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FOREWORD

The Accident Investigation Division of the Air Navigation Committee of ICAO at its first session in 1946 recommended that States forward copies of reports of aircraft accident investigations and inquiries and aeronautical publications and documents relating to research and development work in the field of aircraft accident investigation to ICAO in order that the Secretariat might appraise the information gained and disseminate the knowledge to Contracting States.

The first summary was issued in October 1946 (List No. 1, Doc 2177, AIG/56) entitled "Consolidated List of publications and documents relating to Aircraft Accident Investigation Reports and Procedures, Practices, Research and Development work in the field of Aircraft Accident Investigation received by the ICAO Secretariat from Contracting States". This was followed by further summaries at regular intervals, the last report being issued on 31 July 1950 (List No. 12, Doc 7026, AIG/513). These summary reports were found to be of considerable technical interest to States, and in view of the large number of requests for copies, it was decided, early in 1951, to revise the method of publication and in future to produce the material in the form of an information circular entitled "Aircraft Accident Digest".

The first ICAO information circular entitled "Aircraft Accident Digest, No. 1" (ICAO Circular 18-AN/15) was issued in June 1951; the present circular is the fourth issued under the new title. It is hoped that States will co-operate to the fullest extent their national laws permit in the submission of material for inclusion in future issues of this Digest. It is recognized that investigations take a diversity of forms under the variety of constitutional and juridical systems that exist throughout the membership of ICAO and that, for this reason, accident investigation presents one of the most difficult problems of standardization in international civil aviation. At the same time it is a most fruitful source of material for the attainment of the objectives of the Chicago Convention.

The usefulness of such a publication as this is directly proportional to the thoroughness with which accidents are investigated, the frankness and impartiality of the findings, and the readiness with which they are disclosed and authorized to be published. It is only in this way that this most fertile field for international co-operation can be effectively exploited. The measure of interest which this publication has aroused, and the vital information it imparts amply demonstrate the possibilities of ultimate achievement when every accident is investigated with the greatest thoroughness and the findings disclosed with complete frankness.

The ICAO Manual of Aircraft Investigation has proved to be a valuable guide to securing the information required for accident prevention measures and, whether available facilities and resources permit of the fullest investigation or not, if it is followed to the greatest practicable extent, uniformity of findings and usefulness of the Digest will be enhanced. Briefly, information should include:

1) Aircraft Type;

2) State of Registry;

3) Date and Place of Accident;

4) Résumé of the Accident;

5) Result of the Technical Investigation;

6) Conclusions and Recommendations (if any).

Any restriction upon reproduction in the Digest seriously impairs, of course, the usefulness of any report, as it is only by comparison between the circumstances that occasioned the accident and the circumstances of other operations that potentially hazardous circumstances can be foreseen and avoided.

The material in this Digest has been obtained from various sources, is printed for information only and does not necessarily reflect the views of the International Civil Aviation Organization.

A noticeable trend in the Accident Aircraft Reports in this issue, is the increase of reported mid-air collisions. With higher cruising speeds and the increase of traffic on airways and airports, the introduction of adequate measures to prevent mid-air collisions becomes more and more important. Action in this respect has been undertaken by the United Kingdom where the Authorities have introduced a system of controlled flight at all times in the London Control Area. This system is on a three-months' trial. (See NOTAM on page 184.) In the United States of America, a recent collision between two Convair aircraft near Michigan City has brought the problem into focus. Statements by Aeronautical Organizations and Companies emphasized that action to reduce accidents in this field should cover cockpit design with regard to the reduction of cockpit duties for the pilots, improvement in the functional design of instruments and controls, improvement in visibility and elimination of blind spots and improvements in cockpit lighting; improved navigational lights, i.e., higher intensity and improved flashing sequence rates, general adoption of the high intensity flashing beacon; the introduction of radar anti-collision equipment in all aircraft; and advice from Air Traffic Control on all flights in relation to other aircraft on similar heights or courses or in the vicinity. This indicates the vast scope of the problem which is also under study by ICAO as a high priority project.

A number of Reports in this issue refer to the sensory illusions as a possible reason for certain puzzling aircraft accidents broadly classified as "Pilot's error". An article on this subject by Mr. Prosper Cocquyt, Chief Pilot of Sabena Airlines is included in Part III on page 165.

The danger of fires originating during refueling of aircraft is emphasized by Accident Report No. 18 on page 61. This type of fire has destroyed or put out of service an appalling amount of equipment besides the associated disruption of services. In the accident quoted, a ruptured refueling hose was the cause as has been the case in a large number of these accidents. The Flight Safety Foundation of New York in its research on this subject, found that service tests in refueling hose varied widely or were non-existent. A Technical Committee of the Rubber Manufacturers Association was asked for a test procedure which resulted in the information reproduced on page 176 by kind permission of the Flight Safety Foundation.

PART I

SUMMARIES OF AIRCRAFT ACCIDENT REPORTS

No. 1

Air France DC-4 crashed in the Persian Gulf near Bahrein on 12 June 1950

(Inquiry by the United Kingdom in accordance with Annex 13 to the Convention on International Civil Aviation)

Circumstances

The aircraft was on a scheduled flight from Saigon to Paris and had left Karachi for Bahrein at 1605 hours with eight crew and forty-four passengers. The flight was normal until the aircraft notified Bahrein tower at 2115 hours that it was making its final approach and received clearance to land. Nothing further was heard from the aircraft. Search and Rescue operations were begun at 2135 hours and the wreckage was finally located by an aircraft at about 0520 on 13 June 1950 lying in approximately 12 feet of water at a bearing of approximately 124°N (True) and at a distance of 3.3 statute miles from the approach end of the runway. Six crew and forty passengers were killed or missing. Two crew and four passengers survived.

Investigation and Evidence

The aircraft took off from Karachi at 1605 hours for a non-stop flight to Bahrein. At 2042 hours the aircraft called Bahrein approach control giving its altitude as 6 500 feet and requesting clearance to descend. Approach control gave clearance to descend to 2 000 feet, altimeter setting of 29.51 inches, visibility 1 500 yards (1 370 metres). At 2055 hours approach control asked the aircraft for its position and ETA. Aircraft replied: "(60 miles) ETA 2113 hours". At 2113 hours the aircraft called Bahrein tower, saying "down wind leg"; the tower acknowledged and said "ground wind 310/20 knots", the aircraft called the tower at 2115 hours saying "finals". The tower replied "clear to land". Bahrein then called the aircraft every two minutes on every available frequency by radiotelegraphy and radiotelephony but obtained no reply. At 2135 hours a BOAC Argonaut which was holding at 1 500 feet on the radio beacon was cleared to land and, since nothing further had been heard from the Air France aircraft, search and rescue operations were ordered. One group was organized to search Muharraq Island, devoting particular attention to the approach zone to Runway 29 which was in use at the time. The U.S. Air Force at Dhahran was contacted at 2250 hours and asked to ready a helicopter for search over the sea as soon as it was light. The ground search party returned to the aerodrome at 2256 hours without having found any trace of the aircraft. At 0217 hours on 13 June 1950, the control tower intercepted a message that a ship anchored off Bahrein had rescued a radio officer from the missing aircraft. A bearing on this ship was taken by the control tower and transmitted to the helicopter when it flew over the aerodrome at 0323 hours.

An American B-17 located the wreckage of the aircraft and some survivors on a raft at about 0520 hours.

The Captain's account was that when he first flew over the aerodrome he was at an indicated altitude of 1 000 feet and that at that moment he saw the aerodrome lights and then the "goose-neck" runway flares; he estimated that his indicated altitude above the aerodrome was perfectly normal. The aircraft flew the down wind leg of the approach at an indicated altitude of 1 000 feet following a track parallel to Runway 29, a timed course of 2-1/2 minutes being flown from a point level with the approach control radio beacon (which is located at the approach end of Runway 29) to the start of the procedure turn. During this time, the landing-gear was in the down and locked position, the flaps were set to 15°, and the manifold pressure was 27/28 inches. The altimeter recorded a barometric pressure of 29.953 inches but the radio-altimeter was unserviceable. At the start of the procedure turn the altimeter indicated an altitude of 1 000 feet. During the turn the indicated altitude fell to 900 feet and the manifold pressure was increased to 30/31 inches. At the end of the turn, the indicated altitude was still 900 feet and after some adjustment of heading, using the approach control radio beacon to align the aircraft with Runway 29, the co-pilot reported the altitude to be 800 feet. On instructions from the pilot, the flight engineer then set the flaps to 30°, upon which the aircraft climbed slightly and was leveled off. Following this, the co-pilot reported that the altitude was 800 feet and that the aircraft was tending to lose altitude. The crash occurred almost immediately after this.

The Captain did not follow the Air France landing procedure for Bahrein exactly, but the times and the principles he followed were similar. The total elapsed time between his departure from Saigon and the accident was 22 hours 32 minutes; of this time, 1 hour and 2 minutes and 1 hour and 35 minutes were spent on the ground at Calcutta and Karachi respectively, the remaining 19 hours 55 minutes were spent in flight. The Captain was in command of the aircraft throughout the entire flight from Saigon.

Bahrein aerodrome is located on Muharraq Island. The elevation of the aerodrome is approximately 3 feet above mean sea level. There are no obstructions on the perfectly flat approaches to the runways. The main runway (QDM 29/11) is 2 600 yards long and 50 yards wide and is marked with goose-neck flares along its length. The average space between flares is 200 yards and "Money Buckets" are located on either side of the runway at about 500 yards from the ends. There is no approach lighting for any of the runways, but Schermuly sodium lights are used when visibility is poor. An M/F locator beacon with approach control identification is located at the approach end of the main Runway 29, and can be used in conjunction with an airborne radio compass to align the aircraft with the runway on approach.

Since the Captain suffered a severe shock his testimony could not be taken as entirely reliable. It was also necessary to stress that the Captain, a man of 52 years of age, had been on uninterrupted duty, since departure from Saigon, for 22 hours and a half, of which 19 hours 55 minutes were spent in flight. It therefore appears possible that he was feeling the effects of considerable fatigue just when, after a lengthy flight, he had to undergo the tension inherent in landing operations in unfavourable weather conditions. The report, however, stressed that whatever value the inquiry attached to the Captain's testimony the goodwill with which it was given could not be doubted.

Calculations were made, using the following co-ordinates, in an attempt to reconstruct what may have occurred during the approach procedure:

Down wind leg: Flight time: 2 minutes 30 seconds.
Heading: 110° magnetic.
Indicated airspeed: 140 mph.
Calculated wind at 1 000 feet: 330°, 30 knots.

Final approach: Heading: 299° magnetic.
Indicated airspeed: 135 mph.
Calculated mean wind between the ground and 1 000 feet: 320°, 25 knots.

These calculations indicate:

i) Ground speed during down wind leg: 169 mph;

ii) Distance flown on down wind leg: 7 miles;

iii) Ground speed during final approach: 110 mph; track: 293° magnetic;

iv) Distance flown on final approach: 3.7 miles, i.e., the difference between the distance flown on the down wind leg and the measured distance from the point of the crash to the end of the runway;

v) Flight time on final approach: 3.7 miles at a speed of 110 mph = 2 minutes.

The airspeeds used in these calculations were those given by the pilot in his evidence. The upper wind speeds and directions are only approximations.

The Captain stated that the down wind leg flown at an indicated airspeed of 140 mph and with a manifold pressure of 28 inches, that the landing-gear was down and locked and that the flaps were set at 15°. If this was so, and taking into account the total weight of the aircraft at the time, it would appear reasonable to assume that the rate of descent must have been about 250 feet/minute. Thus, assuming that the indicated altitude was still 1 000 feet when the aircraft entered the timed sector (2 minutes 30 seconds) of the down wind leg, its altitude at the start of the procedure turn would have been approximately 375 feet.

With regard to the final approach, the Captain stated that the indicated airspeed was 135 mph, the manifold pressure was 31 inches, the flaps were set at 30°, and the landing-gear was down and locked. On this basis it is calculated that the rate of descent during the final approach would have been of the order of 200 feet/minute. However, strictly on the basis of the above calculations it would have been:

$$\frac{375}{2} = 187 \text{ feet/minute}$$

The calculated rates of descent are incompatible, however, with the evidence given concerning the indicated altitudes during the approach. Ignoring, for the moment, the possibility of human error, there remains only the possibility of instrument error of equal degree in the case of both precision altimeters. On the basis of the Captain's testimony, the altimeters must have given a reading 800 feet too high at the moment of the crash. It was not possible for them to have been functioning with such an error, however, because, while the aircraft was flying over the aerodrome the captain himself had been satisfied, by seeing the aerodrome lights, that the indicated altitude of 1 000 feet was normal. Moreover, if this error had existed at that stage of the approach, the true altitude of the aircraft when it flew over the aerodrome would have been 200 feet and it seems certain that its passage over the aerodrome at such a low altitude could not have gone unnoticed by observers on the ground. The possibility was considered of the static pressure tube having become accidentally obstructed at a point which would affect both altimeters. For the altimeters actually to be prevented from operating, the obstruction would have had to form an airtight plug. If this had been the case, the altimeters would have continued to indicate the last altitude before the static pressure tube had been blocked, assuming that the instrument cases themselves were airtight. In this event, the airspeed indicators and rate of climb indicators would also have been affected since they are fed from the same static source as the altimeters. There was, however, no evidence from which one could conclude any malfunctioning of these instruments.

It may well be that the most reliable evidence of the indicated altitude of the aircraft at the moment of the crash was provided by the co-pilot's altimeter. The glass on the dial of this instrument was broken, probably on impact, blocking the jointers indicating hundreds and ten of thousands of feet against the dial at the 0 feet mark.

Probable Cause

The probable cause of this accident was that the pilot-in-command did not keep an accurate check of his altitude and rate of descent during the timed approach procedure, thus allowing his aircraft to fly into the surface of the sea.

The possibility that the pilot-in-command was feeling the effects of fatigue cannot be ruled out.

It is recommended that consideration be given to equipping Bahrein Airport with radio landing aids and with suitable runway approach lights. (See Report No. 2.)

ICAO Ref: AR/252

No. 2

Air France DC-4 crashed in the Persian Gulf near Bahrein on 14 June 1950

(Inquiry by the United Kingdom in accordance with Annex 13 to the Convention on International Civil Aviation)

Circumstances

The aircraft was on a scheduled flight from Saigon to Paris and had left Karachi for Bahrein at 1643 hours with eight crew and forty-five passengers. The flight appeared to be normal until the aircraft reported over Bahrein aerodrome at 2141 hours. The last communication received from the aircraft was at 2152 hours during the landing procedure when the aircraft called the Bahrein Tower saying, "Procedure Turn" to which the control tower replied, "No. 1, field clear for landing".

Search and Rescue operations were begun at 2210 hours and the first news of the missing aircraft was received at 0200 hours on 15 June when a vessel anchored off Sitra, reported that one of its boats had rescued nine survivors.

Three crew and thirty-seven passengers were killed or missing and five crew and eight passengers survived.

Investigation and Evidence

The aircraft took off from Karachi at 1643 hours for a non-stop flight to Bahrein.

At 2130 hours the aircraft called Bahrein approach control saying: "ETA 2150 hours, altitude 8 500 feet; flying VFR". Approach Control requested the aircraft to report on its visibility and the reply indicated: "very good". Approach Control gave the aircraft clearance to descend under visual flight rules, reporting that the QNH was 29.52 inches. The aircraft reported that it was over the aerodrome at 2141 hours and approach control instructed it to use the Bahrein tower frequency of 118.1 Mc/s. The aircraft then called the tower and asked for landing instructions. The tower replied: "You are cleared to descend to 1 000 feet and enter our circuit, runway in use 29, surface west-northwest 15 knots, pressure 29.52 inches, report down wing leg." The aircraft acknowledged the message. At 2148 hours the tower asked the aircraft for its position and it replied: "I am over your runway at 3 000 feet." The tower replied: "Understood, report down wind leg." At 2152 hours the aircraft informed the tower that it was making its procedure turn and was told that it was No. 1 and cleared to land. The acknowledgment of this clearance was the last radio contact with the aircraft. The air traffic control officer ordered search and rescue operations at 2210 hours and all available personnel were quickly alerted.

The first news of the missing aircraft came at 0200 hours when the vessel "Greenwich Bay" anchored off Sitra reported by radio that one of its motor boats had rescued nine survivors and that the position of the crashed aircraft was 26°12' N 52°42'E.

The co-pilot who survived reported that the aircraft had carried out the Air France timed landing procedure for Bahrein. On completing the procedure turn, the aircraft was at an altitude of approximately 1 300 feet. Since the automatic aerial of the radio compass was unserviceable, the radio officer was operating the aerial manually and giving the pilot QDM's on the approach control radio beacon which is located at the end of Runway 29. After homing on the approach radio beacon for approximately 1 minute 50 seconds, the co-pilot reset the radio altimeter on the scale 0-400 feet, the precision altimeters then read 500 feet and the needle on the radio-altimeter was very near to the maximum graduation on the scale. A few seconds later, he checked again and the reading was then 300 feet on all three altimeters, the airspeed was 135 mph and the rate of climb indicator reading was zero. From then onwards his attention was distracted because he began to watch outside the aircraft. He reported that the visibility was practically nil. However, by the light from the exhaust he could see the sea, although he took it to be sand and rain, and not more than three or four seconds elapsed between the moment when he read 300 feet on the altimeters and the contact with the sea. When he was first questioned he reported this interval as being about 10 seconds. It seemed to him that the contact with the sea came 2 minutes and 5 seconds after the end of the procedure turn. According to his estimate the aircraft should then have been near the aerodrome. Before arriving over the aerodrome, the Captain had told him he intended to fly at 300 feet at an indicated airspeed of 120 mph, and that if they found it impossible they would proceed without further delay to the alternate aerodrome at Cairo.

The first radio officer stated that at about 2000 hours the automatic radio compass aerial became unserviceable, but that he had been able to operate it manually. The Captain agreed with him that they should follow the Air France landing procedure. When they were over the aerodrome, he saw the runway and the obstruction lights on the radio beacon antennas. The procedure was started at radio beacon BR, the pilot maintaining a 135° heading for 2 minutes 30 seconds, then making a procedure turn. Halfway through this turn the radio officer noted that the indicated altitude was 1 300 feet. He then became fully occupied taking bearings on the approach control radio beacon and giving QDM's to the captain. The bearings indicated a deviation to the left of about 10° and the heading flown during the final approach varied between 290° and 300°. The radio officer then reported that about two minutes later the aircraft was aligned for the final approach, and that just after he had reported QDM 300°, a violent impact was felt as the aircraft crashed. He reported that he had not been able to see the altimeters during the final approach.

The flight engineer stated that the landing procedure had been agreed upon in advance between the pilot, the co-pilot, the radio officer and himself. The aircraft was at 300 feet at the start of the down wind leg, the rate of descent was 500 feet/minute and the indicated airspeed was 180-200 mph. After descending to 1 500 feet the pilot maintained horizontal flight with a manifold pressure of 24 inches and an indicated airspeed varying between 145 and 160 mph. On instructions from the captain the flight engineer then extended the flaps to the 15° position and the descent with a rate of descent reading varying between plus or minus 100 to 200 feet. At the end of the procedure turn the landing-gear was extended and locked; the indicated airspeed was then 140 mph. He again adjusted the manifold pressure to 25 inches and informed the captain that the engines were operating at 2 250 rpm. When at an altitude of about 500 feet he again adjusted the manifold pressure to 28 inches on instructions from the captain; the airspeed was then varying between 125 and 140 mph. The captain asked to be told when the runway could be seen. According to the timed approach procedure it should then have been reached in 30 seconds. At that moment the airspeed was 125/140 mph, the altimeters read 300 feet and the radio-altimeter reading varied between 150 and 400 feet. The rate of descent needle was oscillating violently owing to the turbulence and because the aircraft was flying practically horizontally. The flight engineer looked outside several times and the co-pilot also looked out very frequently, but "everything was as black as an oven". The aircraft then crashed into the sea.

The co-pilot and the flight engineer both stated that the indicated airspeed appeared to be low at cruising altitude. The first radio officer reported that the captain had complained of difficulty in maintaining indicated airspeed on that aircraft.

The surviving passengers said that the impact was not extremely violent. They believed that the pilot had made a rough landing and did not at first realize that they had landed in the sea. They complained of not knowing the location of the life jackets nor how to use them. When told that the life jackets were in the baggage racks they had trouble in finding them because they were under piles of baggage and blankets.

The majority of the passengers stated that fire broke out in the starboard wing after the impact.

Examination of both altimeters showed that they were set correctly and failed to reveal any defect or failure prior to the crash of the aircraft. In fact, all the damage noted was such as could have resulted from prolonged immersion in sea water.

Using the following co-ordinates, calculations were made in order to reconstruct the approach procedure followed by the pilot:

Down wind leg: Flight time: 2 minutes 30 seconds.
Heading: 135° magnetic.
Average indicated airspeed: 175 mph.
Calculated mean wind between 3 000 and 1 500 feet: 330° 30 knots.

Final approach: Heading: 300°.
Average indicated airspeed: 135 mph.
Calculated mean wind between 1 000 and the ground: 330° 23 knots.

These calculations indicated:

i) Ground speed during downwind leg: 210 mph. Track 138° magnetic.

ii) Distance flown on down wind leg: 8.7 statute miles.

iii) Ground speed during final approach: 114 mph. Track: 293° magnetic.

iv) Distance flown on final approach: 4.7 miles, i.e., the difference between the distance flown on the down wind leg and the measured distance from the point of the crash to the end of the runway.

v) Flight time on final approach: 4.7 miles at a speed of 114 mph = 2 minutes 30 seconds.

The co-pilot stated that, after having flown for about one minute and fifty seconds on the final approach, the altimeters read 500 feet and that when he looked at them again a few seconds later, they read 300 feet. This represents a very rapid rate of descent. Nevertheless, even if this rate of descent had been as little as 600 feet per minute the aircraft would have touched the water twenty seconds after the co-pilot had noted for the last time that the altitude was 300 feet. When first questioned, he said that about ten seconds elapsed between the moment when he read 300 feet on the altimeters and the crash of the aircraft on the water; he later said that this interval was not more than three or four seconds. During this interval, he said, he had been fully absorbed in looking out ahead of the aircraft, probably attempting to see the aerodrome lights. It appeared to him that the contact with the water took place after they had flown for about two minutes and five seconds on the final approach, and at this point he thought they must be near the aerodrome. It would appear, therefore, that he had based his estimate of their distance from the aerodrome on the assumption that they would arrive over the latter after flying for two minutes and 30 seconds on the final approach. The co-pilot stated that they had made successful break-throughs on several occasions in the past by following this method. It therefore appears reasonable to suppose that the pilot expected to see the aerodrome lights shortly before the moment when the aircraft crashed, and it is conceivable that, while he concentrated on looking for the lights, he allowed the aircraft to lose its last 300 feet of altitude. Moreover, it is certain that, in the prevailing circumstances, the only explanation why the aircraft had descended to 300 feet was that the captain expected to find himself very close to the runway. From the above calculations, however, it will be seen that the final approach would have taken about four minutes and thirty seconds and that the pilot should not have expected to see the aerodrome lights before about three minutes thirty seconds of the final approach had elapsed.

In the circumstances, the Captain would have been well advised to carry out a "dummy run" before finally attempting a landing.

Probable Cause

The probable cause of the accident was:

i) Failure of the pilot-in-command to adopt the timed approach procedure to the prevailing conditions;

ii) Having descended to 300 feet, the pilot-in-command did not take the necessary steps to maintain this altitude until such time as the runway lights became visible.

It is recommended that consideration be given to equipping Bahrein airport with radio landing aids and with suitable runway approach lights.

ICAO Ref: AR/251

No. 3

Hunting Air Travel Ltd., Viking G-AHPD aircraft crashed near Bordeaux - Mérignac on 8 May 1951 (This enquiry was conducted by France in accordance with Annex 13 to the Convention on International Civil Aviation)

Circumstances

The Viking G-AHPD, operating the service Gibraltar-Bovingdon with point of call at Bordeaux touched down at Bordeaux-Mérignac Airport at 1133 U.T. At 1410 U.T. the aircraft took off for Bovingdon. On throttling down to initial climbing speed, at a height of 50 metres the pilot noted that the speed of the port engine was rapidly decreasing. He shut off this engine and feathered the propeller, opening the starboard engine full out. He then became aware that the aircraft could not maintain its safety speed without losing height and decided to make a wheels up landing on an open space south of the aerodrome. The aircraft slid along the ground for about 100 metres, slewed around and came to a standstill. The co-pilot was injured, however, the remaining four crew members and twenty-six passengers were unharmed.

Investigation and Evidence

As the aircraft had made a belly landing in a zone free of obstructions and in which the soil was sandy, damp and not very firm, it slid along on the fuselage and engine nacelles without its general structure suffering major damage.

The under parts of the aircraft, however, were damaged on impact with the ground (fuselage as far as the flooring crushed, wings damaged, propeller blades twisted but still in place, engine cowlings badly dented, undercarriage smashed); the engines and their controls were only slightly damaged.

Initial examination of the aircraft showed that the articulated control rod of the propeller governor of the port engine was missing, but there was no trace of stripping such as would indicate that such disappearance was due to the forced landing.

Search with a view to finding this articulated rod was immediately made both inside the engine cowling and in the immediate vicinity of the aircraft. The part in question was found, three-quarters buried in the ground, in the furrow ploughed by the aircraft, about three metres to the rear of the starboard wing amongst other light debris torn off at the moment of impact.

Examination of the control rod of the aforesaid link-rod showed clearly that the ball-joint was intact; the threaded end of the spindle on which it hinged exhibited, on the contrary, a considerable moment of irregularity.

This threaded end was very carefully examined and it became apparent that the castellated nut limiting the play of the ball-joint on the spindle had been unscrewed whilst the split-pin was still in place; the body of the latter was, in fact, found inside the hole drilled in the threaded part of the spindle; the tail end of it having been pulled out and pressed into the threads.

The governor spindle, on which the articulated control rod was fixed was found to be in good condition but minus the castellated nut which ensures the attachment of the aforesaid link-rod.

It was clear that the nut holding the ball-joint of the control rod on the link-rod had been unscrewed by force and that the pin on the governor spindle was missing. It is unlikely that it would not have been in place when the governor was mounted on the engine.

