File No. 1-0107

CIVIL AERONAUTICS BOARD

ACCIDENT INVESTIGATION REPORT

Adopted: April 2, 1958 **Released:** April 7, 1958

PIEDMONT AIRLINES, DC-3C, N 3947A,
CHARLOTTESVILLE, VIRGINIA, OCTOBER 2, 1957

The Accident

On October 2, 1957, at approximately 1211,[1/] the landing gear of a DC-3 collapsed as the aircraft was being taxied to the ramp. The aircraft, which was leased to Piedmont Airlines by the U. S. Navy Department, sustained substantial damage. No one was injured.

History of the Flight

N 3947A departed Washington, D. C., at 1130 as Flight 85. Its destination was Knoxville, Tennessee, with intermediate stops scheduled at Charlottesville, Lynchburg, and Roanoke, Virginia; Bluefield and Princeton, West Virginia; and Tri-Cities, Tennessee.

The gross takeoff weight was 23,845 pounds, well under the maximum allowable of 25,346. The load was correctly distributed within the allowable center of gravity limits.

The flight to Charlottesville was made in VFR weather conditions and was routine and uneventful. The copilot was flying the aircraft from the right seat and the captain was performing the duties of copilot. As the flight approached Charlottesville the wind was determined to be southerly and the crew elected to land on runway 21. A normal landing and rollout was made with the copilot still handling the flight controls.

After the landing roll was complete the aircraft was turned around on the runway and taxied approximately 300 feet to a taxiway. A 90-degree right turn was then made and the aircraft taxied an additional 531 feet. As the aircraft approached the ramp the captain took over the controls. At this time both main landing gears collapsed. No fire occurred; however, the aircraft sustained substantial damage. The crew and the 14 passengers deplaned immediately.

Investigation

The cockpit of N 3947A had been secured by the crew immediately following the accident. Inspection revealed that the landing gear selector valve handle was in the NEUTRAL position. The mechanical latch was locked in the POSITIVE LOCK position. The hydraulic fluid level in the right gauge was normal. The hydraulic system pressure gauge indicated 750 pounds pressure and the landing

1/ All times are eastern standard based on the 24-hour clock.

gear pressure indicated zero. When the battery master switch was turned on, the landing gear warning light indicated a red or unsafe gear condition. The landing gear warning horn properly sounded when the throttles were retarded past a point about one-third of their full travel.

Each main landing gear on the DC-3 consists of a wheel assembly mounted between two shock absorber struts which are attached to a truss. The truss is hinged to allow it to retract or extend the wheel when hydraulic pressure is directed to the proper side of an actuating strut. The upper end of this strut attaches to the nacelle structure and the lower end attaches to the movable truss on the landing gear. When the landing gear selector handle in the cockpit is moved, hydraulic pressure is directed to the actuating strut which either extends or retracts, thus actuating the landing gear.

A spring-loaded safety latch is installed in each nacelle on the forward face of the front spar. When the landing gear is fully extended the latches engage a hook slot at the lower end of each actuating strut piston, thereby locking the landing gear in safe landing position to the front spar.

The latches are controlled simultaneously through a system of cables and pulleys operated by a single control handle on the floor in the cockpit. The latch control system is connected by levers to a catch on the landing gear selector handle in such a manner that the latches must be raised manually before the landing gear selector can be moved to the UP position to retract the gear.

The safety latch control has three positions: UP LATCH, SPRING LOCK, and POSITIVE LOCK. When the control is moved to the UP LATCH position, the safety latches (spades) in the nacelle are raised clear of the hook slots on the ends of the actuating struts. The gear can then be retracted by raising the landing gear selector handle to the UP position. When the selector handle is returned to NEUTRAL, the latch control handle automatically moves to the SPRING LOCK position. In this position the safety latches are returned to the full down position and are held in place by spring tension. As the gear extends, the hooks on the ends of the actuating struts raise the latches which are then dropped into the hook slots by the spring tension when the gear is fully extended.

When the latch control is placed in the POSITIVE LOCK position a cable actuated piston exerts a pressure of 100 pounds/square inch on the latches, which prevents them from being withdrawn from the hook end slots.

