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REPORT  
OF THE CIVIL AERONAUTICS BOARD  
Of the investigation of an acci-  
dent involving aircraft of United  
States registry NC 19905, which  
occurred near Pritchett, Colorado,  
on May 17, 1940. T. W. A

An accident involving aircraft of United States registry NC 19905 having occurred approximately 22 miles west of Pritchett, Colorado, on the 17th day of May, 1940, with resultant major damage to the aircraft and with no injuries to persons on board, the Air Safety Board directed that a full and complete investigation of the accident, pursuant to the provisions of Section 702 (a)(2) of the Civil Aeronautics Act of 1938 (52 Stat. 973, 1013), be immediately begun, and that the facts, conditions and circumstances relating to the accident and the probable cause thereof be determined.

For the purpose of carrying out the above order the Air Safety Board designated Frank E. Caldwell, Chief of the Investigation Division, Air Safety Board, as Investigator in Charge. Mr. Caldwell was assisted in the investigation by W. K. Andrews, Air Safety Investigator and G. W. Haskins, Power Plant Engineer, Air Safety Board. The investigation began on May 18, 1940, and was concluded on May 25, 1940.

The functions of the Air Safety Board were transferred to the Civil Aeronautics Board on June 30, 1940, pursuant to the provisions of Reorganization Plans III and IV and Public Resolution No. 75, 76th Congress. The Civil Aeronautics Board, therefore, having considered the evidence adduced in the investigation and research by the Air Safety Board, hereby reports, pursuant to the provisions of Section 702 (a)(2) of the Civil Aeronautics Act of 1938, as amended, the facts, conditions and circumstances relating to the accident and its conclusion as to the probable cause thereof.

FACTS, CONDITIONS AND CIRCUMSTANCES:

Aircraft of United States registry NC 19905, a Boeing 307-B, belonging to Transcontinental and Western Air, Inc. (hereinafter referred to as "TWA") departed Kansas City, Missouri, at 2:43 p.m. (CST) en route to Albuquerque, New Mexico, designated as flight "Boeing 'G-A' of May 17, 1940". This flight was a non-scheduled operation and was a part of the 100-hour Proving Run of the aircraft which was required by the Civil Air Regulations prior to approval by the Civil Aeronautics Authority for scheduled operation over the routes of Transcontinental and Western Air, Inc.

The aircraft was manufactured by the Boeing Aircraft Corporation, Seattle, Washington, and was delivered to TWA a short time preceding the flight herein involved. It had been certificated as airworthy by the Civil Aeronautics Authority and had been approved for operation with a gross weight not to exceed 45,000 pounds. It was equipped

for instrument flight navigation, including radio range receiver, communication receiver, marker receiver, communication transmitter and an automatic direction finder system. The aircraft was powered with four Wright GR-1820G-105A engines, equipped with two-stage superchargers, manufactured by the Wright Aeronautical Corporation, Patterson, New Jersey. Each engine was rated at 900 horse power. The propellers installed on the aircraft were the hydromatic full-feathering type with constant speed control and were manufactured by the Hamilton Standard Propellers Division of United Aircraft Corporation, East Hartford, Connecticut. The aircraft had a total operating time of 133 hours and 12 minutes, while the engines and propellers had a total operating time of approximately 87 hours.<sup>1/</sup>

Captain Otis F. Bryan, aged 32, who was in command of the flight at the time of the accident, had a total flying time of 9412 hours and 13 minutes, approximately 126 hours and 47 minutes of which had been in Boeing 307-B's. Captain F. G. Richardson, aged 37, First Officer on the flight involved, at the time of the accident had a total flying time of 11,177 hours and 19 minutes, approximately 9 hours and 8 minutes of which had been accumulated as copilot on Boeing 307-B's. Both airmen possessed the required ratings and certificates of competency required for the equipment involved. Richard R. deCampo and L. E. Hubbard were assigned to the flight

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<sup>1/</sup> The G102 engines originally installed in the airplane were later changed for the G105-A, which were designed to give greater performance at higher altitudes.

as Flight Engineer and Alternate Flight Engineer, respectively, G. B. Cox, TWA employee was assigned as stenographer for the flight. Hostesses Esther Benefield, E. L. Swarner and Ida Staggers completed the flight crew.

