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CIVIL AERONAUTICS BOARD
SAFETY BUREAU

ACCIDENT INVESTIGATION REPORT

Adopted: November 18, 1947 Released: November 19, 1947

PENNSYLVANIA-CENTRAL AIRLINES CORP., LOOKOUT ROCK, WEST VIRGINIA—JUNE 13, 1947

The Accident

Pennsylvania-Central Airlines' Flight 410, NC 88842, crashed near a point known as Lookout Rock, West Virginia, approximately 8 miles southeast of Charles Town, West Virginia, at approximately 1816 EST,[1] June 13, 1947, while enroute from Pittsburgh, Pennsylvania, to Washington, D.C. All 50 occupants of the aircraft were killed at impact and the Douglas DC-4 was demolished as a result of the crash and subsequent fire.

History of the Flight

Flight 410 departed Chicago, Illinois, at 1352, June 13, 1947, on an instrument flight plan with its destination Norfolk, Virginia, and with stops scheduled at Cleveland, Ohio, Pittsburgh and Washington. While enroute to Cleveland at 7,000 feet, the flight reported that a delay would be necessary because it was attempting to circumnavigate a thunderstorm in the vicinity of Goshen, Indiana. Approximately 15 minutes later a message was again received from the flight indicating that it was not able to circumnavigate the storm and requesting clearance to proceed under it according to contact flight rules. This request was approved by Chicago Airway Traffic Control on the condition that Flight 410 was able to proceed according to contact flight rules (CFR) at an altitude of 2,000 feet. Having received this amended clearance, Flight 410 continued underneath the thunderstorm and arrived at Cleveland at 1604, the flight having consumed 47 minutes more than the one hour and 25 minutes originally estimated by the crew. The flight from Cleveland to Pittsburgh was routine.

The flight departed Pittsburgh at 1724 and at 1753, 29 minutes later, reported over the Flintstone Intersection, 88 miles southeast of Pittsburgh, at 7,000 feet. At 1754 the flight received a message from Washington Airway Traffic Control clearing it to the Herndon Fan Marker to maintain 7,000 feet until further advised. The flight was also instructed that there would be an indefinite delay at Herndon but that approach clearance could be expected no later than 1920, which was approximately one hour and 10 minutes later than its estimated time of arrival. Immediately after receiving this message the flight was given the 1730 hourly weather sequence report for Washington. After acknowledging receipt of the Washington weather report, Flight 410 instructed the company station at Washington to request from Airway Traffic Control a clearance to approach Washington in accordance with contact flight rules on the right side of the west leg of the Arcola radio range. This request was approved by Airway Traffic Control and at 1803 the flight received a message clearing it to the Washington tower to cross the Arcola radio range station at or below 2,500 feet and in accordance with contact flight rules. The flight was advised that if this were not possible it was to hold at 2,500 feet and so to inform Airway Traffic Control.

Prior to establishing its descent the flight was instructed to report when leaving each 1,000-foot level. In accordance with these instructions Flight 410 reported leaving the 7,000-foot level at 1805 and two minutes later another report was received from the flight indicating it was leaving 6,000 feet. The flight reported its position as "south of Martinsburg" at 1808 and immediately thereafter reported that it was leaving 5,000 feet at that time. At 1810 another report was received from the flight, "leaving 4,000 feet." Three

[1] All times referred to herein are Eastern Standard and based on the 24-hour clock.

minutes thereafter the flight again reported its progress and indicated it was leaving 3,000 feet. Approximately 6 minutes later the company station at Washington initiated several calls to the flight but, although these transmissions were continued for several hours, no contact was established.

Investigation

Subsequent investigation disclosed that the aircraft had struck a ridge in the Blue Ridge Mountains approximately two miles east of the Shenandoah River on the right hand edge of the northwest leg of the Arcola radio range at an elevation of approximately 1,425 feet. The aircraft had struck the broken rock formation with severe impact force in an attitude which was laterally level and in an angle of descent of 2 1/2 degrees. The terrain at the scene of the accident slopes upward toward the east at an angle of approximately twenty degrees, the elevation of the crest of the ridge being approximately 225 feet higher than the scene of the accident. The wreckage was scattered for a distance of 125 yards southeast of the point of initial impact.