Several signal systems are incorporated into the landing gear mechanism. A warning horn operated by microswitches sounds whenever either or both throttles are closed, if one or both wheels are retracted or unlatched, or if the landing gear selector handle is not in the NEUTRAL position. Warning lights are operated by a switch connected to the landing gear selector handle. This switch is also connected to the switches on each landing gear. When both wheels are down and locked and the selector handle is in NEUTRAL, a green light comes on in the cockpit. If either wheel is retracted or not locked or the selector handle is not in NEUTRAL, a red light comes on.

If for any reason the safety latches cannot be engaged it is still possible to land and taxi the DC-3 safely. The landing gear selector handle is placed in the DOWN position. When the gear has fully extended and the landing gear pressure has built up equal to the system pressure (750 pounds/square inch), the landing

gear selector handle is returned to the NEUTRAL position. Hydraulic fluid pressure is thus trapped in the down lines against the actuating strut pistons preventing their retraction. In this condition the warning horn will sound and the red light will stay on since both are connected to the safety latches. When brakes are applied the resulting rotative force will have a tendency to cause the landing gear partially to retract, moving the pistons up in the actuating struts and resulting in an increased pressure in the landing gear down lines. If care is not exercised, the increased pressure could become high enough to rupture the down line and allow the gear to collapse.

Examination of the aircraft revealed that the left landing gear was in the fully retracted position and was not damaged. Its mechanical safety latch was found to be undamaged and in the full down position.

The right landing gear was also found in the fully retracted position. However, the inboard side of the wheel axle had broken through the nacelle structure and was forced upwards four inches beyond its normal travel. Its mechanical safety latch was also found in the full down position and undamaged.

When the aircraft was raised the mechanical safety latches were tested. Both were found to be rigged properly and held in the POSITIVE LOCK position under proper cable tension. The mechanical latch cockpit control was then placed in the SPRING LOCK position and the landing gear allowed to fall. The left landing gear locked down with slight hand pressure. The right landing gear fell to the full down position but the mechanical safety latch would not enter the strut end hook slot to lock the gear down.

The right landing gear actuating cylinder hydraulic down line was found to be ruptured. The hydraulic fluid which had been trapped in this line was found in the nacelle and on the pavement directly below the nacelle. It was determined that the rupture of this line resulted in loss of the landing gear hydraulic pressure, allowing the aircraft to settle abruptly. The weight of the aircraft then forced the gear up beyond its normal travel and the severe twisting moment to which it was subjected bent the actuating strut end hook. This slight bend caused a binding which prevented the mechanical safety latch from entering the strut end hook. When the strut end hook was replaced this gear would lock in the down position with slight hand pressure.

After this repair the landing gear was cycled a number of times and it operated normally each time. The gear warning system was also checked and all indications were proper and normal during each operation.

A careful inspection of the entire landing gear system showed that it was operating properly. All clearances were found to be within their respective tolerances. Rigging of cables and pulleys was proper and no binding or malfunction could be found. With the exception of the above noted damage, all components of the system were in good condition.

It was determined that all damage noted was the result of the collapse of the landing gear. No mechanical defect or irregularity could be found which could have interfered with the proper operation of the landing gear. In addition, no malfunction in the operation could be induced which would cause the landing gear to operate incorrectly.

The aircraft was then test flown and the landing gear cycled several times. Each time the gear was extended it would lock down properly and the warning system indicated correctly. In several of the tests the mechanical latch handle was placed in the POSITIVE LOCK position before the landing gear was lowered. In every case the strut end hook raised the safety latch against the cable tension of the latch actuating mechanism and permitted the latch to position itself correctly in the strut end hook and thus lock the gear down normally.

The crew stated that the flight had been routine. They said that in preparation for landing at Charlottesville they had followed the usual checklist. The landing gear was lowered and each pilot checked visually to see that the gear on his side extended. The hydraulic pressure was allowed to build up in the landing gear system to 750 pounds/square inch. The mechanical latch on the cockpit floor was then engaged and the gear selector handle was returned to NEUTRAL. Both pilots stated that after the gear was extended the green "gear safe" light indicated the landing gear was down and locked; further, that both throttles were closed on the flareout before touchdown and that if the gear had not been locked at that time the landing gear warning horn should have sounded. At no time during the landing, the rollout, or the taxiing to the ramp did the crew note any indication of an unsafe gear condition. However, simultaneously with the collapse of the gear at the ramp the warning horn sounded and the red warning light came on.