When the pilot operated the pitch-change control, the transmission rod freed itself from its spindles. The freed propeller governor, automatically took up the high pitch position, communicating this to the propeller. The ensuing drop in speed made it necessary to shut off the engine and the pilot feathered the propeller.

The hypotheses of malicious damage or of faulty maintenance work are equally plausible.

During its stay, which lasted 2 hours 37 minutes, the aircraft was parked on the concrete apron opposite the terminal building, an area under constant supervision by two custodians and the personnel of the Customs services. During the refuelling operations, which lasted about 30 minutes, the flight radio operator checked and tested a faulty aerial. The crew did not ask for any work to be done, nor was any work carried out on the engine or on the aircraft.

Later, when the crew went to have a meal, the aircraft remained under no supervision other than that of the custodians of the parking area. Interrogation of the aerodrome personnel, however, established that nobody had touched the engines. As a matter of fact, a repair would have necessitated the presence of a ladder in front of the defective engine, a detail which could not have passed unnoticed by the numerous airline employees (luggage porters, mechanics) who were continuously present on the parking area.

Probable Cause

The disconnecting of the articulated control rod of the propeller governor due to the lack of a split pin on the governor spindle and to the nut of the ball-joint of the control spindle having been unscrewed by force.

ICAO Ref: AR/231

No. 4

AIRTACO AB, Lockheed 14 H, crashed on take-off at Stockholm-Bromma Airport on 14 July 1951

Circumstances

On 14 July 1951, at 0417 hours, the aircraft engaged in carrying newspaper to Jönköping took off from Runway 13 of Stockholm-Bromma Airport with four passengers and two crew. Weather conditions were good and the aircraft was cleared to fly VFR. The take-off and climb to approximately 20 metres appeared to be normal. At this point the starboard engine lost power and the aircraft, turning to the right and climbing, gradually stalled and crashed at the intersection of the runways. Three passengers and one crew member were killed - the surviving passenger and pilot being severely injured.

Investigation and Evidence

The investigation indicated that the failure of the starboard engine occurred immediately after take-off. The probable cause was a fuel supply failure due to the fact that the tank selector valve was set on a tank containing only a very small quantity of fuel.

The fact that the pilot probably did not check the fuel selector valve on departure, can be ascribed to his very poor flying condition as a result of insufficient sleep. (The pilot had flown every day for a period of fourteen days during which he totalled forty-seven hours of flight time. Prior to this particular flight he had slept at the most only four hours.)

From the circumstances of the accident, it would appear that the aircraft had begun to climb before it had reached a safe take-off speed. The pilot was placed in an extremely difficult position which was aggravated by the fact that his piloting ability was probably reduced through fatigue. This may explain why he did not take immediate action to complete the take-off on one engine. Instead, he endeavoured to re-start the starboard engine by using the hand fuel pump, thus hoping to be able to complete the take-off and then carry out a landing at the airport.

During the investigation, certain facts came to light which indicated that the pilot might not have been acting as pilot at the take-off. One of the accompanying passengers had acted as pilot under the supervision of the pilot five or six years earlier; according to the pilot, however, he had never performed a take-off or landing. The following circumstances would appear to indicate that the passenger had been piloting the aircraft on this occasion. After the accident, the pilot was found lying at some distance from and to the right of the aircraft and it is difficult to believe, therefore, that he was sitting in the pilot's seat. It seems more probable that he was standing behind the front seats or was sitting in the right-hand seat. Furthermore, pieces of clothing with the passenger's belongings were found in such a position that it is possible that he was sitting in the pilot's seat. If the passenger was seated in the pilot's seat, the pilot would not have been able to take over immediate control of the aircraft as it was not provided with dual controls. However, these circumstances cannot in any way be considered as proof that the passenger was piloting the aircraft. The surviving passenger, stated that there had been some changing about, but that he could not recall exactly where those on board were seated, since he did not know the other persons on board the aircraft personally and therefore had no special reason for noting how they were seated. He himself was seated nearest to the rear of the aircraft.

The investigation revealed that on this particular flight the number of persons on board exceeded the maximum number permitted by the certificate of airworthiness and in reporting the flight the pilot did not indicate the actual number of persons on board.

Probable Cause

The probable cause of the accident was a piloting error. The take-off speed was too low and consequently, when an engine failure occurred, the aircraft stalled. The engine failure was probably caused by lack of fuel in the tank on which the pilot had set the selector.

ICAO Ref: AR/269

No. 5

Air France DC-3 crashed in the vicinity of Moisville, France, on 11 August 1951

Circumstances

The aircraft took off from Le Bourget, Paris, at 0750 hours on a flight to test a new type of air scoop. The new scoop was fitted to one engine only to allow comparison tests to be made. Five crew were carried. At about 0925 the aircraft was seen to break up in the air and crash in the vicinity of Moisville. There were no survivors.

Investigation and Evidence

After take-off the aircraft called Paris Control at 0751 reporting that it was directly over Le Bourget on a test flight and that visibility was good, and asked the area control centre in which direction the flight should take place. The area control centre left selection of the route to the pilot provided he did not fly in cloud.

From this point onwards it was possible partially to reconstruct the flight from the handwritten notes of the flight engineer, which were found in the wreckage of the cockpit.

0755 - The aircraft had climbed to 4 300 feet.

0759 - The starboard engine was stopped and the test commenced with a climb on the port engine with cooling gills open.

0811 - Level flight at 6 980 feet. The crew then commenced the second phase of the test with the port engine cooling gills in the trail position.

0822 - Level flight again at 7 900 feet. Cooling gills closed.

0825 - The flight engineer's notes ended here.

The aircraft was seen over the Moisville area flying from north-west to south-east then making a wide turn to the south of Moisville and turning to the north-west again. At about this time (0925) witnesses agreed that the aircraft was flying normally although "somewhat slowly". When level with Moisville, the aircraft made a turn (witnesses were not able to agree on the direction this took). The engine noise became louder and the aircraft began a dive only to pull up again immediately. During these manoeuvres, witnesses saw a flat shaped object come loose from the aircraft and glide down wind. From its size and shape they took it to be a control surface.

In pulling up, the empennage broke off and fell down spinning while the forward part of the aircraft dived very rapidly to the ground. When near the ground the part of the fuselage containing the cockpit separated from the remainder (centre section, nacelles, engine, wings). Fire broke out on the ground in the wreckage of these units.

The aircraft broke into three main portions. Many small pieces, however, broken off by multiple failures, were scattered about by the wind.

The unit consisting of the wings and engine nacelles dropped to the edge of the wood at a point 1,800 metres west of Moisville Town Hall. The cockpit and the central portion of the fuselage crashed into the wood 150 metres south-west of this point. The rear portion of the fuselage and the tailplane fell 250 metres further on, at the south-west edge of the wood.

Among the various portions of the aircraft which were found scattered between the main wreckage and Merbouton farm two appeared to be of particular importance to the investigators. A fuselage nose access door was found approximately 800 metres from the wing. The starboard elevator was found in a field 1 500 metres from the wood. This unit fell further than any other from the main wreckage.

The landing gear was found severely damaged, in the "down and locked" position. This was normal and was due to failure of hydraulic pressure owing to breakage of the lines. The gear was therefore extended by gravity.

The starboard stabilizer showed two well-marked folds, one of which, running at a 45° angle from forward to rear, was also visible on the corresponding elevator. The elevator attachment fittings were broken by a stress in an outward direction. The middle fitting remained attached to the stabilizer spar. It had been subjected to lateral torsion. The linkage remained, but the half-casing attaching it to the elevator tube had become separated from the latter through shearing failure of the rivets. The outer attachment fitting was broken off near its junction with the stabilizer spar.

Characteristic creases due to alternating stresses were found on the covering on the tail-fin, on the left side near the root. The rudder which was not displaced was subjected to a "combustion" stress.The centre portion of the leading edge which contains the balancing counterweight had been crushed and bent backwards.

The starboard elevator was somewhat damaged. The deformations corresponded to those found on the starboard stabilizer. The scores left by the articulation fittings on the inner surface of the recesses in the leading edge of the elevator indicated that the latter was in the tail-down position at the moment when the stabilizer folded back.

Lower fuselage nose access door was crushed from the rear. It had received an impact directly on its edge which is fairly sharp. (The mark of this blow was slightly offset from the axis of symmetry.) This impact was probably caused by the pilot antenna mast which is located directly behind this door.

The two centre Dzus fasteners were in place. The rivets attaching the supporting brackets to the main structure had failed by shear fracture. Both on the forward and the rear edge, one of the Dzus fasteners was completely torn off (in each case on the same side) the other being intact (probably badly engaged).

Tests to determine the effect of the absence of the lower fuselage nose access door were carried out on 11 January 1952 at Coulommiers with a DC-3. At 130 mph no blast or air current was noted in the cockpit and the aircraft flew normally.

On examination of the wreckage of the tail-plane, several control cables to the tail-plane control were found jammed in their grooves. The technical examination showed, however, that this happened as a result of the breaking of the fuselage. Moreover, from information obtained from the manufacturer, it appears that such snagging of the control lines has never been reported in DC-3's.

Although no trim sheet was prepared for this particular flight, inquiries made when the ballast was loaded provided an indication of the distribution of the weights and, hence the actual trim of the aircraft. The centre of gravity was at 24% which is within the prescribed limits. The straps used to tie down the cabin ballast (cast iron weights) could fail under a strain exceeding 1.5 g. Furthermore, the weights in the rear compartment were not tied down. Owing to these two factors, an abnormal manoeuvre could cause a failure of the straps or cause the weights to slide, thus causing a sudden and dangerous change in the equilibrium of the aircraft.

Examination of the wreckage showed buckling and tearing indicative of alternating stresses over the whole length of the stabilizer and fin roots, the starboard stabilizer being folded right back against the fin. Since the deformations found on the stabilizer extended on to the elevator, this folding back of the starboard stabilizer must have occurred while the rudder was still in position. Careful study of the structural deformations confirmed that there must have been violent buffeting in the tail-plane area.

One of the witnesses appeared to have seen the initial phase of the accident. This witness noticed the aircraft, while in level flight, suddenly make a turn, diving slightly at the same time. Almost immediately thereafter he saw an object, which he described as about 50 cm. wide by 2 metres long, fall from the aircraft. It should be noted that the ratio of these dimensions would seem to indicate that the object was the starboard elevator. This theory is confirmed by the point over which the object was reported to have fallen, which corresponds to that at which this elevator was found.

Subsequent examination of the fuselage centre section attachments revealed no trace of failure due to fatigue or to faulty maintenance. The fittings had not broken and the ripping of the skin plates had been violent, from forward to rear, in the direction of torsion of the aircraft.

This would certainly appear to indicate that considerable force was exerted laterally and in torsion on the rear of the aircraft from the tail-plane aft.

The weather situation was good in the area at the time of the accident and cannot be considered to have been a possible cause.

Probable Cause

Study of the flight conditions and circumstances of the accident to the aircraft revealed no mechanical defect which might have been the initial cause of the accident.

The cause would appear to have been an abnormal flight manoeuvre made when the crew experienced difficulty in resuming normal flight on two engines.

Overspeed, reduction of pitch or difficulty in re-starting the engine may have created a dangerous situation and caused the aircraft to stall in dissymmetrical flight, thus subjecting the airframe to stresses accompanied by buffeting which was either alternating or exceeded the design limits of the structure and caused the tail-plane to break off.

ICAO Ref: AR/255

No. 6

Société Alpes Provence, Douglas DC-3 lost in the Mediterranean West of the Baleares Isles, on 12 September 1951

Circumstances

The aircraft arrived at Perpignan, France, on 1 September 1951 from Toulouse and took off for Oran, North Africa, at 1045 on 2 September 1951, with thirty-six passengers and three crew. Contact with the aircraft was maintained until 1228 when the last message, a clearance request, was transmitted from the Alger area control centre.

Bodies and wreckage were found after a four-day search 60 km. north of the estimated position of the last message.

There were no survivors.

Investigation and Evidence

The pilot prepared an IFR flight plan for a direct flight from Perpignan to Oran, at an altitude of 8 000 feet, the duration to be 3 hours and 15 minutes. Alger was listed as the alternate. At 1045 hours the crew requested take-off instructions from Perpignan control tower and following engine run-up, a normal take-off was made at 1045.

After taking-off, aircraft F-BEIZ was seen climbing away, somewhat off the SSE heading (this is the conventional procedure, consisting in flying round Cape Creus in order to avoid the Alberes mountains before heading for Oran). At 1056 the aircraft made radiotelegraphy contact with Perpignan navigational D/F and reported true track: 202 degrees, good visibility, altitude: 8 000 feet and a magnetic bearing (QDR) was requested.

At 1058 the D/F station transmitted a QDR of 162° and reported in its log strong interference caused by static.

At 1131 the aircraft contacted Aix area control centre and reported Barcelona abeam.

At 1200 the aircraft contacted Alger area control centre and reported ETA at Oran: 1415 hours, altitude 8 000 feet: flying sometimes below and sometimes in cloud (QBH-QBF) and reported static interference and requested a true bearing from Alger (QTE). Alger replied: at 1158 hours QTE = 332°.

At 1216 the aircraft reported to Alger: Position at 1208 hours was 40° N - 1° 25' E. ETA at Oran: 1410 hours.

At 1226 the last message was received from the aircraft: Bearing on Alger 317°, altitude 8 000 feet, flying in cloud and requested clearance to descend to 6 000 feet.

The rescue craft found only very mutilated bodies. The aircraft was totally destroyed and sank, with the exception of the port landing gear leg: the left landing gear leg and wheel, pieces of the cabin floor, pieces of seat covers, pieces of suitcases, six life preservers, two of which were still in their containers and a damaged piece of sheet metal. None of these items showed any sign of fire. One of the life preservers was torn, but the other five were in good condition, although one appeared to have been used. The piece of sheet metal appeared to have come from an oil tank.

From the condition of the bodies of the victims and from the wreckage recovered, it was clear that the aircraft was disabled when it hit the water. However, nothing is known of the initial phase of the accident.

The various factors which might have contributed to the accident are discussed below.

The report considered three possible theories. These concern, respectively, the airframe, the power units and the propeller (considered as separate from the power units).

The report stated that it is extremely rare, although not impossible, for failure of the airframe to occur in normal operating conditions. It can occur as a result of an incident due to faulty maintenance or disturbance caused by the failure of an accessory (failure of the inspection door affecting aerodynamic flow, or breakage of the antenna snagging the control lines).

Violent failures affecting one of the power units have been reported as having occurred, but these did not result in any airframe failure.

Although propeller blade failures have been reported on very rare occasions on other aircraft types, no such failure is known to have occurred with the Hamilton Standard propeller fitted on the DC-3's used by French airlines since 1944.

The weather conditions on the Perpignan-Oran route, although not very bad, included thunder-clouds at about the half-way point, which presented a possibility of turbulence with fairly strong vertical or vortical gusts. An Air France aircraft which left Lyon for Oran on the same day, and which was in the area of the Baleares Isles at 1400 hours (sighted Ibize at 1408) reported that it had come down below cloud at 2 000 feet and commented as follows: "Below continuous layer of altocumulus to 3/8 low cloud between 3 000 and sea level from Ibiza onwards. Leaden sky. Visibility 2 to 5 km. Violent QRN. Thunderstorms over Balearic Isles and Valencia. A corridor between the two points. Conditions worse south of 40°."

The cruising altitude entered in the flight plan was 8 000 feet. The request for a change of altitude at the very moment when, according to the meteorological reports, the aircraft was already in the cumulo nimbus zone, is fairly significant, when related to the observations made by the above-mentioned Air France aircraft. It appears very likely that at 8 000 feet the turbulence was such as to make the flight uncomfortable, if not actually causing concern.

Considering, on the one hand, the history of the DC-3, and on the other, the results of systematic tests of flight through thunderstorms, it may be assumed that the structure of this aircraft type was sufficiently strong to withstand, at cruising speed, the strong turbulence encountered in medium thunderstorms (vertical gust speeds of the order of 10 metres per second encountered in cumulo nimbus clouds).

The various instances recorded of failure having occurred in previous accidents to DC-3 aircraft or aircraft of similar type were due to loss of control, generally followed by violent manoeuvres (spin, overspeed, pull-out).

Practically all the cases of loss of control occurred when the aircraft was flying through cumulo nimbus or violent squalls in poor or zero visibility. This is confirmed by the number of instances in which pilots reported just being able to avoid loss of control. The weather conditions over the route flown by the aircraft and the altitudes reported in the last messages received indicate that the aircraft must certainly have encountered a thunderstorm system and had probably entered it at an altitude at which vertical gusts were most active.

Probable Cause

Failure of airframe following loss of control in difficult weather conditions into which the pilot had flown the aircraft.

ICAO Ref: AR/256

No. 7

California Eastern Airways, Inc. & Overseas National Airways, Air Collision near Oakland Municipal Airport, Oakland, California, 17 November 1951, CAB Accident Investigation Report, No. 1-0098, Released 7 October 1951

Circumstances

Overseas National's DC-4 took off from the Oakland Airport at 0820 on a Captain's six-months DC-4 instrument competency check. At 0923, this flight received a clearance from the Oakland tower to make a practice range approach and to remain above 1,500 feet on the final approach to the airport. At 0935 the California Eastern DC-3 took off from the Oakland Airport also for the purpose of a Captain's six-months DC-4 instrument competency check. According to accepted practice, both flights conducted their training checks in the "Bay area" with all manoeuvres above 3 000 feet. Both aircraft were equipped with hoods installed on the left side of each cockpit to prevent the pilots undergoing checking from seeing outside. The check pilots in the right seats, also perform the duties of safety pilots, maintaining watch for other aircraft. There was also a third pilot on board Overseas who acted as an observer.

Shortly before 1013, the approximate time of the accident, both aircraft approached the Oakland low frequency radio range station, which is 0.2 mile northeast from the approach end of Runway 15 of the Oakland Airport. Overseas was on a magnetic heading of approximately 124 degrees inbound on the NW leg of the range; and California was homing on the range on a heading of 75 degrees M. Both aircraft were at an altitude of 3 000 feet.

Weather conditions were good in the San Francisco Bay area at the time. The U.S. Weather Bureau reported at 1016 (three minutes after the accident); ceiling 25 000 feet, thin broken clouds, visibility seven miles, wind south four mph at Oakland. The sun's bearing at 1015 was 153 degrees true, and its altitude above the horizon was 28 degrees and 27 minutes.

During a short period prior to 1013, both aircraft were observed to converge without any apparent change in direction or altitude. Neither attempted to avoid collision but remained in straight and level flight, and collided approximately over the range station at an altitude of about 3 000 feet.

California was at a slightly lower altitude than Overseas, and contact was made between the leading edge of the vertical stabilizer of California and the right side of the fuselage of Overseas just forward of the horizontal stabilizer. Shortly after the collision, Overseas crashed out of control on Doolittle Drive, the highway paralleling the north side of Oakland Airport. Its three pilots were killed at the time of impact with the ground. A number of persons driving on the highway close to the impact site received burns of varying degrees, and several automobiles were destroyed by fire.

The top portions of the vertical stabilizer and rudder of California were torn off in the collision, the aircraft was, however, still controllable at an airspeed of 160 miles an hour. Immediately following the collision, California which was then south of the Oakland Airport at 2 500 feet, requested permission to land on Runway 9R, the longest runway, and to have emergency equipment stand by. However, since all fire equipment was then at the crash scene of Overseas, the flight was directed to the San Francisco Airport, 12 miles away, where an emergency landing was made at 1021.

Investigation and Evidence

Overseas was approaching the Oakland range station inbound on the northwest leg which has a magnetic course of 124 degrees. California was homing on the range station on a heading of 75 degrees magnetic. Thus, the angle of convergence was about 49 degrees; this was borne out by a detailed matching of wreckage, paint marks, cuts, and the probable speeds of both aircraft. The resulting computation conforms the above-mentioned angle of convergence.

The cockpits of both aircraft were hooded on their left sides. Each carried a safety check pilot on the right. Further, the third crew member in Overseas was supposedly acting as an observer and would be normally stationed in the cabin during straight and level flight and at the astrodome during manoeuvres. Since the airplane for some few minutes prior to the collision was observed to be in straight and level flight, it must be assumed that this observer was in the cabin, where his primary duty was to maintain a watch on the left, or the hooded side of the aircraft, for other traffic. Although the observer's field of vision supplements that of the safety pilot, it is also reasonable to assume that he would check the right side for traffic.

The responsibility of the Overseas safety pilot under these conditions was to maintain a lookout ahead and to the right to avoid collision with other aircraft, since his vision to the left was greatly obscured. Since both aircraft were converging at an angle approximately 49 degrees for some period of time prior to collision, the evidence is clear that had the safety pilot been maintaining such a lookout, he would have definitely seen California on his right. As to why he did not do so, we may only conjecture that he, during a portion of the time, was in the process of going through the required cockpit check prior to reaching the range station or that he may have possibly been engaged in grading the pilot in the left seat or in other duties. Had Overseas observed California converging on its right, it would have been required to give way to that aircraft.

As previously stated, California was on a heading of 75 degrees magnetic, which placed the aircraft to the right of Overseas. Thus, the safety pilot of California on the right side of the cockpit could not see more than 45 degrees to his left. As there was no observer stationed in the cabin, it is apparent that this flight could not see Overseas as both aircraft converged on the range station. The fact that a mechanic working in the cabin of California did observe the other aircraft, but too late to alert the crew, is significant. Had an observer been on duty, the accident could have been averted. In fact, during the final stages of convergence both aircraft could have been plainly visible one from the other had safety requirements of adequate lookout from both aircraft been adhered to. Furthermore, had both flights followed their company practices of reporting to the tower immediately prior to arrival over the range station, the tower operator might well have prevented the collision.

At the Oakland Airport the altitude of the traffic pattern is 1 500 feet, as established by the local authorities and approved by the CAA. Below this altitude all aircraft in the traffic pattern are under the control of the tower operator, whose duty it is to assist in maintaining an orderly flow and separation of traffic. Above the traffic pattern altitude, the tower operator does not normally exercise control under VFR conditions. As both flights were on VFR flight plans they were not under control of Air Traffic Control. Thus, neither flight was under any ground control whatever at the time of collision; therefore, responsibility for preventing collision in this case was vested solely in the flight crews.

It appears that the hoods installed in both aircraft met the general requirements of the CAA's Manual of Procedure, No. 4-2-1.

Overseas, following this accident, continued to use the same type of hood, the company believing that this type of hood offered a satisfactory degree of safety because it permitted a reasonable amount of vision to the left by the safety pilot. The company feels that when a competent observer is carried, as was the case when this collision occurred, there is ample vision ahead and to both sides. Overseas is continuing to use a check list prior to arrival over the range station on the initial approach and the Company policy is to complete this check-off at an appreciable period of time before arrival over the range. Following the accident, the CAA recommended that both carriers adopt a different crew arrangement during training flights. This called for the safety pilot in the right seat to have no other duty than keeping continuous watch ahead and to both sides. The engineer's (jump) seat would be occupied by the check pilot who would accomplish grading the trainee and handling the check-off. However, Overseas continued using its former crew arrangement except that the observer is now stationed continuously at the astrodome; this arrangement was acceptable to the CAA.

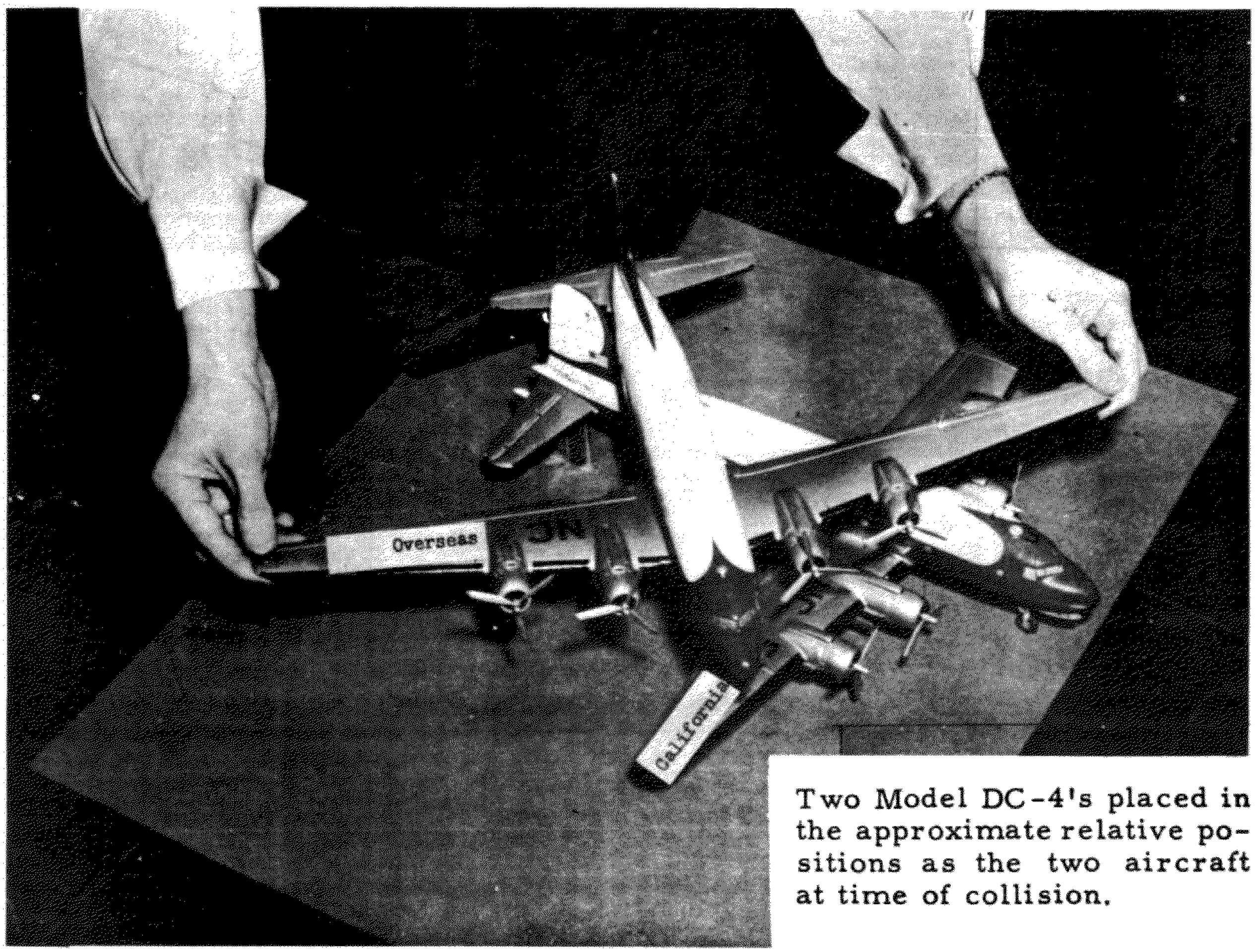
California, immediately after the accident, revised its policy to require that the third crew member or observer on all instrument training flights be stationed at the astrodome. It also changed its type of hood installation, using a vertical slat or baffle type hood, which permits a largely unobstructed field of vision to the left by the safety pilot. Later, following the afore-mentioned recommendation by the CAA, California again revised its crew arrangements, complying with that recommendation in full.