Inspection of the wreckage indicates that both the flaps and the under carriage were retracted at the time of impact. All control surfaces were accounted for at the scene of the accident, and no failure or malfunctioning of the control systems was disclosed. The damage sustained by the engine and propellers indicated that all four engines were developing considerable power at impact. The settings of the aircraft altimeters were within one-hundredth of an inch of the altimeter setting of Washington National Airport which at the time was 29.95 inches of mercury.

Several witnesses were located in the Shenandoah Valley area west of Lookout Rock who had observed or heard the aircraft in flight shortly before the accident. Reconstruction of the flight path on the basis of this testimony indicates that Flight 410 was proceeding in a southeasterly direction at an altitude below the crest of the ridge for at least 10 miles west of the ridge. During this portion of the flight, the aircraft was intermittently on instruments as it passed through the bases of low-hanging clouds.

During the five hours following the time of departure of Flight 410 from Chicago, an occluded front lay across Lake Michigan and arced eastward and southeastward to a point approximately 50 miles west of Detroit. From this point a warm front extended irregularly in a southeasterly direction affecting that portion of the route of Flight 410 from Toledo to Pittsburgh. The weather along this route was characterized by broken to scattered alto stratus and cumulus clouds with thunderstorms in the unstable tropical maritime air south and west of the front.

In an area approximately 30 miles west of Pittsburgh the warm front swung southward for approximately two hundred miles and thence eastward to the vicinity of Norfolk, Virgina. The flight from Pittsburgh to Martinsburg, therefore, was conducted ahead of this slow-moving front. The weather in the more stable maritime air northeast of this front was characterized by rain showers and ground fog, and by a general absence of thunderstorm activity.

Statements received from nine other air carrier pilots, who had been operating over Airway Red 20 at the time of the accident, indicated smooth flying conditions. Although heavy showers were encountered in the vicinity of the accident, no turbulence was associated with these showers at or below 7,000 feet. No lightning or other indication of thunderstorms was observed on this route, the closest thunderstorm having been reported in the vicinity of Frederick, Maryland, which is 25 miles northeast of the scene of the accident.

The ceilings in the Martinsburg-to-Washington area were gradually lowering during the afternoon of the flight. At the time the flight was cleared by Airway Traffic Control to cross Arcola CFR at 2,500 feet or lower, the weather at Washington was being reported as: ceiling measured 1,100 feet, broken clouds; high overcast; visibility 4 miles; light rain showers.[2] A 2,000-foot ceiling was being reported at Front Royal, Virginia, 30 miles southwest of the scene of the accident, according to the 1730 hourly sequence. At 1802, Martinsburg, which is 18 miles northwest of the scene of the accident reported: estimated ceiling

[2] Special No. 8 1748 Washington, D. C.

2,000 feet, overcast; visibility 2 miles, light rain, fog.[3] At 1830 the hourly sequence report for Martinsburg indicated an estimated ceiling of 2,000 feet; visibility 1 3/4 miles, rain shower, fog. Statements of witnesses indicate that rain and low ceilings prevailed in the Shenandoah Valley west of Lookout Rock at the time the accident occurred, and that the tops of the mountain ridge, including the scene of the accident, were definitely obscured by clouds. Light rain was falling west of the Shenandoah Valley increasing to heavy showers closer to the ridge.

A study of the maintenance records of NC 88842 discloses no indications of serious mechanical malfunctioning. The entire maintenance history of this aircraft indicates that there were fewer pilot complaints than is usual. Testimony of pilots who had previously flown this aircraft indicated that it possessed no adverse flight characteristics nor had any unusual history of mechanical malfunctioning. The same crew involved in the accident had previously flown this aircraft from Washington to Chicago and reported no malfunctioning to the company maintenance personnel at Chicago upon their arrival. A turn-around inspection had been accomplished at Chicago approximately five hours before the accident occurred, and the inspection reports indicated that the aircraft was in an airworthy condition at that time. A study of the transcription of all radio contacts with the flight from Pittsburgh to Washington disclosed no indications that the crew were experiencing any difficulty with the aircraft.

