

Instrument Approach

A-337

CIVIL AERONAUTICS BOARD ✓

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AIRCRAFT ACCIDENT REPORT

JAN 8, 1959

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SOUTHEAST AIRLINES DC-3, N 18941, NEAR TRI-CITY AIRPORT,
BRISTOL, TENNESSEE, JANUARY 8, 1959

SYNOPSIS

On January 8, 1959, about 2032 e. s. t., a DC-3, Southeast Airlines Flight 308, struck a mountainside during an ILS approach to the Tri-City Airport, Tennessee. The aircraft was demolished by the impact and subsequent fire. All occupants - seven passengers and three crew members - received fatal injuries.

The evidence indicates Flight 308 departed Nashville, Tennessee, with an inoperative radio compass. Although the flight was cleared by way of low frequency airway Green 5, it does not appear that the facilities defining this airway were used. Upon arriving in the Tri-Cities area the aircraft was east of its intended track and erroneously identified the reporting point from which an ILS approach procedure was to be initiated. During the instrument approach, which was conducted in snow showers, the flight missed the outer marker. The approach was continued under instrument conditions without utilizing the VOR facility which would have been of assistance in confirming the flight's position. Without having clearly established his position, the pilot flew 15 miles beyond the outer marker and descended to an altitude too low to clear high terrain in this area.

Investigation

Southeast Airlines is an intrastate carrier not holding a certificate of public convenience and necessity issued by the Board. Flight 308 is a regular trip which originates in Memphis, Tennessee. Scheduled stops are made at Nashville and Knoxville and the flight terminates at Tri-City. The crew for the segment of the trip of January 8, 1959, from Memphis to Nashville, consisted of Captain Thomas A. Bond, First Officer Robert M. Irwin, and Stewardess Wanda C. Nalley. Captain Robert L. Gollmier, who had deadheaded on this segment, was scheduled to complete the trip to Tri-City with Mr. Irwin and Miss Nalley while Captain Bond returned to Memphis.

At Memphis, the crew made normal preparations for the flight. The weather was checked and the necessary flight papers were filed, including an instrument flight rules flight plan. After receiving IFR clearance to Nashville, the flight departed Memphis at 1630¹ with Captain Bond in command and proceeded

¹/ All times are eastern standard unless otherwise specified, and are based on the 24-hour clock.

uneventfully until reaching the Nashville area. Approaching Nashville, Flight 308 was given radar vectoring to the ILS final approach course by Nashville approach control. It then landed at 1807, 19 minutes late.

Captain Bond stated in his testimony at the public hearing that during the approach to Nashville, First Officer Irwin was unable to pick up the compass locator at the outer marker on the ADF (Automatic Direction Finding Receiver). The captain and first officer attempted several times to tune the radio but were unable to receive either an aural signal or a visual indication from the ADF pointer. Captain Bond stated that upon landing he informed Captain Gollmier of the malfunction but did not make an entry in the log concerning it.

Captain Gollmier took command of the flight at Nashville and made normal preparations for continuation of the trip. A check was made of the weather reports, an instrument flight rules flight plan filed, and ARTC (Air Route Traffic Control) clearance received.

The stop at Nashville took 18 minutes, after which the flight proceeded uneventfully to Knoxville. There, during the one engine operating stop, the crew was given the flight papers for the remaining segment including the latest Tri-City weather observation, a special report at 1859. It was 300 feet scattered clouds, measured 600 feet overcast; 3 miles visibility; light snow and fog; temperature 33 degrees; dewpoint 32 degrees; wind northwest at 8 knots; altimeter 29.99.

Cumulative en route delays resulted in the flight departing Knoxville at 1946, 27 minutes late. It was given ARTC clearance to the Gray intersection via Green Airway 5 to maintain 5,000 feet and to contact Tri-City approach control when over the Bulls Gap marker beacon. The estimated time en route was 34 minutes at a true airspeed of 145 knots. At 1953 the flight advised the company at Knoxville it was estimating Piedmont fan marker at 1956. A few minutes later it reported over Piedmont at 1958, estimating Tri-City at 2023.

At 2010, in accordance with the clearance, Flight 308 reported over Bulls Gap. Tri-City approach control acknowledged the report and further cleared the flight to make an approach to the airport on runway 27. The latest weather information was also transmitted to the flight: ". . . wind is north, variable both sides at 10 knots, gust to 15; altimeter 30.03; Tri-City weather, measured ceiling 900 broken, 1700 overcast, visibility 3; light snow; fog."