Both the Board and the Administrator, in conjunction with the industry and the military, have had the overall problem of airspace collision hazard under intensive study for some time, including the function of airport traffic control under VFR conditions. Concerning the latter, the Board is considering a requirement that all simulated instrument (hooded) flights operating in accordance with visual flight rules be under tower supervision at all times when within the airport control zone.

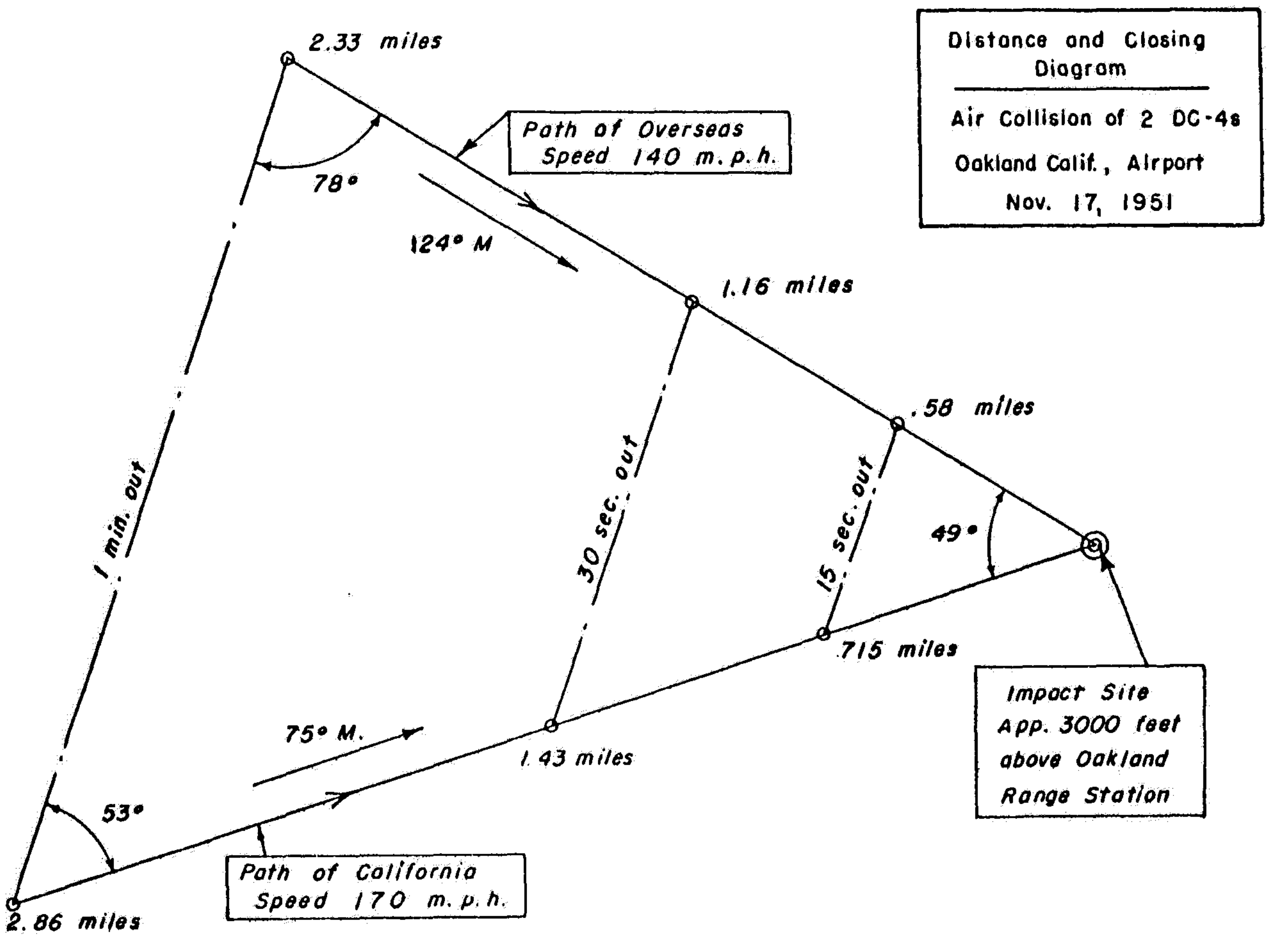
Irrespective of the lack of tower supervision, however, it is clear to the Board that had the responsible crew members of both aircraft complied with existing Civil Air Regulations and maintained the lookout required, this accident would not have occurred.

Probable Cause

The probable cause of this accident was the failure of the Overseas safety pilot and/or his observer to observe and so avoid the other aircraft and the failure of California's safety pilot to carry a qualified observer aboard the aircraft to insure an adequate field of vision.



Two Model DC-4's placed in the approximate relative positions as the two aircraft at time of collision.


Distance and Closing Diagram
Air Collision of 2 DC-4s
Oakland Calif., Airport
Nov. 17, 1951
2.33 miles
Path of Overseas Speed 140 m.p.h.
78°
124° M
1.16 miles
.58 miles
49°
1 min. out
30 sec. out
15 sec. out
.715 miles
Impact Site App. 3000 feet above Oakland Range Station
75° M.
1.43 miles
53°
Path of California Speed 170 m.p.h.
2.86 miles

No. 8

Eastern Air Lines, Inc., and Air Force Civil Patrol, DC-3, N25646 aircraft and Air Force L4-J aircraft air collision at Ocala, Florida on 27 November 1951, CAB Accident Investigation Report No. 1-0102, Released 10 December 1952

Circumstances

Eastern's Flight 167 departed Atlanta, Georgia, on a VFR flight plan at 0806, 27 November 1951. It made several scheduled stops, en route, and then departed Gainsville, Florida at 1126 ramp time for Ocala, Florida, with twenty occupants - seventeen passengers and a crew of three.

At approximately 1145 on 27 November 1951 the L4-J which was engaged on a flight at Taylor Field, Ocala, for the purpose of maintaining pilot proficiency, was seen taxying into position for take-off on Runway 21. There are no known witnesses to the subsequent take-off although one witness saw the L4-J as it passed the open space between two hangars, at which time it was headed in a southwesterly direction along Runway 21. However, several persons observed the collision, at which time both aircraft were on a heading of approximately 120 degrees and at an altitude estimated as between 700 and 800 feet, with the L4-J slightly lower and climbing.

The left propeller of the DC-3 made several span-wise cuts into the left wing of the L4-J in such a manner that the wing, for all practical purposes, was destroyed. The aircraft immediately fell into a heavily wooded area about three-quarters of a mile south of the airport while the DC-3, after circling the area for a few minutes, proceeded to the airport and made a normal landing at 1210. No one in the DC-3 was injured but the pilot of the L4-J lost his life.

Investigation and Evidence

The pilot of the L4-J was issued an Airman Certificate with private and single-engine land ratings 19 August 1941. As a result of an automobile accident in 1946, he lost the sight of his left eye. The pilot enrolled in the refresher flight training course conducted by the Marion County Vocational High School, on 12 December 1950. This course was concluded on 25 June 1951, during which time he received 6 hours 4 minutes dual and 5 hours 5 minutes solo time in a Piper J-3 aircraft owned and operated by the school. On 9 January 1951, he was issued a CAA medical certificate which indicated the left eye to be artificial and the right eye to have 20-20 vision. However, the pilot held no medical waiver to indicate that his physical defect had been found compensated for by his aeronautical experience, ability and judgment, as required by Part 29 of the Civil Air Regulations.

Taylor Field operates under a standard left-hand traffic pattern, and a set of traffic regulations approved by the airport manager and the CAA Chief, Flight Operations Branch. The traffic pattern, however, does not provide any horizontal limits, there being limits only on altitude and angles at which aircraft shall leave or enter it. It provides that an aircraft shall leave the traffic pattern at an angle of 45 degrees to the downwind and at an altitude less than 700 feet, and enter it at an angle of 45 degrees to the downwind leg at an altitude of 700 feet.

At the time of the accident, visibility was reduced to six miles by haze. Therefore the two aircraft, with colouring of low perceptibility, were approaching each other on converging courses against a background of haze. Testimony of the Eastern pilots indicates they were performing no cockpit duties other than flying the aircraft, and that they were maintaining at least the normal vigilance to be expected when approaching an airport having no control tower. There is no reason to believe the pilot of the L4-J was any less vigilant as he climbed out of the field following his take-off. No witness has been found who observed the L4-J continuously from take-off to the point of collision.

While the exact time of collision is not known, conflicting testimony placing it not earlier than 1145 and not later than 1150, it apparently occurred some one and one-half to two minutes after the L4-J started its take-off. From the evidence available, it is reasonable to assume that following take-off, the L4-J continued straight ahead to a point approximately three-quarters of a mile beyond the boundary of the airport where, after making a 90-degree turn to the left, it continued its climb to the point of collision. It is also reasonable to assume that the pilot did not observe the DC-3 approaching the airport from his right since witnesses, who observed both aircraft for a few seconds prior to the impact, noted no evasive action by either. Since the collision occurred while both aircraft were flying on approximately the same heading, with the L4-J slightly below and climbing, it is apparent that the pilot, after completing the 90-degree left-hand turn, was no longer in a position to observe the slightly higher DC-3 then approaching directly from the rear. Also, it is entirely possible that the L4-J in this lower climbing attitude was not within the normal range of vision of the DC-3 crew during the last few seconds preceding the collision.

In studying the circumstances surrounding this accident, consideration has been given to the fact that the pilot of the L4-J's vision was confined entirely to his right eye. Whether or not this was a contributing factor in this accident is not known. However, it cannot be successfully argued that he failed to see the approaching DC-3 because of this restriction to his range of vision when it is considered that the DC-3 was manned by two pilots with unimpaired vision who testified that at no time did they observe the L4-J prior to the collision.

Under the standards specified in Part 29, an airman with only one eye would not qualify for certification. However, the Administrator is given express authority to waive the physical requirements in cases where he finds that the physical deficiency is compensated for by the airman's operational record, ability, and judgment. In granting this power to the Administrator, the Board did not contemplate that it would be exercised by the examining doctor, but rather by the Administrator's personnel who would be in a better position to determine the airman's aeronautical qualifications. In the main, this waiver has been granted by the Administrator's personnel, but the procedure established for this purpose by the Administrator did not guarantee that it would always be so supervised in practice in the case of a periodic renewal of a medical certificate.

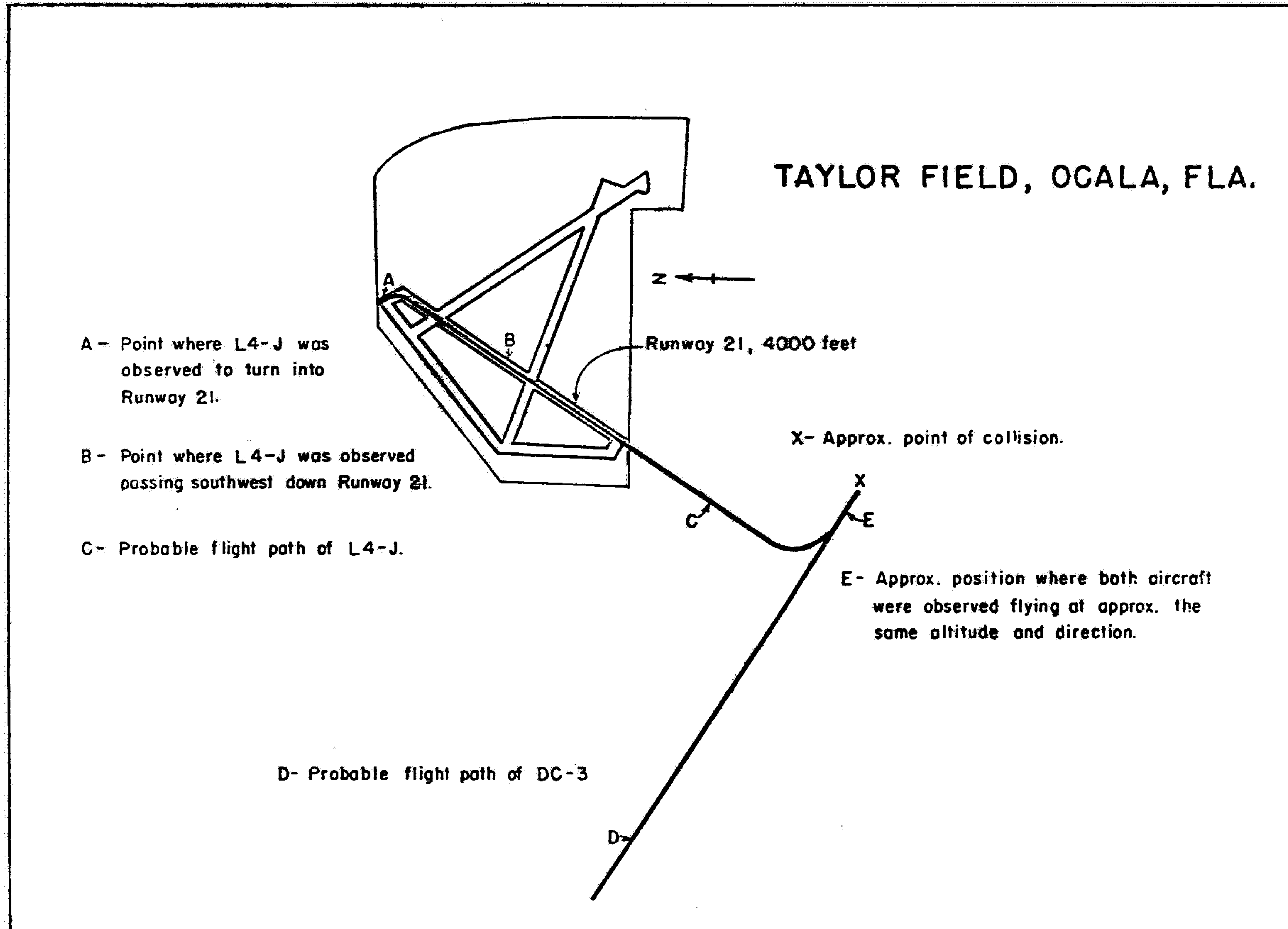
Subsequent to the accident,the Administrator revised his procedures to require that any medical certificate involving a waiver be issued only by the CAA Regional Office, thus precluding the possibility of a recurrence of a situation such as existed in this case. The Board and the Administrator are currently studying the entire problem involving the certification procedures for pilots in order to determine the need for any further changes, either regulatory or procedural.

Eastern began its scheduled operations into Taylor Field on 30 April 1950. As stated, the standard left-hand traffic pattern in effect at the time of this accident was approved by the airport manager and the CAA on 9 September 1950. Since this accident, however, there has been approved and placed in operation a Combination Pattern for safer handling of slow and fast aircraft, which pattern is described in detail in Technical Standard Order N-14 issued by the Civil Aeronautics Administration under date of 24 May 1950. This pattern, in effect, superimposes above the standard left-hand rectangular pattern a circular one operating at a minimum altitude of 1 200 feet, exclusive of take-offs and landings. While this undoubtedly will provide better separation of aircraft having wide differences in speed, it must not in any degree be considered a substitute for continuous vigilance on the part of all pilots operating in the vicinity of this or any other airport.

Probable Cause

The probable cause of this accident was the failure of the pilots of both aircraft to observe the other in time to take the necessary evasive action.

ICAO Ref: AR/241


TAYLOR FIELD, OCALA, FLA.
N
A
B
Runway 21, 4000 feet
A – Point where L4-J was observed to turn into Runway 21.
B – Point where L4-J was observed passing southwest down Runway 21.
C – Probable flight path of L4-J.
X – Approx. point of collision.
X
E
C
E – Approx. position where both aircraft were observed flying at approx. the same altitude and direction.
D – Probable flight path of DC-3
D

No. 9

Aer Lingus Téoranta, DC-3 Dakota aircraft ("Saint Kevin") crashed near Lake Gwynant, Caernarvonshire on 10 January 1952

(The meteorological situation prior to and at the time of the flight is included in considerable detail as important technical information.)

Circumstances

At 1725 hours on 10 January the DC-3 (Saint Kevin) took off from Northolt Airport en route for Dublin, carrying a crew of three and twenty passengers. The flight was without incident as far as Welshpool. The intended course from this point onwards until the coast was reached at a point near Harlech, lay over the Welsh mountains with heights rising to about 3 000 feet.

At 1855 hours the "Saint Kevin", which throughout was flying under Instrument Flight Rules, asked and received permission from Preston Air Traffic Control to ascend from 4 500 feet which was the planned height of the flight, to 6 500 feet, being the next authorized level for westbound flights on this route. No reason was given for this request.

At about 1912 hours the aircraft reported its position to be over Nevin. At some time between 1912 and 1915 hours the "Saint Kevin", having changed to the Dublin frequency requested descent clearance. Dublin acknowledged this request and granted clearance which was not acknowledged. No further radio messages were received. At about 1915 hours the aircraft crashed approximately 18 nautical miles from Nevin Beacon in a northerly direction, at a point about 4 nautical miles E S E from the summit of Snowdon. All the occupants of the aircraft lost their lives.

Investigation and Evidence

The main problems for the Court were to discover:

i) Why the "Saint Kevin" was so far from the position in which the Captain believed it to be, and (the aircraft was neither over nor abeam on her course of Nevin at 1912 hours)

ii) What caused it to strike the ground.

The General Meteorological Situation. Prior to and at the time of the flight there was a broad, deep and rapid stream of air from the middle of the Atlantic across the whole of Ireland and across England south of a line approximately from Morecambe Bay to the Humber. The direction of the stream was from WNW to ESE. There was little variation in the direction up to heights of over 30 000 feet but the speed increased from about 60 knots at 6 000 feet to about 100 knots at 30 000 feet.

The air in this stream had come from the Western Atlantic between the Azores and Bermuda. On 8 and 9 January it had moved thence north about 1 500 miles. The lower layers were cooled as they moved over the colder ocean. These layers became very stable, i.e. resistant to vertical motion, in fact at this stage the temperature at 3 000 feet, 50°F., was higher than the temperature at sea level, about 45°F.

The stream turned gradually eastwards and from longitude 30° W moved at the great speeds already mentioned parallel to a stream of much colder air to the north of it, between latitudes 55° N and 65° N. This latter stream was moving more slowly at heights below 20 000 feet, but at equal or higher speeds at greater heights. In fact above 20 000 feet the two streams had practically the same temperature and could be regarded as merged into one great west to east current.

In the lower layers, however, the streams were separated by a transition zone or frontal surface sloping upwards from south to north with a gradient of about 1 in 50. Such a zone or front is a region where bad weather with extensive masses of cloud of cumulonimbus type is frequently, though not invariably, found. In such clouds dangerous icing is a recognized hazard and in winter it may occur at comparatively low altitudes. The position of this zone in relation to the "Saint Kevin's" route is therefore of prime importance. In the early morning of 10 January the front, at sea level, ran westwards from the North of Ireland and during the forenoon it moved rather slowly northward and extended eastward. In the afternoon it began to move south and by 1800 hours had regained its early morning position in N W Ireland and ran from there just north of the Isle of Man and thence to the Humber. Subsequently it moved more rapidly southwards and reached Dublin at about 2100 hours and North Wales about an hour later or 3 hours after the time of the accident.

The bad weather associated with such a front is usually limited to a narrow band a few miles wide at the front itself and in advance of it, though in some cases the bad weather extends a substantial distance in advance of the front. A careful examination of the recorded observations of cloud and weather in advance of this front, as it moved south across the country, shows that it did not come into the latter category. The hail and snow reported by witnesses as occurring in the Welsh mountains after the accident but before the passage of the front cannot therefore be explained as due to an over-running of cold air from the north in advance of the front. The explanation must be sought in another direction and this will be indicated in the paragraphs immediately following.

Where the air-stream turned eastwards, between 300 and 600 miles south of Greenland, the freezing level on the afternoon of 9 January was at a height of 10 000 feet. It had fallen about 2 000 feet in the preceding 24 hours, through cooling by radiation as the air moved northwards. It was this section of the air-stream which reached England in the afternoon and evening of 10 January after travelling another 1 500 miles across the Atlantic Ocean and Ireland. Its temperature, at heights above 1 000 feet, was still so high that the cooling of the upper layers through radiation continued more slowly. Thus when 12 hours later, at 0300 hours on 10 January, this section of the air-stream reached a British Weather Ship ("Weather Watcher") in lat. 53°N., long. 18-1/2°W., the freezing level was still above 9 500 feet.

Gradually this air, originating from the eastern side of the original northward moving air-stream, was being followed in its track towards England by air, still from the same general stream, coming from further west. This latter air had followed a longer track over the ocean, over an area of ocean of much lower temperature. Consequently it had cooled appreciably more in the layers between 3 000 and 8 000 feet. It arrived earlier in the upper layers above 3 000 feet owing to the greater speed of the wind in these layers with the result that the freezing level at "Weather Watcher" fell after 0300 hours on 10 January at the rate of about 1 000 feet in 6 hours, although the temperature near sea-level showed no change.

For a similar reason, the freezing level was lower in the stream 150 miles north of "Weather Watcher" than at "Weather Watcher" though this was still the warm air-stream as distinct from the cold stream mentioned in a previous paragraph. It was this section of the warm air-stream which reached North Wales.

While the temperature of the upper layers fell, the temperature of the lowest strata of the air-stream increased as the air moved eastwards from south of Greenland to Ireland. It rose from 45° F to over 50° F owing to the increase in the temperature of the ocean from west to east in the track of the air-stream. In labile air this increase of temperature would have lifted the freezing level about 1 000 feet. In fact it had no direct convective influence on the freezing level in this stable air, with its high freezing level, and the effect of the increase in radiation was insignificant.

The result of these different causes affecting the height level was a reduction from the 9 500 feet recorded at "Weather Watcher" to 7 500 feet in the section of the air-stream reaching N.W. Ireland near 1 500 hours on 10 January. This was the section of the stream which reached the Daventry-Nevin section of the route of the flight about 4 hours later when the "Saint Kevin" was in it.

When the air in this rapid stream reached Ireland a new factor of change began to operate on it, viz., large scale turbulence. Over the ocean the turbulence arising from the contact of air and water acts very slowly in changing the lapse-rate of a stable air-stream towards the labile rate. It takes many days for the effect of such turbulence to spread upwards 6 000 feet. This is the approximate height at which freezing level would be reached in the air-stream of 10 January if the stream were transformed by mechanical turbulence from a stable to a fully labile state up to that height. Over level or undulating country the process is still relatively slow and the time for the transformation would still be more than a day. But the large scale turbulence in a 60-knot stream crossing coastal cliffs and mountainous country extends the change of the lapse much more rapidly upwards and the process was assisted on the afternoon of 10 January by the reduction of temperature already mentioned in the layers between 3 000 and 8 000 feet.

When the air reached the Irish Sea it had already lost some of the stability it had possessed over the Atlantic. It underwent a further change when it was over the Welsh mountains. There, as it was lifted, it cooled at the full labile rate. This affected both the freezing level and the weather.

The temperature of the air at 4 500 feet, approaching the mountains from the Irish Sea, deduced from the considerations outlines and the radio-sonde observations, was 38° F, and the freezing level between 6 500 and 7 000 feet. Making the reasonable assumption that the air at 4 500 feet was lifted 1 500 feet, about half the height of the Snowdon range, its temperature on reaching the 6 000-feet level, as it crossed the range, would have fallen to freezing point, thus lowering the freezing level by more than 500 feet.

As the air-stream rose over the mountain range, a high percentage of the moisture in it was condensed and in the violent local upcurrents, to be expected when the 60-knot air-stream met the steep western face of the range, snow would be formed above the freezing level and possibly small hail, though not the usual hail of thunderstorms. The snow, as it fell through the cloud below freezing level, picked up water and melted, producing, as it must by established theory, the rain which fell in the mountains, in contra-distinction to the drizzle which characterized the weather of the nearby sea level meteorological station at the Royal Air Force Station, Valley, in Anglesey.

The rain so formed would be carried rapidly away from its source, but the possibility of its subsequently meeting another ascending current and being carried up again above the freezing level cannot be wholly excluded in the turbulent conditions prevailing over the extensive area of the Welsh mountains on the evening of the 10 January. The ascending current would need to be stronger than 1 000 feet per minute. If the raindrops were carried up, they would become super-cooled and would produce clear ice on an aircraft meeting them. But the cloud of such drops above the freezing level would necessarily be of small horizontal extent in the direction of the air-stream and an aircraft would be quickly through it - probably in less than a minute.

The violent local upcurrents mentioned would have their counterpart in intense local downcurrents on the lee side of the mountain range, and these downcurrents would not be confined to levels below the top of the mountain range. Observations, notably over the Rock of Gibraltar as well as in many other mountains, show that such currents may be found at heights at least double those of mountains of heights comparable with those of North Wales: and that the downward speeds may reach values of 1 000-2 000 feet per minute in winds half the strength of those on 10 January.

The Flight. The "Saint Kevin" took off from Northolt at 1725 hours on the 10 January 1952. According to the "flight plan" Daventry should have been reached at 1759 but the aircraft reported to Uxbridge (London Airways) at 1756 hours by R/T with the words "checked Daventry".