The static system installed in the model DC-4 at the time of the procurement of these aircraft by the company was susceptible to accumulation of water. At the lowest point in the static lines between the two flush static source vents which are on the sides of the fuselage and the static manifolds, there is located a receptacle, or bulb, into which water would drain from the static lines. It was determined that water could enter the static source while the aircraft is on the ground during a driving rain or while the aircraft is being washed down, and, in this system, water would flow down the static line into the drain bulb. One such bulb serves the static lines from both static sources. Pilot statements were received by the Board in the course of the investigation which indicated that failure of the altimeters in this model aircraft has been experienced due to restriction of the static lines as a result of excessive water accumulation and that these failures had been brought to the attention of the company. As a result of such reports, the company initiated a project for the rerouting of the static lines to provide a six-inch rise between the static source vents and the drain bulb. This modification had been accomplished prior to the date of the accident on all DC-4 aircraft operated by the company, including the aircraft involved in the accident. The records of the company indicate that excessive water accumulation has never been experienced in this model since these modifications were accomplished.

The alternate and primary static source selector valves are actuated by mechanical toggle switches, one of which is incorporated in the pilot and copilot static systems respectively. The selector switches, in this instance, were equipped with guards designed to prevent inadvertent change of position. Testimony of Douglas Aircraft Company engineers indicates that the maximum error experienced in use of the alternate source is approximately 200 feet. Although one of the selector switches was recovered in this instance, the guard was tightly crushed against the switch in such a manner that its position previous to impact could not be determined.

The route data contained in the company pilot's flight manual indicates a minimum altitude of 3,000 feet between Martinsburg and Herndon, and 1,500 feet between Herndon and Washington via Airway Red 20. Airway Red 61, from Martinsburg to Washington via Arcola, is immediately adjacent to Airway Red 20. The site of the Herndon fan marker is nine miles northeast of that of the Arcola radio range station. Although the Civil Aeronautics Administration had recently approved the use of Airway Red 61 by PCA, it had not published any minimum altitudes for this airway. The company had not put into operation minimum enroute altitudes for Airway Red 61, nor had it authorized its pilots to utilize this route. The northwest and southeast legs of the Arcola radio range are oriented along Airway Red 61 and comprise the

[3] Special No. 6 1802 Martinsburg, West Virginia.

primary navigational reference along this route. The terrain between Martinsburg and Washington, along both Airway Red 20 and Airway Red 61, rises to a maximum elevation of between 1,600 and 1,800 feet.

Several watches and clocks, which had been stopped as a result of impact forces, were found in the wreckage. The times indicated by these time pieces varied from 1812 to 1822, the average of all indications being 1816:15. The ship's clocks were disintegrated at impact.

Captain Horace Stark, pilot in command of Flight 410, had been engaged in flying operations for 28 years and most of his flight experience had been obtained in the northeastern United States. He had been in the employ of Pennsylvania-Central Airlines and its predecessor companies for 14 years. During this entire period he was engaged in flying over the Pittsburgh-Washington route and was qualified under the provisions of the Civil Air Regulations to pilot air carrier aircraft between those points.

Discussion

Inherent difficulties exist in determining the probable cause of accidents of this character. In a collision with terrain in full flight normally all occupants of the aircraft are killed upon impact; the aircraft itself is usually demolished and fire ensues. But the examination made by the Board, though it may leave "probable" cause to some surmise, has brought forth matters of considerable moment.

This accident, as many others, had a final concluding cause but the chain of causation which enabled the final unfortunate event to occur reaches far back. The first of these that can be noted inheres in certain aspects of the existing system of airway traffic control.