Following the acknowledgment of the approach clearance and weather information, the flight switched to company frequency at Tri-City giving an estimated time of arrival at 2026, reporting the aircraft as being O. K. for turn-around, and asking if it still needed sumps and screens checked.^{2/} The chief dispatcher answered in the affirmative and logged the time of this contact as 2012. The dispatcher was able to identify the transmission as being made by Captain Gollmier. Twelve minutes later, at 2024, Southeast Flight 308 reported to approach control

^{2/} A standard minor line check for foreign material in the oil sumps and fuel screens accomplished every 50 flying hours.

stating it was over Gray intersection^{3/} leaving 5,000 feet making an outer marker approach. The controller advised Flight 308 to report leaving the outer marker inbound.

At 2032, because there was other traffic in the area, the controller called Flight 308 to ask its position. The captain, who occupied the right seat, at this time asked if the glide slope was operating. The controller advised that it was and asked if Flight 308 was inbound to the outer marker. The captain then stated that his ADF was acting up; that he did not pick up the outer marker either aurally or visually and that they were making a procedure turn. The controller acknowledged and asked the flight's altitude. No further word was received from the flight and it must be presumed that the aircraft crashed immediately after its final transmission.

A Piedmont Airlines DC-3 had arrived at the Bristol intersection^{4/} at 2028 and was holding, awaiting clearance to approach to the airport. The Piedmont pilot, a witness at the public hearing, testified that he was VFR at 5,000 feet, in the holding pattern; however, he could see a cloud layer east of the airport in the ILS approach area which extended from about 3,000 feet to 7,500 feet. Clear of the clouds, the visibility was more than 15 miles. He said he could see "lights from several cities to the west and north and could see the Tri-City Airport." The Piedmont captain testified that he heard the conversations between Flight 308 and the approach controller at 2024 and 2032 and was concerned after the latter, when he could not see the Southeast aircraft in the Bluff City area. He said he made special note of the time, 2032, because he knew Flight 308 should not still be eastbound eight minutes after passing Gray intersection. However, he did not see any other aircraft in the area. Several minutes later he canceled his IFR flight plan and proceeded VFR to the airport via the radio range, landing at 2047.

At approximately 2052, after Flight 308 had failed to respond to any radio calls, the controller initiated accident search procedures. The pilot of Piedmont Flight 383 flew in the ILS approach area on his departure from Tri-City in an attempt to locate Flight 308 which was presumed down. He did not see any sign of the aircraft and reported that the reduced visibility and low ceiling in the area of Holston Lake prevented any further search.

The wreckage was located January 9, 1959, about 1130 by a Tennessee Air National Guard aircraft on the northwest side of the Holston mountain range 18.75 n. m. (nautical miles) east of the Tri-City Airport and 1.25 n. m. north of the ILS localizer path. The terrain in which the aircraft crashed was extremely rugged and heavily wooded. A ground party led by Civil Air Patrol personnel reached the scene late in the afternoon after an arduous climb up the snow-covered mountainside and reported back that there were no survivors. A study of the impact area revealed that the aircraft, while on a course of 235 degrees, first struck several trees which severed the left wing approximately 21 feet from the tip and destroyed a portion of the horizontal stabilizer.

^{3/} The intersection of the southwest leg of Tri-City low frequency radio range and the 275-degree radial of the Tri-VOR - 3 miles southwest of the airport.

^{4/} The intersection of the northeast leg of the Tri-City low frequency radio range and 344-degree radial of the Tri-VOR - 9 miles northeast of the airport.

It could be seen from the initial impact marks that the aircraft was in level flight longitudinally with an angle of bank to the right of less than 10 degrees when it struck the trees growing on the 35-degree slope, at an elevation of 3,140 feet near the crest of the mountain. As it continued into the trees, parts separated and finally the outer right wing panel was severed by another tree. The remainder of the aircraft continued over the crest of the hill without hitting the ground. Its forward motion was then stopped by contact with several large trees and it fell to the ground in an upright position. The cabin section of fuselage with the empennage attached then rolled 180 degrees to the right and came to rest inverted across the stub of the right wing.