At Daventry up to which point the average ground speed was 97 nautical miles per hour (hereinafter referred to as "knots") the aircraft had to turn on to a course which brought the wind about dead ahead with a consequent reduction of about 8 knots in the ground speed. At 1800 hours the "Saint Kevin" reported to Uxbridge (South Eastern Flight Information Region) giving the time of passing Daventry as 1756 hours as in the previous message and estimating the time of passing over the point at which the course line cuts the third meridian west of Greenwich (hereinafter called "3° W") as 1841 hours implying an estimated ground speed of 96 knots.

At 1836 hours the aircraft reported to Uxbridge (SEFIR) with the words "Check three degrees west", and because on passing that point it entered the Northern Flight Information Region, at 1838 hours reported to Preston (NFIR) ". . . . check three west now estimate Nevin one zero (i.e. 1910 hours) and Dublin one nine five one (i.e. 1951 hours)".

Assuming that 1838 hours, when the words "check three west now" were used, was the time at which the Captain believed that he was at 3° W he could then have seen that his ground speed from Daventry to that point must have been 103 knots, 7 knots more than his estimate at Daventry and 18 knots more than indicated in the flight plan. This value is much too high in view of the undisputed value of airspeed and wind speed.

In view of the foregoing it is impossible for anyone to say where the "Saint Kevin" actually was at 1838 hours or at what time 3° W actually was reached.

The anticipated ground speeds implied by the 1838 hours report to Preston were 101 knots between 3° W and Nevin and 106 knots between Nevin and Dublin, respectively 6 knots and 11 knots higher than the speeds in the flight plan.

About sixteen minutes before the estimated time of reaching Nevin, i.e. at about 1854 hours, the "Saint Kevin" asked Preston for permission to ascend to 6 500 feet. Permission was given almost immediately and not later than 1855-1/2 hours the aircraft reported "leaving four five now" and at an unascertained moment between 1858 hours and 1902 hours reported "Check six five". According to the estimate made at the time when the Captain thought he was at 3° W he would, at 1858 hours, have been in a position about 8 nautical miles from the coast at Harlech, or about 16 nautical miles almost due south of the place of the crash. The next signal received from the "Saint Kevin" was "check Nevin": this was received by Preston before 1912 hours and was followed by an instruction from Preston to the aircraft to change frequency to Dublin. Before leaving the Preston frequency however, and still before 1912 hours, the "Saint Kevin" asked Preston "Have you any news of any outbound aircraft from Dublin on the London Route" and was told "Affirmative Easy Charlie Item departed Dublin at one eight four eight estimating Nevin at one two minutes past the hour (i.e. at 1912 hours)". A second message from Preston at or immediately before 1912 hours added the information that Charlie Item was at 5 500 feet and immediately afterwards the "Saint Kevin" called up Charlie Item and said "You'll find it pretty rough over the hills tonight we were at four five went up to six five it seems to be right through".

Shortly after 1912 hours and before 1915 hours the "Saint Kevin" having changed to the Dublin frequency reported "We checked over Nevin a minute ago flying six five IFR. We just passed Charlie Item. Request descent clearance please". This signal was acknowledged by Dublin and the desired clearance given. It is not known whether Dublin's signal was ever received by the "Saint Kevin" from which nothing further was heard by any receiving station.

It should be noted here that according to the flight plan Nevin should have been reached at 1924 hours while the "Saint Kevin's own ETA at Nevin given in the last signal which contained any such estimate (i.e. the 1838 hours message to Preston) was 1910 hours, a difference of 14 minutes. For the aircraft to have been where it was reported to be when the signal "check three degrees west" was sent it would have had to have gained 12 minutes on the flight plan estimate. The Court being satisfied that the wind speed was not less than 55 knots was forced to the conclusion that after leaving Daventry, which was probably reached at the time reported, the "Saint Kevin" was always well behind the points which the pilots believed they had reached.

The only evidence about the last moments of the flight comes from the recollection of witnesses on the ground. None of these had any duty to remember or record anything about the auditory sensations from which alone they could derive any impression of the behaviour of the aircraft. The Court is unwilling to base any finding upon the obviously honest but equally obviously inconclusive evidence of such witnesses. This caution is the more compelling upon the Court when it is remembered that it was a wild night of high and gusty winds which no doubt created much noise themselves and would have distorted other noises.

The aircraft struck the ground in a soft peat bog about 1-1/2 miles east of Lake Gwynant in Caernarvonshire at a height of about 1 200 feet above mean sea level. Most of the wreckage was swallowed up by the bog in which the engines completely disappeared. The main part of the wreckage was at the most westerly point at which any part of the debris was found, small fragments mainly of wing skin being found up to 1-1/4 miles to the eastward. The only detail of importance in this trail was the outer portion of the starboard wing which broke off about 26 feet from the wing tip and was found about 266 yards from the main wreckage.

The posture of what was left of the port wing and fuselage suggested that the aircraft struck the ground at a steep diving angle of 80° heading about north.

There was evidence of extensive disintegration upon impact and a fire had occurred in or about the main crater. The fragments lying to the eastward of the main crater showed no signs of burning.

The condition and location of the propeller blade fragments were consistent with the engines being under considerable power at the moment of impact.

The location of the largest detached fragment of the starboard wing together with a study of the fractures of the spars, indicated that the wing had broken shortly before the aircraft struck the ground and suggested that the breaking had been caused by over-stressing beyond the designed limits for upward and backward direction.

The control valve of the de-icing equipment was recovered broken away from the bulkhead to which it was attached and was found to be jammed in the "on" position.

The Weather. The sun had set at 1611 hours and civil twilight ended at about 1700 hours, well before the "Saint Kevin" took off from Northolt. There was, however, a nearly full moon which had risen just before 1400 hours. During the flight the moon was well up in the sky and at the time of the accident its altitude was about the same as the sun's mid-day altitude at the beginning of April. There would, therefore, not be complete darkness above the clouds or in the breaks between them. In fact the Captain of another aircraft flying along the route at 6 500 feet about 50 miles behind the "Saint Kevin" described the flight along the airways, prior to reaching the Welsh mountains, as "quite a pleasant trip": and a resident of Beddgelert who was asked immediately after the accident to look out for any fire which might help to locate the aircraft saw a reflection in the sky which he thought, correctly, might be the moonlight piercing the cloud.

The only direct evidence from the "Saint Kevin" itself of the weather actually experienced in the flight is the message to another aircraft at 1912 hours that it was rough over the hills both at 4 500 and 6 500 feet. The "Saint Kevin" was in communication from time to time with the control stations at London and Preston and at no time made mention of the weather or of any difficulty arising therefrom. The evidence of the weather met by the "Saint Kevin" is therefore mainly indirect. It can, however, be stated with certainty that the wind was about 60 knots and for most of the flight was nearly a direct head wind and that there was neither much turbulence nor bad cloud conditions along the route from Northolt to Wales. Only over the Welsh mountains did the aircraft meet the substantial turbulence implied in the message mentioned.

The value of 60 knots for the wind, derived from the meteorological observations and computations is confirmed by the value calculated from the times taken on six other flights along the Daventry-Nevin section of the route. The average value obtained from the records of these six flights at levels of 4 500, 5 500 and 6 500 feet between 1500 hours and 2200 hours on 10 January is 60 $\pm$ 6 knots.

Evidence was given by the pilots of four other Aer Lingus DC-3 aircraft which flew along the same route as the "Saint Kevin" in the afternoon and evening of the 10 January. The first of these aircraft, EI-ACI, flying from Dublin to Northolt, at 5 500 feet, passed the Nevin Beacon at the same time (i.e. 1912 hours) as the pilots of the "Saint Kevin" flying at 6 500 feet reported that they were passing it. This aircraft, EI-ACI, left Dublin at 1848 hours and had very smooth conditions over the Irish Sea. It received from the "Saint Kevin" the warning about rough conditions and shortly afterwards ran into quite rough turbulence near Barmouth but "not a bit different" from what the Captain had been led to expect from his briefing at Dublin. The aircraft also passed through fairly heavy rain at times and had occasionally a "very, very small amount of very wet ice on the wind screen but none at all sticking to the aircraft". The temperature reading was + 2° C except in cloud where it fell to — 1° C. After a period estimated at 10 to 12 minutes (clearly over-estimated, as will appear) the turbulence ceased, the cloud at and below 5 500 feet broke and the First Officer saw Welshpool as the aircraft passed near it.

The second aircraft, EI-ACT, was flying from Paris to Dublin at 6 500 feet. This was the aircraft which had had "quite a pleasant trip along the airways". It passed above the aircraft EI-ACI at 1922 hours and about 10 minutes later met turbulence which gradually increased in severity and was accompanied by icing, sufficient in quantity to cause eventually a substantial decrease of airspeed. One of the pilots said he saw hail but the other pilot saw no hail and was certain that if there had been hail he would have seen it. The turbulence and bad weather experienced by this aircraft appears certainly to have been the same as that through which the aircraft EI-ACI had flown just before in the opposite direction and at a level 1 000 feet lower. This bad weather was either a patch travelling within the 60-knot air-stream or it was a purely local effect produced in the air-stream by the mountains and restricted to the mountain region. An examination of the times, taken in conjunction with the known speed of the aircraft, shows that if the bad weather had been a travelling patch, the aircraft EI-ACI must have cleared it at about 1916 hours or 4 minutes after leaving Nevin. This was certainly not the case. The conclusion is that the bad weather was, in fact, a local effect and was left behind by EI-ACI between 1919 and 1920 hours. It extended inland only about 15 miles from the Welsh coast near Harlech. The aircraft EI-ACI was in it for about 4 minutes and the aircraft EI-ACT for about 10 minutes.

The aircraft EI-ACT, after reaching the Welsh coast at a point on its planned route about 10 miles from the Nevin Beacon descended, by permission from Preston, to 4 500 feet to escape the icing and then, owing to shortage of fuel (a circumstance which had been pre-occupying the pilots), diverted to Liverpool, flying at 5 000 feet along a route which took it within 5 miles of the wrecked "Saint Kevin" 40 minutes after the accident. On this part of its flight, EI-ACT experienced no icing and less turbulence, so much less in fact that the Captain and the First Officer could, and did, interchange seats.

The aircraft EI-ACT had picked up some rime as it climbed to its flying level of 6 500 feet in France and this rime did not clear from the aircraft in the warmer air over England, for a reason which will appear later. The rime was believed to be a contributory cause of a reduction in the aircraft's airspeed from the 148 knots of the flight plan to 130 knots. But it seems clear from the times of the flight on the English section of the route that the true airspeed there was substantially in excess of 130 knots. The aircraft flew the 116 miles from Daventry to the point of diversion near Harlech in 84 minutes against a 60-knot head wind which implies an average airspeed of 143 knots.

A third aircraft EI-ACD flew from Northolt to Dublin earlier in the afternoon. It left Northolt at 1515 hours and flew at 4 500 feet all the way, passing Daventry at 1551 hours and the Nevin Beacon at 1706 hours. The weather experienced was "reasonable" until about 30 miles from Nevin when some cumulus cloud, heavy rain and moderate turbulence was met over the mountains.

A fourth aircraft EI-ACL left Dublin at 1745 hours and reached Northolt at 1905 hours. It returned to Dublin, leaving Northolt at 2017 hours and arriving at Dublin at 2255 hours. On the first flight at 5 500 feet it was smooth over the Irish Sea. There was short and sharp turbulence around Barmouth and afterwards "nothing much". There was no icing and no precipitation. Temperature was + 2° C. On the return flight at 4 500 feet there was no icing and no precipitation but it was fairly turbulent, "no worse however over the mountains than it had been over England". The turbulence, though definite, was not sufficient to lift the Captain off his feet as he went to the passenger compartment to satisfy himself that all was well there. The temperature was + 4° C.

This evidence of the weather conditions at the levels of flight, based in the main on the recollections of pilots and not on records made at the time, is substantially in accord with the deductions of the meteorological experts from their charts of observations and records of upper air conditions obtained from radio-sondes. It may be supplemented with advantage by the observations recorded at the time by official meteorological stations near the route. At the Royal Air Force Aerodrome, Valley, in Anglesey, about 20 miles directly to windward of Snowdon there was slight drizzle, slight rain and slight mist in the period from 1500 hours to 2100 hours with a cloud base 1 700 at 18 hours. At the Royal Air Force Aerodrome at Shawbury about 60 miles directly to leeward of Snowdon and about 15 miles north of the route there was slight rain followed by intermittent moderate rain in the same period with a cloud base at 2 600 feet at 1800 hours. At Elmdon near Birmingham there was intermittent moderate rain, in the same period, with a cloud base at 3 100 feet at 1800 hours. At Cranfield, between Elmdon and London, there was no rain in the period and the cloud base was at 2 200 feet at 1800 hours, while at London there was slight intermittent drizzle and slight mist in the period with a cloud base at 2 000 feet at 1800 hours. At Collinstown near Dublin there was a slight drizzle with a cloud base at 1 500 feet at 1800 hours and there had been some rain during the day. At all these places the amount of rain was small. In the 12 hours from 0900 to 2100 it was 1/5th inch at Valley and Shawbury, 1/6th inch at Collinstown, 1/12th inch at Elmdon and 1/25th inch at Cranfield and London.

The evidence of the radio-sonde ascents indicates that at 4 000 to 6 000 feet the wind was from the direction 290° to 295° and its speed 55 to 60 knots and that the freezing level on the route was 7 000 feet falling after Daventry to 6 500 feet and over the mountains to 6 000 feet.

As mentioned previously the cold front reached North Wales at about 2200 hours and an aircraft carrying officials of Aer Lingus from Dublin flew thence to Valley in comparatively clear weather and full moonlight behind the front, landing at Valley at 2345 hours.

POSSIBLE CAUSES OF THE ACCIDENT - The "Saint Kevin" struck the ground not later than 1915 hours in a position about 18 nautical miles distant and bearing about 60° from Nevin Beacon. This position is about 14 nautical miles from the nearest point on the direct course from Daventry to Nevin.

It must be stated at once that except on an "airway" there is nothing inherently wrong about being knowingly a few miles one side or the other of a planned course without reporting the fact. The significance of these known facts, however, lies in the circumstance that the deviation of the "Saint Kevin" so far to the northward of the planned course brought the aircraft into the lee of Snowdon at a time when according to his signals the pilot must have thought he was clearing the last of the Welsh land and reaching the Irish Sea.

It seems likely that the beginning of the error which led the pilot to believe that he was at Nevin at a time when the distances recorded in the immediately preceding paragraph show conclusively that he could not have been there, must be looked for in the stage of the flight between Daventry and 3° W. The ground speed assumed by the pilot for this leg as indicated by his signal to Uxbridge (SEFIR) timed 1800 hours was 96 knots whereas the flight plan estimated a ground speed of 85 knots.

It must be a matter of speculation but it may be that the pilot was led to over-estimate his ground speed for the leg Daventry 3° W because his experience on the leg Beacon Hill-Daventry had shown him a ground speed of 98 knots against a flight plan estimate of 93 knots.

There is no means of telling where the "Saint Kevin" was when the report "check three west now" was made at 1838 hours but the aircraft could not in fact have been at 3° W without having made good a ground speed of 103 knots from Daventry or 18 knots better than the ground speed estimated in the flight plan.

There is no evidence from which the Court can say whether the pilots used any or, if any, what navigational aids on that night. All that can be said is that no signal from the "Saint Kevin" gave any hint or suggestion of anxiety, difficulty or confusion in the minds of those flying the aircraft. Their messages to Preston and Dublin announcing their position with reference to Nevin were clear and unequivocal. The request for permission to ascend to 6 500 feet was not explained, though inferentially it can be said to have been due to turbulence or anticipated turbulence: it was probably made at about the time the aircraft was approaching the lee side of the Berwyn Range. What may seem hard to understand is why, at a time when the "Saint Kevin" must in fact have been getting near the lee side of Snowdon, the pilots requested permission to descend. The probable explanation is that the Captain, believing in his own erroneously arrived at estimated time of arrival at Nevin and perhaps having experienced sufficient icing to lead him to switch on his de-icing boots, desiredto come down to the first permitted quadrantal height (4 500 feet) above the safety height (3 000 feet) for the leg Nevin-Dublin as a first step in his run in to Dublin.

It is less easy to understand what led to the deviation to the northward of the track than to see what led to the Captain believing that he was further ahead than he was. In the absence of any fix after Daventry no one can say what compass course was being steered or what allowance was being made for lateral drift. It is possible that some mistake was made but there is no evidence of it. The most likely explanation is that the wind was not as far round to the northward as forecast and allowed for in the flight plan. The wind indicated in the flight plan was blowing from 300° at 60 knots whereas the actual wind was 290°/295° at 55/60 knots. Unless the pilots obtained at least one fix or correctly identified some ground lights after turning into the wind at Daventry they would have had no means of correcting by experience the wind estimated for them in the flight plan. It is also possible that the Captain may have glimpsed lights on the ground and, although a very experienced pilot on this route, misinterpreted them.

The Court is inclined to the view that the explanation of the fatality may be found under one or more of the following three heads:

a) The pilot, being in error as to his true position, began his descent from 6 500 feet to 4 500 feet and before he realized it ran into an unusually strong downward current in the lee of Snowdon. This downward current took him below the level of the crests of the mountains. In such a current an aircraft could lose 2 000 feet of height before any action for recovery of height could be effective. Once the aircraft reached a level below the crests of the mountains, it would in the conditions prevailing there at the time, be in a region of most chaotic turbulence from which in the darkness there would be the greatest difficulty in regaining control and recovering height. While the pilot was making an effort to do this, the aircraft encountered an unusually violent local gust which put the aircraft completely out of control and produced the stresses which broke off the starboard wing and plunged the aircraft into the bog.

b) The aircraft ran into a region of unusual violent turbulence which dislodged the pilot from the controls. Before he could recover control of the aircraft, it had got into an attitude from which control could not be regained before the aircraft hit the ground after losing a wing owing to the stresses set up.

c) The aircraft ran into a region of violent turbulence which dislodged moveable equipment in the cockpit which, in its turn, jammed the controls or injured the pilot and produced the same result as in b).

The Court has considered the possibility of the accident being caused by icing on the aircraft and has rejected it on the following grounds:

a) Icing takes time to build up. It could not have been deposited in sufficient amount to stall the aircraft in the interval between the warning of rough conditions to the aircraft EI-ACI and the accident.

b) If the icing had been appreciable before the warning mention of it, it would almost certainly have been included in the warning.

If the icing had been appreciable the pilot would not have waited until he was past Nevin (as he thought) before asking for permission to descend below the freezing level.

At the same time the possibility that icing was contributory to the difficulty of control in the conditions mentioned cannot be excluded.

Comments and Discussion - Frequency of High Winds - Winds at a height of 5 000 - 6 000 feet on any of the three routes between London and Dublin may exceed 50 knots in any month of the year. Winds of this speed blow mainly from a west or northwest direction. On the average in the winter months one day in four has such winds but in summer they do not occur more than once a month. Winds exceeding 60 knots occur about once in 20 days in winter and twice a year winds exceed 70 knots. The highest value measured at Liverpool at this height in the three years 1948-1950 was 84 knots from a direction 290°. It is clear therefore that gales from between west and northwest, as bad or worse than that of 10 January 1952, may be expected in the future.

Turbulence in High Winds over Mountains - It is clear from observations in manned balloons, in gliders and by pilots of aircraft, that the substantial vertical currents are produced even when an air-stream of moderate speed crosses a mountain range. Vertical currents of 800 feet per minute have been experienced on the lee side of mountains 1 500 feet high, in a transverse wind of only 20 knots. As already mentioned the investigation of vertical currents caused by the Rock of Gibraltar showed that the turbulence extended upwards to a height of more than 5 000 feet. Over a mountain range much higher than the Rock strong vertical currents may be expected up to heights of at least 3 000 or 4 000 feet above the crest of the range, especially in transverse air-streams of low stability. In such conditions the normal clearance of 1 000 feet does not give adequate protection against the hazards of turbulence. For air routes over mountainous regions, where an alternative route is not available or is excluded by other weather hazards, the specified safety level should be related to the meteorological conditions.

Height of Freezing Level - In regions covered by a satisfactory network of radio-sonde observations, the height of the freezing level can usually be specified with a higher degree of accuracy than ± 1 000 feet. The height can also be forecast with the same degree of accuracy for flights over the region, other than at times when changing conditions are being rapidly imported from regions where there is no satisfactory network. The degree of accuracy is not proportional to the height; it is, in such a region, substantially independent of the height. Consequently a percentage tolerance is not appropriate for specifying the degree of accuracy of the height of the freezing level.

Effect of Mountain Range on Height of Freezing Level - When a thermally stable air-stream crosses a mountain range transversely, the freezing level will be lowered owing to the lifting of the air and its consequent expansion and cooling. For example, if the air over Larkhill at 1500 hours on 10 January had been lifted just over 300 feet, the freezing level would have fallen from 7 500 feet to just over 6 000 feet. The change in the height of the freezing level due to this cause disappears when the air-stream again reaches lower ground unless the lifting has produced rain over the mountains, in which case the freezing level may be at a greater height after the air-stream has crossed the mountains than it was before. Although approximate estimates of the magnitude of the effect can be based on theoretical considerations, direct observations at different levels along stable air-streams crossing the mountains appear necessary to provide the data for the formulation of rules for the guidance of meteorological briefing officers.

Effect of Mechanical Turbulence on Height of Freezing Level - When an air-stream, thermally stable over the ocean, crossed land irregular enough in height to cause excessive turbulence, the height of the freezing level may be reduced. This effect, unlike that due to lifting over a mountain range, persists even when the air-stream reaches level or nearly level ground whose average level is not lower than that of the irregular land. The magnitude of the effect on lapse-rate which can be caused by mechanical turbulence arising in this way and the height to which it can appreciably extend can be obtained by direct observation at different levels along air-streams initially stable.

Temperature of the Air - A thermometer on an aeroplane is subject to heating owing to its speed through the air, and the temperature recorded is usually too high. For a thermometer under the wing or nose of an aircraft, properly shielded from radiation, the correction necessary to allow for this effect is approximately 2° C for an airspeed of 140 knots and 4° C for an airspeed of 200 knots. At the freezing level the recorded temperature would be + 2° C or + 4° C at these two speeds. The result might well be to give a pilot an unjustified sense of security against icing if, as appeared from the evidence in this case, no provision was made for ensuring that pilots knew the correction required to the actual readings to give the true temperature of the air. In view of the importance of icing as regards both performance and safety, it seems essential that pilots should know the correct temperature of the air through which they are flying especially when this is in the neighbourhood of the freezing point.

Melting of Rime or Ice on an Aircraft - The melting of rime or ice on an aircraft in flight depends upon the "wet-bulb" temperature. The effective "wet-bulb" temperature is that which would be recorded by a "wet-bulb" thermometer without correction for the speed of the aircraft and situated in the position where the rime exists. In dry air the "wet-bulb" temperature may be several degrees lower than the air temperature and if it is below freezing point, rime or ice will not melt, even if the air temperature is well above freezing point. In such a case the rime or ice would evaporate but this is a slow process. The non-clearance of the rime, collected over France by the aircraft EI-ACT, during the time the aircraft was flying over England in air at a temperature above freezing point appears to have been due to the fact that the "wet-bulb" temperature was below freezing point.

It is pertinent to add that snow or hail falling through air at a temperature above freezing point would not begin to melt unless the corrected "wet-bulb" temperature was also above freezing point.

Radio-Sonde Observations - The network of radio-sonde stations in the British Isles appears to be adequate to enable the meteorological briefing officers to meet the requirements of civil aviation in this respect except on those occasions when changes are occurring with unusual rapidity. On such occasions it is open for consideration whether intermediate observations could be made at key stations selected according to the actual meteorological situation and, in particular, an observation on such an occasion at 0900 hours or 2100 hours at Valentia when the meteorological situation indicated Valentia to be key station.

Consultation with Meteorological Briefing Officer - It emerged in the course of the Inquiry that there was, on occasions, insufficient time between the arrival at, and departure from, an airport for pilots to visit the meteorological officer and receive personal briefing on the meteorological situation. It appears desirable to make such amendment of schedules or instructions as may be necessary to avoid the recurrence of such occasions.

Notification of Meteorological Changes - It also emerged in the Inquiry that a change in the meteorological conditions affecting an air route might arise which (a) was not within the knowledge of, or foreseeable by, the meteorological briefing officer before the departure of an aircraft flying along the route; (b) did not constitute a recognized hazard but might nevertheless lead the pilot unwittingly into a situation of difficulty or into a region where a recognized hazard existed or was developing. Such a change would not, under existing arrangements, be communicated to the aircraft. It appears desirable to ensure that an actual or imminent change on any section of a route which the appropriate meteorological officer recognizes as an appreciable change in the conditions affecting the safety of aircraft should be notified on his authority to the aircraft, unless he is aware that the change has been specified in the forecast provided for the pilot before departure. This last proviso applies only when the appropriate meteorological officer is at a station other than the departure airport. A meteorological officer at the airport would be aware of the forecast provided.

It is no part of the duty of this Court to make specific recommendations as to the administrative measures (involving both the Air Ministry and the Ministry of Civil Aviation) necessary to be taken to give effect to what is here suggested.

Sufficiency of the Crew - It has already been made clear that no one will ever know what if any, use of the navigational aids at their disposal was made by the pilots of the "Saint Kevin" on their last flight. Apparently they were satisfied that they knew where they were although in fact they were somewhere else. It is therefore difficult to relate to the experience of this Inquiry a strongly-urged suggestion that aircraft of this type on this route carry an additional member of the crew in the person of a Radio Officer who would ensure that use could be made of the Gee radio navigational device at times when the two pilots were constrained to remain in their seats. There is no evidence that the Captain of the "Saint Kevin" took any step to obtain a Gee fix, or that he wished to do so but could not because neither he nor his First Officer could leave his seat to go to the apparatus. The Court is not disposed to make any recommendation expressed in terms of the use or non-use of this device. Other suggestions directed to the more accurate ascertainment of position follow later in this Report.