The following non-revenue passengers were on board the aircraft as observers: B. R. Gaines, Civil Aeronautics Authority Air Carrier Inspector (Radio Observer), G. W. Halðeman, Civil Aeronautics Authority Senior Aeronautical Engineering Inspector, M. L. Cunningham, Civil Aeronautics Authority Air Carrier Inspector (Operations), C. A. Williams, Assistant Superintendent of Passenger Transportation, TWA, Feliz Preeg, Flight Captain, TWA, William Maxfield, Superintendent of Maintenance, TWA, E. J. Minser, Chief Meteorologist, TWA; H. K. Morgan, Superintendent of Communications, TWA, J. F. Albert, Flight Superintendent, TWA, Fred Wallace, Stenographer, TWA, R. L. Rouzie, Engineer, Boeing Aircraft Corporation.

The aircraft was fueled with 1275 gallons of gasoline which was distributed between the main fuel tanks and the inboard reserve tanks. The aircraft was also fueled with 352 quarts of oil. Computations of the load aboard at the time of take-off indicated that the aircraft was within its approved gross loading limit of 45,000 pounds.

The flight was dispatched in a normal manner at 2:30 p.m. (CST) and cleared to Albuquerque, New Mexico. The flight plan which had been approved by Airway Traffic Control at Kansas City<sup>2/</sup> indicated

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<sup>2/</sup> The Airway Traffic Control staff, a part of the Civil Aeronautics Administration, regulates the flow of traffic over the civil airways during instrument weather conditions in order to eliminate the possibility of collision between aircraft. Before flying on a civil airway under instrument weather conditions, approval must be secured from Airway Traffic Control for the flight, including the altitude at which it is to be flown.

a cruising altitude of 16,000 feet, instruments authorized, with deviations from the civil airway at the pilot's discretion. Am rillo, Texas, was designated as the alternate airport.

The clearance was based on a trip forecast made by the TIA meteorologist at Kansas City and the latest United States Weather Bureau sequence reports.<sup>3/</sup> An analysis of the weather conditions along the route was made by Captain Bryan and E. J. Minser, Chief Meteorologist for TIA, who accompanied the flight as an observer. The results of this analysis showed that numerous thunderstorms and moderate to heavy rain squalls were to be expected between Kansas City and Albuquerque. As previously stated, the flight had been authorized to leave the airway in order to detour the heavier thunderstorms but it was not anticipated that lengthy deviations would be necessary.

Captain Bryan taxied to the southwest end of the northeast-southwest runway of the Kansas City Municipal Airport, and after running up the engines, made a normal take-off at approximately 2:43 p.m. The flight reported its position over Lebo, Kansas, at 16,000 feet at 3:20 p.m. proceeding contact on a compass heading of 235 degrees. At this time the cabin was supercharged to an air density equivalent to 9,000 feet altitude.

The flight arrived over Cassoday, Kansas, at 3:37 p.m., at which point Captain Bryan elected to leave the airway in order to avoid thunderstorms in his flight path. The aircraft was headed on a

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<sup>3/</sup> See Appendix A.

course of 270 degrees until it crossed the north leg of the Wichita radio range at 3:52 p.m. A position report was radioed to the Wichita ground station at this time.

Seven minutes later Captain Bryan, skirting the edge of thunderstorms which rose high above the altitude of the aircraft, changed the course to 240 degrees. It was anticipated that this course would have returned the aircraft to the airway about half way between Amarillo and Albuquerque and would enable the flight to pass to the north of thunderstorms known to be in the vicinity of the airway between Amarillo and Tecumcari, New Mexico. As the flight progressed, static interrupted communications between the aircraft and ground stations although the captain was able to read the weather reports broadcast by Civil Aeronautics Authority Airway Communication Stations and to take bearings at regular intervals with a Sperry Automatic Direction Finder.

