

AIRCRAFT ACCIDENT REPORT *WLO*

ADOPTED: June 25, 1959

RELEASED: July 2, 1959

FRONTIER AIRLINES, INC., DC-3C, N 64424, PUEBLO, COLORADO, AUGUST 23, 1958

SYNOPSIS

Shortly after noon August 23, 1958, Frontier Airlines Flight 73 experienced an emergency gear-up landing two miles northwest of Pueblo Memorial Airport and two minutes after its takeoff from runway 30 of that airport. Several of the 19 passengers and crew of 3 received minor bruises; there were no serious injuries. The aircraft was substantially damaged; fire did not occur. The weather was good.

Flight 73 is scheduled daily, originating at Denver and terminating at Grand Junction, Colorado. Intermediate stops are at Pueblo, Gunnison, and Montrose, Colorado.

A normal takeoff was made from the Pueblo Airport by the first officer in the left pilot seat. Immediately after the aircraft became airborne and gear retraction had started, the captain, in the right pilot seat, observed the cockpit fire warning for the left engine come on. In accordance with operations manual instructions, he immediately tested the fire-warning system but the warning light remained on; the captain then feathered the left propeller. The Pueblo control tower was advised that the flight was returning to the airport and the captain took over control. Because of higher terrain ahead, a shallow left turn was made at an altitude of 50 to 75 feet and at an indicated airspeed of 95 knots. This altitude and airspeed could not be maintained. After passing under a 34-foot high power line with the airspeed dropping to 75 knots, the power was cut on the right engine. Ground contact occurred almost immediately and after a ground slide of nearly 1,000 feet the aircraft came to rest on the underside of its fuselage.

There had been no fire in the left engine. A false fire warning had occurred because of a faulty electrical circuit. The carrier's maintenance procedures prescribed in its manual are adequate; however, in this instance a failure on the part of the maintenance department to find and remedy the defect precipitated the accident.

As a result of this accident the carrier is revising its operations manual instructions so that a pilot, when a cockpit engine-fire-warning signal occurs, may use his judgment and discretion about immediate feathering without a visual fire check.

Investigation

Frontier Flight 73 originated at Stapleton Field, Denver, departing at 1108^{1/} with 21 passengers. The crew consisted of Captain James R. Langhofer, First Officer Donald L. Lockwood, and Stewardess Joanne V. Lohse. The flight to Pueblo was routine with arrival at 1145. Flight 73 departed Pueblo with 19 passengers and the same crew at 1204 on a VFR (visual flight rules) flight plan from runway 30. According to company load computation the aircraft was loaded to 24,420 pounds, which is below the allowable takeoff weight of 24,900 pounds under the prevailing conditions; the weight was properly distributed with respect to the center of gravity.

According to aeronautically competent witnesses situated at the north end of runway 30, the left propeller of N 64424 was seen to become completely feathered as the aircraft passed over them 50 feet high at the end of the runway. They also observed complete retraction of the landing gear. The aircraft gained altitude very slowly on one engine, reaching approximately 100 feet above the ground as it went straight out on the runway heading. A shallow left turn was started, followed by a gradual loss of altitude until contact with the ground was made. The witnesses were in agreement that no fire or smoke was observed while the aircraft was in flight or on the ground and that no parts or pieces were seen to fall during flight.

The emergency gear-up landing occurred at 1206 on unimproved ground two miles west-northwest of the Pueblo Memorial Airport.^{2/} The ground elevation is 4,725 feet. Marks on the ground indicated the aircraft made contact on a heading of 190 degrees magnetic. The aircraft then skidded on the underside of its fuselage for a distance of 841 feet and passed over three shallow ditches or washes. At the third one the aircraft swung approximately 115 degrees to the right and the right engine was completely separated from its attachment at the firewall. One blade of the right propeller punctured the right side of the cockpit, severely damaging the right pilot seat and severing the CO₂ line thereby discharging the CO₂ bottle aft of the right seat.

Evacuation began immediately after the aircraft came to rest and was completed in approximately 1-1/2 minutes. The first officer left through the front cargo door and proceeded to the main cabin door. The captain went through the cabin and opened the main cabin air stair door. All passengers except three deplaned through the main door without difficulty; these three passengers, acting on their own initiative, made their exit through the rear emergency window on the right side. At least one emergency inertia cabin light came on and remained on for nearly three hours.

Examination of the aircraft revealed no evidence of failure or malfunction of the airframe or powerplants prior to ground impact. This is substantiated by the pilots who stated that there was no roughness or indicated engine malfunction during the takeoff. The warning light went out after the feathering and no CO₂ was discharged intentionally either in flight or on the ground.

^{1/} All times herein are mountain standard based on the 24-hour clock; all altitudes are mean sea level unless otherwise stated.

^{2/} See Attachment "A" chart of airport and vicinity.