It will be noted that Airway Red 61 was approved for use by the Civil Aeronautics Administration without any publication of a minimum altitude for flight under instrument conditions. Indeed, the whole subject of what are minimum altitudes and who prescribes them was in considerable confusion at the time of the accident. This is evidenced by the fact that a number of witnesses from the Airway Traffic Control Section of the Civil Aeronautics Administration were unable to state who, if anyone, prescribes such minimum altitudes and what effect follows upon their establishment.

The basic minimum altitude for all flying under instrument conditions over all terrain on or off any civil airway is established at 1,000 feet above terrain by Civil Air Regulation 60.23.[4] This requirement will, of course, provide no uniform flight level over any particular route since the height of the terrain will vary. In the Airman's Guide minimum altitudes for most routes are published; but these minimum altitudes are merely advisory and flight below those altitudes as long as it is 1,000 feet above terrain violates no regulation.

Meanwhile the companies, for operational purposes, establish their own minimum altitudes. The procedure for doing this, though it does not seem wholly uniform, is to set forth these minimums in the company's operating manuals and not in the operating certificates. Minimums governing landings and take-offs, however, are included in the company's operating certificates. The consequences of this differentiation seem, at least, two: (a) operating certificates are "approved" by the Civil Aeronautics Administration; operations manuals, though they may be scrutinized by the Civil Aeronautics Administration, are not "approved," and (b) departure from the operating certificate is a violation of the Civil Air Regulations involving legal consequences; departure from the operations manual of itself is not a "violation," whatever disciplinary action the company may take against its personnel for such departures.

The minimums established by the companies under this procedure vary from both each other and those published in the Airman's Guide. The situation is further complicated by the fact that the Army has its own minimums established on a different basis. It therefore became apparent that the necessity existed for a general standardization of minimum enroute altitudes. Any alteration in the minimum enroute altitudes in general will of necessity require that attention also be given initial instrument approach

[4] Part 60, Air Traffic Rules, August 1, 1945.

altitudes in order that no conflict exist between the two.

The problem of minimum altitudes for instrument conditions is of great significance to mere operational safety in flight. But it is of equal significance to airway traffic control, for without established minimums it is impossible accurately to know what flight lanes can be made available to aircraft. If the minimums vary, the airway traffic controller must keep these variations in mind, otherwise he may give a clearance to aircraft of one company which for the pilot of that company to accept would involve an infraction of his company's rules. Pilots of another company might, however, accept such a clearance with impunity.

If one realizes the significance of minimums to airway traffic control, the wisdom of the Civil Aeronautics Administration in approving a new airway for use without even publishing a minimum must be regarded as debatable. True, Airway Red 61 was immediately adjacent and parallel to Airway Red 20, and presumably the published minimum of 3,000 feet for the latter would be applicable to the former since the nature of the terrain underlying the two was essentially similar. But care for technical correctness in these matters, as will be seen, is of the highest moment.

For example, it was testified that the published Airman's Guide minimums and the company minimums are posted at the head of the board on which the traffic over any particular airway is posted. But this could not have happened in the case of Airway Red 61 since no minimums, other than those provided by CAR 60.23,[5] were in existence for this airway.

This is of particular importance with regard to the nature of the clearance given to the aircraft in this case. It will be remembered that Flight 410 was originally cleared to the Herndon fan marker over Airway Red 20 at 7,000 feet to hold until further notification. The flight was told that, due to the traffic situation around Washington, a delay of over an hour might be expected at that point. Flight 410 then called its company communication station to request a contact clearance down the west course of the Arcola radio range. This was transmitted to Airway Traffic Control and a clearance granted to the flight to proceed to the Washington tower to cross the Arcola radio range station at or below 2,500 feet and in accordance with contact flight rules. The flight was also advised that if it were not possible to maintain contact it should hold at Arcola at 2,500 feet and inform Airway Traffic Control.[6]

This series of events involves matters for criticism of three parties. In the first place, the pilot in asking for this clearance was asking for something in violation of company rules. The use of the Arcola range had not been authorized by the company, nor had the pilot been qualified to fly it. However, it must be recognized that in view of the pilot's exceptionally long experience over this area such lack of qualification is only a technicality. In the second place, the company dispatcher, whose business it is to supervise matters of this character, was totally unconversant with the fact that the Arcola range had not been approved for use by the company and that the pilot had not been qualified to fly it. As a matter of practice, air traffic control clearances are delivered by the company communication station to the pilot and the company dispatcher simultaneously. In this instance the dispatcher raised no question as to the propriety of the captain's request for the clearance nor to the appropriateness of the provisions of the clearance provided by Airway Traffic Control.