The Sufficiency of Navigational Aids - It is, of course, obvious that there must be limits to the provision of costly devices such as radio ranges, fan markers and radio beacons. Not every route can be turned into an "airway". Risk of confusion as well as lack of money and free frequencies would preclude such a solution to the problems of navigators. At the same time it must be realized that the air traffic between England and Eire is important and growing and that the shortest route between London and Dublin passes over a difficult mountainous terrain and close to Snowdon. In the view of the Court, consideration should be given to the practicability of giving pilots a better lead over the part of the route which lies between 3° W and Nevin Beacon. Although use can be made of some or all of the aids available, there is between Daventry and Nevin no specifically located navigational aid. It is perhaps a fair inference from the few facts established in this Inquiry that, in practice, pilots tend to be content to do without recourse to aids which "take up time on the air" especially when such aids may be suspected of giving no greater accuracy on a short route or stage of a route than does dead-reckoning. It is for consideration whether on this route a specifically located aid in the form perhaps of an intermediate radio beacon ought to be provided.

Detection of Icing in Darkness - It emerged in the course of the Inquiry that on DC-3 aircraft no light is fitted by which the parts of the airframe liable to receive a build-up of icing can be seen from the cockpit. Pilots must either use a hand or resort to switching the landing lights on and off and observing the amount of the build-up on the glass of the lights in the dying glow. Neither of these methods can be regarded as satisfactory. In certain DC-3 aircraft adapted for service on commercial air lines a special light is fitted so as to illumine the leading edges of the wings and this might well be made a standard practice for all aircraft.

The Importance of "de-briefing" - The meteorological service provided for the benefit of aviators is like any other intelligence service dependent upon the reading of data obtained from a large variety of sources. One of the most valuable sources is the experience of persons having just come in from a flight on the same route. This giving of information by pilots to the meteorological officers is known as "de-briefing" and it is the opinion of the Court that pilots should be encouraged to attend at the "Met Office" for "de-briefing" within some specified period (say 30 minutes) of landing from any flight under instrument flight rules or where any unexpected weather phenomenon has been experienced.

Recommendations - The safety height for stages of an air route which cross mountain ranges should be related to meteorological as well as to orographical data. This means that on occasions when the meteorological forecast indicates that strong winds will be encountered at the approaches to and over the range, the safety height (which is usually 1 000 feet above the contours) should be increased and so shown on the flight plan. The following clearances are provisionally suggested for flights under IFR pending the results of the investigation proposed in the next paragraph Wind speed at height of crest

	Clearance
26-35 knots	2 000 feet
36-45 "	2 500 "
46-55 "	3 000 "
56-65 "	4 000 "

It is recognized that such clearances might, on some occasions, force an aircraft above the freezing level and that with slow-climbing aircraft the duration of a flight on a short route might be unduly prolonged. Such matters would have to be brought into calculation before any mandatory regulations could be made.

Investigations should be made of the vertical currents in air-streams of high velocity and differing degrees of stability crossing mountain ranges so that the resulting data may be applied to the establishment of safety heights on regular air routes crossing such ranges.

An investigation should be made of the reduction in the height of the freezing level in a stable air-stream crossing a mountain range and meteorological officers should indicate the allowance, based on the investigation, in their forecasts and briefing.

An investigation should be made of the effect of turbulence over the land in changing a thermally stable air-stream towards a labile state in order to determine the resulting change in the height of the freezing level when this lies within the layer affected.

Consideration should be given to the desirability of making more frequent radio-sonde observations at one or more of the stations in key positions when the meteorological situation is changing exceptionally rapidly.

Consideration should be given to the desirability of discontinuing the use of a percentage tolerance in the forecast height of the freezing level. It is probable that the layout of the conventional form for route forecasts is in itself an invitation to forecasters to be less explicit than they might be about the limits between which the freezing level is expected to lie. In the opinion of the Court those limits should be explicitly stated.

Air crews should be provided with the corrections necessary to obtain the true air temperature from the reading of the thermometer on the aircraft. They should also receive instruction as to the significance of "wet-bulb" temperature in relation to freezing and melting.

Consideration should be given to improving the system of collaboration between the Air Ministry (Meteorological Office), the Ministry of Civil Aviation (Air Traffic Control) and Operators of Civil Aircraft whereby it can be ensured that substantial actual or imminent changes in the meteorological conditions along an air route are notified by controllers to aircraft on the route.

The framers of schedules and those responsible for rostering pilots as well as the pilots themselves should always keep in mind the importance of allowing sufficient time at airport to permit direct personal briefing of pilots by meteorological officers. The location of the meteorological office may be an influence in encouraging or discouraging pilots to or from making a personal visit to the forecaster, and a too rapid "turn-round" may be a real discouragement. The value of direct personal briefing in marginal weather conditions is too great to be sacrificed to the other concerns which may engage the attention of pilots during quick "turn-rounds".

Consideration should be given to devising a discipline which will minimize the risk of moveable objects, e.g. computers, Verey pistol, articles of clothing and crews' effects getting adrift in the cockpit in turbulent conditions. Articles of this kind, unless properly stowed, may easily slip down into the mechanism of the control system and lead to the jamming of controls. It may be that the provision of better stowage facilities ought to precede the formulation of disciplinary rules.

Careful thought should be given to the question as to whether or not pilots are actually encouraged to rely too much upon dead-reckoning through the absence of sufficiently strict instructions from their employers on the subject of entries in the aircraft navigational log. The Court leans to the view that it might lead to better all-around navigation if it were made mandatory upon Captains to record in the log a definite "fix" of position every so many (depending upon the length and/or nature of the route) minutes of flight with an annotation showing the method used to obtain such "fix". It is further for consideration whether such "fixes" ought to be reported by R/T to the appropriate FIR when a fix shows that the aircraft is materially off-course: such consideration will, of course, have due regard to the importance of securing a prudent economy in the use of busy communication channels.

Consideration should be given to the question of providing a specifically located aid to navigation between Daventry and Nevin.

Study should be given to the problem of designing a means whereby the build-up of icing can be watched during darkness. It is for consideration whether the provision of such means ought to be made compulsory and its continuous use in icing conditions be prescribed in the disciplinary code of operators.

No. 10

Northeast Airlines, Inc., Convair CV-240 aircraft, crashed in Flushing Bay, New York (near La Guardia Field) on 14 January 1952. CAB Accident Investigation Report, File No. 1-0013, Released 18 November 1952

Circumstances

The flight originated at Boston, Mass. at 0745 for La Guardia Field, New York, nonstop, carrying thirty-three passengers and three crew. The flight proceeded uneventfully and at 0858 it reported leaving New Rochelle and was cleared for an approach to Runway 22. The flight reported leaving La Guardia range at 1900 and was cleared to land on Runway 22. There was no further communication with the aircraft and at 0903 it struck the water of Flushing Bay, some 3 600 feet from the approach end of Runway 22. A motorboat, docked about one and a half miles away, reached the site approximately four minutes later and all occupants were rescued. Five passengers were seriously injured and the three crew members were slightly hurt.

Investigation and Evidence

Investigation disclosed that the Captain, a company Convair captain and check pilot, occupied the right-hand seat during this flight. His piloting experience was extensive with a total of nearly 14 000 hours, of which nearly 2 400 had been on Convairs. He testified that he had made an estimated five or six instrument approaches to La Guardia each month during the preceding ten years.

The First Officer was making the approach. His flying experience was also extensive with a total piloting time of about 5 100 hours. At the time of this accident he was completing his sixth week flying as a Convair trainee-captain under the supervision of the Captain. This was in accordance with the company's policy of requiring a minimum of one month of such flying before co-pilots are eligible for upgrading. Because there was no captain vacancy immediately available, the First Officer had continued in training at his own request. He had a total of 83 hours as a Convair trainee-captain, of which 66 hours had been during the past 30 days. According to the check pilot, he had satisfactorily completed his line-flight training for Convairs. The company operation manual requires a minimum of 10 hours' specialized training. This is completed after the required 30 days' line training. In this instance, the final check had not been given by the Test Officer but was to be given him before the company formally rated him as a Convair captain. However, he had successfully completed the company's ground training programme as set forth in the company's operational manual.

The standard range approach calls for passing over the range station, in line with and located 3.2 miles from Runway 22, at an altitude of 800 feet. With landing-gear lowered and with wing flaps extended 21-1/2 degrees, the rate of descent would be about 600 feet per minute with the air-speed at 140 miles per hour. The intervening distance from range to runway is over water. The crew testified that the range was crossed at 800 feet altitude, whereupon the landing-gear was lowered and the flaps were extended 21-1/2 degrees. The authorized minimums for a straight-in approach to Runway 22 at La Guardia for the subject aircraft are 500-foot ceiling and one mile visibility. The last report given the flight concerning La Guardia weather for the 0900 sequence was, estimated at 1700 broken, one and one-half miles ..."

The Captain testified that he first had visual contact with the lights on the approach end of the runway at an altitude of 500 feet, and so advised the First Officer, who was making the approach on instruments. The First Officer testified that he glanced up, saw no lights, indicated to the captain that he had no visual contact, and continued descent by instrument. The Captain said that he then checked the flight instruments, ascertained that readings were as they should be, including an air-speed of 140 miles per hour, and then looked again at the runway lights. This was at an altitude of 420 feet. Again he checked the readings of flight instruments and found them satisfactory, including an air-speed of 140 miles per hour. At 300 feet he once more checked the runway lights and noted that they appeared to rise rapidly and suddenly vanish. Almost simultaneously the aircraft was in the water.

The First Officer stated that at no time during the approach did he have ground reference of any kind. He noted the altimeter indicator "going through" 300 feet and stated that almost immediately the aircraft struck. Neither pilot remembers any instrument reading below 300 feet. Both pilots testified, and the consensus of passengers' testimony concurs, that deceleration after the aircraft had contacted the water was uniform and although strong, was not violent.

Both altimeters were found set at 30.00 the setting last given the flight. One altimeter had been damaged to such an extent that it could not be functionally tested; the other was tested and proved to be within normal tolerances.

During the descent and approach to La Guardia an observation was taken that showed the first definite deterioration of weather and was as follows: ceiling measured 1 700, broken, with an overcast at 2 800, visibility 1-1/2, very light rain and smoke, wind ENE 4. This was given to the flight at 0900. Following this the visibility at La Guardia dropped to one-half mile at 0909 (six minutes after the accident), and the ceiling was reported to be 600 feet at 0910 because a low broken stratus layer moved over the field. However, at Idlewild, the alternate, the ceiling did not drop below 2 700 feet, nor visibility below one mile, up to and including 0923.

A very low layer of stratus coupled with poor surface visibility lay north of La Guardia at the time of the approach of Flight 801 and possibly before that time. However, weather reporting stations were unaware of this condition, and its presence had not been reported by any pilot. Surface and low altitude wind at La Guardia had been light southeasterly but shifted to ENE at 0900 and to N by 0910, causing this low stratus to drift across the airport. It is possible that a continuous watch by a weather observer might have revealed the moving in of the low clouds a little sooner than was reported, but probably not in time to have given it to the flight. This condition of surface weather at the time and place of the crash is well substantiated by passengers, both pilots, and rescue personnel. Their testimony indicates that there was a horizontal surface visibility of one-half mile or less with no wind, resulting in an unusually smooth (glassy) water surface. Pilot reports from flights operating at La Guardia shortly after the accident, confirm rapid fluctuation of weather conditions. One flight approaching the same runway went to its minimum altitude of 500 feet and executed a missed approach because of a local and heavy rain shower. On the second approach this flight became contact at 500 feet and landed at about 0849, 14 minutes before the accident.

Flight 801 was given advisory reports by GCA during its approach. Because the direction of this approach is opposite that of the ILS approach, there is no glide slope provided. The GCA advisories for the subject approach do not include deviation from the desired altitudes, but merely deviations of azimuth at fixed distances from the runway. Such advisories are customarily not acknowledged by the incoming flight. During this approach they were received by the flight and appropriate corrections in azimuth were made. Indication of the aircraft vanished from the GCA scope at a point about one-half mile northeast of the end of Runway 22.

The operating procedures of this carrier are set forth in its Operating Manual. The Manual is explicit as to minimum altitudes during approaches. The minimum altitude for a standard range approach, as was being made, at La Guardia for Convairs of this carrier is 500 feet. There is, however, an additional 50 feet allowed as an operating tolerance to take care of certain intangible factors. When the flight went below an altitude of 450 feet on instruments, it was in violation of the company's procedures and consequently of the CAA-approved operating specifications. It was clearly the responsibility of the pilot-in-command of the flight, not to allow his co-pilot to go below 450 feet unless the aircraft was being flown visually.

As the Captain stated that he had the runway in sight from 500 feet on down, it was therefore his duty to take over the flying of the aircraft when the First Officer indicated, at an altitude of 500 feet, that he did not have visual contact, or to instruct him to start a missed approach. To allow the co-pilot to continue a descent on instruments was clearly contrary to the carrier's CAA-approved operating procedures, because the meaning of a minimum altitude is that all flight below that level shall be made exclusively by visual means.

The nature of the damage to the aircraft, as well as the Captain's testimony that the aircraft's nose may have been raised slightly just before impact, strongly suggests that the approach was being made visually by the First Officer and that he inadvertently caused, or allowed the air-speed to drop markedly below the specified 140 mph approach speed, and too near the stall speed with its attendant extremely high sinking rate. This could well account for the similar testimony of both pilots in that neither remembers any instrument readings, including altimeter, during the last 300 feet of descent. The surface of the water was glassy, limiting its use as a medium of depth perception.

An important psychological factor enters into making an approach under the subject conditions; it concerns the erroneous impression of altitude and is described in "The Sensory Illusions of Pilots," by P.P. Cocquyt, Chief Pilot of Sabena, the Belgian airline*. He writes, " .... The illusion of flying horizontally with respect to a landmark when flying more nose up than imagined is dangerous because the pilot believes himself to be higher than he really is. The angle at which a pilot observes a point of light on the horizon depends on his altitude and his distance from the point. Evaluation of that angle is not a matter of mathematics but is one of feeling (purely subjective). This illusion may have serious consequences. In fact, if the pilot without realizing it changes the angle of his airplane with respect to its initial position by as little as one degree, this error translates into differences in altitude of:

17.5 metres for a landmark 1 kilometre away
35.0 metres for a landmark 2 kilometres away
87.5 metres for a landmark 5 kilometres away
175.0 metres for a landmark 10 kilometres away

The illusion cited above must certainly be a cause of many aircraft accidents occurring just before the airplane reaches the airfield, especially when no adequate landmark can be found in the approaches (for example: an aerodrome located on the edge of the ocean) .....".

In the above passage the author refers to a night approach toward a lighted airport, and particularly when this approach is over water. This particular accident happened under quite similar conditions, despite its being daylight. The runway lights were on and the last 3.2 miles of approach were over water. Inasmuch as the surface visibility at the airport was being reported as only 1-1/2 miles and was much less at the crash site, the flight had no adequate ground reference, merely lights on the approach end of the runway. Riker's Island was to the right and ahead of the aircraft at its point of contact with the water and only approximately one-fourth mile away. The Captain, on the right side, stated that he saw the near end of this island, but at best he could have seen it but vaguely and fleetingly; otherwise he could have used it as a visual altitude reference.

The lights on the approach end of the runway, as reportedly seen by the Captain, can well be considered as a single visual reference point because of their apparently close spacing from an aircraft an appreciable distance away. Thus, we have a set of conditions closely simulating those of the above-quoted passage. The Captain stated that he could not dismiss the possibility of having had an erroneous illusion of altitude and distance due to weather.

Strong, but not violent, deceleration as described by aircraft occupants seems to be convincing evidence that contact with the water was at a speed far less than the recommended approach speed of about 140 miles per hour. In fact, it seems unlikely that a modern transport with landing-gear extended and carrying 33 passengers could be ditched at 140 miles per hour during a no-wind condition without widespread serious injuries to its occupants.

If we pursue further the hypothesis that the First Officer was attempting to make the approach visually, it appears probable that he allowed the aircraft's speed to fall constantly as he eased the control wheel backward. This hypothesis is further strengthened by the nature of the aircraft's damage. The central and rear portions of the underside of the fuselage were completely collapsed, whereas the forward portion of the underside of the fuselage showed comparatively little damage. This indicates that the aircraft went into the water in approximately the same attitude as does a flying boat under a practically full stall, tail first touchdown.

Inasmuch as there was no malfunctioning of any kind, it appears that this accident was the result of the series of events as described in the above hypothesis. The prescribed let-down procedures during a standard range approach are rigid. They include control of air-speed by appropriate power settings and degree of flap extension. If the air-speed had been maintained, the aircraft could have descended to the level of the runway only on the runway and near its approach end, assuming no change in power settings, as appears to have been the case. It must, therefore, be concluded that an air-speed of about 140 miles per hour was not maintained but was allowed to decrease to such an extent that the aircraft settled rapidly to the surface.

Probable Cause

The probable cause of this accident was the failure of the captain-in-command to monitor the co-pilot's approach and take corrective action when the aircraft first went appreciably below a normal approach path.

* See reproduction of this report on page 165.

ICAO Ref: AR/239

No. 11

Air France SO.161 Languedoc crashed shortly after taking off from Nice-Le-Var, on 3 March 1952

Circumstances

The aircraft, a SO.161 Languedoc, took off at 0810 hours on a scheduled Nice to Le Bourget flight, with thirty-four passengers and four crew.

Shortly after take-off the aircraft was seen to turn to the left. The bank to the left increased progressively and shortly after, the aircraft turned on its back and crashed. The four crew and thirty-three passengers were killed, the remaining passenger died later from injuries sustained.

Investigation and Evidence

On arrival at the south-west end of the runway (QFU 05), the crew proceeded to run up the engines and to go through the check list. The time spent on these operations seemed normal and nothing unusual was noted by the aerodrome and airline personnel.

At 0810 hours the aircraft started along the runway and took off normally after a ground run of approximately 750 metres.

The take-off was visual and in fine weather.

Immediately after take-off, the landing gear was retracted. At that instant the aircraft was at an altitude which the witnesses estimated to be one or two metres, and began to change direction slightly towards the left. It cleared the end of the runway centre line.

Four hundred metres further, the aircraft entered into a left turn. The control tower operator immediately notified the crew by R/T that the circling procedure at take-off from QFU 05 should be made to the right, but received no reply.

Twenty seconds after the take-off, the aircraft was at an altitude of some fifty metres, flying at 90° with respect to its initial heading.

According to some of the witnesses, the turn seemed to decrease in sharpness for a few seconds and the aircraft appeared to be pulling out, but at that moment, it was flying towards a series of obstructions which it could not avoid, and was seen to turn further to the left. The bank on the left wing increased progressively. The aircraft turned on its back, the nose making a large downward angle with the horizontal, and crashed.

On the basis of investigations and examinations at the scene of the wreckage, it was established with reasonable certainty that:

1) the aircraft landed on its back, the first contact having occurred between the left wing and an olive tree;

2) the four engines were operating normally;

3) at the instant of the crash, the engines were supplying little or no power to the propellers;

4) the elevator and rudder control tabs were in neutral.

Attention was then given to the movable surfaces controlling the roll of the aircraft. These were examined thoroughly before the wreckage was moved.

Nothing unusual was found as regards the camberflaps and ailerons that had escaped destruction in the fire.

Their transmission systems had, on the whole, suffered considerably from the impact and the fire and it was not possible, at the site, to make more than a rough estimate of the relative position of their components, at the moment of impact, and when they came to rest. Moreover, unusual failures in the chains of the cockpit control column required a thorough investigation. It was therefore decided to have the relevant pieces put through further tests.

Investigations regarding the ailerons and their controls as a possible cause of the accident involved a study of the maintenance log of the aircraft, a detailed examination of the bell cranks of the control system and of the cockpit controls, studies and research work on a full scale model built with SO.161 type parts, test flights of the SO.161 with ailerons blocked and a study of the failures of the chains of the aircraft.

On 2, 3, 5 and 6 October 1951, the different pilots-in-command who flew the aircraft, reported that the aileron controls and the automatic pilot were stiff. Chains were slackened. On 21 October, a pilot mentioned that there was play in the aileron control column. The chains of the pilot's and co-pilot's controls were tightened again.

There were no further comments regarding the aileron controls until 29 November. On departure from Nice, the pilot-in-command noticed during ground run that the aileron controls could not be pushed to the end of the clearance to the left. By applying more pressure he succeeded in overcoming a stiffness at two-thirds of the control wheel clearance, which seemed to decrease when the controls operated rapidly. During the check-listing, after the engines had been run up, a new trial confirmed the presence of an irregularity, as the stiffness persisted and seemed to have increased. The aircraft was therefore taxied back to the terminal and placed in the workshop where it remained until 9 December. During the inspection of the aileron controls a 1.5 mm pin was found crushed in the grease at the lower bell-crank of the co-pilot's stick.

Further examination of the aileron controls after the accident revealed that at the pilot's seat, the control-wheel was broken. It was blocked in the right turn position and corresponded to an aileron angle of 5°;

The joint connecting the pilot's column-arm to the column was deformed;

Some links of the rear chain, near the connecting-rod were broken.

Inside the column, there were marks left by link checks on the upper chain-case.

At the co-pilot's seat:

The control wheel was broken and turned 180° to the right*.

The gear-teeth on each of the control wheel sprocket crowns were twisted;

The column-arm was not seriously deformed on the outside but showed chain marks on the inside. The rear chain had five links broken, while the front chain was broken in two places.

Central sprocket axle; pushed in at the back; front bearing burst open.

In the upper portion inside the column:

Six marks left by links of the rear chain on the upper casing (left side);

Five marks by links of the front chain on the front portion of the casing;

The head of the locking pin was torn off (marks on steel lining);

The locking pin was bent;

Links Nos. 5, 10, 11 and 12 on upper rear chain were destroyed;

One outer cheek of a link had been detached from the chain for some time (operating marks on the sides. Borings clogged up by the grease);

A 3 mm bolt with a 45° bend was found jutting into the inside of the column.

* The normal clearance is 110° on either side of neutral.

In the lower portion inside the column:

On the chain-guide tube: friction marks over 360° and deep imprints of links from two chains (facing the two front pinions and over 90°);

On the lower rear chain (connected to the cable), one link was broken and two were indented.

On the rear chain: signs of prolonged friction on the cheeks of links engaging the lower sprocket indicate that the chain had slipped off and had been operating in abnormal conditions for a long time.

In order to make a systematic analysis of all the causes of aileron control system blocking, a series of tests were conducted at Le Bourget on all the cockpit controls of a full-size model and of other SO.161 Languedoc aircraft in the process of being overhauled.

The test schedule involved five series of tests:

First series: disconnection of the central system at those joints for which the bell-crank axles had not been retrieved.

Second series: disconnection of a chain in one of the cockpit columns.

Third series: blocking of chains inside the columns by the introduction of a foreign body.

Fourth series: accidental blocking by the device which locks the ailerons when the aircraft is on the ground.

Fifth series: slipping off of a chain from the lower bell-crank sprocket inside the cockpit column.

Results.- First series: four bell-crank axles of the aileron transmission system, situated in front of the inner wing, had not been found in the wreckage at the site of the accident, and therefore when the tests were carried out, one axle was removed at a time and a separate test was performed in each case.

The results were as follows:

Main bell-crank No. 6200 under the fuselage, rod No. 6323: the cockpit control-wheels were disconnected from the ailerons which were still interconnected but could move freely.

Left bell crank: the left ailerons could move freely; the right ailerons remained under control.

Right bell crank: the right ailerons could move freely; the left ailerons remained under control.

Left bell crank No. 6300, rod No. 6326: the left aileron could move freely; the right aileron could be operated between the neutral and the lowered position (left turn); during the movement from the neutral to the aileron raised position, rod No. 6326 could, in certain unlikely circumstances, jam against a heating tube or against the bearing of No. 6300 bell crank, but a simple oscillating motion would probably have caused it to slip off.

Moreover, the resistance offered by these obstructions could have been overcome by the exertion of manual efforts on the control-wheels, which would have made the aircraft bank slightly to the right.

Second series: in this test, the controls were solidly blocked by an arching of the chain between the bell crank sprocket and the chain guide, at the lower end of the column.

Third series: since a previous incident had shown that a foreign body could become lodged between the sprockets and the chains, a series of investigations to determine the possibility of a blocking of the controls through such an incident were undertaken.

In the case of foreign bodies such as fragments of pins of less than 2 mm in diameter, the results might vary from one test to another, and in some instances might only amount to a sticking which would add to the tension in the chains but which the pilot could control. This was shown to be true in the previous incident.

Normally, particles of 2 mm in diameter produce rather serious jammings of the chains. The presence of a 3 mm bolt might even cause a deformation of the lower chain guide or the failure of a link cheek.

Fourth series: accidental blocking by the older type device used for the locking of ailerons when the aircraft is on the ground.

This device consisted of a notched ring fixed to the shaft of the upper sprockets of the column. The notch was moving in front of a locking pin which could be pushed into the notch when it was desired to lock the controls. This was done by means of a milled edge knob which could be turned to lower the locking pin into the notch.

However, to insure against inappropriate locking, this device was replaced by exterior locks and the milled edge knob was kept in a fitted portion by a clip.

Since the locking pin in the co-pilot's column was found to be free to move by the action of the knob, the Inquiry considered the possibility of a loosening of the knob as a result of vibration, and of a subsequent slipping of the locking pin into the notch and the ensuing blocking of the ailerons.

To check this theory, the following tests were carried out:

a) The pin was engaged in the notch of the ring by 2 mm. Result: the controls were blocked in both directions; when a small effort was exerted on the control-wheel, the stiffness was overcome and the controls could be operated;

b) The pin engaged in the notch by 5 mm. Result: the controls were blocked in both directions; when a very strong effort was exerted on the control-wheel, a slight slipping to the right or to the left was noted, depending on the direction of the effort, but the controls could not be disengaged.

Fifth series: slipping off of a chain from the lower bell crank sprocket inside the cockpit column.

Since the marks on one of the chains of the aircraft showed that it had operated for some time after having slipped off its sprocket, a test under similar conditions appeared to be necessary. It showed that when a chain was placed between its sprocket and the adjacent chain the control-wheels could be operated without the irregularity being noticed. One of the two chains could have been strongly distended and could have obstructed its own movement by arching itself out.

On 26 March 1952, a test flight was made at Le Bourget on a similar aircraft, in order to determine the bank periods and the straightening effect of the rudder pedals, for different aileron settings.

The take-off weight and the load distribution were the same and the weather conditions were also similar. The wind at take-off was very similar to that at Nice as regards force and direction with reference to the runway.