Because of the circumstances related by the flight crew, immediate attention was directed to the fire-warning system. A review of pilot flight reports disclosed that N 64424 had experienced five false engine fire warnings between July 9, 1958, and August 19, 1958. In each instance the left engine was involved and in no case was there a fire. The crew in this accident was not aware of the false fire-warning reports.

According to statements of the flight crew, the left propeller was feathered because of the left engine fire warning appearing as gear retraction was started. A minute examination of the left powerplant failed to disclose any evidence of fire or of a hot spot that could have actuated the fire-warning signal.

The fire-warning system employed by Frontier Airlines on N 64424 consists of a series of thermocouples, any one or all of which when subjected to rapid heat rise will generate a very low voltage current which is sent through the circuit to a very sensitive relay in the relay panel. This sensitive relay closes at approximately four milliamps completing a circuit to a slave relay, thus closing it. When the slave relay closes it connects the 24-volt circuit to the warning lamp circuit and lights the warning signal in the cockpit. The aircraft is equipped with a fire-warning thermal test unit on the cockpit instrument panel which tests the system for normal operation by switching in 28 volts to the system. As the element lights, the thermocouple is heated and creates a voltage, thus operating the circuit. Also incorporated is a switch called the fire panel "opposite" switch. This switch transfers the circuit system from one relay to another thereby providing a check for a false warning from a relay malfunction. In the present incident the "opposite" switch was actuated and the right warning light came on, which indicated absence of a fault in the left relay system and the probability of a fire.

In order to energize the cockpit warning signal, the sensitive and slave relays must be activated. With both relays operating normally a minimum current of four milliamps must be introduced into the sensitive thermocouple circuit. The two ways of accomplishing this are: (1) an actual fire resulting in a rapid heat rise at a thermocouple; (2) current as little as four milliamps from an outside source such as leakage of current from a 28-volt line in the same bundle of wire containing the fire-warning circuit as the result of frayed wire covering, dampness, chafed wire insulation, et cetera.

Subsequent to the accident, the relays and cockpit test switch were removed from the aircraft for examination. Each unit, plus the left engine thermocouples, was subjected to bench tests designed to test their integrity. The tests proved that all units were operating normally in accordance with specifications and that they were, in themselves, incapable of actuating a false fire warning.

Since there was actually no fire during flight, the circuits of the aircraft were carefully tested for continuity as well as possible leakage and/or short circuits between wires. All circuits in the fuselage, wing, nose, and associated junction boxes and instrument panels were found to be without electrical faults. Extending from the firewall junction box to the inboard nacelle junction box is a flexible conduit, approximately 40 inches long and three-fourths of an inch inside diameter, containing 15 tightly bundled wires. These wires included the sensitive thermocouple circuit wires as well as

28-volt circuits. An ohmmeter indicated an irregularity in the thermocouple circuits. By moving one of the thermocouple wires in this conduit a variable resistance was present. Removal of the wires from the conduit disclosed a substance consisting of damp oxidized aluminum, oil, and dirt in the area of the conduit ferrule which connects to the junction box where bending and movement occurs. Two wires of the bundle were unnecessarily long and were found criss-crossing other wires. This condition was found to exist in the area where the electrical fault was found. Examination failed to disclose further indication of circuit faults.

Frontier Airlines' Policy and Procedures Manual, Flight Emergency Procedures section, stipulates that a captain, upon the first indication of engine fire-warning light in flight, will immediately check the warning light by switching the crossover switch to "opposite," as was done in this instance. If the transfer indicates "fire" he will call out the proper engine and immediately accomplish the single-engine checklist. The company's chief pilot confirmed that the emergency procedures in effect at the time of this accident did not call for a visual check of the engine prior to feathering.

The five previous false warnings occurred at different stations away from Denver and in various aircraft configurations. The pilot write-ups and their dispositions were as follows: (1) Found loose cannon plug at firewall. Tightened plug, checks OK; (2) Checked system, no repairs recorded; (3) Repaired loose connection, system on left engine checks OK; (4) Checked system and found nothing wrong; (5) Changed fire-warning relay box complete. Pilot report copies were forwarded to the Denver base in each case but the base records do not indicate that corrective action was taken at the Denver base to eliminate the recurring false warnings.

A special weather observation taken by the Pueblo Weather Bureau Airport Station at 1205 on August 23, 1958, records the following conditions: measured 5,000 broken, 14,000 broken with higher broken; visibility 40 miles; temperature 77; dewpoint 48; wind north-northeast 14 knots, gusts to 21 knots; altimeter 30.14. Flight 73 had no choice of runways because of construction work at the airport. Company policy directs that the maximum cross-wind component is 22 knots and that it will be based on reported gust velocities. In this case the cross-wind component was 20 knots.

