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REPORT OF THE CIVIL AERONAUTICS BOARD

Of the investigation of an accident
involving civil aircraft of the United
States NC 28394 which occurred near
Atlanta, Georgia, on February 26, 1941.

I.

CONDUCT OF INVESTIGATION

An accident involving aircraft NC 28394 occurred in the vicinity of Atlanta, Georgia, on February 26, 1941, about 11:50 p.m. (CST)^{1/}, while the aircraft was operating in scheduled air carrier service between New York, New York, and Brownsville, Texas, as Trip 21 of Eastern Air Lines, Inc. The accident resulted in the destruction of the airplane, fatal injuries to five passengers and three members of the crew, serious injuries to five passengers, and minor injuries to three passengers. Although the accident occurred at 11:50 p.m., the wreckage was not located until about 6:30 a.m. the next morning. The Washington office of the Civil Aeronautics Board (hereinafter referred to as the "Board") was officially notified of the accident about 8:30 (EST) that morning.

Inspection and Preservation of the Wreckage

Immediately after receiving this notification, the Board initiated an investigation of the accident in accordance with the provisions of Section 702 (a) (2) of the Civil Aeronautics Act of 1938, as amended (hereinafter referred to as the "Act"). Accident investigators of the Board arrived at the Atlanta Municipal Airport on the afternoon of February 27, 1941, and immediately proceeded to the scene of the accident. In accordance with instructions of the Board, the damaged airplane had been placed under guard and the airplane had not been disturbed except to the extent necessary to remove injured persons and cargo from the wreckage. Upon arrival, the investigators took custody of the wreckage and began their inspection.

^{1/} All times used herein are Central Standard Time unless otherwise indicated.

The engines, propellers, and certain other parts of the airplane were removed from the scene of the accident and shipped under seal by common carrier to Eastern Air Lines' maintenance shop at Miami, Florida, so that a more complete inspection might be made of them. The disassembling and inspection of the engines and other equipment at Miami were done under the direct supervision of the Board's power plant engineer. After the inspection of all of the parts of the aircraft was completed by the Board on March 8, 1941, the aircraft was released to Eastern Air Lines.

Public Hearing

In connection with the investigation of the accident, a public hearing was held at Atlanta, Georgia, beginning on March 6 and continuing through March 9, 1941. G. Grant Mason, Jr., one of the five members of the Board, was designated by the Board to preside at the hearing. He was assisted by Robert W. Chrisp, Attorney of the Board, who acted as Associate Examiner; Jerome Lederer, Director of the Safety Bureau of the Board; Frank E. Caldwell, Chief of the Investigation Division of the Safety Bureau; Paul A. Gareau, Air Safety Specialist in Meteorology of the Safety Bureau; and James E. Peyton, Investigator in Charge of the Atlanta Office of the Safety Bureau.

All of the evidence available to the Board at that time was presented at the hearing. Testimony was given by forty witnesses, including witnesses from the vicinity of the accident and experts in various technical subjects, and fifty-seven exhibits were introduced. The depositions of seven persons who were passengers on the airplane at the time of the accident were read into the record at the hearing. The other surviving passenger, Captain E. V. Rickenbacker, President of Eastern Air Lines, was in such a critical condition that it was impossible to obtain a

deposition from him before the close of the hearing. His deposition was obtained, however, on March 28, 1941, and has been made a part of the record of the hearing.

While the Examiners and the representatives of the Safety Bureau were the only ones designated to ask questions directly of the witnesses, the Presiding Examiner, acting under instruction of the Board, announced at the opening of the hearing that any person who had any evidence, questions, or suggestions to present for consideration in the proceeding might submit them to the Examiners. Fifty-one written questions were so submitted during the hearing. Every question submitted was asked unless the subject matter of the question had previously been covered by the testimony.

Upon the basis of all the evidence accumulated in the investigation and hearing the Board now makes its report in accordance with the provisions of the Act.

SUMMARY AND ANALYSIS OF EVIDENCE

Air Carrier

Eastern Air Lines, Inc. (hereinafter referred to as "Eastern"), a Delaware corporation, was operating at the time of the accident as an air carrier under currently effective certificates of public convenience and necessity and air carrier operating certificates theretofore issued to it pursuant to the Act. Eastern is authorized by the certificates of public convenience and necessity, pursuant to which Trip 21 was operating, to engage in air transportation with respect to persons, property and mail between the co-terminal points

Newark, New Jersey, and New York, New York, and the terminal point New Orleans, Louisiana (designated as Route No. 5); between the terminal point New Orleans, Louisiana, and the terminal point Houston, Texas (designated as Route No. 20); and between the terminal point Houston, Texas, and the terminal point Brownsville, Texas, and between the terminal point Houston, Texas, and the terminal point San Antonio, Texas (designated as Route No. 42). The certificate for Route No. 5 designates as intermediate points Washington, D. C., Charlotte, North Carolina, and Atlanta, Georgia, among others.

