File No. 1-0009

CIVIL AERONAUTICS BOARD

ACCIDENT INVESTIGATION REPORT

Adopted: May 8, 1953 **Released:** May 12, 1953

THE UNIT EXPORT COMPANY, INC., PRESCOTT, ARIZONA,
AUGUST 31, 1952

The Accident

Power loss immediately after takeoff forced a wheels-up landing of a C-46F, N 1688M, near the Prescott, Arizona, Airport on August 31, 1952. There were no personal injuries and no fire. The aircraft, owned by the United States Air Force, was under lease to, and operated by, The Unit Export Company, Inc., an irregular air carrier.

History of the Flight

The flight originated at Oakland, California, and its destination was Keesler Air Force Base, Biloxi, Mississippi. The stop at Prescott was to refuel. This was a Civil Air Movement flight with 36 passengers, all military personnel.

A flight plan was prepared and approved at Prescott. It specified Visual Flight Rules at 9,000 feet altitude to Oklahoma City, Oklahoma, on airways Green 4 and Red 24. The Weight and Balance Manifest showed a gross weight of 44,989 pounds, 11 pounds less than the certificated maximum, and the aircraft's center of gravity to be within prescribed limits.

The crew consisted of Pilot Harold Rothstein, Copilot Harold M. Roberts, and Steward Thomas F. Abdoo. Captain Naron H. Lee, the company's chief pilot, occupied the jump seat and another company copliot, Marilyn Grover, was seated in the cabin.

The aircraft was fueled to a total of 767 gallons of 100 octane gasoline. Captain Rothstein ran up both engines and determined that they were operating properly. He and his copliot then went through the takeoff check list, and the copilot obtained tower clearance to take off.

Runway No. 3 was used. It is paved for 7,600 feet and has 500 feet of graded land beyond its end. In addition, there is another 1,400 feet of fairly level terrain beyond that. The weather was good with wind from the SW of 12 miles per hour. Altitude of the Prescott Airport is 5,042 feet; the density altitude at the time of the accident was about 8,000 feet.

Takeoff was started at about 1508 Mountain Standard Time. The power settings used were normal with both engines indicating a manifold pressure of 44 inches of Hg. and 2,700 rpm. At an ias (indicated air speed) of 115 mph the aircraft left the runway and the wheels were braked and retracted, according to the crew.

At an altitude of about 75 feet and an ias of 125 mph, the aircraft passed over the end of the runway. Captain Rothstein signaled his copilot to reduce power. As the copilot reached for the propeller controls a loud noise was heard seemingly in or from the right engine and simultaneously the rpm fell from 2,700 to 1,500. The right propeller was feathered as soon as possible thereafter, and single-engine procedure was set up with takeoff power maintained on the left engine.

The aircraft was turned slightly to the left and the altitude of 75 feet was maintained to avoid rising terrain ahead. Air speed dropped steadily and the copilot kept calling it to the captain. When it reached 90 mph Captain Lee, in the jump seat, told the copilot to go to the cabin and check passengers' safety belts. As he did Captain Lee took the copilot's position.

At the time the aircraft was steadily losing air speed and a crash appeared inevitable. The right propeller was unfeathered in the hope that partial power could be obtained from the right engine. None was obtained. While the propeller was windmilling it was noted that the oil pressure read "zero" and the fuel pressure rose to only 8-10 psi (pounds per square inch), even with the fuel booster pump in the high position.

It was decided to belly land. Both throttles were closed at an altitude of about 15 feet and an air speed of 80-85 mph. The aircraft skidded about 500 feet before coming to rest in open land about 4.7 miles north of the airport. Both cockpit controls for the firewall shutoff valves were immediately closed, mixtures cut, fuel valves closed and switches turned off.

All occupants quickly deplaned, uninjured. The copilot emptied a bottle of CO_2 into the inoperative engine to prevent a possible fire.

Investigation

Damage to the aircraft included the bending rearward of all six propeller blades and general crushing of the underside of the fuselage.

The aircraft was raised and it was found that both cables in the right wheel well which actuate the firewall shutoff valves had been pulled out of position and broken. This movement of the cables closed the fuel, oil and hydraulic valves at the firewall. Considerable other damage resulted in the right wheel well as a result of the violent motion of the cable.

Marks on components within the wheel well showed conclusively that the tire of the retracting right wheel, still rotating, fouled the cables, closing all three valves.