The company training program included single-engine procedures in both original training and rechecks of their pilots. However, in practice emergencies a propeller feathering was simulated by reducing power to a no-thrust position. Testimony reflected that the company went beyond the usual requirements, one item being that all pilots receive three, rather than two, proficiency checks annually.

Analysis

Reference to the company weight versus indicated airspeed chart for flight reveals that for a gross weight of 24,420 pounds the airspeed for best single-engine climb and maneuvering is 92 knots. The company manual minimum airspeed for single-engine is 84 knots. With an indicated 95 knots following takeoff and the feathering of the left propeller, Captain Langhofer had three knots above the best single-engine speed for straight climb or maneuvering flight. According to competent witnesses, altitude was being gained very slowly as

the aircraft left the airport boundary. The aircraft was then going toward higher terrain ahead and to its right. Testimony was received regarding the effect of air-temperature upon rate of climb (reference-CAA Flight Engineering Report #12 issued under Safety Release #153). It was shown that with the gross weight of 24,420 pounds and the temperature of 75 degrees F, the aircraft should have been capable of a rate of climb of 282 feet per minute on one engine. Even if it were possible to obtain this performance, the aircraft could not have cleared the high terrain lying ahead. Consequently, there was no alternative for the left turn away from the higher land. This turn, in conjunction with the loss of performance resulting from gustiness and turbulence caused by the high ground to windward, was a factor in the aircraft losing airspeed and altitude.

A glance back from the cockpit toward the left engine would have disclosed no evidence of fire and the action could have delayed the feathering of the propeller and averted the accident. However, the captain carried out emergency instructions as outlined in the company operations manual at that time. These instructions are currently being revised to give the captain an opportunity to use his own judgment regarding immediate feathering in the case of engine fire warnings.

Referring to maintenance practices it appears, in this instance, there was a definite failure to comply with the prescribed procedures in that the log office did not discover the recurring false fire warnings when they reviewed the pilot reports.

Conclusion

A study of the available evidence makes it obvious that regardless of the other circumstances of the accident, a false warning due to faulty wiring and/or the presence of foreign matter would not have occurred and triggered the events that followed had the maintenance department properly corrected the recent and recurring difficulties reflected in pilot write-ups of false fire warnings on this same engine and aircraft. A few circuit tests would have revealed the electrical leakage and pointed out the need for replacement of the wires. The Board therefore concludes that the log sheets of the aircraft were not properly monitored; that corrective action taken by the maintenance personnel was not adequate; that there was a laxity on the part of the maintenance supervisory personnel in not detecting this inadequacy; and that the maintenance department was amiss in not progressing prompt and adequate corrective action as a result of the continued write-ups concerning the fire-warning system.

Probable Cause

The Board determines that the probable cause of the accident was a false fire warning during climb-out toward rising terrain, followed by the immediate feathering of a propeller. The resulting aircraft performance under the existing conditions necessitated an off-airport landing. The false fire warning was due to inadequate maintenance.

BY THE CIVIL AERONAUTICS BOARD:

/s/ JAMES R. DURFEE

/s/ CHAN GURNEY

/s/ HARMAR D. DENNY

/s/ G. JOSEPH MINETTI

/s/ LOUIS J. HECTOR

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

Investigation and Taking of Depositions

The Civil Aeronautics Board was notified of the accident the afternoon of August 23, 1958. 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 at Kansas City, Missouri, October 20; Pueblo, Colorado, October 21; and Denver, Colorado, October 22-23, 1958.

Air Carrier

Frontier Airlines, Inc., a Nevada corporation, is a scheduled air carrier with its principal offices at Denver, Colorado. The company possesses a currently effective certificate of convenience and necessity issued by the Civil Aeronautics Board and an air carrier operating certificate issued by the Civil Aeronautics Administration (now Federal Aviation Agency) which authorize the carriage of persons, property, and mail over the route described in this report.

Flight Personnel

Captain James R. Langhofer, age 32, was employed by Frontier Airlines May 5, 1950. He held a valid airman certificate with an airline transport rating and type rating for DC-3 aircraft. According to company records he had a total of 10,879 hours, of which 7,564 were acquired in DC-3 equipment. His last CAA (FAA) first-class physical examination was passed, no waivers or restrictions, on August 20, 1958. The date of his last line check was April 4, 1958, and his last instrument check was taken December 5, 1957.

First Officer Donald L. Lockwood, age 25, was employed by Frontier Airlines August 31, 1954. He held a valid airman certificate with commercial pilot and instrument ratings. According to company records he had a total of 910 pilot hours, of which 498 were acquired in DC-3 equipment. His last CAA (FAA) physical examination was passed on December 13, 1957, with no waivers or restrictions. His last instrument check was on December 27, 1957.