Flight Personnel

On the flight in question, the crew consisted of Captain James A. Perry, Pilot Luther E. Thomas, and Flight Steward Clarence Moore.

Captain Perry, aged 29, had accumulated a total of approximately 4,193 hours of flight time and was the holder of airline transport pilot certificate No. 9524. Since his employment by Eastern on May 15, 1937, he had accumulated 3,268 hours, of which approximately 838 hours had been as captain in Douglas DC-2 and DC-3 type airplanes. His last physical examination required by the Civil Air Regulations, which was taken on December 18, 1940, showed that he was in a satisfactory physical condition. Captain Perry, in addition to actual experience, had been given, from time to time, flight checks under simulated instrument conditions. Company records indicated that he was a well-qualified and proficient pilot.

Pilot Luther E. Thomas, aged 31 years, had accumulated a total of approximately 806 hours as copilot with Eastern on DC-2 and DC-3 airplanes and at the date of his employment by Eastern his total accumulated flight time had been approximately 2,459 hours. At the time of

the accident he held commercial pilot certificate No. 10926 with an instrument rating. His last physical examination required by the Civil Air Regulations was given on February 26, 1941, by a medical officer of the United States Army Air Corps at Mitchell Field, Long Island, New York, and showed him to be in a satisfactory physical condition. He had been employed by Eastern since February 24, 1940, and before entering on his duties, had completed the regular company training course for pilots.

Prior to leaving LaGuardia Field on the day in question, Captain Perry had received about 1-1/2 hours' check time in instrument operation during the afternoon. This, plus the flight time on Trip 21 between New York and Atlanta, was his total flight time during the 24 hours preceding the accident.

Thus, it appears from the evidence that both Captain Perry and Pilot Thomas were physically qualified and held the proper certificates of competency for the flight and equipment involved.

Airplane and Equipment

Aircraft NC 28394 was a Douglas Model DST manufactured by the Douglas Aircraft Corporation of Santa Monica, California, and was purchased by Eastern on October 11, 1940. It was powered by two Wright Cyclone G202A engines each rated at 1200 h.p. for take-off, and was equipped with Hamilton Standard hydromatic propellers. The hub model of these propellers was 23E50-189 and the blade design of both propellers was 6153A-18. This model aircraft and its equipment had been approved by the Civil Aeronautics Authority for air carrier operation over routes flown by Eastern for 23 passengers and a crew of four. This particular airplane was convertible into berth sections for use at night. When so converted, the airplane carried a normal complement of 16 passengers. The airplane, as equipped with de-icers, had been certificated for operation with a standard gross weight of 24,546 pounds and a

provisional gross weight of 25,346 pounds.^{2/} At the time of departure of Trip 21 from Washington, the gross weight of the aircraft was approximately 25,322 pounds including mail, cargo, 650 gallons of fuel, 44 gallons of oil, 13 passengers and a crew of three. The record further shows that the airplane was loaded in accordance with the current approved loading schedule prescribed by the Civil Aeronautics Administration^{3/} which was attached to the airworthiness certificate of the airplane.

The airplane and its equipment had received the overhauls, periodic inspections and checks which are provided for in company practice and approved by the Civil Aeronautics Administration.

History of the Flight

Eastern Air Lines Trip 21 of February 26, 1941, originating at LaGuardia Field, New York, New York, and operating as a scheduled air carrier from New York to Brownsville, Texas, with intermediate stops at Washington, D. C., Atlanta, Georgia, New Orleans, Louisiana, and Houston, Texas, was dispatched to Washington, D. C., about 7:18 p.m. (EST) and took off at 7:21 p.m. (EST).

Prior to departure from LaGuardia Field, Captain Perry, with the assistance of the company flight dispatcher and meteorologist, prepared a flight plan for the trip from New York to Atlanta. This flight plan was based on

^{2/} The "standard gross weight" of an airplane is the maximum allowable gross weight for landing, while the "provisional gross weight" of an airplane is the maximum allowable gross weight for take-off. When an airplane takes off at its maximum provisional gross weight, the weight of the airplane must be thereafter reduced by gasoline consumption at least to the standard gross weight for landing prior to arrival at its next scheduled stop. If sufficient gasoline has not been consumed between time of take-off and any emergency landing, gasoline can be dumped by the use of tested and approved dump valves in order to reduce the total weight to the approved gross weight for landing. At the time of the accident the weight of the airplane had been reduced since its departure from Washington, D. C., to well below its authorized standard gross weight.