The left engine separated from the aircraft during the impact sequence and came to rest at the crest of the ridge. The left propeller and nose section had broken away from the engine and had fallen about 20 feet back along the crash path. The right propeller separated during the first 135 feet after initial impact and came to a stop about 35 feet behind the main wreckage. The right engine continued forward when the aircraft was stopped by the large trees and came to rest about 300 feet down hill from the wreckage.

An intense fire ensued in the main wreckage consuming the nose section, cabin sides and belly of the fuselage, the nacelles, and forward part of the wing center section. Inasmuch as there was no evidence of fire or heat on the trees, underbrush, or pieces of wreckage along the crash path, this fire must have occurred after the wreckage stopped.

All components of the aircraft structure were accounted for in the wreckage area. All control surface hinges and control surface bell cranks were located and all damage was determined to have been the result of impact forces. The control system cables were traced and found to be intact with the exception of those points at which the outer wing panels had separated. The landing gear and flaps were in the fully retracted position and, as near as could be determined, all trim tabs were in the neutral position.

The left propeller was found almost at the top of the ridge. It had broken from the engine at the nose section and had lodged in an upright position against a tree. All three blades remained attached to the hub but were bent at various angles and about eight inches of the tip of the No. 1 blade was broken off. The propeller dome shell was broken and the piston was partially collapsed by a load on its forward end. Upon disassembly the low pitch stops were found to be crushed by the rotating cam stops at impact. The dome piston was at 24 degrees. Only one of the three blade shim plates bore markings sufficiently distinct for blade angle correlation. It indicated a blade angle of 24 degrees at impact.

The left engine was found lying on its nose section near the crest just a few feet from its propeller. Two cylinders and rocker assemblies were broken away from the engine by impact. The power section was inspected and was found to have had adequate lubrication. There was no evidence of abnormal heat discoloration, flailing, or interference of the moving parts. The nose case was broken open and the reduction gears were separated from the engine. They appeared normal and adequately lubricated. All engine accessories were examined and no evidence of operating difficulty was found.

All three blades of the right propeller were bent and the tips of Nos. 1 and 2 were broken off. The propeller dome shell was intact and the piston was positioned at 26 degrees. The shim plates bore impact markings as follows: No. 1 at 15 degrees; No. 2, two marks at 24 degrees and 18 degrees; and No. 3 at 23 degrees.

The right engine rolled about 300 feet down a slope from the main wreckage. Several of its cylinders and rocker assemblies were broken off by impact. Examination of the power section showed adequate lubrication and there was no evidence of operating difficulty. The nose case was broken open but the gears appeared to be normal with adequate lubrication. The accessories were examined and none indicated evidence of malfunction prior to impact.

The main oil screens and sump plugs of both engines were examined and found to be free of metal particles. In addition, the main fuel screens for each engine were found to be clean and undamaged. All damage noted to both powerplants was the result of impact forces. There was no fire damage either in flight or after impact on either engine.

Maintenance records indicated that both the airframe and powerplants had been maintained in accordance with all applicable regulations. There were no outstanding discrepancies and no maintenance carry-over items which might have affected the airworthiness of the aircraft.

The radio equipment installed in N 18941 was subjected to heavy impact forces and fire which followed. The two VOR's (VHF navigation receivers) with which the aircraft was equipped were recovered. By comparing the pilots' tuning knob with an undamaged one it was determined that VOR No. 1 was tuned to 109.9 mcs. (megacycles). Inspection of the receiver confirmed this setting which is the frequency of the Tri-City ILS localizer. The tuning knob on VOR 2 indicated 111.3 mcs. but no reading could be obtained from its receiver because of extensive damage. This frequency is not one used for any radio navigational facility in the Tri-City area.

The two glide slope receivers installed were recovered but both were damaged so extensively that no settings or other useful information could be obtained.

There was also one ADF and one low frequency receiver with fixed loop on the aircraft. Both of these receivers were found. The ADF receiver was badly damaged and burned but it was possible to determine that it was tuned to 221 kcs., the Tri-City low frequency radio range. No positive determination could be made for the low frequency receiver. However, it appeared to be set between 324 kcs. and 349 kcs.

The single VHF transceiver was tuned to 119.5 approach control frequency and the single HF transceiver was tuned to a company operating frequency.

The marker beacon receiver was recovered in fairly good condition. However, all but one tube were missing from the set. As none of the tube sockets were damaged and no pieces of tubes were found inside the receiver, it is presumed some souvenir hunter had appropriated them. After the tubes were replaced, and one connection which had been damaged at impact was repaired, the receiver operated and produced both an aural and visual signal.