As a result of this test it was shown that with the ailerons set at 10 degrees, the aircraft cannot be maintained in a straight line and control of the aircraft can only be maintained if the action of the rudder pedals is immediate.

The following assumption was considered as a conclusion regarding the chain failures.

All the failures noted on the various components of the two cockpit stations, with the exception of links 10, 11, 12 and 13 of the rear chain at the co-pilot's station, resulted directly from the crash.

The latter failures did not occur at the same time as the simultaneous destruction of the upper chains and sprockets at the two cockpit stations, since the associated stresses would have left local marks on the sprocket or on the casing.

If the failures concerned had been the result of a stress applied between the time of take-off and the time the airframe came to rest after the crash, they would have taken the form of a tensional failure of one of the links that were not engaged on the teeth of the sprockets. This stress would naturally have been presumed to act along the chain, and could not have produced the scattered effect which it did: compound tensional failure of one cheek (link No. 10), another cheek bent into a Z shape (link No. 11), one link open (13).

These failures therefore occurred before the two rear upper chains were disrupted. If it were possible to attribute them to one of the shocks of the crash, their position at the time of the occurrence could have been determined.

Therefore, the only role which these failures could have played in the accident is that of the cause itself.

The most probable cause of the failures seems to be the uncrimping of one of the cheeks of link No. 11, which was found in the grease at the top of the co-pilot's column. An arching out and jamming of the chain against the boss of the blocking device was possible in the area corresponding to aileron positions between 5° and 10° to the left.

The relevant boss shows impact marks which are identified as imprints of chain cheeks, while the upper cylindrical surface near the boss and on its left portion shows link marks from a chain that had slipped off. The marks are probably the result of the efforts of the crew to straighten the aircraft. The damages to various parts, required to overcome this jamming and to bring the two control-wheels into the identical right turn positions in which they were found and which gave rise to this study, were destroyed probably when the nose of the aircraft was smashed.

Probable Cause

It was decided that the unusual path of the aircraft immediately following the take-off, was due to the blocking of the ailerons to the left at an angle of approximately 10°.

It was determined on the basis of analysis that the probable cause of the blocking was the unclamping of a link cheek of the upper rear chain of the co-pilot's control column, as a result of which the chain slipped off the sprocket and jammed against the internal boss of the pin which locks the ailerons in the neutral position.

More broadly, the investigation brought to light the difficulty of setting and inspecting the chains inside the dual control columns.

This difficulty is directly attributable to the design, and may cause certain chains which have not been properly studied in relation to the type of service for which they are intended, to become unclamped by torsion during maintenance and setting work.

ICAO Ref: AR/254

No. 12

Maritime Central Airways, Douglas DC-3, Missing between Saint John, New Brunswick and Goose, Labrador, 22 March 1952, Dept. of Transport, Air Services Branch, Civil Aviation Division. Serial No: 52-11

Circumstances

At 1348 hours AST on 22 March 1952, the pilot-in-command took off on a non-scheduled flight from Saint John, N.B. to Goose, Labrador with a crew of one, three passengers and a mixed cargo of freight. The flight was conducted under Instrument Flight Rules.

At 1434 AST the aircraft gave its position by Chatham, estimating Seven Islands at 1544 hours AST. This was the last communication received from the aircraft.

From 1417 hours to 1445 hours AST the aircraft was seen and identified on the radar screen at Chatham, N.B. During this period the aircraft was observed (by radar) to be flying at 7 000 feet. At 1445 hours AST the trace faded and the aircraft was not seen again.

Investigation and Evidence

From records available, the aircraft appeared to have been serviceable although written confirmation that the aircraft had been certified as airworthy was not obtainable inasmuch as the log book containing this certification was stated to have been on board the aircraft as require by the Air Regulations. The aircraft had sufficient fuel on board for the flight and was properly loaded in accordance with the Loading Schedule and Weight and Balance Report.

Before midday on 22 March 1952, the pilot-in-command was briefed on the meteorological conditions to be expected during the flight. A weak depression was forecast to move south-eastwards from a position 100 miles east of Seven Islands to lie off the end of Anticosti Island for the period of the flight. A weak cold front running from south to southwest from the centre of the depression was expected to lie in southern New Brunswick at the time of take-off of the aircraft. The freezing level was forecast at about 1 000 feet and it was pointed out to the pilot that moderate rime icing might be encountered up to 1 000 feet. The portion of the route where the poorest weather was expected was in the Gaspé-Seven Islands area* where layered cloud and light rime icing in the Gaspé-Seven Islands area was only partially borne out by subsequent upper air observations.

It is not considered that these weather conditions would have presented any unusual difficulty for this operation.

The flight appeared to have proceeded normally from Saint John to Chatham when the pilot-in-command reported his position as by Chatham, and no distress calls were received from the aircraft. There is no indication that conditions for radio reception were satisfactory as the aircraft was called by Seven Islands radio numerous times between 1554 hours and 1640 hours AST (without reply) and these calls were heard by another aircraft in the area.

Probable Cause

As no trace of the aircraft or its occupants has been found to date, the cause of its disappearance has not been determined.

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*Secretariat Comment

On 27 August 1953, the wreckage of this aircraft was spotted 40 miles from Gaspé, Quebe by the pilot of a plane operated by Trans-Gaspesian Airline. A search party sent to the scene reported finding skeletons near the wreckage. The investigation has been re-opened and a subsequent report will be issued.

ICAO Ref: AR/233

No. 13

KLM, Royal Dutch Airlines, Constellation L749 Damaged on landing at Don Muang Airport, Bangkok on 23 March 1952

Circumstances

The aircraft, on a scheduled flight from Amsterdam, took off from Karachi for Bangkok at 2111 hours on 22 March 1953, with a crew of ten and thirty-four passengers. The flight was routine until approximately fifty-four kilometres from Don Muang Airport, near Bangkok, when the pilot noticed an abnormally clear, though not alarming, vibration of the control wheel and the dashboard. Increase of revolutions of the engines reduced the vibration to an insignificant point. Flying at approximately 500 metres on the approach to the airport, a turn to the left to base leg was started with a view to landing on Runway 21-03.

Suddenly a loud noise was heard and the aircraft vibrated heavily. This was caused by the failure of one of the propeller blades of No. 3 engine. Immediately after the engine broke free from the aircraft and fire broke out in the engine nacelle. The aircraft landed normally on Runway 21-03 but before the aircraft had come to a stop the right main landing-gear collapsed and the fire spread. All passengers and crew left the aircraft safely but the aircraft was destroyed by fire.

Investigation and Evidence

An investigation was made into the causes of the failure of the propeller-blade. The first cause of the fracture was due to a large number of tiny cracks, caused by hydrogen contained in the weld. These cracks led either by stress-raising effects or by stress-patterns caused by the hydrogen which the weld contained, to a combination of fissure-like fractures, which formed the starting point of the fatigue-failure.

About one hour before the failure of the propeller, the pilots noticed an abnormal, although not alarming, vibration of the control-wheel and the dashboard, the cause of which could not be established. The engine revolutions at the time were 2 050 per minute. The pilot-in-command considered the vibrations to be due to ice-accretion on the propellers and therefore changed the altitude from 5300 metres to 4200 metres. However, the vibration did not disappear altogether by this change in altitude so that they could not be attributed to ice-accretion.

The vibration was not considered to be due to engine-trouble, because the engine instruments did not show any vibration, the settings of the B. M. E. P. did not point to a decrease of power on any engine and an examination of the magnetos revealed that they were functioning normally. The vibrations were decreased to an important extent, however, by increasing the number of revolutions to 2 150 per minute.

The manufacturer of the propellers suggested that the vibration might have been caused by engine-roughness, which might have resulted in too high a stress of the blade in connection with the quality of the weld.

The Inquiry, on the evidence of the crew with respect to the operation of the engines and the disappearance of the vibration with the change of revolutions, did not deem this supposition to be acceptable. An investigation of No. 3 engine did not reveal any malfunctioning of the engine, however, there is no certainty in this respect, since the engine was damaged to an important extent and some parts were not recovered. Moreover, during a flight with an aircraft of a similar type, when two cylinders of No. 3 engine were not operating, vibration phenomena of a different nature occurred.

The Inquiry considered that as the propeller succumbed to a fatigue failure, the vibration may have been caused by the crack in the propeller-blade, which may have extended over an important part of the circumstance of the fracture, a considerable time before the moment of failure.

A crack will decrease the rigidity of the blade against bending. However, it is doubtful, whether this local decrease in rigidity, especially at the lightly stressed trailing edge of the blade-shank during bending, may have caused such a decrease of the frequency of the bending vibration that as a consequence resonance would have set in at the number of revolutions during which the vibration was noticed.

During the investigation it was not possible to investigate to what degree a crack in the blade-shank influenced its frequency. Such an investigation might have been made by means of an experimental determination of the frequency of a non-rotating blade clamped at the shank, for the undamaged condition of the blade as well as for conditions in which the blade-shank had been affected by cuts of different lengths.

Due to the possibility of recurrence of blade-failures, the Inquiry considered it advisable, in spite of the guarantee offered by a system of regular inspections introduced after the accident by the operator, to recommend that it should be ascertained whether abnormal vibrations, such as occurred in this case, should be considered as a warning that a fatigue-failure had developed in the blade. The Inquiry therefore recommended that an investigation should be made into the influence of failure development on the frequency of the propeller-blade.

Probable Cause

The probable cause was the failure of the propeller-blade during flight shortly before landing at Don Muang Airport. This caused the loss of No. 3 engine and fire to break out in the engine nacelle which could not be extinguished. When landing, the right main landing-gears collapsed as a consequence of the fire.

ICAO Ref: AR/271

No. 14

Société Aérienne de Transports Tropicaux, Lockheed 60 crashed during take-off by night, at Gao, Niger, on 24 March 1952

Circumstances

The aircraft took off from Gao at night at 0307 hours on 24 March 1952 with eighteen passengers and three crew. The take-off was normal and the aircraft rose to an altitude of about 10 metres. The navigation lights were then seen to fade gradually and to disappear in a depression beyond the runway, and shortly afterwards, flashes from a fire were seen and the alarm given. The aircraft collided with the ground after take-off completely destroying the aircraft. Fourteen passengers and three crew were killed and two passengers injured.

Investigation and Evidence

The flight, non-scheduled, was a Nice-Abidjan round trip and departed from Nice on 21 March 1952. It stopped at Algiers, El Golia and Tamanrasset where the night was spent. On the following day the aircraft arrived at Abidjan via Gao and Ouagadougou. The following morning the aircraft left Abidjan on its return flight, a night stop being scheduled at Tamanrasset. However, the flight was behind schedule and in view of the fact that Tamanrasset was not provided with night markings, the pilot decided to spend the night at Gao and leave the following morning at about 0900 hours. He mentioned also that he was tired. Later that evening word was received from the company which caused the pilot to change his plans and decide to leave at 0300.

On arrival at the meteorological office for preparation of the pre-flight plan, the pilot, during a conversation with the air traffic controller, complained that he was very tired and mentioned that the Gao-Nice flight would have to be made with only short stops on the way and that he had to fly in an aircraft not equipped with an automatic pilot and in which he was also required to perform the duties of navigator. He seemed to dread the take-off at night very much and went so far as to ask the controller to prohibit him from taking off. The controller could not comply with such a request, as the flight planned was normal from the regulation point of view.

The weather at the time of the accident was, clear sky, very black night with slightly misty horizon (visibility 8-10 kms.), the air was calm and surface temperature 22°.

After taxying to the end of the runway, the engines were run up for about seven or eight minutes and, after receiving clearance, the aircraft took off after a run of about 900 metres. The landing lights were not used on take-off.

In the direction of take-off the aerodrome is about ten metres above the surrounding plain. At the end of the runway there is a sharp drop and the take-off path is therefore completely clear of any obstructions. The plain, stretching to the horizon, is absolutely flat except for minor rolls which never exceed a height of one metre.

According to the surviving passengers, who were seated at the rear of the aircraft, after a flight of about fifteen or twenty seconds a series of shocks, mild at first becoming progressively more violent, gave the impression that the aircraft was running over uneven ground.

The wreckage of the aircraft was located approximately 2 km. beyond the cliff, very nearly on the extended centre line of the runway. The first contact with the ground occurred at 1 500 metres from the end of the runway and approximately on its centre line, the first contacts being made with the propellers followed by the underside of the fuselage at a flat angle and at high speed.

It was established that engine or airframe failure did not occur and that the pilot was in full control of the aircraft and not anticipating contact with the ground.

During the course of a flight on the aircraft of the Aéro-Africaine, the pilot-in-command is required to fulfill several duties.

As pilot, he performs the usual technical duties at stop-overs (flight plan, etc.) and durin the flight, he remains constantly at the controls of a naturally unstable aircraft which is not equipped with an automatic pilot.

As navigator, he controls the course of the aircraft over routes where ground services are scarce and where it is important not to depart from the initially determined route (Sahara).

As representative of the airline, he must see to the accommodation of the passengers during stops at isolated aerodromes where the possibilities are limited.

Moreover, the crew have to withstand the effects of repeated climatic changes of flights in rough atmosphere during the hours of maximum heat in tropical regions, and to cope with high temperatures which make rest at stop-overs inadequate.

To sum up, it may be assumed that a Nice-French Equatorial and Africa return trip, without protracted stop-overs, and at the rate of two flights of three hours each, per day, does not exceed the capabilities of a normal crew. However, when changes of schedule or difficulties causing the individual flights to be lengthened arise, the effort required is considerable, and the ensuing fatigue can have a detrimental effect on the efficiency of the crew.

A recapitulation of the trip made by the pilot was as follows:

March 21: Nice-Algiers-El Golea-Tamanrasset, amounting to eight hours of flying with two intervening stops.

March 22: Tamanrasset-Gao-Ougadougou-Abidjan, i.e., eight hours of flying with two stops.

March 23: Abidjan-Bobo Dioulasso-Bamako-Gao, i.e., eight hours and thirty minutes of flying with two stops.

Proposed for 24 March: Rise at 1 a.m., take-off at night from Gao and two hours of night flying to Tamanrasset. Stops at Tamanrasset, El Golea, Algiers and Nice, amounting to about twelve hours of flying.

It can therefore be appreciated that the pilot was tired on arrival at Gao, and after a relatively short rest, he hesitated to leave in view of the heavy schedule outlined for the following day.

According to the practice within the airline, the pilot could have delayed his departure from Gao and reached Nice two days later, in spite of the message received from Algiers, but for personal reasons this alternative was waived by him.

Probable Cause

The probable cause was an untimely contact with the ground after a take-off at night without any visible references beyond the runway lights. The contact was due to an unsuspected loss of altitude.

The reasons for this poor altitude control are not well-known; they may be attributed to the pilot's state of fatigue or to an occurrence, perhaps of minor significance in the cockpit which distracted the pilot's attention.

ICAO Ref: AR/253

No. 15

Braniff Airways, Inc., Douglas DC-4 aircraft, N-65143 made emergency landing due to fire in flight on 26 March 1952 near Hugoton, Kansas, CAB Accident Report No. 1-0025. Released 29 September 1952.

Circumstances

The flight departed Denver, Colorado, at 1535 on 26 March 1952 for Dallas, Texas with intermediate stops scheduled at Colorado Springs, Colorado, and Oklahoma City, Oklahoma. At 1657, the flight cancelled its IFR flight plan and advised that it was proceeding VFR (Visual Flight Rules) direct to Oklahoma City via Liberal, Kansas. When in the vicinity of Hugoton, Kansas, at approximately 6 000 feet above mean sea level (3 000 feet above the ground), one of the hostesses advised the crew that the right wing was on fire. This was the first indication the crew had that anything was wrong, as the fire-warning signal devices had not functioned and all engines appeared to be operating in a normal manner. From reflection on the inboard surface of No. 4 engine nacelle the fire was believed to be in No. 3 engine. The brilliance of the reflection indicated a fire of considerable proportion. The Captain decided to land immediately at a small airport near Hugoton which has turf runways, the largest of which is 2 000 feet. Of the 45 passengers and four crew members, one passenger received a minor injury. The aircraft was substantially damaged by fire.

Investigation and Evidence

After deciding to make the emergency landing, the Captain then disengaged the autopilot, closed the throttle of the No. 3 engine, put the mixture control at idle cut off, closed the fuel selector valve, and set the propeller control at the full high pitch position. Following this, he dived the aircraft in an attempt to extinguish the fire and to lose altitude. At this time the co-pilot asked the Captain if he wanted the No. 3 engine's propeller feathered, and the Captain said, "No".

When an airspeed of approximately 230 miles per hour was reached, power was reduced on the remaining three engines. During the dive the aircraft was heading in a southeasterly direction, and after a short time the dive was decreased and a steep left turn was made to a westerly heading. When the airspeed decreased to approximately 200 miles per hour, the Captain pulled the No. 3 fire extinguisher selector valve control handle (this also operates the fire wall shutoff valves, and then pulled the discharge handle of the left CO_2 bottle. When this bottle was discharged, the reflection on the No. 4 engine nacelle was observed to diminish appreciably. The Captain said that at this time he thought he asked the co-pilot to discharge the right CO_2 bottle; however, this bottle was not discharged. The landing-gear was lowered, and power was resumed on the three remaining engines. About this time the fire warning light in the cockpit came on, and the bell rang. These warning signals continued to operate intermittently. As soon as the gear was down, the descent was steepened and a series of steep slipping "S" turns were made toward the north while approaching the airport.

At the altitude of approximately 200 to 300 feet above the ground, a pronounced buffeting (similar to that which accompanies a near stalling attitude) was experienced. This buffeting was so pronounced it was difficult to control the aircraft; however, it soon stopped and normal control was again resumed. When the buffeting occurred, the indicated airspeed was approximately 150 mph. It is believed that the No. 3 engine fell from the aircraft at this time. The Captain next called for full flaps. Although the co-pilot immediately executed this command, no apparent effect of the flaps being lowered was noticed by the crew, and a few seconds later, the aircraft touched down in the middle of the airport. The Captain applied brake pressure immediately, but the aircraft did not decelerate. Approaching the north boundary of the field, the Captain tried to turn left to avoid crossing a road which was adjacent to the airport, but the nose steering wheel was inoperative. Left rudder was immediately applied; however, the aircraft responded so quickly to this action that right rudder had to be applied at once to keep the aircraft from ground looping. After the aircraft was again rolling straight, the Captain pulled back on the wheel, causing the nose wheel to lift from the ground, and the aircraft rolled beyond the airport boundary across a highway, through two fences and a ditch, and came to rest in a wheat field. All of the occupants were evacuated in an orderly manner, some through the forward compartment and main cabin doors by using descent ropes and a few by means of an emergency exit located on the left side of the aircraft.

No. 3 engine was recovered and a reconstruction was made, using all parts which were recovered and identifiable, in an effort to determine the fire pattern. A study of this assembly revealed no evidence of fire in Zone 1. There was considerable evidence of fire in Zone 2, with the intense fire area being confined to the lower right rear portion of this zone. Evidence of fire was noticeable to a lesser degree in the lower left rear portion of this zone and also forward and immediately below the rear accessory case. The vacuum pump housing was broken above the inlet boss, and the lower portion of the housing, including the steel sleeve, rotor and vanes, was missing. The section of the vacuum pump housing which includes the fusible plug was attached to the engine rear case pad; the fusible alloy in the plug was missing. The inlet line to the vacuum pump was torn and frayed near one end. Examination of the remaining three engines showed that the vacuum pump inlet line was installed so that it passed extremely close to the air exit opening of the generator housing. The vacuum pump oil separator, which is located on the upper right forward side of the fire wall, was missing, and all vacuum pump lines were badly burned. The generator, normally mounted on the rear of the engine directly above the vacuum pump, was missing. The generator housing was recovered, and its lower right side showed considerable evidence of fire. Several turns of the blast tube former wire were wrapped around the housing. The terminal block and brush assembly were missing. The armature, minus its pencil drive shaft, was recovered. The front and rear inner ball bearing races of the armature were attached to the shaft, and these had been subjected to intense heat. The front and rear outer bearing races were missing. Marks on the armature throughout 180 degrees of its circumference indicated that it had whipped and rubbed against the pole shoes.

The motor section of the starter was missing; the gear section remained attached to the engine. The external right side of the starter case, which is mounted immediately above the generator, had been subjected to heat.

All of Zone 3 was badly burned. The rear portion of the oil tank was missing. The electrical junction box located on the rear side of the fire wall was destroyed. Although there was considerable evidence of fire throughout this entire area, the landing-gear tires were not badly damaged during flight. This was evidenced by tire markings on the ground made during the landing roll.

The No. 3 engine was subsequently dismantled and examined. The drive shafts of the vacuum, fuel, and hydraulic pumps were discolored by heat. The rear portion of the generator drive shaft was scored, and it showed evidence of having rotated unevenly before the generator broke from its mount; the staking pin was loose. Although the engine was severely damaged by impact with the ground, no evidence was found to indicate that it failed in flight. No reason was found for the failure of the fire warning system.

A study of past in-flight engine fires has shown that the majority of fires originating in Zone 3 have not progressed forward into Zone 2. In this instance it is possible that the flexible bus, which extends from the junction box on the rear of the fire wall in Zone 3, through the fire wall along the inside of the leading edge of the wing, could have short-circuited at or near the junction box and created a fire. This would have occurred if the insulated copper cable of the bus had chafed against the inside wall of its aluminum conduit, which is grounded to the aircraft frame. However, the cable did not reveal any evidence of electrical arcing despite the fact that the conduit and cable insulation were destroyed. It was considered more likely that the fire originated in Zone 2. This could have occurred in several ways. If the flexible oil pressure gauge line rubbed against the positive terminal of the generator and wore a hole through the cable to the metal braid, arcing would have resulted which would eventually ignite the escaping oil. A nacelle fire from such a cause had occurred only a few weeks prior to this accident on this same aircraft. However, the company was alerted to such a possibility, and had taken the necessary corrective action.

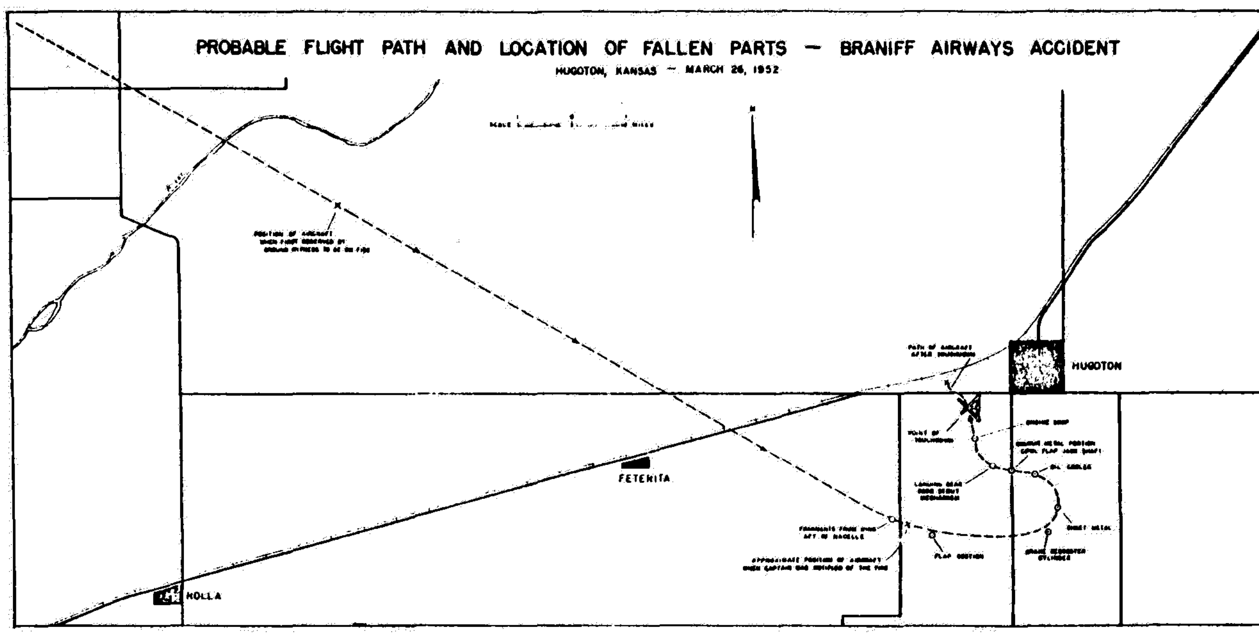
Another possibility was that the generator failed mechanically, causing intense frictional heat to be transferred to the vacuum pump inlet line which was installed in close proximity to the generator. The temperature of the air which flows through this line would then be increased to such an extent by the action of the pump that it would melt the fusible plug which is designed as a safety factor to melt at a temperature lower than that of combustion. Oil vapor would then be released into the nacelle, and this vapor could be ignited by sparks from the failing generator Since the alloy of the fusible plug did melt, this possibility cannot be discounted. This could also have occurred if there had been a restriction in the pressure discharge line of the vacuum pump.

The Captain stated that when the emergency occurred he did not know whether the right wing or the No. 3 engine was on fire and that his prime consideration was the saving of life by landing as quickly as possible. While the emergency procedures set forth in the company's Operational Manual* were not followed in their entirety, in this instance it does not appear that the failure to do so resulted in any way in making the situation worse. In fact, had the oil line to the feathering mechanism been weakened or burned through by the fire, an attempt to feather the No. 3 propeller would have sprayed hot oil throughout Zone 2 of the nacelle, greatly intensifying the fire.

The Captain also said that the emergency air brakes were not used during the landing roll because, in his judgment, the application of these brakes would have forced the nose wheel immediately to the ground and with the high speed of the aircraft at that time serious damage might have resulted by the gear striking an obstruction. Since the aircraft did roll across a highway and through two fences and a ditch before stopping, it appears that the Captain exercised good judgment in not using these brakes.

Probable Cause

The Board determines that the probable cause of this accident was an uncontrollable engine fire of unknown origin which necessitated an immediate landing.



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* The company's Operations Manual, under "Emergency Procedures", specifies the following: "WING FIRE. If a wing fire exists, shut off fuel, tank selector, cross-feed valves and booster pumps and LAND AS QUICKLY AS POSSIBLE." Under "Engine Fires", the manual lists the following procedure to be followed: "Gear up; flaps, as required; throttle, closed; propeller control, lowest RPM; mixture, idle cut-off; feather, check button for snap out; increase power, as required; fire wall shut-off, pull; fuel selector and cross-feed, off; vacuum, check; booster pump, off; generator, off; cowl flaps and mixtures, as required; ignition, off; fire extinguished, as needed." The pilot's check list does not include any emergency procedures.