^{3/} A loading schedule for an aircraft provides for distribution of passengers, cargo and fuel in such manner as to maintain the center of gravity within approved limits.

weather reports issued by the United States Weather Bureau for various points along the route. The weather for the New York- Washington area permitted contact flight. Weather conditions in the Washington-Atlanta area indicated that the flight would encounter a general lowering of ceilings as it progressed southward. The terminal forecast issued by the company's meteorologist at Atlanta indicated the conditions at Atlanta to be ". . . overcast, occasional light rain and light fog, ceilings becoming 200 to 500" after 9:00 p.m. (CST). The airway weather report for Atlanta at 7:35 p.m. (CST) was "contact, ceiling 1,100 feet, overcast, visibility six miles, light rain, temperature 42, dew point 38, wind east 12, barometer 30.03". These reports indicated that the weather was at this time above the required minimums for landing down through but that an instrument approach would be necessary on arrival at Atlanta. All subsequent weather broadcasts were available to the trip en route.

In the flight plan Charlotte, North Carolina, was designated as an alternate terminal on this trip in accordance with company procedure. The weather at this point at the time of departure from New York was above the minimums required by the company operations manual for an alternate airport and was expected to remain, and did remain, above these minimums until after the flight was scheduled to arrive at Atlanta.

Captain Perry's flight plan called for a cruising altitude of 4000 feet with estimated flight times of one hour and twenty-six minutes from New York to Washington and of three hours and thirty-two minutes from Washington to Atlanta. The flight proceeded from LaGuardia Field to the Washington-Hoover Airport, Washington, D. C., in a routine manner.

On the basis of current weather reports along the route to be flown, the company flight dispatcher in charge at Atlanta issued authority to

clear Trip 21 for a non-stop instrument flight from Washington, D. C., to Candler Field, Atlanta, Georgia. This clearance and flight plan were approved by the Airway Traffic Control ^{4/} at Washington, D. C., and Atlanta, Georgia. At Washington the aircraft was refueled to depart with 650 gallons of gasoline which was sufficient for the trip from Washington to Atlanta at normal cruising power and, in case of emergency, provided a sufficient reserve to return from Atlanta to Charlotte, the designated alternate terminal, arriving at that point with more than 45 minutes fuel remaining in the tanks.

Trip 21 departed the Washington-Hoover Airport at 9:05 p.m. (EST) and reported over Mason Springs, Maryland, the first check point, at 9:22 p.m. (EST). As the flight proceeded southward toward Atlanta, its positions were given by radio over "fixes" ^{5/} at Richmond, Virginia; South Boston, Virginia; Greensboro, North Carolina; the Charlotte, North Carolina, radio range intersection; and Spartanburg, South Carolina. These messages were all received and acknowledged by either the company radio operator at Washington, D. C., or Atlanta, Georgia. The position reports show that Trip 21 passed over these various fixes within three minutes of the estimated time shown on Captain Perry's flight plan. Just prior to reaching the Stone Mountain fan marker, which is located on the northeast leg of the Atlanta radio range 17 miles from the Atlanta range station, the company radio operator at Atlanta called Trip 21 and advised: "EAL Trip 21 cleared to Atlanta Tower. Number one to approach. Change to day frequency."

^{4/} The Airway Traffic Control staff, a part of the Civil Aeronautics Administration, regulates the flow of traffic over a civil airway 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.

^{5/} Points at which the exact position of the aircraft may be determined by radio, e.g., a fan marker, a cone of silence marker over a radio range station, or an intersection of radio ranges.

This clearance had been received by the company radio operator from the Atlanta Airway Traffic Control office and was relayed to the pilot. Trip 21 acknowledged receipt of the message. At 11:38 p.m., Trip 21 called the company radio operator at Atlanta and reported "Passing over Stone Mountain, Georgia, . . . descending." The EAL radio operator at Atlanta acknowledged receipt of this message and in turn gave Trip 21 a Kollsman altimeter^{6/} reading of 28.94 and the following weather report: "Ceiling 300 . . . visibility one mile, light rain, light fog, ceiling variable from 200 to 500 feet. Trip 19^{7/} reported it 300."^{8/} Trip 21 repeated the Kollsman reading and acknowledged receipt of the message. Trip 21 then called the Atlanta airport control tower^{9/} and transmitted the following message: "EAL Trip 21 to Atlanta Tower - over Stone Mountain 11:37 p.m. making approach."^{10/} Will give you a call over range station." The Atlanta control tower acknowledged receipt of the message and transmitted the surface wind as "Surface northeast 10." Trip 21 acknowledged receipt of

^{6/} The Civil Air Regulations (sec. 04.532(d)) require that all air carrier aircraft be equipped with two altimeters of the sensitive type. Eastern uses an instrument known as Kollsman. On Eastern aircraft barometric pressure of one altimeter is kept at sea level pressure which allows the pilot to fly at indicated altitudes above sea level. Prior to landing the barometric scale of the other altimeter is set to correspond with a duplicate instrument on the airport which is kept set to show zero elevation. This allows the pilot to land to a zero reading at that particular airport.