Both pilots were also positive that the gear had been properly extended and locked. Both testified that the landing gear controls had not been moved after the gear was lowered and locked and that no controls were moved after the gear collapsed at the ramp.

Analysis

The landing gear on the DC-3 is relatively uncomplicated in design and its reliability has been proved by many years of successful use. It is also foolproof in operation providing all cables, pulleys, struts, etc., are properly rigged and clearances are correct.

The examination of the landing gear on N 3947A showed that no defect existed in the system prior to the collapse.

Both safety latches were found in the POSITIVE LOCK position with the hooks withdrawn. In addition, the safety latch control in the cockpit was latched to the floor. In order for both gears to collapse as they did both safety latches would have had to have jammed in the UP LATCH position. This possibility is extremely unlikely and no evidence was found on either latch mechanism which could have caused a double failure such as this. In addition, the latch spade mechanism is actuated by a cable and pulley arrangement and if one or both of the latches had hung up it would have required considerably greater than normal force to latch the cockpit control. Further, even if by some almost impossible chance one or both latches had hung up and the cockpit control could be properly latched, the red "Unsafe" warning light would have come on in the cockpit and the warning horn would have sounded. This would also have been evident during the examination of the aircraft because for such to have been possible the rigging of the latching mechanism would have had to have been improper. It was not.

It would have been impossible for the landing gear to retract with the safety latches properly engaged in the hook end slots without considerable damage to the latch mechanisms or the hooks. The only damage noted was a slight bend in the actuating strut end hook for the right gear. This damage occurred as the gear twisted when it was forced up beyond its normal travel by the abrupt settling of the aircraft. Here again, even if this damage had been present prior to the collapse it would have been evident. First, if the gear would not lock down, the red warning light would have stayed on and the warning horn would have sounded. Second, the left landing gear would not have been affected and would have locked down safely.

The hydraulic down line which was found ruptured was determined to have burst as a result of excessive pressure. This line could not have failed before the gear was extended for landing. If it had, when the gear selector handle was placed in the DOWN position the hydraulic fluid in the main system would have been lost. When the aircraft was examined the hydraulic fluid level was normal. In addition, a small amount of hydraulic fluid that had been trapped in the down line was found under the aircraft on the ramp, indicating that the line had burst after the aircraft had reached this point.

The failed hydraulic down line also indicates the way this accident happened. In order for the line to have ruptured as it did, the landing gear selector handle had to have been in NEUTRAL with the latches in the UP LATCH position. In any position other than NEUTRAL, excessive pressure, built up as a result of the partial collapse of the gear, would have been relieved through pressure relief valves. Further, if the safety latches had been engaged in the hook end slots the gear retraction would have been prevented by the mechanical latch.

In summary, the Board concludes that for this accident to have occurred in the manner indicated by the crew a number of simultaneous malfunctions would have had to have occurred. First, both safety latches would have had to hang up and then seat themselves properly after the collapse. Second, the cockpit latch control would have had to have been misrigged and then have corrected itself when the latches were forced to the full down position after the gear had collapsed. Third, the three microswitches operating the landing gear warning system would have had to have not only failed but would have also had to reverse normal functions, giving a green gear safe light instead of a red unsafe light. This condition also would have had to have corrected itself when the aircraft settled. Fourth, the landing gear warning horn would have had to have been inoperative and then have corrected itself.

In the absence of evidence to substantiate any such malfunctions, the Board must conclude that no mechanical failure occurred which even contributed to the cause of this accident.

Findings

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

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

2. The flight was routine and no mechanical difficulties were experienced by the crew.

3. According to the crew the landing gear was extended and locked properly as the aircraft was prepared for landing and a green "gear safe" indicator light came on in the cockpit.