The Tri-City Airport has standard instrument landing system equipment. Both the localizer and the glide slope are equipped with dual transmitters with a provision for automatic switchover in the event of a malfunction of any kind in the main equipment. They are also provided with standby power units in the event of commercial power failure. Finally, both the localizer and glide path are self-monitored and any malfunction in the equipment will actuate a red light and sound a buzzer in the tower.

In addition, the ILS installation includes an outer marker and a middle marker beacon. These VHF marker beacons are located on the ground in line with the localizer path at specific distances from the end of the runway to enable the pilot to orient himself in relation to the distance to the runway threshold. As an additional assistance to the pilot there is a low frequency compass locator at each marker beacon location which is normally utilized by means of the ADF. The compass locators for the middle and outer markers transmit nondirectional signals on frequencies of 201 kcs. and 239 kcs., respectively.

The marker beacons and the compass locators are single-transmitter installations and do not have standby power provided. However, like the localizer and glide path they are automatically monitored and any malfunction will actuate equipment failure alarms in the tower. The components of the ILS and the compass locators were functioning properly on the night of the accident. No such equipment failure alarm occurred in the tower. In addition, another Southeast flight executed an ILS approach subsequent to Flight 308 and reported the system normal. A flight check by the Federal Aviation Agency was made of all the Tri-City radio facilities the following day and all were operating normally.

At the Tri-City Airport the middle marker and outer marker were located on the localizer path 5 and 3.7 nautical miles, respectively, east of the approach end of runway 27. Eight and six-tenths nautical miles farther east on the localizer path (12.3 nautical miles east of the runway threshold) there is another low frequency nondirectional "H" facility known as the Emmett beacon. Two additional radio aids are a low frequency radio range and a VOR (VHF omni directional range).

There are two specified altitudes at which procedure turns are authorized for an ILS approach to Tri-City. Originally the minimum altitude at which the turn could be made was 5,500 feet within 10 miles east of Emmett "H." Later an alternative procedure turn was authorized at an altitude of 3,000 feet within 5 miles east of the outer marker. The 5-mile restriction is necessary because beyond this area the terrain rises rapidly to elevations well above 3,000 feet.

According to a company witness, the Southeast training program covered the Tri-City ILS procedures. He said that the procedure taught is to cross Gray intersection, proceed to the middle marker, and thence to the outer marker. All Southeast pilots have been instructed that the flying time from Gray to the outer marker is approximately three minutes. They are also instructed that the procedure turn must be started 30 seconds after passing the outer marker to ensure that it is completed within the 5-mile radius of the LOM (outer marker and compass locator). Shortly after the accident Southeast Airlines sent the following message to all of its pilots: "Effective immediately positive identification of Gray intersection will be made utilizing the facilities that comprise the intersection. Namely, the 275° radial of TRI-VOR and Southwest course of TRI-LFR (Tri-City Low Frequency Range). Descent below 5,000 prohibited until positively identified."

It has been the company practice to use the 344-degree radial of the Tri-City VOR which crosses the localizer about 6-1/2 miles east of the outer marker as an additional safety measure to assist the pilot in remaining within a safe area.

The company witness further said that the ADF is not an essential piece of radio equipment for the ILS procedure. However, he said a properly operating ADF is required by Civil Air Regulations and company regulations for flight in instrument weather conditions. In such conditions the company considers it a "no go" item. He said also that when malfunction occurs to this unit or other such item, company policy requires that it be noted in the aircraft log and corrective action be taken before originating a flight segment. As stated before, Captain Bond made no entry in the flight log concerning the ADF although he was certain that it was not operating. Records indicate that no maintenance was performed on the receiver during the stops at Nashville or Knoxville.

During the investigation many persons were interviewed in an attempt to locate witnesses to the flight of the aircraft. Many saw aircraft during the evening; however, none was able to establish the time of his observation with sufficient accuracy to be of great value to the Board in plotting a probable path for Flight 308.