^{7/} Trip 19 had landed a few minutes prior to Trip 21's arrival over the Stone Mountain fan marker.

^{8/} Weather minimums prescribed in accordance with the Civil Air Regulations in competency letters issued to Eastern by the Civil Aeronautics Administration authorized weather minimums for landing down through at Candler Field, Atlanta, Georgia, as ceiling 300 feet, one mile visibility, day or night.

^{9/} Airport control towers are erected and maintained by municipalities at various municipal airports for the purpose of regulating the flow of traffic in the vicinity of the airport in order to eliminate the possibility of collision between aircraft. These towers are normally equipped with radio receivers tuned to air carrier company frequencies as well as to frequencies used by military and privately owned aircraft. They usually are also equipped with a transmitter which operates on 278 kilocycles.

^{10/} See sketch of Eastern's instrument approach procedure which is incorporated in the company operations manual.

the message and repeated it as "Northeast 10. Thanks". Trip 21 next reported to the Atlanta control tower at 11:44 p.m., flying at 1800 feet above sea level over the Atlanta range station, which is located two miles southeast of the airport. The elevation of Candler Field is 985 feet above sea level. The Atlanta control tower acknowledged receipt of this message and again transmitted the surface wind as being northeast 10. The company radio operator at Atlanta then called Trip 21 and transmitted the following message: "Dispatcher suggests you land straight in."^{11/} Trip 21 acknowledged receipt of this message. No further radio contacts were made with Trip 21 and when it failed to land at the airport within a reasonable length of time the company's flight dispatcher became concerned and at 12:09 a.m. requested that emergency warnings be broadcast by the Airway Communication System over the Atlanta radio range. This request was complied with immediately and as the trip was still unreported the communications supervisor ordered that the Atlanta radio range station be monitored at once to determine if all courses were in proper alignment and if the signals were being transmitted properly. Believing that Trip 21 had been involved

^{11/} When making an instrument approach from the northeast at Atlanta, Georgia, the normal procedure is to pass over the radio range station at 1800 feet above sea level. A turn is then made and the pilot proceeds out the southeast leg of the radio range for about two minutes where a procedure turn is made and the ship is then headed back along the southeast leg to the range station. During this time a gradual descent is effected and the airplane passes over the range station on the final approach at an altitude of 500 feet above the level of the airport. From this point a let-down is made to a minimum authorized ceiling of 300 feet and upon making visual contact with the ground the flight, with a northeast wind of ten miles per hour, can normally continue straight ahead and effect a landing on the southeast-northwest runway.

in an accident in the vicinity of the radio range station, Eastern Air Lines operations personnel organized a searching party, which discovered the wreckage about 6:30 a.m. in a pine grove approximately 5 miles southeast of the radio range station, and 7 miles southeast of Candler Field.

A survey of the wreckage disclosed that, while traveling in a northerly direction, aircraft NC 28394 had first struck the tops of three small pine trees growing on a knoll located 1500 feet south of the final resting place. The lowest tree was struck at an elevation of 915 feet above sea level. The tops of these trees were broken off and several small pieces of red glass were picked up from the ground in this area, indicating that the left, or red, navigation light was shattered by contact with the trees. The aircraft apparently continued in an almost level flight attitude across a small valley in a northerly direction for approximately 1500 feet. There is an open field in this valley which is bordered on the north and east by a thick growth of pine and north of the field the terrain rises gently for a distance of several hundred feet. As the plane reached the northeast corner of the field the right wing tip struck the top of a poplar tree standing on the edge of the field. The point of impact with this tree was 946 feet above sea level. The aircraft then struck several scattered pine trees, and finally crashed in a thick pine grove.

Condition of Wreckage

The aircraft was completely demolished. Both wings had been sheared off by pine trees approximately eight inches in diameter and the major portion of the wreckage was found about 35 feet from where the first wing

had been sheared off. The fuselage was in an inverted position with the right engine underneath. The left engine was torn from its nacelle and was thrown approximately 20 feet forward of the major portion of the wreckage. The elevation of the terrain at this point was 896 feet above sea level.

