CIVIL AERONAUTICS BOARD

ACCIDENT INVESTIGATION REPORT

Adopted: November 19, 1951 Released: November 23, 1951

MID-CONTINENT AIRLINES, INC., TULSA, OKLAHOMA, FEBRUARY 27, 1951

THE ACCIDENT

At approximately 1303,[1] February 27, 1951, a Convair 240, N-90664, owned and operated by Mid-Continent Airlines, crashed and burned following take-off from the Tulsa Municipal Airport, Tulsa, Oklahoma. All 29 passengers and crew of four escaped without serious injury.

HISTORY OF THE FLIGHT

The flight departed Minneapolis, Minnesota, at 0746, on February 27, 1951, for Houston, Texas, via scheduled intermediate points. A crew change was made at Kansas City, Missouri, and no mechanical discrepancies were reported by the incoming crew with the exception that the left engine torque meter pressure indication was approximately 90 PSI; the normal being approximately 145 PSI. The flight departed Kansas City and proceeded in a routine manner to Tulsa, arriving at 1244. The left engine torque meter pressure indicator was considered inoperative because of its low reading, and was, therefore, disregarded during the flight.[2] Following touchdown at Tulsa, the propellers were placed in reverse thrust, and when being returned to positive thrust, the left propeller went to the full feathered position and the engine ceased operation. While taxiing to the loading ramp, attempts were made to start the left engine but were not successful. On departure from Tulsa, no difficulty was encountered in starting the left engine, and the propeller which was in the full feathered position was returned to the low pitch position by use of the propeller governor control.

Take-off was accomplished from Tulsa at 1302, with 29 passengers, including one infant, and a flight crew consisting of Paul C. Walters, captain; Forrest A. Hull, copilot; Cecelia Littell and Joan Stoltenberg, the two stewardesses. Total aircraft weight was 40,304 pounds, which was within the allowable gross weight of 40,500 pounds, and the load was distributed so that the center of gravity was within the certificated limits.

Prior to take-off, the engines were run up and the pre-flight check accomplished using a check list. All items checked satisfactorily, with the exception that the left engine torque meter pressure indicator was abnormally low. Flaps were positioned at 24 degrees for take-off. The take-off roll was started on Runway 12, and the signal devices in the cockpit indicated that the automatic feathering unit and the anti-detonation injection unit were functioning.

During the take-off roll, the copilot called out the following indicated air speeds: Vmc, 107 miles per hour; V_1, 121 miles per hour; and V_2, 122 miles per hour.[3] The aircraft became airborne at 124 miles per hour, or slightly higher. The landing gear was immediately retracted and the air speed was then observed to be 145 miles per hour. At this time, at an altitude estimated to be

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

[2] Engine torque meter pressure indicators in the cockpit are not required flight equipment by the Civil Air Regulations, and a flight can be conducted with both indicators inoperative.

[3] Definitions:

Vmc—The minimum speed at which the airplane can be maintained in straight flight after an engine suddenly becomes inoperative. Section 4b.129, Civil Air Regulations

V_1—The critical engine failure speed, a true indicated air speed, chosen by the applicant, which shall not be less than the minimum speed at which the controlability is demonstrated during take-off run to be adequate to permit proceeding safely with the take-off using normal piloting skill when the critical engine is suddenly made inoperative. Section 4b.95, Civil Air Regulations

V_2—The minimum take-off climb speed with the critical engine inoperative.

Section 4b.95, Civil Air Regulations.

not over 50 feet, the left propeller was observed to feather and then immediately to rotate slowly. It continued to rotate until the aircraft struck the ground.

The crew first became aware that the left engine was malfunctioning when a severe vibration was felt immediately after the gear had been retracted and at the same time the aircraft yawed to the left momentarily. Both engine controls were left at the take-off setting, and a single-engine climb was then initiated. The air speed decreased to approximately 124 miles per hour during the climb to a maximum altitude of approximately 150 feet. At this point, since it was doubtful that this air speed could be maintained, the aircraft was leveled off and a shallow turn to the left was made to avoid flying over a building.[4] As the aircraft started turning at an approximate air speed of 122 miles per hour, the captain, according to the copilot, gave the command to retract the flaps from the 24-degree position to the 12-degree position. The copilot states that he immediately executed the command, stopping the retraction of the flaps at 12 degrees. The captain states that he gave the following command, ".... 12-degree flaps. No, leave them where they are." However, the captain testified that the command was given when the air speed was 107 miles per hour and at a point approximately 3000 feet further along the flight path than where the copilot stated he retracted the flaps.

While in the left turn, the aircraft was observed to lose altitude steadily until it struck a grove of trees at a point approximately 17 feet above the ground. After striking the trees it slid on the ground on the underside of the fuselage. All passengers and crew were evacuated safely and in an orderly manner. The aircraft was destroyed by fire.