At 4:55 p.m. the line of thunderstorms moved north and the course was again changed to a heading of 263 degrees. As the flight passed north of Amarillo attempts were made to contact the ground station for clearance to Albuquerque, but static prevented the contact from being completed. Captain Bryan elected to proceed without clearance rather than attempt to land at Amarillo where thunderstorms had been reported 20 minutes earlier.

A weather report received at this time indicated a ceiling of 7000 feet with visibility of more than 10 miles at Albuquerque.

Weather sequence reports along the route to be followed indicated

that conditions were fairly steady. Amarillo was reporting thunderstorms in the vicinity and lower scattered clouds at 600 feet. Behind the flight Wichita was still reporting thunderstorms. The heading of the airplane at this time (263 degrees) was slightly north of a line parallel to the Amarillo-Albuquerque airway and clear of any storms. At 5:02 p.m. Captain Richardson, who was acting as first officer, estimated the aircraft's ground speed at 171 m.p.h. The four engines were functioning normally and developing approximately 550 horse power each.

Progress was steady and at 5:25 p.m., when it appeared to Captain Bryan that he had passed the worst of the storm area, he changed his course to 210 degrees with the intention of intercepting the airway at Otto, New Mexico, approximately 40 miles east of Albuquerque and proceeding from Otto in the clear, or on top of the overcast. A few minutes later, however, when it appeared that the flight would have to go on instruments to return to the airway, another attempt was made without success to radio Amarillo and Albuquerque. The aircraft at this time had been out of communication with the ground stations for 1 hour and 38 minutes.

At 5:35 p.m. the captain ordered the fuel supply switched from the auxiliary tanks to the main tanks and full heat applied to the carburetors. Two minutes later as the aircraft nosed into the clouds at an altitude of approximately 16,000 feet above sea level, heavy snow was encountered and the temperature gauge indicated the outside temperature at 22 degrees. Just as the aircraft entered the overcast,

Acting Flight Engineer deCámpo reported that sparks were jumping from the base of the whip antenna to the aircraft structure. The captain immediately reduced the power output of the engines and slowed to an indicated air speed of 125 m.p h. to lessen the danger of a static discharge from the aircraft to the clouds.

Approximately nine minutes after entering the overcast Captain Bryan noticed a slight trace of ice on the outside of the aircraft and shortly thereafter one of the engines began to "sputter". Immediately turn of 180 degrees was made to reverse the course in order to get out of the overcast. After the turn was completed, the No. 4 (right outboard) engine began to show a loss of manifold pressure and power output. Two more engines lost power in rapid succession until only No. 2 (left inboard) engine was functioning and it was operating at reduced power. At the first indication of engine trouble, descent was begun in an attempt to reach an altitude where the temperature was above freezing and power would be restored. While Captain Bryan concentrated on the descent, which was nearly all under instrument conditions, First Officer Richardson and Engineer deCámpo, following the captain's instructions, made repeated efforts to start the engines. Throttle settings were changed; carburetor heat controls were checked to make sure they were in a full hot position, one engine was backfired by leaning the mixture in an attempt to blow the ice from the carburetor, and the fuel pressure and other gauges and instruments pertaining to engine operation were checked. During



this time the first officer also made repeated unsuccessful efforts to radio Albuquerque to inform that station of the situation. The vacuum supply was switched from an engine pump to a dynamotor to insure continued operation of the flight instruments.

At 5:57 p.m., or approximately eleven minutes after the loss of power began, the aircraft had descended to an altitude of 10,000 feet and the outside temperature was 30 degrees. At this time Captain Bryan ordered the flight engineer to request George W. Haldeman, Civil Aeronautics Authority Engineering Inspector, to come forward from the passenger cabin to assist with the engines.

