extremely beneficial to the industry as a whole, and provided needed information relative to procedures to be followed should an unwanted reversal occur while in level flight. Within a few days following this accident UAL conducted another series of flight tests to further investigate, among other things, the effects of a reversed outboard propeller upon the handling characteristics of a DC-6 at low airspeeds.

These tests indicated, among other things, that in the takeoff configuration with METO power or higher on No. 1, No. 2, and No. 3 engines, the aircraft almost immediately became uncontrollable when full power was applied in reverse on No. 4 engine and the aircraft speed was 100 knots or less. In this test the roll was delayed for a short time by using full opposite aileron. The violent yawing continued, however, with an attendant loss of airspeed, and within a few seconds a violent roll and pitch developed. The resulting aircraft maneuver closely approximated the maneuver which N 37512 made.

One of the most significant points developed during the tests related to the positioning of the throttle following an unintentional displacement of the throttle into the reverse range. The tests confirmed the fact that if the throttle is moved into the reverse range during a takeoff run, moving the throttle back into the forward thrust range after becoming airborne will not bring the propeller out of reverse but will only result in increased thrust power. This follows since, as described earlier, the reversing circuity is de-energized upon becoming airborne, and the propeller remains in the reverse range, in which position it was placed while on the ground. Unreversing can only be accomplished under this condition by depressing the feathering button or by raising the reverse warning flag and advancing the throttle.

In the investigation, computations were made to determine what the V_1 and V_2 speeds would have been for the aircraft at the time of takeoff.3/ This

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3/ V_1 - Critical engine failure speed, with adequate control to permit continuance of takeoff.

V_2 - Minimum takeoff safety speed, permitting a specified rate of climb.

brought out that the V_1 speed was approximately 80 knots and the V_2 speed approximately 92 knots. The takeoff distance, as measured, showed that the aircraft became airborne at about V_2. Witnesses stated that the takeoff appeared normal in all respects.

UAL's instrument proficiency check procedures were studied by Board investigators, and the sequence in which Captain Hoyt usually introduced the various check items was ascertained from persons familiar with his check technique. It was found that he consistently gave airwork items, a radio range problem, and an ILS approach and initial landing at MacArthur, in that order, and conscientiously followed UAL's thorough check procedures. When Captain Hoyt was checking two captains, he would usually give both of them the airwork and range problem before the ILS approach was made. The pilot who made the landing at MacArthur would then be told to make an instrument takeoff and advised that he would be given a simulated failure of an outboard engine on takeoff. After this was accomplished they would change seats in the air and the other pilot would then be checked on his ILS approach and landing, and on his instrument takeoff, with a simulated engine failure.

Company instructions specify that the simulated engine failure will be accomplished by reducing power to zero thrust. This is about 1,200 r. p. m., or 300 r. p. m. more than forward idle. In testimony interpreting flight manual instructions on when the power reduction is to be initiated, UAL's director of flying stated that the power reduction will be made in the vicinity of and following V_2. The manager of flight operations for the New York area further advised that the throttle reduction is started on the ground and zero thrust position is reached shortly after becoming airborne. Climb should be made at V_2. At least three seconds are to be taken in retarding the throttle steadily and positively; this is to prevent snapping or chopping the throttle back, with attendant difficulty in maintaining control of the aircraft. On a check flight shortly before the accident, a CAA Aviation Safety Agent noted that Captain Hoyt took five or six seconds to retard the throttle to zero thrust in a positive and deliberate manner.

The company also has instructions that the check pilot will consider several factors, such as wind conditions, location of buildings on the airport, and the proximity of congested areas near the airport, in selection of the outboard engine on which he will simulate failure. In this case, No. 4 engine was the proper one for the simulated failure. Investigation revealed that check practices employed by Captain Hoyt consistently conformed with these instructions.

The UAL manager of flight operations for the New York area, who was Captain Hoyt's senior, testified that Captain Hoyt would logically have given an instrument takeoff and simulated engine failure at this point in the check. He also stated that all three pilots were considered quite competent.