The aircraft was ferried to Miami, the company's base, after necessary repairs, including replacement of the right engine and splicing of the right wheel well cables. That engine was subsequently shipped to Miami and disassembled under the direct supervision of a Board investigator.

At Miami the previously mentioned damage within the right wheel well was confirmed. The disassembly of the engine resulted in the discovery of two failures. First, three piston rings of No. 8 cylinder (front row) were broken. Second, the front master rod bearing was found seized on the crankshaft. No metal particles were found in the engine, and there was no sign of oil starvation of any part other than the front row master rod bearing.

At the time of this accident the right engine had a total of 533 hours. Careful examination of the seven flight logs prior to the subject flight did not indicate any irregularities in the operation of the right engine that could have been pertinent to the accident. Investigation revealed that the right tire had been recapped but was approximately 1½ inches less than the 55-inch maximum allowable major diameter as specified.

Analysis

The crew stated that the wheels were braked and their rotation presumably stopped before retraction. But it is clearly apparent from the nature of the damage within the right wheel well that the right wheel must have been rotating when it fouled the cables.

The damage destroyed all possibility of determining if the cables had been unduly loose or otherwise misrigged. Had the cables been loose enough to have appreciable slack, the fouling could have occurred in that manner. This seems to be the most likely probability because fouling of the cables occurred during retraction of the rotating wheel. If the cable support system had been improperly located or aligned at the time of installation so that the cables were dangerously close to the tire, and had the wheels not been braked during retraction on previous takeoffs, the fouling of the cables would probably have occurred long before. Secondly, the retracting mechanism is of such design that a latching device prevents overtravel of the wheel following retraction; therefore, properly rigged cables would not have been contacted by the tire.

The crew testified as to a loud noise, seemingly in or from the right engine, at the time it lost power. However, the noise did not originate within the engine but occurred when the wheel well shutoff cables were yanked violently enough to pull their supporting pulley bracket loose from its wall, as well as break the cables themselves. With both fuel and oil shut off from this engine, the engine would normally act exactly as this one did, as described by the crew. Almost simultaneously with the shutting off of the source of fuel, the engine's speed would drop down to windmilling speed, which in this case was approximately 1500 rpm. Also, the fuel pressure gauge would drop to a reading of approximately 8-10 psi, as occurred in this instance.

In the interval of time between the unwanted closing of the fuel and oil valves until the propeller was feathered, the oil supply within the propeller was being rapidly depleted. This accounts for the fact that when the propeller was subsequently unfeathered in a futile attempt to restart the engine, it was noted that the oil pressure gauge of that engine read "zero" even while it was windmilling. As far as can be learned, the engine was still rotating (windmilling) at the time of impact. For a short interval of time prior to impact there had been little or no oil to the highly-loaded front master rod

bearing. This bearing, therefore, was at the point of seizure at the time of impact, and subsequent cooling of the entire metal mass consummated the seizure. This hypothesis is well borne out by the fact that the front master rod bearing is farther from the source of oil than is the rear master rod bearing and would be expected to fail first.

There is no relation between the seized master rod bearing and the broken piston rings of No. 8 cylinder

The possibility of the right wheel having been badly unbalanced, with resultant vibration severe enough to allow the wheel to contact the cables during retraction, has been considered. This possibility is quite unlikely because such vibration would have been readily sensed by the crew. They did not report any vibration. Moreover, no vibration was reported on the ferry flight to Miami which was made with the same wheel and tire.

According to the CAA Approved Airplane Flight Manual for the Slick C-46F, the airplane should have been able to continue climbing at a rate of approximately 105 feet per minute after the right engine failed and the propeller was feathered under the atmospheric temperature and pressure conditions existing at the time and place of the accident - if the indicated airspeed of the airplane was 130 miles per hour.