INVESTIGATION

The aircraft made contact with the ground on a heading of 30 degrees, slid 540 feet and turned anti-clockwise to a heading of approximately 310 degrees as it came to rest. Both fuel tanks ruptured, and the fire that followed consumed all of the fuselage forward of the tail section. The right wing and part of the center section were torn from the aircraft by impact with a tree and were subsequently destroyed by fire. Approximately 22 feet of the inboard section of the left wing was destroyed by fire, but the remaining outer section was intact.

The nose gear and main landing gear were found in the "up" and "locked" position.

An examination of the wing flap gear box and allied mechanism indicated that the wing flaps were in the "up" or "near up" position at the time of impact. This was further substantiated by an examination of the left inboard flap cable drum which showed that the "up" flap cable was almost fully wound on the drum and the roller carriage was in the "up" position. Also, an examination of the impact abrasions on the underside of the undamaged portion of the left wing and flap revealed that they were in line only when the flap was extended to approximately the four-degree position.

An examination of the flap position transmitter installation showed that the set screw did not project through the wall of the actuating shaft far enough to make contact with the transmitter shaft. It is possible that this condition could result in slippage in the installation which might give a false indication of the flap position on the cockpit indicator. The crew stated that the flap indicator appeared to be functioning normally prior to the accident. Furthermore, because of the very low torque required to rotate the transmitter shaft (a fraction of an inch - pound), it is not believed that slippage is likely. Several installations were checked by the manufacturer following the accident, and there was no interruption of flap indication, even when the set screw was removed completely from the actuating arm.

No evidence was found which would indicate a failure or malfunction of any of the flight controls or their mechanisms. There was also no evidence of any structural failure of any of the components of the aircraft prior to the accident, with the exception of the torque piston assemblies in the engine nose section. A review of the maintenance records

[4] An aircraft plant 76 feet high, 4000 feet long, and at a right angle to the runway. It is approximately 1500 feet from the end of the runway.

of the aircraft indicated that it should have been airworthy at the time of take-off.

Both engines were completely detached having separated at the motor mount members. The propellers with the blades bent or broken, but otherwise intact, remained on the propeller shaft; however, all portions of the broken propeller blades were recovered. The left propeller was found set at 28-degree blade angle position, and the right propeller at 14-degree blade angle position.

A damage survey of both engines indicated that they could be operated after making minor repairs. These repairs were accomplished and the engines run in a test cell. The right engine operated satisfactorily at full power and produced approximately the same horsepower that it did on the test run following the last overhaul. When the left engine was run, it was found that the torque boost and torque pressures were abnormally low, and as the oil temperatures increased, these pressures decreased. After 10 minutes of operation, the engine was stopped and the nose section removed. It was found that the torque meter piston and ballend assembly in the No. 5 position had failed. The ballend had broken adjacent to the flange, and the ballend and slipper bearing were out of position. Also, four of the remaining five torque meter pistons were cracked or broken in varying degrees.[5]

These failures resulted in a decrease in torque boost and torque pressures due to excess oil flow past the torque indicator pistons. These were progressive failures as indicated by the decreasing pressure reading of the left engine torque meter previous to the accident. Although the failures did not affect the operation of the engine, they did cause a sufficient decrease in torque pressure to actuate the auto feathering system which feathered the left propeller. Since the left engine controls remained at take-off power settings after the propeller feathered and the ignition switch remained on, the engine continued to operate. Operation of the engine following feathering was erratic due to upset carburetor metering and unequal mixture distribution to the cylinders. Since the propeller governor senses only rpm, it caused the propeller to move out of the full feathered position due to normal governor action. This latter action also contributed to the continued rotation of the propeller following its feathering operation. The low speed rotation of the propeller accounts for the vibration noted by the crew. Furthermore, flight tests subsequently conducted by the operator conclusively revealed that rotation of the propeller will continue following feathering if the ignition switch and anti-detonate injection remain on due to leakage of fluid through the ADI system.

Following the accident, the manufacturer of the aircraft conducted flight tests under conditions comparable to those existing at the time of the accident. These tests indicated that the aircraft is able to maintain altitude in a shallow turn at an air speed of 124 miles per hour with one engine developing take-off power, the other engine windmilling at 1000 rpm, and the flaps set at 24 degrees. Since reduction in the flap deflection decreases lift, it is apparent that increased air speeds are necessary to maintain altitude with lesser flap deflections. Conversely, if the air speed is held at 124 mph while the flap deflection is reduced from 24 degrees, as it was in this instance, it is also apparent from the test results that the aircraft will lose altitude. These tests also indicate that if the turn had not been made the aircraft would have continued to climb.