4. A normal landing and rollout was made.

5. As the aircraft approached the ramp both main gears collapsed.

6. Several simultaneous malfunctions would have had to occur for the landing gear to collapse while a "gear safe" condition was indicated.

7. Examination showed there was no malfunction in the landing gear, landing gear safety latch mechanisms, or landing gear warning systems.

Probable Cause

The Board determines that the probable cause of this accident was that the cockpit landing gear safety latch lever was accidentally or inadvertently moved to the UP LATCH position while the aircraft was being taxied to the ramp.

BY THE CIVIL AERONAUTICS BOARD:

/s/ JAMES R. DURFEE

/s/ CHAN GURNEY

/s/ HARMAR D. DENNY

/s/ G. JOSEPH MINETTI

/s/ LOUIS J. HECTOR

SUPPLEMENTAL DATA

Investigation and Taking of Depositions

The Civil Aeronautics Board was notified of this accident on the afternoon of October 2, 1957. An investigation was immediately initiated in accordance with the provisions of Section 702 (a) (2) of the Civil Aeronautics Act of 1938, as amended. Depositions, ordered by the Board, were taken in the CAB offices in Washington, D. C., on November 12, 1957.

Air Carrier

Piedmont Aviation, Inc., the parent company, conducts a general aircraft sales and service type of operation. The company is incorporated in the State of North Carolina with its principal offices in Winston-Salem, North Carolina. In December 1947 the company established the Piedmont Airlines Division. The company operates under a currently effective certificate of public convenience and necessity issued by the Civil Aeronautics Board and an air carrier operating certificate issued by the Civil Aeronautics Administration. These certificates authorize the company to transport by air persons, property, and mail between various points in the continental United States, including the route involved.

Flight Personnel

Captain Howard Coe Kelly, age 43, was employed by Piedmont Airlines March 22, 1948. He had accumulated a total of 12,110 flying hours, of which 8,282 were in DC-3 equipment. Captain Kelly held a valid airman certificate with an airline transport rating and type rating in the DC-3. His latest six-month proficiency check was May 28, 1957, and his last en route check was April 24, 1957. He had passed his CAA physical May 20, 1957. Captain Kelly had flown 46 minutes in the preceding 24-hour period and 2 hours, 28 minutes total in the preceding seven days.

Copilot Fred Kozak, age 29, was employed by Piedmont Airlines March 17, 1953. He held a valid airman certificate with commercial privileges, airplane single-engine land, and instrument ratings. Mr. Kozak had a total of 2,095 flying hours, of which 1,871 were in the DC-3. His latest copilot proficiency check and instrument certification was in August 1957. His last CAA physical was passed January 25, 1957. Mr. Kozak had flown 46 minutes in the preceding 24-hour period and nine hours, four minutes total in the preceding seven days.

The Aircraft

Douglas DC-3C, N 3947A, company identification 58V, manufactured January 1944, was owned by the U. S. Navy Department and leased to Piedmont Aviation, Inc., Winston-Salem, North Carolina, the operator. It had a total of 7,780 flying hours, and a total of 3,929 flying hours since overhaul. The total time on the landing gear was 7,780 and the total time since the No. 4 maintenance check, when the last landing gear retraction test was performed, was 639. Several minor landing gear discrepancies were corrected at that time. The landing gear rigging and microswitches were inspected and passed on the last No. 2 inspection performed September 21, 1957. The aircraft had flown 64 hours since that check. The aircraft was equipped with Pratt and Whitney engines, model R1830-92, and Hamilton Standard propellers, model 23E50.

W201

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Administrator of Civil Aeronautics

April 7, 1958

Civil Aeronautics Board

Report of the C.A.B. on an accident which occurred on October 2, 1957, at Charlottesville, Virginia, involving an aircraft operated by Piedmont Airlines.

There is transmitted a report on the investigation of an accident which occurred on October 2, 1957, at Charlottesville, Virginia, involving a DC-3C, N 3947A, operated by Piedmont Airlines.

(Signed) M. C. Mulligan

M. C. Mulligan
Secretary

Attachment
AMC
CC: Deputy Administrator-CAA