Examination was made of the wreckage including the engines, propellers, instruments, radio equipment, controls and other parts of the aircraft, by technical representatives of the Civil Aeronautics Board. The results of this examination showed that there was no structural or mechanical failure of the airplane prior to the time it struck the trees southeast of the airport. The right hand threaded terminal of a turnbuckle connecting the down aileron control cable from the left wing to the master bell-crank was found to be unscrewed and the two end threads within the barrel were stripped. However, this turnbuckle was submitted to the National Bureau of Standards for test purposes and it was determined that its condition was probably caused by impact loads imposed at the time of the crash.

All of the evidence indicates that considerable power was being developed from each engine at the time the aircraft struck the trees and the ground. The ignition switch and the master ignition switch were found in the "on" position. The condition of the engines and propellers and the extent of the cutting of limbs and trees by the propellers indicate that a normal amount of power for that stage of the instrument approach was being developed at the time of impact.

A barograph chart ^{12/} which was found in the wreckage recorded the

12/ Section 61.341 of the Civil Air Regulations, which requires that all air carrier aircraft having a gross weight in excess of 10,000 pounds used in scheduled air transportation of passengers be equipped with instruments for automatically recording altitudes while in flight, was passed by the Board on February 21, 1941 and will become effective on January 1, 1942.

altitude at which the aircraft flew at all times during its flight from New York. It showed a practically constant cruising altitude of 4,000 feet between New York and Washington and between Washington and the vicinity of Atlanta. The chart also showed a normal descent and ascent at Washington and a steady descent in the vicinity of Atlanta continuing from approximately the time the pilot reported over Stone Mountain until the time of the crash. The chart contained no indication of any abnormal operation of the aircraft in the period preceding the crash. However, the information contained therein is not sufficiently exact to allow for an accurate determination of the altitude of the aircraft at any particular location after its descent was begun in the vicinity of Atlanta.^{13/}

In the wreckage were found two sensitive type Kollsman altimeters which had been torn from the instrument panel and lay partially buried in mud. An examination of the barometric scale settings of these altimeters at the scene of the crash showed a setting of 30.33 inches of mercury in altimeter No. 031-2522 and 29.92 inches of mercury in altimeter No. 01-1366. Altimeter No. 031-2522 was the one used in route flying and was kept adjusted to sea level barometric pressure. This setting as supplied by the United States Weather Bureau for the Washington station at 8:35 p.m. (EST) was 30.23, and as supplied by the Weather Bureau for the Atlanta station at 10:35 p.m. (CST) was 30.02. Altimeter No. 01-1366 was the one used for instrument approaches and should have been adjusted

^{13/} The chart upon which the altitude is registered has such a small time interval scale that it fails to show exactly the maneuvers of the aircraft in the short period between the beginning of its descent at Stone Mountain and its subsequent crash. This period of 10 minutes embraces no more than an eighth of an inch on the scale of the chart and an enlargement only serves to distort the size of the altitude line in relation to the scale.

for barometric pressure to read zero at the airport of intended landing. As previously mentioned, the evidence shows that a setting for this instrument of 28.94 was given to Trip 21 by Eastern Air Lines radio operator at Atlanta, Georgia, at 11:38 p.m. when Trip 21 reported over the Stone Mountain fan marker.

Conduct of the Flight

The dispatching of the flight from New York, New York, to Washington, D. C., and from Washington, D. C., to Atlanta, Georgia, was in accordance with proper procedure. Clearance was issued for contact operations between New York, New York, and Washington, D. C., and for instrument operations between Washington, D. C., and Atlanta, Georgia, which corresponded with weather forecast for those parts of the route.

Investigation of all weather services involved disclosed that the forecasts and other weather advice made available to Captain Perry prior to departure were substantially accurate. The official observational facilities maintained at Atlanta by the United States Weather Bureau functioned in an entirely normal manner throughout the flight. The observer on duty followed at all times the approved practice and carried out his duties adequately. It further appears that weather reports were broadcast regularly by the radio ranges along the route, including the one at Atlanta, and that Captain Perry was fully apprised of all weather conditions and changes therein along the entire route.

The evidence reveals that the radio range at Atlanta was functioning in the proper manner during this period. The range was monitored by the Civil Aeronautics Administration's communications stations immediately after it became apparent that Trip 21 had experienced difficulty in that

vicinity and there was no evidence discovered which would indicate any malfunctioning of the range. Furthermore, two trips of Eastern had, during that period, effected successful landings at Candler Field under instrument conditions, Trip 19 at 11:36 p.m. and Trip 26 at 12:46 a.m., and did not report anything wrong with the range.