However, unlike aircraft certificated in the transport category, for which the field length required to clear a 50-foot obstacle is based on take-off at the single-engine climb speed, the C-46F was certificated under Part 3 of the Civil Air Regulations and is approved for take-off at an indicated air speed of 105 miles per hour and a climb to 50 feet with an air speed of 123.5 miles per hour indicated, while the en route single-engine climb speed is 130 miles per hour indicated. At the indicated air speed of 123.5 miles per hour, the single-engine climb performance of the C-46F is less than at 130 miles per hour. In addition, the propeller of the dead engine will produce a high drag during the short critical interval until it is feathered, seriously reducing the climb performance during this interval. Extrapolated transport category performance data determined by the CAA indicate that with the airplane weight and atmospheric conditions existing at the time and place of the accident, and with the inoperative propeller windmilling, the airplane has a rate of descent of several hundred feet per minute at the optimum single-engine climb speed for this configuration. Any variation from this speed results in a further increase in the rate of descent. In view of the above it is apparent that when the right engine of N 1688M ceased producing power, the airplane needed either a considerable margin of speed above 130 miles per hour to sacrifice in maintaining altitude until the propeller was feathered, or considerable altitude to sacrifice in maintaining or gaining a speed of 130 miles per hour during this interval. It is most significant to determine, therefore, whether or not N 1688M could be expected to have been flying under one of the above conditions when the right engine ceased producing power.

According to the approved Slick Flight Manual, the airplane should have been able to reach a 50-foot altitude and an air speed of 123.5 miles per hour

at a point approximately 6150 feet from the beginning of the take-off run under the conditions existing at the time and place of the accident, except for neglect of the ground wind and runway slope. Although data on the effects of these variables are not available for the C-46F, because of certification under Part 3 instead of the transport category requirements, examination of the data for other twin-engine aircraft certificated in the T-category indicates that the effects of the 1% downward slope of the runway on shortening the take-off run approximately cancel the effects of the reported 12 mile per hour tail wind on lengthening the take-off and climb to 50 feet. It appears, therefore, that these two variables can be disregarded with small error.

The maximum additional two-engine climb possible with gear up from the 50-foot point to the end of the 7600-foot runway, approximately the point at which engine failure was reported to have occurred, is calculated to be approximately 100 feet. This makes a possible total height above the ground of approximately 150 feet at the end of the runway, at an indicated air speed of 123.5 miles per hour. However, N 1688M was reported to have reached an altitude of only 75 feet at this point. Assuming that the best piloting techniques were used from the beginning of the take-off run until the end of the runway was reached, it is calculated that the excess horsepower resulting from the climb to the reported altitude of 75 feet at less than the maximum rate of climb could accelerate the airplane to an indicated air speed of approximately 130 miles per hour. The crew of N 1688M reported that the airplane had reached an indicated air speed of 125 miles per hour as it passed by the end of the runway when the power loss occurred. Therefore, it is evident that the power developed by the engines during the take-off and initial climb was very close to the maximum possible and that during this period the crew used techniques which extracted nearly the optimum performance from the airplane.

In explanation of the above, the approved data for the distance required to climb to a 50-foot altitude after take-off were computed on the assumption of no ground effect and of a constant indicated air speed of 123.5 miles per hour from the beginning to the end of the climb. Relative to the first assumption, ground effect very appreciably decreases drag and the power required to fly at a given air speed when the airplane is very close to the ground. However, when the height of the airplane wing is greater than approximately one-half of the wing span above the ground, 54 feet for C-46 aircraft, the beneficial ground effect drops to a negligible value. Relative to the second assumption, the approved take-off speed of 105 miles per hour for the C-46F is less than the epeed at which climb to the 50-foot altitude was computed with the result that the rate of climb will be adversely affected until the speed approaches 123 miles per hour. Since the effects of these two assumptions tend to counteract each other, it appears that the assumptions do not introduce significant conservatism in the approved take-off climb data for the C-46F aircraft.

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*Other approved data based on an air speed of 126 miles per hour in the climb indicate a distance of 6900 feet. However, the shorter distance of 6150 feet, which is more favorable to the airplane, is used throughout the remainder of this analysis.

It is apparent also that there was no appreciable ground effect on the climb performance of N 1688M from the time it climbed above the 50-foot altitude until it descended to within 50 feet of the ground beyond the confines of the airport, where ground effect cannot be depended on to assist the airplane unless the airplane can be flown over water or flat terrain free of trees, power lines, buildings and other obstructions.