A meteorologist, who was on duty at the Tri-City Airport testified concerning the weather conditions which existed at the time of the accident. He said that the ceiling was 1,700 feet overcast with scattered clouds at 1,000 feet. The visibility was 5 miles. The witness said a study of the information available to him indicated that from Bulls Gap to Tri-City at 5,000 feet the flight would have been operated in instrument weather conditions. He estimated the en route winds would have been north-northwest at approximately 20 knots. The Piedmont captain of Flight 383 estimated winds which he encountered at 5,000 feet were from the west-northwest at 25-30 knots.

Analysis

Examination of the wreckage of N 18941 revealed no evidence of any failure or malfunction of either the airframe or the powerplants. There was no indication of fire in flight and all components of the airframe were accounted for in the wreckage. Both engines and propellers were capable of normal operation prior to impact. From this evidence it is clear that no structural or mechanical failure or malfunction occurred which in any way contributed to the cause of this accident.

Examination of the radio equipment of N 18941 indicated that the crew was not utilizing all the facilities available to them. First, the No. 2 navigation receiver was not tuned to a frequency of any facility in the area. It is therefore presumed that the No. 2 navigation receiver was not in use. Normally this receiver would be tuned to the TRI VOR (117.7 mcs.) and utilized to determine the backup radials which define the safe easternmost limit of the procedure turn area.

Second, as near as can be determined the low frequency receiver was tuned between 325 kcs. and 349 kcs. Again, this frequency is unrelated to that of any facility in this area which could be utilized by this receiver.

The closest frequency of any local facility to this setting is the Emmett "H" radio beacon which is 320 kcs. It is extremely doubtful that this receiver would be utilized on Emmett "H," however, as this homer is nondirectional. Normally the low frequency receiver is tuned to the TRI low frequency radio range, 221 kcs., and used as another aid in determining the aircraft position in relation to the radio range legs. It is clear this receiver was not being used on the TRI-LFR because it is extremely improbable that impact forces could move the frequency over 100 kcs.

Third, the ADF was tuned to the radio range frequency of 221 kcs. While en route from Knoxville to Tri-City it would be expected that the radio compass would be used to follow the airway. However, after the aircraft had reached the vicinity of the airport and an approach on the ILS was started, the crew would normally tune the ADF to the nondirectional compass locator associated with the middle or outer marker. These frequencies are: 201 kcs. and 239 kcs., respectively.

Another alternative would be to tune the ADF to the Emmett "H" facility for assistance in establishing the safe easternmost limit of the procedure turn area.

Two inferences arise because the radio compass was not tuned to the frequency of a facility which would assist in determining position along the localizer. The first is that the automatic direction finding feature was not functioning or was not being used. The second is that the radio compass was entirely inoperative and neither the visual presentation nor the audio signals could be received.

During the last transmission from the flight, the pilot stated that ". . . his ADF was acting up." In addition, Captain Bond testified that he was unable to receive either visual or aural signals on the ADF prior to landing at Nashville. The evidence also indicates that he informed Captain Gollmier of the malfunction at Nashville but that no maintenance was performed there or at Knoxville. It is therefore reasonable to presume that the ADF was completely inoperative and further that the crew was aware of the situation prior to takeoff from Nashville.

It should be noted here that there is a remote possibility that a sightseer at the crash site could have altered the setting found on the No. 2 navigation receiver frequency selector; it is also possible that the frequency selector was moved as a result of heavy inertia forces. If this were true and the receiver was being used on the TRI VOR, the pilot should have been acutely aware of his position. As for the ADF, because of the fire markings on the dial and exposed gears, investigators determined that the frequency setting had not been altered. It is clear that this receiver was tuned to 221 kcs.

Flight 308 reported as being over Gray intersection at 2024. About 2032, the conversation with the tower took place. Before completion of that conversation the aircraft crashed. This would place the accident, as near as can be determined, at 2032. A study was made to determine the airspeed which would have been required for the aircraft to traverse the distance from Gray to the crash site in eight minutes. Knowing the straight-line distance from the crash site to Gray, and the wind, and assuming a standard procedure turn and standard

rate turns throughout, it was possible to calculate, mathematically, this airspeed. These calculations revealed that N 18941 would have had to have had an airspeed of 180 knots or a groundspeed of 191 knots to travel from Gray intersection to the accident site in the eight minutes. Obviously, this speed is much too high for a DC-3, especially while maneuvering prior to an ILS approach. From the calculations it is evident that N 18941 could not have been over Gray at 2024, as it reported.