The engines, which were equipped with two-stage superchargers, had been operating during the flight on the higher of the two supercharging ratios. Shortly after the first engine began to lose power, however, it was shifted to the lower ratio. Inspector Haldeman immediately shifted the remaining three engines to low blower and took other measures to start the engines, without success. By this time the aircraft had reached an altitude of about 7500 feet and the outside temperature was 35 degrees.

As the aircraft continued to descend, the one remaining engine steadily lost power. The aircraft momentarily broke out of the overcast at 7000 feet above sea level but quickly went back into the overcast before breaking into the clear at an altitude of approximately 5750 feet above sea level and approximately 800 feet above the ground. It was raining and visibility was about one mile.

The landing gear was ordered down. At this time the No. 4 engine started a surge of power which indicated that the engines would probably resume normal operation, so the captain ordered the gear up again. This surge of power, however, died out and as only one engine was operating and at reduced power, the gear was ordered down again. It was then too late to fully extend the gear and the aircraft contacted the ground while the gear was only partially extended. The ground was covered with soft sod and the landing shock was slight as the aircraft skidded along on the under surface of the fuselage.

The accident occurred about 6:03 p.m. (CST) at a point approximately 22 miles west of Pritchett, Colorado, and resulted in major damage to the aircraft. Members of the crew and the passengers received no injuries. Although there are no official weather reporting stations in the vicinity of the point where the landing was made, the conditions which prevailed at the time of the accident are reliably fixed by Captain Bryan's observation as being overcast at about 800 feet with a visibility of about one mile because of a moderate rainfall.

Immediately after the landing, a carburetor was removed from one of the engines and it was found to contain a large amount of soft rime ice. The remaining three carburetors were inspected the following day and each was found to contain a considerable quantity of water at that time. Examination of the gasoline tanks showed the fuel to be ample and to be free from water or dirt.

Subsequent investigation disclosed that the aircraft skidded approximately 646 feet before coming to a stop. All four propellers were damaged and the 12 blades were bent back at an angle of approximately 85 degrees. The cowling and engine mounts on No. 2 and No. 3 engines were badly damaged. The landing gear and two inboard oil tanks were also damaged, as well as the under surface of the fuselage.

The carburetor air heating system on this airplane took warm air from the rear engine compartment only when the carburetor was set at full heat. This, through the experience and recommendation of the engine and airplane manufacturers, was deemed sufficient to provide a minimum of  $40^{\circ}$  F. heat rise of the intake air when the outside temperature was  $32^{\circ}$  F. This met with Civil Aeronautics Authority regulations for heat rise in connection with the non-icing cam type Venturi carburetor with which these engines were equipped. Actual tests indicated that on this installation a heat rise of  $46^{\circ}$  F. was available at full-heat setting.

The engine cowl flaps of all four engines were connected to a common control in the cockpit. Through some maladjustment of linkage, the cowl flaps of No. 2 engine (left inboard) were more nearly closed than on the other three engines. Inasmuch as at full heat the carburetor air is drawn from the rear engine compartment, the position of the cowl flaps influence carburetor heat through the variation of the compartment temperature. The greater heat available on No. 2

engine was probably sufficient to prevent any further ice formation, but was insufficient to remove any small amount of ice already accumulated. This probably accounts for the fact that No. 2 engine continued to operate with a slight loss of power.

The reduction in power necessitated by the danger of a static discharge from the airplane to the clouds contributed to a certain degree toward the icing of the carburetors since the lower power reduced the heat available in the rear compartment.

As a result of the investigation of this accident and subsequent flight tests conducted by TWA in cooperation with representatives of the Air Safety Board, Civil Aeronautics Authority, Wright Aeronautical Corporation, and Boeing Aircraft Company, it was decided to provide this airplane with a positive air preheating system through the use of a muff receiving heat from the four upper engine cylinder exhausts. This method provides a temperature rise of at least 100° F.