There is no evidence indicating any unusual facts affecting the operation of the flight from New York to Washington, D. C. From Washington south it appears that the flight proceeded in a normal manner at least until several minutes before the crash. Radio contacts with the flight indicated that operations were being conducted in strict accordance with the flight plan and all of the witnesses agree that the aircraft was operating in a normal manner during the period preceding the events directly leading up to the crash. Some of the passengers, including Captain E. V. Rickenbacker, stated that they felt a slight shock immediately preceding the final impact. After this shock, which was probably due to the aircraft brushing the tops of the trees located about 1500 feet from the point at which the plane came to rest, Captain Rickenbacker testified that he arose from his seat and started toward the rear of the plane. Almost simultaneously a violent maneuver of the aircraft threw him from his feet and while he was in a prone position the aircraft crashed in the pine grove.

According to Eastern's procedure, a normal let-down would have resulted in the aircraft being at an altitude of between 800 and 900 feet above the level of the airport at the place of the crash. In reality, the aircraft, when it contacted the trees, was at an altitude slightly

below that of the Atlanta airport. The crux of the question presented in this investigation is the reason for the conduct of the operation at an altitude so far below normal.

The record contains no evidence of any mechanical or structural failure of any part of the aircraft which would account for operations being conducted at an altitude so far below normal. Subsequent examination of all parts of the aircraft gave no indication of any malfunctioning of the engines, controls, or instruments which would have led to abnormal operations. Moreover, the known facts concerning the operation of the aircraft in the vicinity of Atlanta lead inevitably to the conclusion that the crash cannot be attributed to any mechanical or structural failure, with the possible exception of the altimeters. From the testimony of witnesses on the ground who saw or heard the airplane during its flight out the southeast leg of the Atlanta range, it appears that operations were being conducted at all times at an altitude substantially below normal. Yet, there was no evidence that the aircraft was in distress or that any emergency measures were being taken at any time. The standard approach procedure was followed and apparently no attempt was made to shorten it. Clearly, Captain Perry was not attempting an emergency landing at the time of the crash for he had made no use of his radio to indicate that he was in trouble nor did he drop landing flares to serve as guides during such a landing. In addition, the aircraft apparently traveled the last 1500 feet preceding the crash in practically level flight and the condition of the engines and propellers as found in the wreckage revealed that at the time of the crash a normal amount of power for that stage of a let-down-through procedure was being applied to the engines.

Consideration has been given to the question whether ice in the carburetors could have contributed to the accident. Atmospheric conditions on the night of February 26, 1941, at Atlanta, Georgia, were such as to make carburetor icing a possibility. The ground temperature was 40 degrees Fahrenheit and the relative humidity varied from 93 per cent near the ground to 100 per cent at 200 or 300 feet above the ground. Under these conditions, only eight degrees Fahrenheit expansion cooling in the carburetors would have been necessary to form ice in them which, in view of the moisture content in the air, was a distinct possibility. As found in the wreckage, the carburetor heat controls were in full "on" position and the carburetor de-icer valves were both partly open. Thus, Captain Perry had anticipated the possibility of carburetor icing and had taken steps to prevent it. Ice in carburetors of a sufficient extent to have contributed to the accident certainly would have been detected by Captain Perry because such a marked loss of power would have been immediately apparent. However, as we have pointed out, Captain Perry gave no evidence of knowledge of an emergency and took no measures to combat it. The probability of the accident being due to loss of power from carburetor ice is also refuted by the fact that for the last 1500 feet the plane is known to have proceeded in practically level flight and to have crashed with normal power being developed by the engines. Thus all of the circumstances surrounding the flight indicate that carburetor ice was not present, or, if present, was not of such a degree as to be a contributing factor in the accident.

Accordingly, it is our belief that neither a structural nor

mechanical failure, nor the presence of carburetor ice was a contributing factor in the crash. The fact that he was operating at a dangerously low altitude due to any of the foregoing reasons would have been apparent to Captain Perry if his altimeters were reflecting the correct altitude at the time, and he would have taken some emergency measures as outlined above to have averted the crash. Accordingly, we must conclude that Captain Perry did not know that he was flying at such a low altitude.

In order to have flown at such an unusually low altitude without knowing it, Captain Perry must have either ignored his altimeters altogether or must have placed reliance upon an altimeter, or altimeters, which were out of order or misset. It is inconceivable that he could have ignored his altimeters for in the performance of an instrument approach he must have placed complete reliance upon his instruments. Accordingly, we are left with only two alternatives, either that the altimeter, or altimeters, by which operations were being conducted were out of order, or that one, or both, were misset.