The Board therefore selected two airspeeds, 130 knots and 110 knots, as representative maneuvering speeds at which an ILS procedure would be flown. Substituting each of these speeds in the computations, and starting at the crash site working back toward Gray, it was possible to determine two lines of position along one of which N 18941 had to be located eight minutes before the crash. (These are displayed graphically on attachment A.) It was immediately discerned that the 110-knot line of position could not, in all probability, be correct because it was impossible to correlate the en route reporting times to it. However, the 130-knot line of position appears to be consistent with all the known facts.

From the position report over Piedmont at 1958 and the report over Bulls Gap, which is 30.5 miles from Piedmont, at 2010, it can be seen that the groundspeed of the aircraft was 152 knots. The next position report was over Gray, 32 miles from Bulls Gap. At a groundspeed of 152 knots, this segment should have taken 12.5 minutes. However, the flight did not report over Gray until 2024, 14 minutes after passing Bulls Gap. At this same groundspeed the airplane would have traveled 35.5 miles, or at least 3.5 miles closer to the accident site than Gray. In other words, when the flight reported over Gray it was actually 3.5 miles or 1.5 minutes beyond Gray. By plotting this distance (35.5 miles from Bulls Gap) on a chart, it was found to cross the 275-degree radial of the Tri-City omni at the same approximate point as the line of position calculated for a maneuvering speed of 130 knots. Again referring to attachment A, it can be seen that a course from Bulls Gap to this point would pass approximately two miles east of Gray.

As stated before, the Board believes that the ADF was inoperative as reported by Captain Bond. It further believes that the flight from Knoxville to Tri-City was made in instrument weather conditions without using the low frequency radio aids which define Green Airway 5. There was evidence at the public hearing that in some instances pilots were using the intersection of the 65-degree radial of the Knoxville VOR and the 275-degree radial of the Tri-City VOR as Gray intersection. The intersection of these radials is very indefinite because of the distance from Knoxville and it is possible to receive an indication which could place it several miles east of Gray.

On the basis of all this evidence the Board believes that the crew of N 18941 flew from Knoxville to Tri-City, utilizing the Knoxville VOR, and attempted to locate Gray without the aid of the low frequency radio. As will be recalled, the winds aloft were reported to be from the north-northwest and would tend to drift the aircraft east of its course. It is clear that all of these factors combined to cause the airplane to arrive at the position which was reported as Gray intersection.

Had the aircraft been at Gray the correct procedure would have been to continue on the same heading as the low frequency range leg (65 degrees) to

intersect the localizer at the middle marker and then to turn to a 90-degree heading to track outbound past the outer marker. It is probable that the crew, thinking they were in the vicinity of Gray, followed the normal procedure for intercepting the localizer. From the position it has been shown N 18941 was over when it reported Gray, a course of 65 degrees to the localizer would pass south and east of the outer marker. Thereafter, without receiving the outer marker and without the use of the low frequency receivers or the No. 2 navigation receiver, the flight would be unable to determine its position along the localizer.

From the calculations which were mentioned above, the time interval from the Gray report to the beginning of the procedure turn was found to be 5 minutes and 45 seconds. Normally, a procedure turn would have been started approximately 3 minutes and 30 seconds after passing Gray. Even if the flight had been over Gray, as it reported, to continue 2 minutes and 15 seconds beyond the normal flying time to the outer marker would place the procedure turn well beyond the authorized 5-mile limit and probably beyond the 5-mile buffer area which is provided as a safety zone east of the procedure turn area. Actually, Flight 308 flew for a period of 5 minutes and 45 seconds from the position, which was erroneously reported as Gray, before starting its procedure turn. Had a procedure turn been started 3 minutes and 30 seconds after this report, as is normal, it is probable the accident would have been avoided.

It is apparent that the flight finally realized it had missed the outer marker and must have realized they were east of it, because they started their turn. Both crew members were familiar with the Tri-City Airport and facilities, and both must have been well aware of the terrain variations in the area. When they realized they were east of the outer marker an unknown distance, the first and only proper action was to execute a missed-approach procedure, climbing to 5,500 feet on the west course of the localizer.

It is assumed that the flight did receive the localizer indications. However, it did not receive an indication of the outer marker. The transmission from the flight asking if the glide slope was operating indicates that this instrument was not operating properly or that they could not rationalize the indication from it with their supposed geographic location. If the localizer had been intercepted to the west of the outer marker, the glide slope indicator would have been at a full fly-down deflection because the aircraft would have been above the glide slope. It would have changed from full fly-down to full fly-up as the aircraft proceeded eastward on the localizer past the outer marker.