No. 16

U.S. Airlines, Inc. C-46F aircraft, N-1911M, crashed at Jamaica, N.Y. on 5 April 1952. CAB Accident Investigation Report. No. 1-0021. Released 25 September 1952

Circumstances

The flight was being operated as the second section of a regularly scheduled cargo flight. The aircraft departed Fort Lauderdale at 0055 on 5 April 1952. The destination was Teterboro, New Jersey, with stops at Charleston, South Carolina and Raleigh-Durham, North Carolina. The trip until arriving at Raleigh-Durham was normal. At Raleigh-Durham the pilots were briefed on current and forecast weather conditions and the original destination, Teterboro, was changed to Idlewild because of worsening weather at Teterboro. No difficulty was expected en route to New York, but the ceiling and visibilities there and at Philadelphia, the alternate, were forecast as 800 feet and five miles, with heavy rain upon arrival.

The weather on arrival at Idlewild given to the aircraft was "measured 500 broken, 1800' overcast, visibility 1-1/2 miles in heavy rain, altimeter 29-82". Flight was cleared for a straight-in approach and also cleared to "pass over Runway 4 and make turn into Runway 13 left". The aircraft reported "contact" over the outer marker of the Idlewild range station and the controller then advised the flight to "bear left and make a right turn into Runway 13L, that's the big runway on the north side of the airport (Captain was relatively unfamiliar with Idlewild Airport), and call base leg coming up on the Federal Building". This was acknowledged by the flight which presumably intended to comply because the message was not questioned. Two minutes later the local controller saw the aircraft below the overcast, at an estimated altitude of 500 feet, between the Tower and Runway 4, and again advised the flight to turn left for an approach to Runway 13L. However, almost immediately the flight disappeared from view and the local controller asked if the left turn had been started. The flight then replied by stating that it was pulling up for a missed approach. The tower gave immediate instruction to turn right and proceed to Long Beach Intersection (the SE leg of the Idlewild Range and the SW leg of the Hempstead Range, about 10 miles SE of Idlewild) at 1 500 feet altitude. This transmission was acknowledged. This was the last communication from the flight. A very short time later the aircraft crashed at the intersection of 169th Street and 89th Avenue, Jamaica, New York, about 4.4 miles north of the Idlewild control tower. The only occupants, two pilots, were killed, as were three persons on the ground. Five other persons were injured, four buildings were destroyed, several automobiles were damaged, and the aircraft was destroyed by impact and subsequent fire.

Investigation and Evidence

The altitude of the aircraft during its final approach was determined by observation of its path in the precision approach radar (PAR or precision scope), which indicates altitude deviation in azimuth and distance.

The aircraft was observed to level out at an altitude of about 500 feet when approximately 1/3 mile in from the outer marker, which was maintained until it had passed beyond the limit of the scope approximately one-third the way up Runway 4 from the approach end.

According to the testimony of witnesses the aircraft passed across the airport heading in a northerly direction. The landing-gear was down and engine noise normal. Witnesses along the final 2 miles of the flight path testified that both ceiling and visibility were close to zero, and rain was falling at the time and place of the accident. When the aircraft was first seen below the overcast by witnesses at the scene of the accident it was in a steep right bank and descending rapidly, engine noise diminished, came on with an unusually loud roar momentarily, again diminished, and came on again with a similar extremely loud roar, whereupon impact occurred.

At the time of the accident the gross weight and the centre of gravity of the aircraft were within the certified limits. Weather was established as being substantially as reported and that turbulence existed, variously described as from "light" to "severe", from the surface up to 1 000 feet level.

During the investigation the left engine was completely dismantled and its various components examined thoroughly. The diaphragms of both the fuel feed valve and engine-driven fuel pump were found to be ruptured. The fuel feed valve diaphragm was not only ruptured but was stiffened as from age or from unusual exposure. No other significant irregularity was found.

Subsequent ground tests made with a like model engine on an aircraft of the same carrier, and with the fuel feed valve diaphragm purposely damaged in simulation of the one in the crashed aircraft, demonstrated that:

(a) the engine would operate normally at low power (corresponding to the amount of power ordinarily used during an approach);

(b) the engine would backfire violently, and stop completely if its throttle were advanced to the position of cruise power or more.

The left engine had only been in use for six hours and forty-five minutes since its last overhaul. Investigation further disclosed that the engine had been overhauled at a certificated engine overhaul station. The diaphragm in question is an integral part of the engine and not of any accessory, and was supposedly installed at the time of the engine overhaul. Replacement of this diaphragm is mandatory during engine overhauls, which for this particular carrier are required at part of 905 hours or less of operation. Testimony of the mechanic employee who worked on that portion of the engine at the time of overhaul was to the effect that he could not remember replacing a new diaphragm on the subject engine, but that he had never failed to install new diaphragms on all engines upon which he had worked.

The diaphragm is some two inches in diameter and of fabric, coated with synthetic rubber. It is fastened to the engine intermediate rear case by a metal cover secured by six filuster head screws. This cover was permanently deformed (depressed) at all six screw holes as if the screws had been tightened excessively. The cover itself bore no signs of heat. Cover deformation of this nature could have contributed to, or possibly precipitated, failure of the diaphragm. Analysis of the behaviour of the aircraft, established that, as the aircraft was pulling up for a missed approach, the left engine acted erratically with violent surging as the fuel feed valve diaphragm failed. This type of surging has an extremely adverse effect upon the aircraft's controllability. Control of the aircraft was then lost because of this surging and also because of the turbulent air. Altitude was lost rapidly in what was probably an extreme right sideslip, taking on some of the aspects of a right spin, and the aircraft crashed.

The inquiry found that no operational error was involved in this accident. The Captain likewise could not be criticized for not following the tower's advice but was noted that it would have been better practice for the flight to inform the tower if it did not intend to follow such advice.

Failure of the fuel feed valve diaphragm might possibly cause pressure surges at the fuel pump outlet resulting in failure of the fuel pump diaphragm. It is more likely, however, that this failure was the result of a pressure surge which occurred in the fuel line at impact. The condition of the fuel feed valve diaphragm, as found, could not have resulted from heat of the ground fire following impact because its location insulates it quite well from heat.

There is conflict in the testimony as to the responsibility for the installation of the defective diaphragm and its deformed retaining cover in this overhauled engine.

The investigation revealed no evidence that the engine as received from the overhaul station had been tampered with in the shops of the airline.

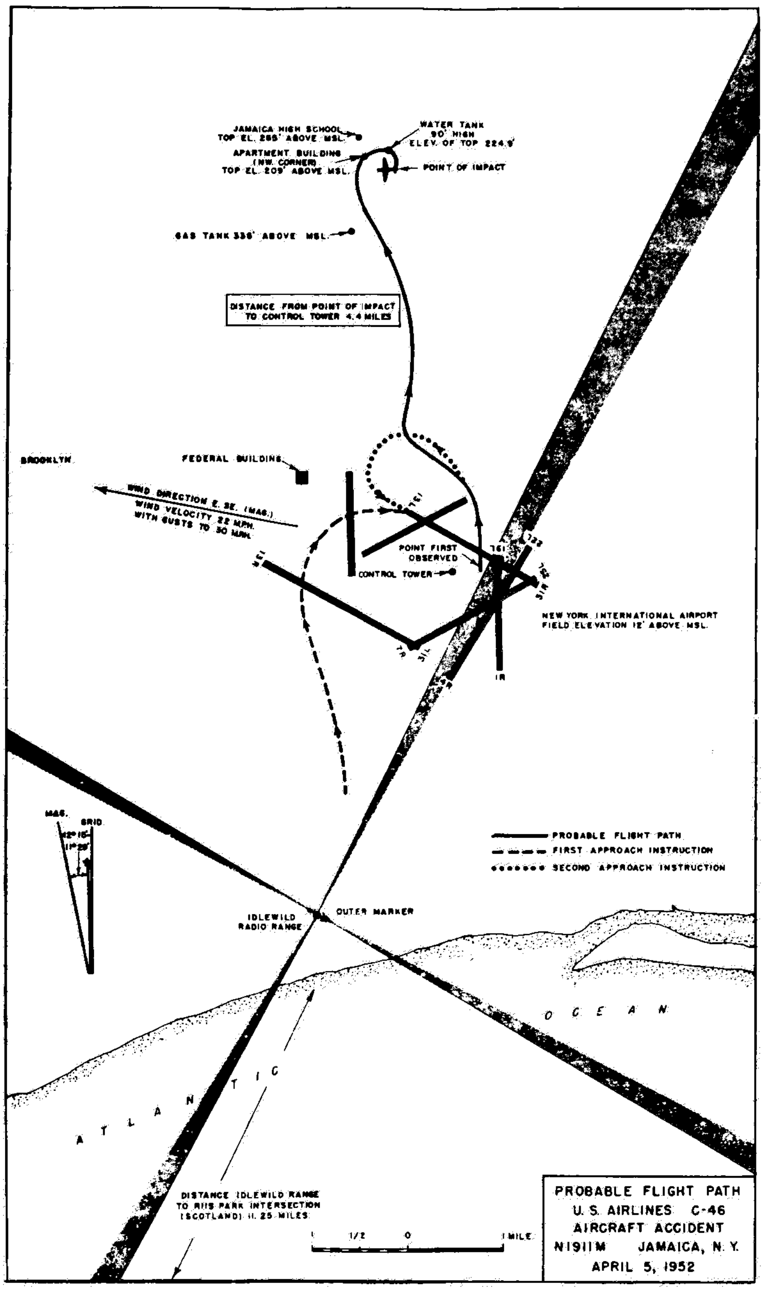
The Bureau of Standards' tests indicate, on the contrary, that the first possibility - that the diaphragm was not replaced at the time of overhaul - is the probable explanation for the presence of the defective diaphragm in the left engine at the time of the crash. The Bureau of Standards' tests indicated that an immersion of a similar new diaphragm in aviation fuel for 1,000 hours and then in the type of decreasing agent solution, used by the overhaul station, would deteriorate a new diaphragm to a condition substantially the same as that of the failed diaphragm in question.

As the time for overhauls of the subject engine was 905 hours, it must be concluded that the diaphragm in question had been in use, i.e., exposed to fuel for this period of time, had not been removed, was immersed in a cleaning agent, and put back in the overhauled engine.

Although officials of the overhaul station testified that such omission could not possibly happen because of their shop methods, the Board finds that the diaphragm in question was not replaced at the time of engine overhaul, and that its deteriorated condition as found, was due to its having been subjected to previous service and to the action of the cleaning agent. It is quite obvious that had a new diaphragm been installed, its condition could not have been reduced to the state of the one involved during six odd hours of engine use.

Probable Cause

The probable cause of this accident was loss of control following sudden engine failure, caused by a deteriorated fuel feed valve diaphragm, during an attempted missed approach.



PROBABLE FLIGHT PATH
U. S. AIRLINES C-46
AIRCRAFT ACCIDENT
N1911M JAMAICA, N. Y.
APRIL 5, 1952

ICAO Ref: AR/224

No. 17

Pan American World Airways, Inc., Douglas DC-4, N-88899 was ditched on 11 April 1952 northwest of San Juan, Puerto Rico. CAB Accident Investigation Report, No. 1-0026. Released 26 September 1952

Circumstances

The flight originated at San Juan and departed there at 1211 on 11 April 1952 for New York, N.Y. During the climb after take-off the First Officer noticed that the oil pressure of No. 3 engine was falling and the oil temperature increasing. The Captain advised the San Juan tower that they were returning to the airport. At 1217, the tower asked the flight to report its position and received the reply "We are still quite a way out". At 1218, the tower advised the U.S. Coast Guard Rescue Coordination Centre at San Juan that the flight was in trouble and gave its position as 7 miles, 300 degrees from the tower. The flight continued to lose altitude, and the throttles of engines Nos. 1 and 2 were advanced to their stops. With the airspeed near 120 mph, the flaps were lowered to five degrees. Shortly after this, a landing on the water was made. The aircraft sank approximately three minutes after landing on the water. At the time of the accident the weather was: high broken clouds at 35 000 feet with lower scattered clouds at 3 000 feet, visibility 20 miles and wind from east-southeast, 16 mph. Heavy seas were running with waves 10 to 15 feet high. On board were 5 crew members and 64 passengers, including 6 infants. Fifty-two passengers lost their lives as a result of this ditching, and the aircraft sank in water approximately 2 000 feet deep and could not be recovered.

Investigation and Evidence

The Captain stated that when the "pre-take-off" check was accomplished all engines operated normally but that during the take-off the aircraft was a little slow in accelerating. However, the engine instruments indicated that they were delivering normal power with all pressure, temperature, and fuel flow gauges indicating a normal operation. According to the Captain's testimony, from the time No. 3 propeller was feathered until landing on the water, he was either attempting to establish a climb or was flying the aircraft in a nose-high attitude in an effort to maintain altitude, and airspeed and altitude were diminishing throughout the entire period.

Three twenty-man rafts and one ten-man raft were carried on board the aircraft as a part of the life-saving gear. These were stowed in an open rack to the rear of the pilot's compartment. In addition, a pneumatic life jacket was available for each passenger and these were located in a pocket at the back of each seat with a sign, in both Spanish and English, describing the location of the jackets. Only a minor trim correction for yaw was required from the time the propeller was feathered on No. 3 engine until the aircraft was ditched. This was true, despite the fact that during certain portions of the flight, take-off and maximum power were used on engines Nos. 1 and 2. During these power settings, No. 4 engine was set at 32-35 inches of mercury, as on any increase of power the engine backfired and ran rough. From this it can be seen that the No. 4 engine was producing considerable power; otherwise, there would have been a decided yawing moment when power was increased on engines 1 and 2. It was also established by flight tests that the DC-4 aircraft loaded in a like manner will maintain level flight, and climb slowly, with only two engines operating at a maximum continuous power and with the propellers of the remaining two engines feathered. Therefore, the aircraft, under the conditions described, should have at least maintained altitude.

Throughout the flight and the subsequent ditching, the Captain stated he followed the prescribed procedures outlined in the company's Operation and Flight Manuals. He said that, after feathering the No. 3 propeller, he established an airspeed of 145 miles per hour throughout the climb but after experiencing difficulty with No. 4 engine he then established an airspeed of 135 miles per hour in an effort to climb at the maximum rate. Although the company's Flight Manual states that these airspeeds are correct for 3-engine and 2-engine operations, respectively, this applies to aircraft equipped with lower horsepower engines than those on this aircraft. The manual also states under "Engine Failure" and "During Climb After Take-off", "should an engine fail after power has been reduced to climb power or at any time after take-off, set power on good engines to 'rated power' or 'take-off' if necessary. After power has been increased, the engine feathering procedure should be completed".

The Captain stated that after he had established airspeed of 135 miles per hour, the aircraft continued to lose altitude, and that the two good engines were not increased to take-off power until he decided to dump fuel. Since it was established that the fuel dumping operation was started approximately two minutes prior to the landing on the water, a considerable period of time was dissipated in attempting to climb at rated power. In an emergency such as this, where the maximum altitude involved was only 550 feet, good flying technique would not permit a loss of airspeed by maintaining a continuous nose-high attitude. This could well have meant the difference between maintaining level flight and losing altitude.

The purser and steward were not advised sufficiently early that the aircraft was to be ditched for them to adequately prepare the passengers for a water landing. When the second officer first came to the cabin, he told the attendants to close all electrical circuits to prevent a possible fire as fuel was to be dumped. This was done, and according to the purser and the steward, they considered these instructions as routine and did not interpret them to mean a ditching was imminent. When the second officer next returned to the cabin, they could not hear him from where they were seated, but from his actions they knew the aircraft was to be ditched. They immediately put on their own jackets but made no attempt to warn the passengers. Additional lives might have been saved if previous instructions had been given the passengers in the location and use of the jackets.

An inquiry noted that the company's policy of stowing all life rafts in a single compartment to the rear of the pilots did not permit ready accessibility. In this location they are available only to the crew, and because of the close quarters in this section of the aircraft, they cannot be readily launched. In this instance, only one raft could be released from its moorings, as a second raft was jammed when attempts were made to release it. If more life rafts had been readily available, additional lives might have been saved.

The mechanics at San Juan who performed the service on the No. 3 engine and changed this engine's nose section said that all work done by them was performed as prescribed in the company's Maintenance Manual. The assistant chief mechanic, however, did not consider it necessary to change the engine, although a large quantity of metal flakes was found in the oil hopper, etc. This did not necessarily mean that these particles had traveled through the engine; however, it did indicate that some part or parts of the engine had failed. To determine the extent of this failure, the engine should have been further disassembled. This was not done. Instead, a new nose section was installed despite considerable evidence of metal particles in the old nose section and the lower front of the power section of the engine. A dispatch describing the action being taken was then sent to the company's Miami office. That office, having received this information should have issued instructions to San Juan that this engine be changed. Due to the condition of the No. 3 engine, the aircraft was not airworthy when it departed San Juan.

The analysis of the contents of six sludge cups from this engine's propeller reduction gearing definitely showed particles of metals other than aluminum. The top 1/32-inch of sludge was predominantly silver and iron, whereas the major metallic constituent of the remainder of the sludge was lead. The rate of deposit of material can be expected to increase in the event of a progressive failure in the engine. Therefore, the silver and iron deposit in the top 1/32-inch of sludge indicated that a progressive failure was occurring. The above reasoning is in accord with the observed wear pattern on the propeller reduction pinions and drive gear.

As a result of this and similar accidents, the Board has proposed amendments to Parts 40, 41, 42 and 61 of the Civil Air Regulations with relation to emergency and evacuation equipment and procedures, to assure a greater degree of safety to the occupants of aircraft flying over water routes. It has been found that accidents have occurred when there was insufficient time to adequately plan and prepare for a ditching. Among others, the following amendments to the Board's regulations have been proposed:

1. All required rafts and life vests shall be approved, shall be adequately equipped for the route to be flown, and shall be installed in approved locations. They shall be readily available and easily accessible to the crew and passengers in the event of an unplanned ditching.

2. In the case of extended over-water operations, each air carrier shall establish procedures for orally briefing passengers as to the location and method of operation of life vests and emergency exits and the location of life rafts. Such briefing shall include a demonstration of the method of donning a life jacket. Such briefing shall be accomplished

prior to take-off on all extended over-water flights on which the aircraft proceeds directly over water. On flights not proceeding directly over water, the briefing shall be accomplished sometime prior to reaching the over-water portion of the flight.

The Board is continuing studies of problems relating to aircraft ditching and evacuation.

Probable Cause

The probable cause of this accident was:

a) The company's inadequate maintenance in not changing the No. 3 engine which resulted in its failure immediately subsequent to take-off, and

b) The persistent action of the captain in attempting to re-establish a climb, without using all available power, following the critical loss of power to another engine.

This resulted in a nose-high attitude, progressive loss of airspeed and the settling of the aircraft at too low an altitude to effect recovery.

ICAO Ref: AR/225

No. 18

TWA Constellation, Fueling Fire at New York International Airport, 21 April 1952, Special Airport Fire Bulletin of The Committee On Aviation And Airport Fire Protection National Fire Protection Association, International

Circumstances

While fueling the left wing tanks of a Constellation from a tank truck, the gasoline hose of the fueling truck burst at a point just inside the truck's pumping compartment resulting in a fuel spill and fire involving about 150 to 200 gallons of gasoline. The fuel truck was quickly driven about 200 feet away from the aircraft but the spill and fire directly exposed the left side of the fuselage of the Constellation forward of the leading edge of the left wing. The truck and spill fires were quickly extinguished but the heat and flame fused the aluminum skin of the fuselage and resulted in a smoldering fire in the concealed space between the outer skin and the interior cabin sheathing which subsequently extended into the fuselage causing an aircraft loss of approximately $700,000.

Sequence

A TWA Constellation was parked on a 400-feet wide apron in front of Hangar No. 5 at the New York International Airport being refueled from a 4,000 gallon capacity gasoline semi-trailer tank truck. The weather was clear and dry with an 18 miles per hour north wind. The right wing tanks of the aircraft and the inboard left tank had been refueled. The mid-wing tanks to the left side were being refueled as the accident occurred. The truck was parked parallel to the left wing and the pumping compartment, in the rear of the modified F-1A tank truck, was perhaps 15 to 20 feet from the nose section of the Constellation. The fueling operation was a routine one until approximately 9:14 A.M. when the gasoline hose on the tank truck burst at a point just inside the pumping compartment of the truck. A fire resulted which was witnessed by several persons in the vicinity and by the Airport Control Tower. The fire alarm was given by the Control Tower to the Airport Fire Department and to the New York City Fire Department by a TWA employee who pulled a city fire alarm box in the vicinity. Immediately after the fire was noted by TWA employees, one of them jumped into the cab of the semi-trailer and drove it 200 feet away from the aircraft.

Fire Equipment Response and Conditions at Time of Arrival - The Port Authority Airport Fire Department despatched its two fog-foam trucks with two "nurse" (water tank) trucks. The first equipment reached the scene (about a mile from the fire station) within two minutes. The New York City Fire Department responded with three pumpers and two other trucks. The first units of the NYCFD equipment arrived within three minutes. With the combined forces, 65 fire-fighters were available. The fire involved the pumping compartment of the tank truck, a trail of fire between the re-positioned truck and the original location and the ground spill near the aircraft. A few lazy puffs of smoke were observed issuing from the aircraft but this, at first, was not considered too serious. Apparently, however, the spill fire had fused and burned through a relatively small area of the aluminum skin of the aircraft forward of the left wing and a smoldering fire inside the Constellation was developing.

Source of Ignition and Development of Fire - The fire started in the pumping compartment when the gasoline from the pressure break in the hose occurred. The break was at a point just inside the pumping compartment where the gasoline was sprayed both into the pump compartment and onto the ground. The side panels on the pump engine had been removed exposing the entire engine to the fuel spray. The break occurred an inch or two from a coupling joining two 50-foot sections of the gasoline hose. Both couplings were of the female type connected by a short section of iron pipe. It is easy to understand why the break occurred at this point as continual winding and rewinding on the reel would place severe strains on the hose at this location, aggravated by the rigid pipe section inserted to join the two 50-foot lengths. The most probable ignition source of the gasoline vapors was at the pump engine generator which was mounted directly below the pump. At the time of the hose failure, one attendant was on the left wing filling the tanks located outboard of the inboard engine. The hose (about 60 feet extended from the reel) was draped under the inboard engine and up by the ladder, located about mid-wing. A second attendant was on the ground, standing by the pump engine controls. Upon noticing the hose bursting, he believes he shut off the pump engine. Almost instantaneously the vapors ignited and he suffered second degree burns about the face and neck. The attendant on the wing escaped safely over the trailing edge of the wing, the ladder position being untenable because of the fire.

When the truck was driven away from the scene, the hose was dragged along the ground and a trail of fire connected the spill and the burning truck. Conclusive proof has not been submitted whether the employee actually succeeded in shutting-off the engine but evidence indicates that fusible elements in the truck pump compartment operated efficiently and their operation assured that 150 GPM flow of fuel through the broken hose was stopped. One fusible control was installed to cut the ignition system on the pumping engine and additional fusible links were installed on the suction side of the pump control valves. After the fire, all were found to have operated.

The spill fire directly exposed the forward fuselage section of the Constellation. The direct flame exposure burned through the aluminum skin at half-a-dozen points and wrinkled the skin in an area about 90 inches wide by 40 inches long. The seriousness of these burn-throughs was not immediately apparent. A few puffs of smoke issuing therefrom were noted but no flame was visible. Gradually, despite the extinguishing of the spill fire, the smoke increased in intensity and fire-fighters found that their attack was not producing results. Eventually (about 20 minutes after the outbreak) the fire progressed to a point where it ate its way into the cabin. Here the fire retardant cabin lining melted, sponge rubber seats in the lounge ignited and the entire interior of the aircraft was gradually consumed. The amount of interior combustibles was greater than normal due to bedding in the overseas "sleeper". Combustion, however, was slow, aided only by the rear cabin door which was open and which acted as a chimney opening in the otherwise enclosed fuselage (flue). Plexiglas windows were heated and assumed their "rubbery" quality resisting breakage with fire axes.

Analysis of the progress of the fire within the aircraft "shell" is difficult. It appears that the following components were present and aided in the manner indicated:

a) Outer aluminum skin	Fused and burned in local areas (not over 90 inches by 40 inches)
b) Fiberglas and mineral wool insulation applied between ribbing with adhesive on outer skin and rayon membrane adhered to " c)"	Fiberglas and mineral wool non-combustible but apparently adhesive and rayon slow burning
c) Plywood (about 3/16" thickness) which was originally interior cabin decoration but which had been covered over with " d)" and " e)" to meet CAR specifications for flame retardant cabin interiors	Ignited and sustained fire but was slow burning because of oxygen deficiency
d) Second layer of fiberglas insulation, about 1/8" thickness	Non-combustible
e) Cabin lining-applied with adhesive to fiberglas	Flame retardant and slow burning

The only readily combustible material was therefore the plywood and flame spread over this surface was undoubtedly slowed by the limited oxygen supply available due to the insulation which covered both surfaces. Hydraulic lines in the area apparently did not melt. The lines were fluid filled and this prevented burn-throughs.

Fire Extinguishing - TWA employees first attacked the fire with at least one 140-lb. dry chemical, wheeled-type extinguisher. Control could not be attained with this equipment as the areas were too large and reflashes occurred following localized control. This fire and the fire in the tank truck were easily extinguished, however, with foam from turret nozzles of the PNYA crash trucks.

The aircraft fire presented more serious extinguishing problems with the equipment that was available. Turret nozzles and hand lines from the foam units were used and while good coverage was secured on the exterior of the aircraft, difficulty was experienced in reaching the flames concealed between the exterior fuselage skin and the interior sheathing. Efforts to direct carbon dioxide into the concealed spaces were ineffective. This condition lasted for about twenty minutes before the fire broke out in the interior of the fuselage. After this happened, the fire was attacked at various locations with straight water streams, portions of the cabin lining and interior plywood being torn away by forcible entry-tools by NYCFD fire fighters. Following this treatment the fire was brought under control within less than 20 minutes. Mop-up operations took about two hours.