Although subsequent examination of the altimeters revealed no defect therein which had existed prior to the crash, that possibility cannot be excluded because of their damaged condition when found. In considering the possibility of malfunctioning of the altimeters, it is necessary to predicate the discussion on two hypotheses: (1) That both altimeters were out of order; (2) That one altimeter was out of order. On the aircraft involved in the accident both altimeters were connected to the same static pressure line; therefore, any defect in this line would have resulted in the same error being registered by both altimeters.

However, in this event, the altimeters would probably register the static pressure prevailing in the cockpit which would result in an error which would not be sufficient to account for the accident as it happened. The possibility of any other kind of mechanical or structural defect being present in both altimeters, which would result in both of them being erroneous to the same extent (i.e., indicating an altitude about 800 feet higher than the actual altitude) would be a coincidence so extraordinary as to be highly improbable. However, we have no evidence upon which to exclude definitely the possibility of the malfunctioning of the one altimeter which was supposed to have been set at airport barometric pressure and upon which presumably reliance was being placed in the conduct of the instrument approach.

The only other probable explanation is that the altimeter by which operations were being conducted was not correctly set to airport barometric pressure during the conduct of the instrument approach. The record indicates that no error was made in transmitting the setting from the ground station for the radio log of the Eastern radio station at Atlanta and the testimony of the operator on duty indicate that the correct barometric setting was given to Trip 21 about the time it was over Stone Mountain. This is substantiated by the testimony of Eastern's dispatcher in charge of the flight who stated that he heard the correct setting broadcast to Trip 21 and on his own initiative verified the setting transmitted. In reply to this message the setting was acknowledged correctly by either Captain Perry or Pilot Thomas.

However, it is not known whether any adjustment was made in the setting of either altimeter after receipt of this message and there remains

the possibility that the instrument was not changed from the setting of 30.03 previously made at Washington. In that event the error would have amounted to approximately 1,200 feet and would probably have resulted in a crash at a much earlier stage of the instrument approach than that at which it actually occurred. Moreover, it is most improbable that some adjustment was not made in this instrument after the Atlanta Airport setting was broadcast to Trip 21 and correctly acknowledged by a member of the crew.

As evidence of a possible missetting it should be noted that the setting of the altimeter by which operations presumably were being conducted as found in the wreckage was 29.92 inches, which was .98 of an inch in error. This setting did not correspond with the barometric pressure at any point en route. Such an erroneous setting at prevailing temperature would have resulted in the altimeter showing an altitude of 883 feet greater than was actually the fact. As previously mentioned, this instrument may not have been set exactly as found in the wreckage, especially since the setting of the other, or route altimeter as found was so manifestly in error as to indicate that the crash had materially altered the setting. Nevertheless, a setting of this altimeter approximately as found could explain fully the conduct of operations preceding the crash, providing the pilots failed to check both instruments for their accuracy, and would also account for Captain Perry's absence of knowledge of the correct altitude, and his failure to realize that he was confronted by an emergency.

As heretofore pointed out, it is not clear from the evidence which member of the crew received the barometric setting from Eastern's radio

station at Atlanta and acknowledged it correctly. Nor is it clear whether the altimeter being used during the instrument approach was incorrectly set or was not functioning properly. However, in any event, it was the responsibility of Captain Perry, by virtue of his position as captain in charge of the flight, to conduct it in accordance with the highest degree of care which certainly would include cross-checking the two altimeters to determine if both were correctly set and functioning properly. Such a check would have been a simple matter, for if both instruments were registering the correct altitude the difference between the two readings would have closely approximated the height above sea level of the Atlanta Airport, or 985 feet. If the airport altimeter had read so incorrectly as to result in operations at an altitude at least 800 feet below normal during the instrument approach, the two instruments would have registered very nearly the same altitude. Thus, it must be concluded that Captain Perry failed in his duty of adequately checking the instrument prior to placing complete reliance on it during his approach.

Although Captain Perry by virtue of his position was primarily responsible for the safe conduct of the flight, Eastern is not without responsibility. Investigation into operating procedures revealed that Eastern did not have a definitely established cockpit procedure in which the captain and the pilot checked with each other in the setting of various navigation instruments and the operation of cockpit controls. It is the responsibility of airlines as common carriers of persons, property and mail in the exercise of the highest degree of care to take cognizance of the fact that perfection has not yet been achieved either