A review of the company's approved Convair 240 training program revealed that pilots were required to complete a transition course incorporating all pertinent operational procedures applicable to the aircraft. This included flights under emergency procedures of simulated single engine operation following take-off. The program also included indoctrination of speeds and flap

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[5] Since the accident the engine manufacturer has issued the following Service Bulletin No. 1212, dated May 8, 1951:

"In order to provide increased durability, the torque meter pistons in the torque meter piston and ballend assemblies have been progressively improved as follows: 1) shot peening on the forward side of the web, 2) increased cross sectional area at the junction between the web and journal, 3) large fillet radii between the web and journal.

It is recommended that, at overhaul of subject engines, only the torque meter piston and ballend assemblies having the above improvements be used ....."

settings for the best climb configuration of the aircraft under certain load conditions. Both Captain Walters and First Officer Hull had satisfactorily completed this course.

At the time of the accident the weather was reported by the U. S. Weather Bureau to be as follows: Ceiling unlimited, thin scattered clouds 25,000 feet, visibility more than 15 miles, temperature 69 degrees, dew point 42 degrees, wind from the south-southeast at nine miles per hour, and altimeter setting at 29.92 inches.

ANALYSIS

In reconstructing this flight, it appears that the captain was confronted with a series of circumstances during take-off which required the utmost judgment and skill. With the left engine producing erratic power due to upset carburetor metering and unequal mixture distribution, the propeller continued to rotate at irregular rpm. This would have caused vibration and buffeting of the aircraft. Furthermore, the indicated air speed decreased from 145 miles per hour to 122 miles per hour, at which time the aircraft was leveled off at approximately 150 feet altitude. At this low air speed, the aircraft was subjected to pre-stall buffeting which would increase with a further progressive decrease in air speed which occurred in this instance. The aircraft was loaded to within 196 pounds of its approved maximum take-off weight limitations, and under the foregoing conditions, the captain elected to make a left turn for fear that the aircraft would not retain the altitude gained to clear a building 76 feet high in line with the take-off path. It was at this time, or shortly thereafter, that the flaps were retracted, following which the air speed was noted to be 107 miles per hour. The captain's concern for the safety of the flight and his decision to make the turn away from the hangar is justified; however, his decision to retract the flaps even to the 12-degree position with decreasing air speed is not consistent with the approved Convair 240 single-engine operation procedures, as previously stated in this report.

The testimony of the captain and copilot differ as to the location of the aircraft at time that the flaps were retracted. However, a preponderance of the testimony disclosed that the aircraft lost altitude at the beginning of the left turn, and it is therefore reasonable to conclude that the flaps were retracted at this time. Although the copilot stated that the flaps were retracted to the 12-degree position and that thereafter the flap control switch was not touched, the physical evidence, upon examination of the flap worm gear mechanism, showed that the flaps were in the "up" or "near up" position at impact. Impact forces could not alter the position of the flap worm gear mechanism.

Thus, it must be concluded that although the copilot thought that he retracted the flaps to the 12-degree position only, he must have raised them to the nearly fully retracted position. This is particularly probable since the captain countermanded his initial order to retract the flaps to the 12-degree position and then ordered the copilot to leave them where they were.

As previously stated, the manufacturer's flight tests, under the conditions that existed at the time of the accident, showed that the aircraft either should have been able to maintain altitude in the turn or have continued to climb straight ahead clearing all obstacles; however, because the flaps were retracted from the 24-degree position at critically low air speed, the aircraft could not maintain altitude and crashed.

As a result of this accident, the Civil Aeronautics Board recommended to the Civil Aeronautics Administration on March 29, 1951, that the following procedure be established by operators of equipment which incorporates automatic feathering unless the automatic feathering feature is disarmed and not used:

1. In the event of abnormal BMEP indication it be mandatory that prior to take-off, the cause of the difficulty be positively isolated to either the engine torque meter system or to that portion of the system outside of the engine.

2. If the difficulty is in the system outside of the engine, the flight be continued to a terminal station where the necessary repairs be made; flight time under these conditions to be kept at an absolute minimum.

3. If the difficulty is found to be in the engine-nose section, corrective measures be taken prior to another take-off.

The Board believes that it is essential that the operation of an engine with an inoperative BMEP gauge be kept at a minimum because this instrument is the only positive means whereby a failure of the torque meter system in the nose section of the engine can be detected by the flight crew.

The Administrator alerted the carriers operating aircraft incorporating automatic feathering to the recommended procedures and the reasons therefor. The majority of such carriers are complying with the above-recommended procedures, although some carriers operating aircraft incorporating automatic feathering do not have BMEP gauges installed and are, therefore, unable to comply. These carriers, however, have improved the indicating means by the installation of improved arming type torque pressure switches which arm at specified values causing a light indication in the cockpit to indicate the performance of the torque meter system.