In the third place, the clearance was faulty for many reasons. Under existing instructions Airway Traffic Control is not authorized to give a pilot a clearance below minimums unless requested by the pilot and the pilot must then be advised that the clearance is below the minimum. The minimum that Airway Traffic Control must use is the minimum established by the company. But if no such minimum has been established or is readily available, the controller shall use the minimum published in the Airman's Guide. If neither of these minimums is

[5] Part 60.—Air Traffic Rules (effective August 1, 1945), § 60.2 *Instrument flight rules (IFR)*, § 60.23 *Minimum altitudes*. Except when necessary for taking off or landing, aircraft shall be flown not less than 1,000 feet above the surface.

[6] "ATC clears Capital four-one-zero to the Washington tower, cross Arcola at or below two thousand five hundred, CFR approach, if not possible hold two thousand five hundred at Arcola and advise. Traffic is eastbound over Front Royal one-seven-five-four, seven thousand descending to five thousand.—HB."

available the rule is unclear as to what should be done but in any event CAR 60 establishes the lowest possible minimum.[7]

An examination of the clearance shows that no request for a clearance beneath minimums was ever made by the pilot. All he asked for was a contact clearance. Again, the pilot was never advised that the clearance was below minimums. The clearance was below any standard of a minimum for this airway. If one should assume that the minimum for the parallel Airway Red 20 governed this range, the clearance was below the 3,000 feet provided by the company for both instrument and contact operations and below the minimum altitude prescribed by the Airman's Guide for instrument operations. If one should deem these minimums did not govern, the clearance authorized flight on instruments less than 1,000 feet above the terrain.[8]

The clearance, in short, authorized the pilot who was then on instruments to descent below 3,000 feet to 2,500 feet *or below* in order to make contact and go into Washington contact. The clearance, moreover, in essence invited such a maneuver. For if the pilot was still on instruments at 3,000 feet and chose not to descend to 2,500 feet *or below*, he had no alternative except to request Airway Traffic Control for a new clearance. The clearance thus was faulty and should never have been offered by the controller nor accepted by the pilot.

But the clearance though clearly a contributing cause was not the eventual cause of the accident. It is the pilot's ultimate responsibility so to operate his aircraft, whatever clearance he receives, to avoid collision with terrain. The pilot of this aircraft was familier with the general characteristics of the terrain between Martinsburg and Washington. Nevertheless he was flying at an elevation of 1,425 feet over terrain that at points rose to greater heights.

The question that naturally arises is whether the pilot knew that his altitude was only 1,425 feet. It should be noted in this connection that the pilot reported, as required, vacating every 1000-foot level save the 2000-foot level. Too much emphasis should not be placed on this fact alone, for delay in reporting having left a particular level may be occasioned by attention to other duties and is alleged to be, a somewhat common practice.[9]

The pilot would, of course, be mistaken as to the altitude he was maintaining if the altimeter failed to report correctly. Altimeter errors have been a subject of considerable inquiry particularly since this accident. They do occur, due to a variety of causes. Among those, which it is difficult to believe could have played a part in this case, are temperature variations, an abnormal enroute barometric pressure variation, and the effect of strong air currents over mountainous terrain. But there are two possible sources of altimeter error which must be examined.

The first is that, unknown to the pilot, the selector switch between the alternate and primary static systems may have been in a position other than "primary." The possibility of this having happened seems remote since the switches were safety-wired in the "primary" position and, furthermore, both switches were provided with guards designed to prevent inadvertent change of position. It must be recalled moreover that had such an occurrence taken place in spite of these precautionary measures the maximum error which could be attributed to the use of alternate source is 200 feet. Unlike the switches of earlier design used in this model, the switch installed in the aircraft involved in the accident was so constructed that no position along its total vertical travel could shut off both static sources simultaneously.