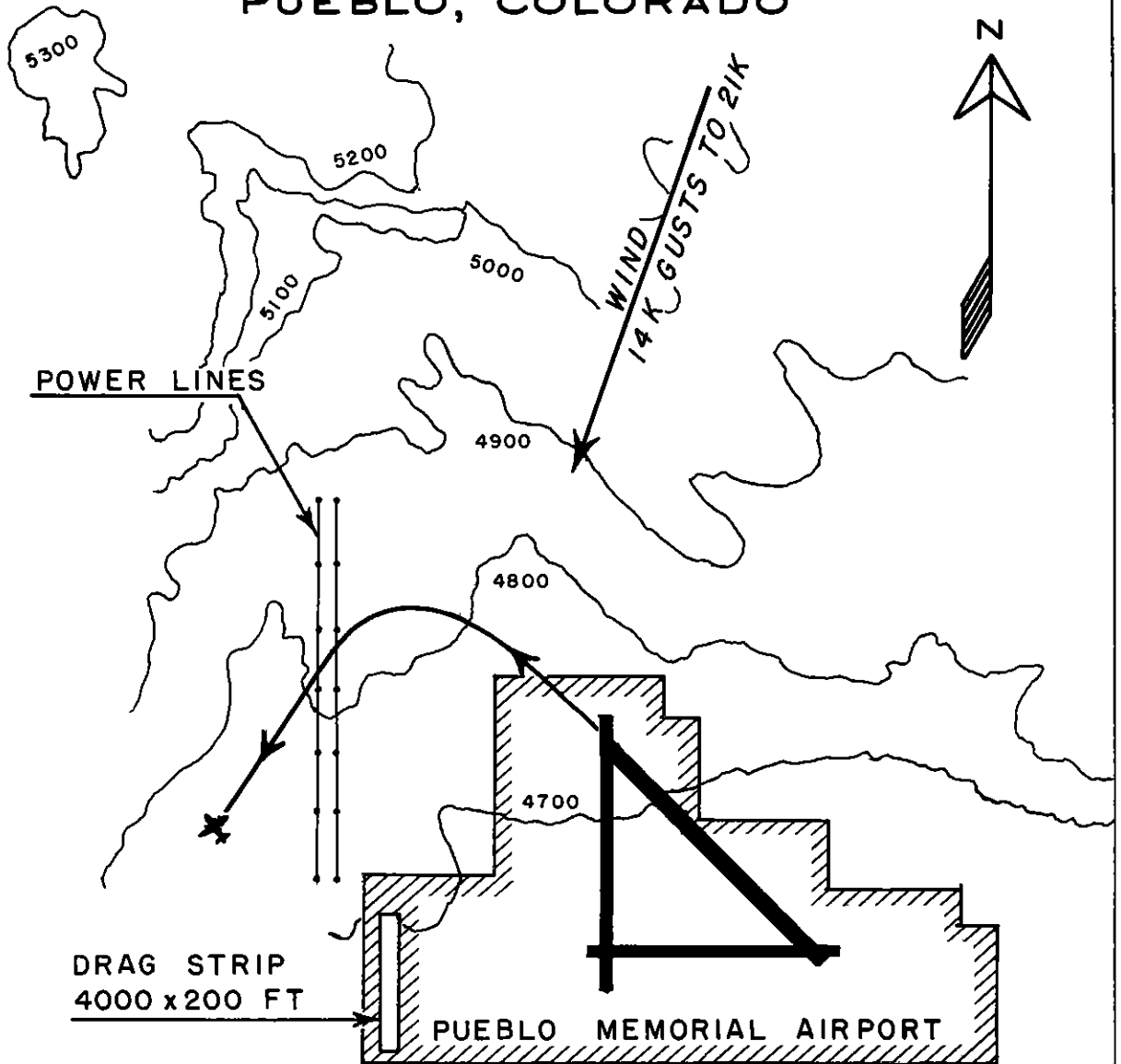
Stewardess Joanne V. Lohse, age 24, had been employed by the company since February 2, 1955. Her training was completed March 31, 1955.

The Aircraft

Douglas DC-3C, serial 4424, N 64424, was manufactured in June 1942, and had a total flight time of 31,082 hours. The aircraft had 9,188 hours since the last overhaul and 39 minutes since the last No. 3 inspection. It was equipped with two Pratt and Whitney R-1830-92-S1C3G engines and two Hamilton Standard 23E50-473 propellers. The left and right engines had 794 and 847 hours, respectively, since the last overhaul. The propellers had 2,201 and 1,941 hours, respectively, since the last overhaul or reassembly. This aircraft was approved under Type Certificate No. 669 with a maximum allowable weight of 25,346 pounds, including de-icers. It was not approved under Note 12 for transport category operation.

ATTACHMENT "A"

FRONTIER AIRLINES
AUGUST 23, 1958
PUEBLO MEMORIAL AIRPORT
PUEBLO, COLORADO



Scale 1" = 1 Mile
100' Contour Lines