The Board also recommended to the Administrator on January 11, 1950, that aircraft, equipped with torque meters be required to have BMEP gauges (torque meter pressure indicators) installed in the cockpit and that they be maintained in a satisfactory operating condition.

FINDINGS

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

1. The aircraft, the crew, and the company were properly certificated.
2. The left engine torque meter pressure indication was below normal, prior to take-off.
3. The aircraft became airborne at 124 miles per hour, or slightly higher.
4. Following the retraction of the gear at approximately 145 miles per hour, there was a failure of the left engine torque meter assembly which caused the left engine to automatically feather.
5. The propeller went to the feathered position, but continued to rotate because the failure of the torque meter assembly did not affect engine power output, since the throttle was still advanced and the mixture control was in the normal "rich" position, also, the ADI (anti-detonate injection) was being used and the ignition switch was "on".
6. The aircraft climbed straight ahead to a maximum altitude of approximately 150 feet, at which time the air speed had reduced to approximately 124 miles per hour.
7. The aircraft began to lose air speed and a left turn was initiated to avoid flying over a building.
8. At the start of the turn, the flaps were retracted from the 24-degree position and the indicated air speed dropped to approximately 107 mph.
9. The aircraft continued to lose altitude until it struck the ground.
10. The flaps were found to be in the "up" or "near up" position.

PROBABLE CAUSE

The Board determines that the probable cause of the accident was the retraction of the flaps from the take-off setting at a critical air speed, following the failure of the left engine torque meter assembly.

BY THE CIVIL AERONAUTICS BOARD:

/s/ DONALD W. NYROP
/s/ OSWALD RYAN
/s/ JOSH LEE
/s/ JOSEPH P. ADAMS
/s/ CHAN GURNEY

Supplemental Data

INVESTIGATION AND HEARING

The Civil Aeronautics Board received notification of the accident at 1330, February 27, 1951, from the Chief of Flight Operations, CAA Region IV. An investigation was begun immediately in accordance with Section 702 (a) (2) of the Civil Aeronautics Act of 1938, as amended. As part of the investigation, a public hearing was held on March 22, 23 and 24, 1951, at Tulsa, Oklahoma.

AIR CARRIER

Mid-Continent Airlines, Inc., is a corporation organized and existing under the laws of the State of Delaware, having its principal office at 102 East Ninth Street, Kansas City, Missouri, and its maintenance and overhauling base at Minneapolis-St. Paul International Airport, Minneapolis, Minnesota. The corporation was organized May 6, 1936. It holds a certificate of public convenience and necessity from the Civil Aeronautics Board to engage in scheduled air transportation with respect to persons, property and mail. It also holds an air carrier operating certificate No. 22, which was issued December 30, 1946, by the Administrator of Civil Aeronautics.

FLIGHT PERSONNEL

Paul C. Walters, captain, age 43, had been continuously employed by Mid-Continent Airlines since June 6, 1938. He holds a currently effective airline transport rating No. 26797 with appropriate ratings. He had accumulated a total of 14,968 flying hours, of which 724 hours had been obtained in the Convair 240 type aircraft. He had flown a total of 72 hours in the last 30 days. His last CAA physical examination was accomplished September 30, 1950; his last instrument check November 17, 1950; and the last line check February 25, 1951.

Forrest A. Hull, copilot, age 29, had been continuously employed by Mid-Continent Airlines since April 1, 1947. He held an airman certificate No. 498797 with a commercial and other appropriate ratings. He had accumulated a total of 5,240 flying hours, of which 704 hours had been obtained in the Convair 240 type aircraft. He had flown a total of 72 hours in the last 30 days. His last CAA physical examination was accomplished October 31, 1950. There is no record of his last instrument check because it is not required of the copilot.

THE AIRCRAFT

The aircraft, a Convair 240, was manufactured May 26, 1948. It was purchased by Mid-Continent Airlines March 16, 1950, and had a total aircraft time of 2391 hours. It was entered in scheduled service by Mid-Continent Airlines on June 1, 1950, and at the time of the accident it had accumulated a total aircraft time of 4115 hours. It was equipped with two Pratt & Whitney Model R-2800-CA18 engines. The left engine had a total time of 2042 hours, and 622 had been accumulated since the last overhaul. The right engine had a total time of 1953 hours, and 376 had been accumulated since the last overhaul. The engines were equipped with two Hamilton Standard propellers No. 23630. The left propeller had a total time of 1748 hours, and 837 since overhaul; and the right propeller 3291 hours, and 1498 since overhaul.