Following acquisition of DC-7 equipment and favorable operating experience with the sequence gate latch (or Martin bar) on those aircraft, UAL decided to equip its DC-6 and DC-6B aircraft with the device. In principle, it consists of a bar placed across the throttles at the idle position. It may be moved out of the way by the pilot when he wishes to pull the throttles back into reverse; when in position, it is impossible to pull the throttles into reverse. Orders were placed for the Martin bar kits several months prior to this accident and the first DC-6 was modified about a week before the accident occurred. UAL expects to have its DC-6 and DC-6B aircraft modified with the Martin bar by February 1956. A UAL engineer testified that although the present propeller control system has functioned quite satisfactorily, the mechanical lock feature of the Martin bar (actuated by the pilot) should make it a more reliable and safer device than the previous installation (as in this aircraft), with its numerous switches, relays, and automatic operation.

Reverse thrust indicator lights were not installed on N 37512. At the time of the accident a program was in being to install them on UAL DC-6 and DC-6B aircraft. The light comes on as warning to the pilot that a propeller is reversing when the propeller, in the UAL installations, passes the zero degree blade angle.

The company, the aircraft, and the crew were currently certificated.

Analysis

The flight experiments showed that at takeoff configuration and airspeed, the aircraft will become uncontrollable with an outboard propeller in reverse pitch and its engine operating at full power. Control will be lost so quickly that there is little, if anything, that the pilot can do if it occurs at low altitude. He must recognize what is occurring, analyze it, and take action to unreverse in a very limited amount of time. It is doubtful that unreversing could have been accomplished in this instance before control was lost. Owing to the time element, it is also questionable that propeller reversing warning lights would have been of any aid in this instance.

The tests brought out that if the throttle of the reversed propeller is at either forward or reverse idle, the engine will stall when the aircraft is airborne. There was evidence that the No. 4 engine was running at impact. The tests also showed that in order to approximate a flight path similar to that of N 37512, full reverse power was required on No. 4 engine (with the propeller in reverse), and the other three engines developing METO power. Further, it would be a natural reaction for the pilot to move the throttle from the reverse range in an effort to unreverse. However, if the reverse warning flag were not lifted, additional reverse power would continue to be delivered. These pieces of evidence lead to the conclusion that the throttle was in some position other than idle and an undetermined amount of reverse thrust was being delivered.

The reverse pitch position of the No. 4 propeller could have been the result of (1) failure or malfunction in the propeller control system, or (2) unintentional action by the check pilot in retarding the throttle too far just before becoming airborne.

Examination of all relays, switches and other components of the electrical system of No. 4 propeller failed to disclose any evidence of operational failure or malfunction. It is reasonable to conclude, therefore, that propeller reversal did not occur as a result of electrical system failure or malfunction.

Investigation showed several things which indicate an instrument takeoff and simulation of engine failure. In accordance with company requirements, No. 4 was the proper engine to select for the simulated failure; this was the logical point in the check to give these two items; and the short delay at the end of the runway coincided with the practice of making a final check of all items before an instrument takeoff. An instrument takeoff would normally be followed by a simulated engine failure; had an instrument takeoff not been made, there might be some question that a simulated engine failure was given. These things, plus the fact that examination of the propeller control system produced nothing indicating malfunction, make it more probable that the pilot unintentionally brought the throttle too far back rather than a malfunction having occurred.

The Martin bar, or sequence gate latch kits were being delivered to UAL at the time of this accident, as earlier reported, and installation was proceeding as fast as deliveries could be made. UAL's decision to install the Martin bar was predicated on its belief that the device was a simpler and more positive means of reducing the possibility of unwanted reversals. Recognizing these desirable features, and on the basis of service experience, the CAA on August 29, 1955, issued Airworthiness Directive 55-18-2 which required that DC-6 and DC-6B aircraft (among others) be equipped with the sequence gate latch, or equivalent, by January 1, 1957.

It should be noted that the circumstances of this accident were entirely peculiar to pilot proficiency testing and would not occur in scheduled operation, for the reason that a throttle would not be retarded in scheduled operation to simulate engine failure. To do so requires considerable rearward movement of the throttle, and normal power reductions fall far short of this amount of retardation.