#### SUMMARY OF FINDINGS

1. Aircraft NC 19905, a Boeing 307-B, was certificated as airworthy by the Civil Aeronautics Authority.
2. Both airmen held required ratings and certificates of competency for the flight and equipment involved.
3. The flight was a non-scheduled operation and a part of the 100-hour proving run for this type aircraft.

4. The computations of the load at the time of take-off indicated that the aircraft was within the gross loading limit of 45,000 pounds.

5. The flight, which was designated as Boang G-A, was properly dispatched from Kansas City, Kansas, in accordance with approved company procedure.

6. A detailed weather analysis of the route to be flown indicated that numerous thunderstorms and moderate to heavy rain squalls would be encountered between Kansas City, Kansas, and Albuquerque, New Mexico.

7. The flight departed at 2:43 p.m. and at 3:20 p.m. reported its position over Lebo, Kansas, contact at 16,000 feet. At 3:37 p.m. the flight arrived over Cassoday, Kansas, at which point Captain Bryan elected to leave the airway in order to avoid thunderstorms in the proposed path of the flight.

8. As the flight progressed, static interrupted communications between the aircraft and ground stations although the captain was able to read the weather reports broadcast by Civil Aeronautics Authority Communication Stations.

9. At 5:25 p.m. the course of the aircraft was changed with the intention of intercepting the airway at Otto, New Mexico. A few minutes later when it appeared that the flight would have to go on instruments to return to the airway, the captain ordered full heat applied to the carburetors. As the aircraft entered the overcast, heavy snow was encountered and the temperature gauge indicated

the outside temperature at 22 degrees. At this time power was reduced to lessen the danger of a static discharge from the aircraft to the clouds.

10. Approximately 9 minutes after entering the overcast, one engine was heard to sputter. Immediately a turn of 180 degrees was made to reverse the course and upon completion of the turn the other three engines began to lose power.

11. At 5:57 p.m., or approximately 11 minutes after the loss of power began, the aircraft had descended to an altitude of 10,000 feet and the outside temperature was 30 degrees. All efforts to restore power to the engines were unsuccessful.

12. The aircraft finally broke out under the clouds at 5750 feet above sea level and approximately 800 feet above the ground. At this time the landing gear was ordered down. However, No. 1 engine started a surge of power which indicated a possibility that the engines would probably resume normal operation so the captain ordered the gear up again. This power, however, died out and it was then too late to extend the gear more than part way down before the aircraft contacted the ground.

13. The accident occurred about 6:03 p.m. (CST) at a point approximately 22 miles west of Pritchett, Colorado, and resulted in major damage to the aircraft. Members of the crew and the passengers received no injuries.

14. The weather conditions in the vicinity of the accident at 6:03 p.m. were overcast at an altitude of approximately 800 feet above the ground, moderate rain and visibility of approximately 1 mile.

15. Subsequent to the landing, one of the carburetors was removed and was found to contain a large amount of soft rimc ice. The remaining three carburetors were inspected the following day and each was found to contain a considerable quantity of water. Examination of the gasoline tanks showed the fuel to be ample and to be free from water and dirt.

#### PROBABLE CAUSE

Loss of power in flight resulting from icing of carburetor system.

#### COMMENTS

The subject of icing has been under careful study for some time and continuous effort is being made to obtain sufficient data and experience to eliminate this hazard completely. Progress has been fairly satisfactory as shown by the marked reduction of icing accidents. The enforcement of the new Civil Air Regulations covering means for the prevention and elimination of ice has contributed substantially to this progress. This part of C.A.R. 04.6 was issued on

August 1, 1940, under Certificate and Inspection Division Release No. 21, which required a 100° F. heat rise with suitable indicators or a 40° F. heat rise with an auxiliary emergency de-icing system controllable from the cockpit, utilizing alcohol, Anilol, etc. All air carrier aircraft had to comply with this regulation by October 1, 1940.