It is to be noted that the single-engine rate of climb of 105 feet per minute at an indicated air speed of 130 miles per hour, mentioned above, is based on full throttle operation of the engine at the maximum continuous rpm of 2550. Power curves for the engine indicate that full throttle operation at the take-off rpm of 2700 would produce approximately 75 additional brake horsepower under the conditions existing at the time and place of the accident if the cylinder head temperatures did not exceed the approved maximum. However, the transport category performance data determined by the CAA indicate that at an indicated air speed of 130 miles per hour, operation of the engines at the maximum continuous setting causes the cylinder head temperatures to exceed the maximum allowable by an average of 19°F during flight at the maximum outside air temperature anticipated by the Civil Air Regulations. The reported outside temperature at the time and place of the accident was 9°F higher than the maximum anticipated by the regulations, which tended to further increase the excess cylinder head temperatures. Operation at any air speed lower than 130 miles per hour, or at any power demand greater than maximum continuous, would further increase the head temperatures. The excess temperatures decrease the volumetric efficiency of the engine and the resultant horsepower output is less than that shown on the power curves. Although readings of the actual engine temperatures on N 1688M at the time the right engine ceased producing power are not available, both test data and operational experience indicate that they probably exceeded the maximum allowable and that the attempt of the crew to continue single-engine operation at the maximum possible power increased the excess temperature with the result that the actual power developed by the left engine was appreciably less than that indicated by the power curves. As a result, little if any increase in the rate of climb over that indicated by the approved data could be achieved by single-engine operation at 2700 rpm.

It is apparent that the 8000-foot density altitude at the time and place of the accident adversely affected the aircraft's single-engine performance and the aircraft could not be expected to continue flight.

Findings

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

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

2. The aircraft's gross weight was within its maximum of 45,000 pounds.

3. The density altitude at the time and place of the accident was approximately 8,000 feet.

4. When the landing gear was retracted after takeoff, the right tire fouled the cables to the fuel, oil and hydraulic emergency shutoff valves at the firewall.

5. This fouling instantly closed those valves.

6. Almost at once the right engine lost all power and its propeller was feathered.

7. It was not possible to maintain single-engine flight.

8. Damage to the right engine's front master rod bearing followed the shutting off of the engine's oil supply.

Probable Cause

The Board finds that the probable cause of this accident was complete loss of power from the right engine shortly after the aircraft became airborne at an altitude of approximately 75 feet above terrain, with an indicated air speed of 125 mph and at a density altitude of 8,000 feet, under which circumstances the aircraft would not maintain single-engine flight. This loss of power resulted from the closing of the emergency shutoff valves due to the fouling of their actuating cables by the right tire.

BY THE CIVIL AERONAUTICS BOARD:

/s/ OSWALD RYAN

/s/ HARMAR D. DENNY

/s/ JOSH LEE

/s/ JOSEPH P. ADAMS

/s/ CHAN GURNEY

SUPPLEMENTAL DATA

Investigation

The Civil Aeronautics Board was notified of the accident immediately after occurrence by teletype to the Board's Santa Monica, California, office. Investigation was started at once in accordance with the provisions of Section 702 (a) (2) of the Civil Aeronautics Act of 1938, as amended. There was no public hearing on this accident

Air Carrier

The Unit Export Company, Inc., has its headquarters at Miami International Airport, Florida. The company holds Letter of Registration No. 145S as a non-certificated irregular air carrier. It also holds Air Carrier Operating Certificate No. 2-371, authorizing operation as an irregular air carrier.

Flight Personnel

Captain Harold Rothstein was properly certificated with an airline transport pilot rating. His piloting experience totaled about 6,000 hours, of which about 3,000 hours had been in C-46 aircraft.

Copilot Harold Roberts held a commercial pilot certificate with appropriate ratings. His piloting experience totaled about 1,800 hours, of which about 800 hours had been in C-46 aircraft.

Captain Naron H. Lee, the company's chief pilot, was also properly certificated with an airline transport pilot rating.

Copilot Marilyn Grover (seated in the cabin during the subject flight) held a commercial pilot certificate with appropriate ratings.

The Aircraft

N 1688M was a Curtiss Wright C-46F. It had been leased from the United States Air Force in June 1948. Civil certification was accomplished in January 1951.

It may be pertinent to point out at this time that the subject aircraft was one of many of its type built exclusively for military use. Before it and similar aircraft were certificated by the Civil Aeronautics Administration for civilian commercial use, it was necessary to install the entire emergency fuel, oil, and hydraulic shutoff system within both wheel wells because the aircraft was not originally equipped with these shutoffs. These installations, including those on the subject aircraft, were approved by the CAA.

The engines were Pratt & Whitney R-2800-75, and the propellers were Hamilton Standard hydromatic full-feathering.