in men or equipment and to anticipate as far as possible the occurrence of human error or mechanical defect so that measures to prevent them or avoid their potentially tragic effects may be taken. It is the established practice of most of the major air carriers to provide a definite procedure by which all essential instruments and controls are checked at certain specified times during operation. This is usually accomplished by means of a check list upon which the instruments and controls are listed and is so firmly established as to be a matter of routine. Had such a formal procedure been in effect at the time Trip 21 was performing an instrument approach at Atlanta, a routine check would have revealed such an error in altimeter reading as appears to have been involved in this case. If, for some reason, it had not been possible for both officers to receive the setting relayed from the field and thus to check the instruments, a comparison of the readings on the two altimeters would have revealed a material discrepancy. However, in the absence of a formal procedure, it is entirely possible that an originally erroneous setting made by the officer who received the message from the ground station could escape unnoticed by the other officer. Therefore, even though Captain Perry did not adequately perform the duties incumbent upon him by failing to check carefully the altimeter settings before commencing a let-down procedure in complete reliance upon one of them, it is also apparent that Eastern did not exercise the requisite degree of caution by failing to establish a cockpit procedure to guard against just such occurrences as probably befell Trip 21 at Atlanta.

III.

CONCLUSION

Findings

Upon all of the evidence available to the Board at this time, we find that the facts relating to the accident involving aircraft of United States registry NC 28394, which occurred near Atlanta, Georgia, on February 26, 1941, are as follows:

1. The accident which occurred at approximately 11:50 p.m. (CST) on February 26, 1941, to Eastern Air Lines' Trip 21 of that date resulted in major damage to aircraft NC 28394, fatal injuries to five passengers and three members of the crew, serious injuries to five passengers, and minor injuries to three passengers.

2. At the time of the accident Eastern Air Lines held currently effective certificates of public convenience and necessity and air carrier operating certificates authorizing it to conduct the flight.

3. Captain Perry and Pilot Thomas were physically qualified and held proper certificates of competency to operate as air carrier pilots over a route between New York, New York, and Atlanta, Georgia, via intermediate points.

4. Aircraft NC 28394 was currently certificated as airworthy at the time of the accident.

5. Trip 21 was cleared in accordance with proper procedure from New York, New York, to Washington, D. C., and from Washington, D. C., to Atlanta, Georgia.

6. At the time of departure from Washington, D. C., and at the time of the accident the gross weight of the airplane did not exceed the permissible gross weight and the usable load was properly distributed with reference to the location of the center of gravity.

7. At the time of departure from Washington, D. C., for Atlanta, Georgia, the aircraft carried sufficient fuel to permit flight at normal cruising power to Atlanta and thereafter to permit it to proceed to Charlotte, its alternate airport with sufficient fuel still remaining in the tanks for more than 45 minutes of flight thereafter.

8. Trip 21 proceeded normally from New York, New York, to Washington, D. C., and from Washington, D. C., until it arrived in the vicinity of Atlanta.

9. Weather reports for Atlanta consistently had indicated variable conditions of ceiling and visibility. However, Trip 19, which arrived at Atlanta just prior to Trip 21's arrival over the Stone Mountain fan marker, reported the weather at Atlanta to be equal to those weather minimums authorized in Eastern Air Lines' letter of competency.

10. After arriving over the Atlanta radio range station, Captain Perry began an instrument lat-down-through procedure.

11. While executing this procedure, Trip 21 descended to an altitude of 39 feet below the elevation of the airport where it contacted a number of trees and was demolished approximately 5 miles southeast of the Atlanta radio range station.

12. Considerable power was being applied to the engines at the time the aircraft contacted the trees and the ground.

13. The evidence does not show whether Captain Perry or Pilot Thomas was flying the aircraft at the time of the accident.

14. Aircraft NC 28394, its engines and all of its equipment, with the possible exception of the altimeters, were apparently functioning normally until its contact with the trees.

Probable Cause

On the basis of the foregoing findings and the entire record available to us at this time, we find that the probable cause of the accident to NC 28394 (Eastern Air Lines Trip 21) on February 26, 1941, was the failure of the captain in charge of the flight to exercise the proper degree of care by not checking his altimeters to determine whether both were correctly set and properly functioning before commencing his landing approach. A substantial contributing factor was the absence of an established uniform cockpit procedure on Eastern Air Lines by which both the captain and pilot are required to make a complete check of the controls and instruments during landing operations.^{14/}

BY THE CIVIL AERONAUTICS BOARD:

/s/ Harllee Branch
Harllee Branch, Chairman

/s/ G. Grant Mason, Jr.
G. Grant Mason, Jr., Member

/s/ George P. Baker
George P. Baker, Member

(Mr. Edward P. Warner, Vice Chairman, and Mr. Oswald Ryan, Member, did not take part in the adoption of this report.)

^{14/} On May 8, 1941 the Board recommended to the Administrator that he institute an informal investigation of operating procedures being followed on Eastern. This investigation has been begun and is still in progress.

A study is currently being made by the Board as to the advisability of promulgating requirements for type certification of instruments under Section 603 of the Act.