The second is the restriction of the static lines due to water accumulation flooding the static drain bulb. With the cooperation of the carrier, the Civil Aeronautics Board has, since the date of

[7] ANC-IFR, Standards for the Control of Instrument Flight Rule Traffic *"2.0401 Minimum Altitude:* Altitudes below the minimum safe altitude specified in CAR 60 or by an aircraft operator shall not be assigned. A pilot's request for such altitudes may be approved if known traffic conditions permit. The pilot should be advised, however, that the requested altitude is below minimum. If the publication containing the minimums specified by an aircraft operator is not available, the minimum altitudes shown in Air Navigation Radio Aids should be used as a guide."

[8] The controller testified that because no enroute minimums seemed to exist for this particular route, he referred to an aeronautical chart for an indication of the height of the terrain between Martinsburg and Washington. The controller misread the chart for he admitted that he concluded no terrain existed in this area higher than 1,000 feet.

[9] A reason for delaying a report of this character for a minute or so is that the pilot does not want the level he is vacating to be occupied by another craft until he is safely out of that level.

this accident, conducted flight tests to determine the effect of such water accumulation. It was observed that during descent the indications of the altimeter were retarded and the indications of the air speed indicator were progressively greater than actual. In other words, were this condition to prevail for a period of several minutes, it is possible for the aircraft to descend to an altitude more than 1,000 feet lower than the altitude being indicated in the altimeter. It is significant to note, however, that the company had provided the aircraft involved in this accident with a static system which was not susceptible to the water accumulation described above. It must be concluded, therefore, that altimeter errors resulting from water accumulation did not exist in this instance. The Civil Aeronautics Board has investigated this situation throughout the country in order to ascertain that similar precautionary measures have been initiated to encompass all users of DC-4 equipment to insure against the occurrence of a similar accident due to serious altimeter errors. This investigation disclosed that all DC-4 static systems now possess a rise in the primary static lines similar to that designed by Pennsylvania-Central Airlines and that no serious water accumulation has been experienced by any other operator since such a provision has been incorporated in the static system.

The fact remains that the pilot exercised poor judgment in attempting to conduct the flight between Martinsburg and Arcola at an altitude less than 3,000 feet. He was clearly prompted by the desire to become contact and thus avoid the delay that would be occasioned by having to hold either over Herndon or Arcola. It is patent that he did not establish contact at 3,000 feet, for even though he may have had occasional vertical reference to the ground, he could hardly have had any forward visibility. The testimony of the witnesses indicates clearly that the aircraft subsequently passed intermittently through low clouds at an altitude below the crest of the ridge and that, immediately before impact, it entered a dense cloud covering the top of the ridge. There is further grave doubt that the pilot had an appropriate realization of his position. At 1808 he reported "south of Martinsburg," but it is clear that he was not directly over the range station at that time. Moreover, the testimony of the witnesses establishes that he was not maintaining a straight flight path between Martinsburg and the scene of the accident. It can be concluded, therefore, that the pilot was not certain of his location, and the evidence is strong to indicate that for one reason or the other he was seeking to make visual contact with the terrain at an altitude known to him to be below 3,000 feet.

There remains one further question, namely, that raised by the position of the mixture controls at "full rich." Due to the locking devices present on these controls their position could not have been shifted by impact. It has been suggested that the existence of these controls in that position is indicative of lack of adequate engine performance. But this suggestion seems hardly tenable. All four controls were at "full rich." For all four engines to give trouble simultaneously would be extraordinary. Moreover three minutes elapsed between the last communication from the pilot, that of leaving 3,000 feet, and the time of impact. Some communication with the company dispatcher would normally have occurred had engine trouble been experienced. Since the testimony of lay witnesses who observed the aircraft did not indicate malfunctioning of the engines, since the angle of descent as established by investigation at the scene of impact indicates a normal path of descent and, since the inspection of the power plants themselves disclosed no cause for malfunctioning, it must be concluded that the engines were operating normally prior to and up to the moment of impact.