Steps were immediately taken to eliminate the probability of ice forming in this type of carburetors by increasing heat rise to 100° F.

In addition, intensive studies of icing with various types of carburetors, etc., are now being conducted at the Bureau of Standards through the combined cooperation of the Navy Department, War Department, National Advisory Committee for Aeronautics, Civil Aeronautics Administration, and the Safety Bureau of the Civil Aeronautics Board.

BY THE BOARD

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Secretary



## APPENDIX A

The following United States Weather Bureau Sequence Reports (2:35 P.M.) were made a part of the clearance for the flight:

Kansas City, Missouri. C (Satisfactory for contact flight) ceiling estimated 6000 feet, overcast, lower scattered clouds at 1500 feet, visibility 7 miles, light rain showers, pressure 1015.2 millibars, temperature 57, dew point 54, wind ENE 9, altimeter setting 29.96.

Lebo, Kansas. Ceiling estimated 3500 feet, high overcast, lower broken clouds, visibility over 10 miles, pressure 1010.8 millibars, temperature 68, dew point 55, wind NE 9, altimeter setting 29.87.

Ft. Riley, Kansas. Ceiling estimated 6000 feet, overcast, visibility over 10 miles, pressure 1012.9 millibars, temperature 61, dew point 52, wind E 18, altimeter setting 29.89.

Cassoday, Kansas. Ceiling unlimited, high thin broken clouds, visibility over 10 miles, temperature 77, dew point 64, wind SE 15.

Wichita, Kansas. C (satisfactory for contact flight) ceiling estimated 2500 feet, high overcast, lower broken clouds, visibility over 10 miles, pressure 1007.8 millibars, temperature 80, dew point 64, wind SE 13, altimeter setting 29.78.

Anthony, Kansas. Ceiling estimated 6000 feet, high thin broken clouds, lower broken clouds, visibility over 10 miles, temperature 86, dew point 60, wind S 16.

Waynoka, Oklahoma. Ceiling unlimited, high thin overcast, lower scattered clouds at 4000 feet, visibility over 10 miles, pressure 1006.1 millibars, temperature 83, dew point 57, wind SSW 13, altimeter setting 29.75.

Gage, Oklahoma. Ceiling unlimited, high overcast, visibility over 10 miles, temperature 85, dew point 59, wind SSE 16.

Pampa, Texas. Ceiling unlimited, high thin broken clouds, lower scattered clouds at 5000 feet, visibility over 10 miles, pressure 1003.7 millibars, temperature 80, dew point 51, wind SSE 16, altimeter setting 29.76.

Amarillo, Texas. C (satisfactory for contact flight) ceiling unlimited, high thin scattered clouds, lower scattered clouds 5000 feet, visibility over 10 miles, pressure 1002.4 millibars, temperature 83, dew point 52, wind SSE 15, altimeter setting 29.75.

Tecumcari, New Mexico. Ceiling unlimited, high broken clouds, lower scattered clouds at 3000 feet, visibility over 10 miles, pressure 1003.1 millibars, temperature 80, dew point 50, wind SSW 5, altimeter setting 29.77. Light rain showers SE thunderheads all quadrants.

Anton Chico, New Mexico. Ceiling unlimited, high thin broken clouds, lower scattered clouds at 4000 feet, visibility over 10 miles, pressure 1001.7 millibars, temperature 68, dew point 46, wind WNW 26, strong gusts,

altimeter setting 29.84.

Otto, New Mexico. Ceiling estimated 7000 feet, broken clouds, lower scattered clouds at 4000 feet, visibility over 10 miles, temperature 62, dew point 44, wind NW 33, strong gusts.

Albuquerque, New Mexico. C (satisfactory for contact flight) ceiling unlimited, high broken clouds, lower scattered clouds at 5000 feet, visibility over 10 miles, pressure 1009.5 millibars, temperature 61, dew point 51, wind N 12, pressure 30.00. Scattered clouds topping Sandias.