It is possible that either the glide slope indicator or the outer marker beacon did not function properly. It may be that the crew concluded they were inoperative. In this event they were wrong in continuing the approach.

Actually, the aircraft intercepted the localizer east of the outer marker. At this point, the glide slope indicator would have been at a full fly-up deflection because the glide slope was above the aircraft. It may be that the crew was confused when, thinking they were west of the outer marker, they received an indication opposite to that expected. It is also possible that high terrain intervening between the transmitter and the aircraft may have blocked the signal (which is VHF and line-of-sight) from being received by the aircraft, causing a flag to appear in the deviation indicator of the aircraft. In either case the Board believes the crew had a clear duty to discontinue the procedure immediately and execute the approved missed approach.

Several other factors have been considered by the Board as equally important in the analysis of this accident. First, company regulations specifically require an operable ADF for all flights dispatched in accordance with instrument flight rules. Next, the operations specifications issued by the Administrator, Federal Aviation Agency, clearly set out the equipment requirements for an ILS approach procedure: ". . . (a) An ILS instrument approach procedure for the purpose of conducting a straight-in approach to the ILS runway is authorized if (1) no more than one component of the ILS (other than the localizer) is inoperative or the signals therefrom cannot be received (2) all other components of the ILS and related airborne equipment are in normal operation . . . (b) an ILS instrument approach procedure for the purpose of conducting a straight-in approach to the ILS runway is authorized if (1) the localizer and either the outer marker or outer compass locator and related airborne equipment are in normal operation. . .

It is impossible to rationalize the pilot's thoughts concerning the absence of outer marker and glide slope indications. He may have believed either of the facilities (including ground or airborne equipment) inoperative. The Operations Specifications issued by the Administrator of the Federal Aviation Agency clearly limit the use of the ILS to facilities in which both functions are operable. Accordingly, it would have been necessary that the approach be abandoned. On the other hand, had he considered that both functions were operating satisfactorily he had no alternative but to conclude he was too far east of the outer marker to have used the minimum altitude specified for a procedure turn within 5 miles of the outer marker.

Conclusions

On the basis of all the evidence, the Board concludes that the radio compass (ADF) was inoperative and could not be used either for navigation along the low frequency radio range or receive the compass locators associated with the ILS. Further, the Board believes this condition was known to the crew at Nashville. It is also obvious that they did not use the other low frequency receiver aboard the aircraft because the flight was not on Green Airway 5 as it neared Tri-City. As stated before, the Board believes that the 65-degree radial of the Knoxville VOR was used to navigate to Tri-City and was also used to locate Gray intersection. It is concluded that the flight was east of its intended course and reported as being over Gray when it was actually several miles east of Gray. This conclusion is inescapable in view of all the known facts.

The Board further concludes that the crew, without realizing their actual position, followed the usual procedure for intercepting the localizer and in so doing passed to the south and east of the outer marker. After missing the outer marker, the only way position along the localizer could have been determined was by means of the Tri-City VOR. It is evident that the crew did not use this facility as an aid in the procedure.

A faulty indication or malfunction of equipment could not be used to mitigate the pilot's responsibility in these circumstances. Several additional facilities were available for a cross-check if in his mind he thought the outer marker or the marker beacon receiver was inoperative.

One of the provisions in the operations specifications issued to the company by the FAA clearly establishes the conditions under which an ILS can

be executed. Those specifications make it clear that an ILS approach may not be commenced if more than one component of the ILS is inoperative or the signals cannot be received. Here N 18941 could not receive the compass locators and did not receive the outer marker. Although it may have received the glide slope signal it is obvious the crew did not or could not understand the indications.

The foregoing procedures are contained in the operations specifications issued to the carrier by the Administrator of the Federal Aviation Agency in accordance with Part 40.18 of the Civil Air Regulations. This regulation prohibits any operation in violation of these specifications. Part 40.364, moreover, fortifies this provision by requiring that the ILS procedures authorized in these operations specifications be adhered to. A determination as to when a procedure turn may be conducted at Tri-City east of the outer marker within 5 miles cannot be made without identifying the outer marker in passing.