The position of these controls actually supports the earlier thesis. To place them at "full rich" puts the pilot in a position where rapid climb can be immediately undertaken without movement of these controls. It supports the thought that the pilot in descending and seeking for contact conditions was somewhat uncertain of his position and consequently as a precaution placed the mixture controls in "full rich" in order to give him an opportunity immediately to climb in the event that such a maneuver became necessary.

Findings

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

1. The aircraft, crew and company were properly certificated.

2. Flight 410 departed Pittsburgh, Pennsylvania, at 1724 to cruise to Washington at 7,000 feet on an instrument flight plan.

3. At the time of departure the aircraft was properly loaded with respect to maximum gross weight and the center of gravity location.

4. In the vicinity of the Flintstone Intersection, the flight was cleared to the Herndon fan maker to 7,000 feet and advised that a delay of approximately one hour and 20 minutes could be expected.

5. The pilot requested permission to approach Washington in accordance with contact flight rules on the northwest leg of the Arcola radio range.

6. Airway Traffic Control cleared Flight 410 to cross Arcola at 2,500 feet or below in accordance with contact flight rules, and, in the event that this was not possible, to hold at Arcola at 2,500 feet and so to inform Airway Traffic Control.

7. The airway between Martinsburg and Herndon is contiguous to the airway between Martinsburg and Arcola, Herndon being nine miles northeast of Arcola, and the contour of the terrain is essentially the same over each route.

8. The existing company enroute minimum altitude between Martinsburg and Herndon is 3,000 feet for both instrument and contact flight.

9. No enroute minimum altitude between Martinsburg and Arcola had been published in the Airman's Guide before the route was put into operation.

10. The company had not authorized operations on the Martinsburg-Arcola route, nor published any minimum altitudes governing it.

11. The pilot requested a clearance on the Arcola range contrary to established company operating procedures.

12. The company dispatcher made no effort to determine whether the clearance that was requested and the clearance that was given was in accordance with company procedures.

13. The clearance given was not in accordance with instructions then governing Airway Traffic Control.

14. Five minutes after reporting having passed south of Martinsburg, the flight reported descending below 3,000 feet.

15. The aircraft was seen west of a ridge of mountains which paralleled the Shenandoah River maneuvering in a southeasterly direction at an altitude below the crest of the ridge.

16. After entering a cloud which covered the top of the ridge, the aircraft crashed at an elevation of approximately 1,425 feet near a point known as Lookout Rock, West Virginia, and was demolished by impact and subsequent fire.

17. The aircraft struck the ground in an attitude which was laterally level and in a slight descent.

18. No malfunctioning of the primary aircraft structure, the control system, or the power plants occured prior to impact.

19. Until the time of the accident, the pilot and copilot had flown a total of 8 hours and 6 minutes in the preceding 12-hour period.

Probable Cause

The Board finds that the probable cause of this accident was the action of the pilot in descending below the minimum enroute altitude under conditions of weather which prevented adquate visual reference to the ground. A contributing cause was the faulty clearance given by Airway Traffic Control, tacitly approved by the company dispatcher, and accepted by Flight 410.

BY THE CIVIL AERONAUTICS BOARD:

/s/ J. M. LANDIS
/s/ HARLLEE BRANCH
/s/ JOSH LEE

Ryan, Vice Chairman, did not take part in the decision.

Appendix

Several of the deficiencies in regulation, administration and operation of air carriers considered in the course of the investigation of this accident were being studied by the Civil Aeronautics Administration, the Civil Aeronautics Board, and agencies of the aviation industry prior to the date of this accident. However, much of the impetus toward implementation of corrective action came as a result of specific recommendations of the President's Special Board of Inquiry on Air Safety which explored the numerous problems associated with or responsible for this and other recent accidents.