Findings

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

1. The carrier, the aircraft, and the crew were currently certificated.

2. The gross weight of the aircraft was less than the maximum allowable and the load was properly distributed.

3. The aircraft was airworthy, and weather conditions good for a standard instrument proficiency check on a VFR flight plan.

4. No evidence of failure or malfunctioning of the structure powerplants, propellers, or electrical system was found.

5. In reducing power to zero thrust during an instrument takeoff with a simulated engine out, No. 4 propeller was unintentionally reversed before the aircraft became airborne.

6. Evidence indicated that No. 4 throttle was moved out of reverse by the pilot into the forward position in an attempt to unreverse, but the reverse warning flag was not lifted, resulting in increased reverse thrust.

7. An outboard propeller on a DC-6 reversing as the aircraft becomes airborne, in conjunction with high power output of the other three engines, at takeoff configuration and airspeed causes the aircraft to become almost immediately uncontrollable.

8. There was insufficient time and altitude for any pilot corrective measures to become effective.

Probable Cause

The Board determines that the probable cause of this accident was unintentional movement of No. 4 throttle into the reverse range just before breaking ground, with the other three engines operating at high power output, which resulted in the aircraft very quickly becoming uncontrollable once airborne.

BY THE CIVIL AERONAUTICS BOARD:

/s/ ROSS RIZLEY

/s/ JOSEPH P. ADAMS

/s/ JOSH LEE

/s/ CHAN GURNEY

/s/ HARMAR D. DENNY

S U P P L E M E N T A L   D A T A

Investigation and Hearing

The Civil Aeronautics Board was promptly notified of this accident by telephone. 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 New York, New York, on May 26, 1955.

Air Carrier

United Air Lines, Inc., a Delaware corporation, has its general offices at 5959 South Cicero Avenue, Chicago, Illinois. The company holds a certificate of public convenience and necessity issued by the Civil Aeronautics Board authorizing the carriage of passengers, property, and mail. It also possesses an air carrier operating certificate issued by the Civil Aeronautics Administration.

Flight Personnel

Captain Stanley C. Hoyt, age 45, had been employed by United Air Lines since June 2, 1937. He held a valid airman certificate with an airline transport pilot rating, check pilot rating, and dispatcher's certificate, as well as type ratings for several transport aircraft. He had 9,763 pilot hours, of which 549 were in DC-6 equipment, and 666 hours instrument time. Captain Hoyt had been a Flight Manager since August 1, 1952, and a check pilot since September 22, 1952. He received his last line check on February 2, 1955, and his last instrument check on February 10, 1955. Captain Hoyt received his last first-class CAA physical examination on March 22, 1955. He had nearly 94 hours rest period prior to this flight.

Captain Henry M. Dozier, age 40, had been employed by United Air Lines since October 1, 1942. He held a valid airman certificate with an airline transport pilot rating and aircraft type ratings for several transport aircraft. He had 9,018 pilot hours, of which 1,156 were in DC-6 equipment, and 604 hours were instrument flying time. Captain Dozier received his last line check on August 19, 1954, and his last instrument check, prior to the one he was taking, on December 3, 1954. His last first-class CAA physical examination was taken on March 31, 1955. Captain Dozier had over 215 hours rest period prior to the subject flight.

Captain Vernis H. Webb, age 35, had been employed by United Air Lines since October 5, 1944. He held a valid airman certificate with an airline transport pilot rating and type ratings for several transport aircraft. Captain Webb had 9,454 pilot hours, of which 878 were in DC-6 equipment and 500 were instrument flying time. His last line check was given on January 21, 1955, and his last instrument check, prior to the one he was on, was received on December 7, 1954. Captain Webb received his last first-class CAA physical examination on December 10, 1954. He had a rest period of 114 hours prior to this flight.

The Aircraft

N 37512, a Douglas DC-6, serial number 43001, was owned and operated by United Air Lines, Inc. It had a total of 22,068 flying hours and had undergone a 1,500-hour inspection 105 hours before the accident. The inspection time interval on United Air Lines DC-6 aircraft is 125 hours. It was equipped with four Pratt and Whitney R2800-CB16 engines and Hamilton Standard 43E60-317 propellers.