The Board cannot conceive of any justification for the manner in which this flight was conducted. The purpose of the company regulation requiring an operable ADF for IFR flight is to prevent just this type of accident. The Board concludes that the malfunctioning ADF should have been noted in the aircraft log. Ample facilities were available at Nashville and Knoxville for corrective action to be taken before takeoff.

When Captain Gollmier chose to continue the flight in violation of company regulations it would have been expected that he use all other radio equipment available to him. This was not done.

All the radio aids in the Tri-City area are maintained by the Federal Government for the use of all pilots. While the use of all radios may not be mandatory for IFR flight, good operating practices dictate a maximum cross-check of all available facilities. If Flight 308 had utilized either the low frequency receiver on the Tri-City range or the No. 2 navigation receiver on the VOR, this accident would in all probability have been avoided.

Probable Cause

The Board determines the probable cause of this accident was the failure of the pilot to identify Gray intersection properly and his decision to continue an ILS approach contrary to company and regulatory procedures.

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 Hearing

The Civil Aeronautics Board was notified of this accident at 2200, January 8, 1959, and an investigation was immediately initiated in accordance with the provisions of Section 701 (a) (2) of the Federal Aviation Act of 1958. A public hearing was held in Kingsport, Tennessee, March 2 and 3, 1959.

Operator

Southeastern Aviation, Inc., doing business as Southeast Airlines, is a Tennessee corporation. The corporation was formed in August 1956 and applied to the State Bureau of Aeronautics for a certificate of convenience and necessity for the carriage of persons and property within the State of Tennessee. After qualification, the certificate was issued December 18, 1956, for designated intrastate routes, including the route being flown in this instance. Subsequently, Southeast was given a series of check flights and issued Commercial Operator Certificate No. FW-15(c) by the Civil Aeronautics Administration (now Federal Aviation Agency). Scheduled intrastate operations began February 8, 1957, and have been continued in accordance with the provisions of Part 40 of the Civil Air Regulations.

Flight Personnel

Captain Robert L. Gollmier, age 36, was employed by Southeast February 22, 1957, as a copilot. May 29, 1957, he was promoted to captain. He held a currently effective airman certificate with an airline transport rating, type ratings in the Douglas DC-3, and Convair CV-240, CV-340, CV-440 aircraft, and instrument rating. Captain Gollmier had a total of 7,214 flying hours, of which 2,674 were in DC-3 equipment. He had a total of 449 hours of instrument time, 42 hours of which had been accumulated in the preceding 90 days. He also had executed 38 ILS approaches within the preceding 90-day period. He had received his last line check October 16, 1958, and his last semi-annual proficiency check November 10, 1958. His last first-class physical examination was given September 25, 1958.

Mr. Robert M. Irwin, age 28, was employed by Southeast Airlines August 10, 1958. He held a currently effective airman certificate with a commercial pilot rating for single- and multiengine land aircraft, and an instrument rating. Mr. Irwin had a total of 2,367 flying hours, of which 432 were in DC-3 equipment. He had a total of 202 hours of instrument time, 26 hours of which had been accumulated in the preceding 90 days. He also had executed 13 ILS approaches within the preceding 90-day period. He had received his latest line check August 12, 1958, and his last instrument check August 10, 1958. His last first-class physical examination was given August 7, 1958.

Miss Wanda C. Nalley, age 20, was employed by Southeast Airlines January 1, 1958. She had completed a correspondence course at Weaver Airline School and had received 40 hours of ground school training with Southeast Airlines. Her last line check was given August 7, 1958. Her last physical examination was given December 30, 1957.

The Aircraft

N 18941, a Douglas DC-3A, serial No. 2007, was manufactured April 8, 1938. It was purchased by Southeastern Aviation, Inc., on November 19, 1956. At its departure from Memphis the airframe had a total time of 56,755.9 hours. The time since its last overhaul was 7,242 hours. The aircraft had flown 48 hours since its last No. 1 inspection on December 30, 1958, and 132 hours since the last No. 3 inspection December 15, 1958. Records showed that the aircraft was maintained in accordance with applicable regulations and there were no uncorrected discrepancies or carry-over items of maintenance. The aircraft was equipped with Pratt & Whitney 1830-92 engines and Hamilton Standard propellers 23E50-505.

ATTACHMENT A
AIRCRAFT ACCIDENT
TRI-CITY, TENNESSEE
SOUTHEAST AIRLINES DC-3 N18941
JANUARY 8, 1959