A summary of corrective action follows:

1. The Civil Aeronautics Board promulgated a revision of Part 60 of the Civil Air Regulations, October 8, 1947, which provided for the establishment of minimum enroute instrument cruising altitudes by the Administrator of Civil Aeronautics. The Civil Aeronautics Administration has established such minimum enroute instrument altitudes wherever practicable; where these minimums have not been established, aircraft will not be flown lower than 2,000 feet above the terrain under instrument flight rules conditions in mountainous areas designated by the Administrator.

2. The Civil Aeronautics Board has circulated a proposed amendment to Parts 42 and 61 of the Civil Air Regulations which is designed to require a minimum clearance of 2,000 feet for night visual flight rules operation over mountainous terrain, except over routes on which the Administrator may find that existing navigational facilities permit equivalent safety at lower altitudes. Under no conditions will such altitude be less than 1,000 feet above the terrain.

3. The Administrator of Civil Aeronautics called a conference of all air lines and of his regional personnel in order to establish enroute cruising altitudes and initial approach altitudes which are completely uniform for all air carriers throughout the United States.

4. The Administrator of Civil Aeronautics has issued appropriate instructions to Civil Aeronautics Administration personnel prohibiting the issuance of Airway Traffic Control clearances below established minimums.

5. Existing manuals and instructions governing the issuance of clearances by Airway Traffic Control are currently being modified by the Civil Aeronautics Administration with a view toward simplifying them.

6. On October 10, 1947, the Civil Aeronautics Board adopted a special civil air regulation which required the installation of absolute terrain warning indicators in addition to aneroid altimeters in all scheduled air carrier aircraft. Production difficulties required the postponement of the effective date from January 1, 1948, to February 15, 1948. As of that date such equipment will be mandatory in all air carrier aircraft.

7. Further studies with reference to altimeter errors are being conducted by the National Advisory Committee for Aeronautics and by the scheduled air carriers.

Supplemental Data

Investigation

The Board was informed of the accident at midnight, June 13, 1947, and investigation was initiated immediately in accordance with the provisions of Section 702(a)(2) of the Civil Aeronautics Act of 1938, as amended. Investigators of the Board's New York Office arrived at Leesburg, Virginia, at 0800 the following morning, and shortly after the wreckage was located from the air they proceeded toward the scene of the accident, arriving at 1300, June 14. A public hearing was ordered by the Board and was held in Leesburg, Virginia, July 2 and 3, 1947.

Air Carrier

Pennsylvania-Central Airlines is incorporated in the State of Delaware and maintains its headquarters at Washington, D. C. At the time of the accident, it was operating under a certificate of public convenience and necessity and an air carrier operating certificate, both issued pursuant to the provisions of the Civil Aeronautics Act of 1938, as amended. These certificates authorized the company to transport persons, property, and mail in scheduled air commerce between various points in the United States including Chicago, Illinois, and Washington, D. C.

Flight Personnel

Captain Horace Stark, age 46, of Arlington, Virginia, was the pilot of the aircraft. He possessed an airline transport pilot rating and until the date of the accident had accumulated a total of 18,001 hours, of which 1,309 hours had been accumulated in DC-4 type equipment. First Officer R. N. Creekmore, age 28, of Alexandria, Virginia, was copilot of the aircraft. He possessed an airline transport pilot rating and had accumulated a total of 2,513 hours, of which 1,833 hours were accumulated in DC-4 type equipment. Miss Margaret Wells of Guntersville, Alabama, was hostess.

Aircraft

The Douglas DC-4, NC-88842, serial number 3112, had been operated a total of 8,038 hours since its manufacture in October 1942. It was equipped with four Pratt and Whitney R-2000-7 engines, which had accumulated a total of 2,763 hours, 1,199 hours, 2,936 hours, and 1,745 hours for the numbers 1, 2, 3 and 4 engines, respectively, of which 195 hours, 385 hours, 643 hours, and 438 hours, respectively, had been accumulated since the last major overhaul. Hamilton Standard propellers were installed. At the time of departure from Pittsburgh, the gross weight of the aircraft was approximately 6,000 pounds less than the maximum authorized and the load was distributed with respect to the center of gravity within approved limits.