A total of 4,800 gallons of foam were used and 800 pounds of carbon dioxide from the high pressure CO_2 cylinder supplies on the two PNYA trucks. Unlimited water supplies were available from hydrants adjacent to the hangars in the vicinity (nearest hydrant about 400 feet). None of the 2,400 gallons of gasoline in the aircraft was involved.

Damages

The aircraft damage is estimated at $700,000. The entire fuselage was gutted and structural members were warped and twisted by the heat. The wing sections and power plants were substantially unaffected.

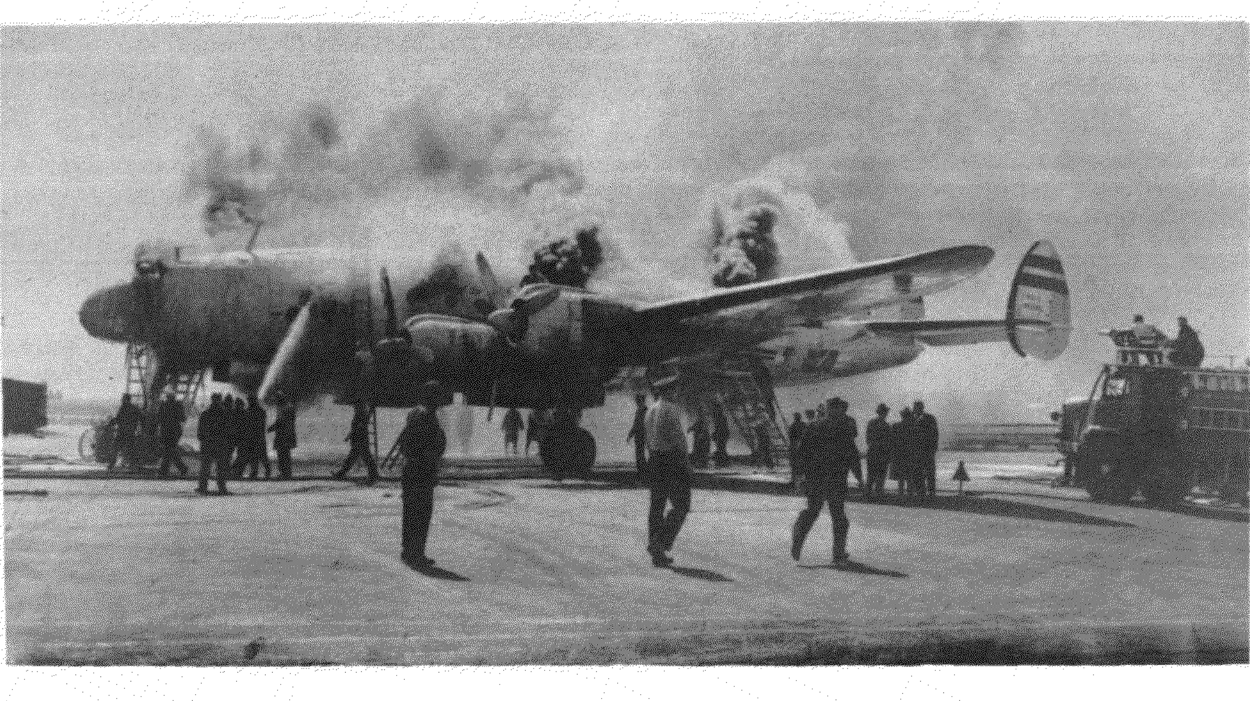
The fuel truck sustained about $3,000 damage, chiefly to the pumping compartments and adjacent areas.

Observations

1. Maintenance of gasoline hose is an important part of proper gasoline fueling operations. The failure in this case might be attributed to the stiff jointing of two 50-foot sections by an iron pipe which placed a strain on the adjacent hose over a period of time as the hose was reeled and re-reeled on a circular drum.

2. The burn-through of the fuselage within 2 to 3 minutes of exposure fire could be anticipated but the resultant interior fire was most unusual and was chiefly complicated by the peculiar construction of this particular aircraft.

3. Fusible elements in the truck pumping compartment assured that the flow of gasoline would be automatically stopped. The location of a gasoline powered pumping engine with its auxiliary generator in the pump compartment (even when partially enclosed) is, however, an obvious hazard which should be thoroughly analyzed with a view to eliminating these sources of ignition on all similar tank vehicles. It is understood that a method for hydraulic operation has been developed and conversions are being made as circumstances permit.



No. 19

Pan American World Airways Boeing 377 crashed near Carolina, Brazil, 29 April, 1952

Circumstances

The aircraft, operating flight 202 between Buenos Aires, Argentina, and New York, departed Rio de Janeiro, Brazil, at 0243, on 29 April 1952, for Port of Spain, Trinidad, carrying 41 passengers and 9 crew. The aircraft was cleared to cruise on an off-airways direct route from Rio de Janeiro to Port of Spain at 12 500 feet to Barreiras check point and thereafter to San Traem at 14 500 feet and from San Traem to Port of Spain at 18 500 feet. At 0616 a message was reported received from the aircraft reporting abeam Barreiras at 0615 flying at 14 500 feet under VFR conditions. This was the last known message from the flight. On 1 May 1952, the wrecked aircraft was spotted from the air in dense jungle approximately on course 282 nautical miles north north-west of the Barreiras abeam check point and approximately 887 nautical miles from Rio the point of departure. There were no survivors.

Investigation and Evidence

The report describes in some detail the difficulties encountered by the investigation team in penetrating the dense jungle in Para State, Brazil, and in maintaining supplies for the party. The following paragraphs from the report indicate some of the difficulties.

"On 7 May the Brazilian Boundary Commission and the Indian Protective Agencies were visited to obtain information on the conditions to be expected in the jungle and the equipment needed. During this discussion officials of these agencies stated that friendly Carajai and Tapirape Indians would be found in the Lago Grande area but that the wreckage was located in an area known to be occupied by hostile Ciapos Indian tribes. They further advised that any party going into this area should be well-armed; should not attempt any contact with the Ciapos tribe; should remain in a group and not become isolated; should fire upon Indians if they were encountered; should equip themselves with suitable clothing to protect against jungle briars, thorns, and vines; and that protection should be provided against wild boars, black leopards, jaguars, and snakes of the boa constrictor and viper species. They further stated that the area surrounding the wreckage had never been explored and, as far as known, there was no habitation west of the Araguaia River.

"On 8 May Major Correa accepted the services of the three CAB personnel present, two of whom had just arrived, as chairmen of working groups to be set up to establish proper division of work and responsibility. Major Correa then named members of the structures, power-plant, and investigation groups, realizing that some re-arranging of the groups might become necessary depending upon conditions met. It was further agreed that the technical personnel would remain in Belem until the helicopter arrived and the base camp at Lago Grande was ready.

The base camp was established at Lago Grande and arrangements made to clear the approach path to the Araguacema landing strip to permit the USAF transport aircraft to deliver the helicopter. While this was being accomplished, a message was received at Belem from the Lago Grande base camp stating that, while flying over the wreckage area, the crew of a supply flight observed parachutes in the tops of trees and the presence of persons in a partial clearing located about four air miles from the main wreckage. The following day Brazilian newspapers reported that the parachutists dropped into the clearing were a group of civilians backed by Ademar de Barros, former Governor of Sao Paulo State. It was later learned that after the clearing was sufficiently enlarged, Linos de Matos, a leader of the group and deputy to the former Governor, had been transported to the clearing in a Brazilian two-place helicopter."

The wreckage was located at an altitude of approximately 1 300 feet on the side of the Tomanacu Mountain Range and was found lying in an inverted position on an approximate heading of 90 degrees.

The wreckage area consisted of a large burned-out hole in the jungle approximately 100 feet in diameter. Indications were that this portion of the aircraft had made a nearly vertical descent while in a horizontal attitude; this was evidenced by the condition of the surrounding trees, all of which had been damaged directly overhead. One such tree approximately four inches in diameter had vertically pierced No. 4 engine cowling.

Further observations disclosed extreme disintegration of the aircraft, accompanied by fire which followed impact and had probably continued for many hours. The heat of this fire melted many pieces of the aluminum alloy structure, which resolidified into unrecognizable globules and masses of metal. Many structural parts which retained identifiable shape had their fractured edges melted or burned away, making study of them impossible.

As a result of air and ground search, it was found that parts of the wrecked airplane were scattered over an irregularly shaped jungle area whose major dimension was approximately 4 000 feet.

The engine and propeller which had been installed in the No. 2 position were not located.

The parts at the main wreckage site consisted roughly of the fuselage from the nose back to and including the dorsal fin, the complete landing gear, the right wing with Nos.3 and 4 nacelles complete with engines and propellers, that portion of the left wing from the fuselage outward to a point slightly outboard of the No. 2 nacelle, and the No. 2 nacelle minus the No. 2 engine, engine cowling, and propeller. The outboard portion of the left wing was found approximately 2 300 feet from and on a bearing of 318 degrees from the main wreckage, complete with No. 1 nacelle, engine, engine cowling, propeller, aileron, and outer portion of the left flap. Examination revealed that this portion of the wing had struck the ground, inboard end first, at an angle approximately 60 degrees from horizontal.

The tail assembly wreckage consisted of the vertical fin, right elevator, horizontal stabilizer from the right tip to approximately the mid span of the left stabilizer, and the aft end of the fuselage. This piece of wreckage was found approximately 2 500 feet from and on a bearing of 50 degrees from the left wing wreckage. At different points close by were found the rudder and approximately the inboard third of the left elevator.

Most of the remaining structural parts of the aircraft were found within an area encompassed by a circle of approximately a 350-foot radius. From the centre of this circle,the distance to the tail assembly wreckage was approximately 1 000 feet on a bearing of roughly 340 degrees. These parts included the outer portion of the left horizontal stabilizer, the middle portion of the left elevator, two inboard pieces of the left flap, the right-hand nose wheel well door, and the tip section of the right aileron.

Since these pieces from different extremities of the aircraft do not vary too greatly in density, their close grouping indicates that the disintegration of the aircraft's structure occurred in a very short interval of time.

In analyzing the factual data obtained during the investigation, it is necessary to fully consider the pertinent circumstances under which this accident occurred. These circumstances are as follows:

1. Cruising flight on a magnetic heading of 343° at an altitude of 14 500 feet MSL (approximately 13 000 feet above the ground) was planned over the area where the wreckage was found.

2. The weather conditions in the general area at the time of the accident were such that violent turbulence of the air appears unlikely. However, due to the long distances between stations which report weather in the general area of the crash, no positive statement can be made that a storm did or did not exist in the area of the crash. An analysis of the weather conditions in that area indicates that no storms occurred at the time and place of the accident and that the air was generally smooth. Apparently the winds aloft in that part of Brazil at the time of the accident were generally light and from a northerly to northeasterly direction.

3. The last message received from the aircraft was a routine position report. No radio was received indicating any in-flight difficulties or impending disaster. With the reported unsatisfactory radio reception due to meteorological interference in the accident area, together with the scarcity of aeronautical radio stations, it is entirely possible that

an emergency message could have been transmitted without its ever having been received, or not understood if received due to the language difficulties in that part of the world.

4. The type of propeller blade with which this aircraft was equipped is subject to fatigue failure as the result of comparatively minor blade damage.

5. Since No. 2 engine and propeller were not recovered, they could not be examined to determine the cause of their separation from the aircraft. However, it can be concluded from examination of No. 2 engine mount, which remained with the aircraft, that separation resulted from the application of forces beyond that for which it was designed. Similar separations of engines from B-377 aircraft in flight, due to excessive loads being applied to the engine mount, are known. In all cases where the engine and propeller were recovered, examination disclosed that the separation resulted from a propeller blade failure and the resulting destructive load due to the propeller unbalance.

6. The distribution of the wreckage indicates that the structural disintegration, with the possible exception of No. 2 engine mount separation, occurred in a very short interval of time and at a moderately high altitude.

These circumstances, in general, indicate the probability of an emergency occurring with little or no warning, which required the full attention of the flight crew. Considering the density of the jungle vegetation in the crash area, the failure to find the No. 2 engine and propeller does not preclude the possibility that they are in the area covered by both ground and air search. If so, the time interval between their separation from the airplane and the final disintegration of the structure was extremely short.

The significance of the wreckage distribution, together with other factual information revealed by detailed examination of the wreckage, throws additional light on the sequence of failure and subsequent disintegration.

1. Numerous parts of the structure were covered with a film of engine oil. The areas covered by oil include the left side of the vertical fin and dorsal fin, the rudder, the normally exposed portion of the upper surface of the left flap in the area aft of the No. 2 nacelle, the most rearward portions of the fuselage left skin found at the main wreckage site, and the left stabilizer. Since these pieces of wreckage were found at widely scattered points, as shown on the wreckage distribution chart, it is apparent that there was an abnormally large quantity of engine oil discharged from the No. 2 nacelle area before any of these parts separated from the airplane. This, considered in conjunction with the determination that No. 2 engine mount probably failed due to high unbalance of forces, indicates the probability that the oil was discharged from the severed oil lines between engine and tank when the No. 2 engine separated from the airplane. Since extremely violent manoeuvres or high gust loads would be more critical for the outboard engine mounts than for Nos. 2 and 3, it appears that the emergency resulting in disintegration was caused by a failure in either the No. 2 engine or propeller rather than an emergency causing high acceleration resulting in the loss of the No. 2 engine.

2. A trough-shaped depression in the leading edge of the dorsal fin appears to have been caused by impact with a relatively lightweight object which had a flat surface approximately four inches in width and was moving rearward and slightly to the right. A piece of cowling from the No. 2 engine appears to be the most likely object to have caused this damage.

3. A small hole was punched through the upper skin of the right stabilizer, and a tear in the upper fabric of the right elevator appeared to have been caused by impact with an unidentified small object of light weight moving rearward to the right and downward. This evidence merely indicates the probable separation of objects from the airplane prior to the fuselage separation.

4. With reference to the hole in the upper skin of the left horizontal stabilizer just forward of the rear spar at Station 122, it is apparent that most of this damage was caused by the inboard end of the rear spar upper cap outboard of Station 130 after the upper cap had failed. However, in addition to zinc chromate deposits on the exterior surface of the skin, which were rubbed off the rear spar, there were also some gray smears similar to paint. Analysis of these smears disclosed that they were cellulose acetate butyrate dope. It is impossible that the gray smudge was caused by elevator fabric being carried into the hole by the fractured spar end.

5. The tail section of the airplane did not bear any evidence of impact in flight from a large or heavy piece of the airplane. In addition, the separated pieces of the left inboard flap bore no evidence of impact with the tail end of the airplane, other than cable marks diagonally across the top skin of one of the pieces. It therefore appears doubtful that the left wing and pieces of flap passed rearward of the tail section prior to the fuselage separation.

6. All flap actuator screws were found with the nuts at 13 to 14 threads from the retracted position, which corresponds to a few degrees' flap extention. This is not normal for cruising flight. It suggests the probability of an attempt by the crew of the aircraft to stop tail buffeting, which could be caused by disturbed airflow over the No. 2 nacelle minus its engine. Although at least one B-377 is known to have lost an engine without severe buffeting, differences in the distortion of the cowling and the amount that hung on to the nacelle could very easily be the determining factor as to whether or not buffeting occurs in a particular case.

Considering further the wreckage distribution, it is significant to note again the close grouping of parts from various extremities of the airplane; namely, the outboard section of the right aileron, the centre third of the left elevator, the right-hand nose wheel well door, the inboard sections of the left flap, and the outer half of the left stabilizer. These pieces were found within an area encompassed by a circle of approximately 350 feet radius. As these pieces are fairly uniform in density, it is apparent that all separated from the airplane in a very short interval of time. It is significant, then, that the bearing from the centre of this circle to the tail section wreckage was approximately 340 degrees or practically identical to the intended track of the airplane over this area. The winds aloft were probably light from a northerly to northeasterly direction; therefore, they would have comparatively little effect on the relative paths of these pieces of wreckage in falling to the ground from high altitudes. Since the left flap obviously broke up as a result of the left wing failure and the pieces of flap came to rest near pieces of the left elevator and stabilizer, it is apparent that there was practically no time interval between the wing failure and the tail separation.

The location in which the No. 2 engine scoop was found fits in with this reasoning as to the flight path of the airplane when disintegration occurred, since the path of the scoop shown on the wreckage distribution chart appears to have resulted from the dense piece of wreckage having first struck a rock, from which it ricocheted along the ground on a bearing of 200 degrees. However, the location in which the intercooler installation parts of the No. 2 engine were found is approximately 1 000 feet east of where one would expect to find them if they separated from the airplane while it was making a track of 343 degrees. The location of the left wing and the main wreckage relative to the other pieces is not inconsistent, since these two parts consisted largely of unstable lifting surfaces which could modify their path of descent from fairly high altitude to a very great extent. In addition, the engines could have produced thrust during all or part of the descent, further affecting the path of descent.

Considering all of the above evidence and reasoning, it appears that the emergency originated either in the No. 2 propeller or engine. It appears that very shortly after this, the left wing failed.

Almost simultaneously and as a result of violent pitching of the aircraft during the wing separation, entire tail group broke from the fuselage in a downward direction at a point just aft of the dorsal fin, probably before the left wing proceeded that far rearward.

The probable sequence of failure indicates to some extent the probable cause of the structural disintegration. However, as it does not give clear-cut proof, it is necessary to consider other possible causes of structural disintegration. Since the weather does not appear to have had any bearing on the accident and since continued cruising flight over the area of the accident was intended, numerous possible causes of structural disintegration are eliminated without further analysis. The remaining possibilities are analyzed in the following sections on the basis of available information:

1. Explosion

Due to the apparent suddenness of the disintegration, the theory of an explosion causing the accident gained some credence. However, examination of the wreckage disclosed no evidence of distortion of a nature which would be caused by an explosion in the airplane. Although the central portion of the fuselage was completely destroyed by impact and subsequent fire, a number of components, which are normally located in this section, still remained in their relative positions. However, the fire damage could have obliterated possible evidence of an explosion. Nevertheless, it appears that any explosion in this part of the airplane which would have been severe enough to cause the accident should have caused the fuselage to separate at either the front spar station or the rear spar station. This did not occur, and no evidence was found to support the explosion theory.

2. Sabotage

Examination of the wreckage disclosed no evidence of sabotage. However, due to the extreme destruction in the central portion of the airplane, evidence of many types could have been obliterated. Nevertheless, the type of sabotage most likely to cause a very sudden disintegration, namely, a bomb exploding, is extremely unlikely as discussed above.

3. Fatigue Failure of the Airframe

Any fatigue failure likely to be a direct cause of sudden disintegration should occur in one of the heavy load carrying members, such as the wing spar caps. Careful examination of the wing spar caps in the area where the left wing separated disclosed no evidence of fatigue cracking. Only indications of extremely high tensile stresses were in evidence. These indications point to upward failure of the wing due to excessive aerodynamic loads. Numerous other fractures throughout the structure were examined for evidence of fatigue cracking, without any being found. It can, therefore, be concluded that fatigue failure of a structural member of the airframe was not the direct cause of the disintegration. One theory which has been advanced as a possible cause was loss of the left nose wheel well door which then collided with the No. 2 propeller, resulting in unbalanced forces which tore the engine from the aircraft. The loss of a nose wheel well door could result from fatigue of one of the attachments. However, the only portion of the left nose wheel well door identified was a small fragment attached to a piece of fuselage structure by means of the rear hinge. The edges of this remaining door fragment were all curled inward, and the door structure immediately adjacent to the hinge showed no evidence of twisting deformation. If the front hinge had failed in flight due to fatigue or any other cause, allowing the front end of the door to drop down and to cause enough drag to tear the door off, the skin forward of the rear hinge should be curled outward and the structure adjacent to the rear hinge should show twisting deformation. It appears probable, therefore, that the left nose wheel well door did not twist off in flight and strike the No. 2 propeller.

4. Fire in Flight Weakening Structure

Numerous indications of fire as a result of impact with the ground and burning due to the jungle fire months after the accident were found. Although it is possible that some of this fire damage could have obliterated any evidence of damage due to fire in flight, a sufficient number of the pieces of wreckage which separated from the airplane in flight were found with either no fire damage at all or only minor damage resulting from jungle fire. Examination of the wreckage disclosed no evidence of fire in flight, consequently, the disintegration of the aircraft did not occur as a result of weakening of the structure from this source.

5. Hard-Over Signal from Autopilot

The autopilot was so completely destroyed in the ground impact and the subsequent fire that no information could be obtained from examination of it. However, the establishment of limiting torques intended to prevent the application of loads in excess of the structural strength was included in the type certification of the Boeing 377. Therefore, structural disintegration due to excessive loads caused by a hard-over signal from the autopilot appears highly improbable.

6. Malfunctioning of Rudder Boost System

Excessive loads due to malfunctioning of the rudder boost system are possible. However, the rudder boost system on the Boeing 377 is normally used only for take-off and landing. Examination of the Geneva-loc type shut—off valve in the rudder boost panel disclosed that it was in the closed, or boost off, position. Since this type of valve is secure against actuation except by the normal electrification motivation, it is evident that the disintegration was not due to excessive loads resulting from malfunction of the rudder boost system.

7. Collision with Foreign Object

As pointed out previously, little evidence of impact damage in flight was found. What was found appears to have been the result of the initial disintegration rather than its cause. The possibility of a piece of propeller blade piercing the fuselage has been considered. As pointed out under investigation, evidence of such damage was not found. However, due to the severe melting of the fuselage in the region of the inboard propellers, most of the fuselage skin could not be identified. However, even if a piece of propeller did slash through the fuselage, it would not necessarily result in disintegration. If disintegration did occur due to weakening of the fuselage structure in this area, the fuselage should have parted at this point, which it did not. If a piece of propeller blade slashed control cables, the airplane could become uncontrollable and develop excessive loads, causing disintegration. However, the manner in which the primary control cables failed indicates they were intact until the structure started breaking up. It, therefore, appears improbable that structural disintegration was the result of the control cables being severed by a piece of propeller blade.

Another possibility to be considered is a bird strike on the windshield. No evidence of this was found on the recovered portions of the windshield or frames. Due to the cruising altitude of 14 500 feet MSL, it is improbable that any bird would be flying at that altitude. However, even if a bird strike did occur, it is unlikely that it would incapacitate both the pilot and the co-pilot. It, therefore, appears highly improbable that the structural disintegration resulted from collision with a bird.

8. Buffeting and/or Flutter

No indication of flutter, as such, prior to disintegration was found by examination of the wreckage, although particular attention was paid to the condition surface hinges and balance weights for indications of looseness and working. As pointed out in Item B (6), above, the finding of the nuts on the flap actuator screws in a position corresponding to a few degrees' flap extension strongly suggests an attempt on the part of the crew to stop buffeting. The slight extension of the flaps also suggests the possibility that disintegration occurred before the flaps were extended as far as the crew may have intended.

Examination of the tail assembly wreckage disclosed evidence of the application of very high loads in both the up and down directions, as would result from buffeting. Examination of the break in the left stabilizer indicated further that after partial failures had occurred in the spars and shell, the outer portion of the stabilizer oscillated up and down through several cycles before separating from the inner portion. Buffeting is the most likely cause of such oscillation. The more severe indications of buffeting on the left stabilizer than on the right stabilizer fit in with the No. 2 nacelle being the source of the disturbed airflow. As a result, it appears probable that severe buffeting, set up by the No. 2 nacelle after the engine separated from the airplane, was more severe on the left stabilizer than on the right and caused a partial failure of the left stabilizer at about its mid-span while only causing wrinkling of the upper skin of the right stabilizer. While the outer portion of the left stabilizer was still hanging on and oscillating up and down, it may have disturbed the hinge line in such a manner as to snap the elevators upward, causing a very high down load on the horizontal tail surfaces sufficient to cause a great increase in lift on the wing and upward failure of the left wing. The nose down pitching acceleration of the airplane when the wing failed, combined with the already high down load on the tail, would then be likely to cause the tail assembly to fail downward.

Another possible cause of buffeting, one which caused an alarming emergency for three to five minutes on another Boeing 377, between Galeao Airport, Rio de Janeiro, and Port of Spain on 10 April 1951, should be considered. Distortion and weakening of the left door of the nose wheel well, by interference with the nose wheel during retraction, resulted in a gap at its leading edge when the door was in the closed position. At cruising speed the discontinuity at the leading edge of the door apparently was sufficient to cause the forward part of the door to snap down into the wind stream and cause sufficient turbulence to create violent buffeting.

Comparison of this case with the known facts relative to N 1039V does not permit a positive finding relative to the left nose wheel well door on the basis of the physical evidence, since most of the left door was never identified. However, a distorted nose wheel well door does not appear to be a likely cause of the disintegration of the aircraft for the reason that the accident occurred hours after the airplane reached cruising altitude and speed. If a distorted door had been the cause, it should have caused buffeting as the airplane was approaching cruising or very soon after it reached cruising speed. Examination of the nose wheel well right door eliminated it as a probable cause of buffeting, since it bore no distortion that would be likely to cause buffeting. Distortion at the front end was obviously from impact with the ground. The only other distortion was caused by the door being blown off the airplane by excessive air loads acting on the door to the right while the door was in the open position. Experience with a military model of aircraft similar in design in many respects to the Boeing 377 which has disintegrated in flight, indicates that when the left wing fails, the right nose wheel well door can be expected to tear off in this manner in the violent left slip that results from the wing failure.

Still another instance of severe buffeting has been reported involving the Boeing 377 while on a night training flight in which third pilots were making qualifying take-offs and landings at Idlewild, New York. In this instance, while operating at an altitude of 1 200 feet with No. 1 engine windmilling as a result of oil difficulties and inability to feather the propeller, the engineer, to put out a suspected engine fire, opened the engines' cowl flaps to their maximum instead of the normal 2-1/2" opening prescribed. This cowl flap setting, in combination with the windmilling propeller, created such severe buffeting and vibration of the aircraft that only with great difficulty was the pilot able to hold the left wing up or maintain directional control. The engineer, upon realizing that the difficulty was caused by the cowl flap position, closed them and the buffeting and vibration stopped immediately. However, during this period the aircraft's altitude had dropped to 500 feet and was maintained only by the use of full rated power on the remaining engines.

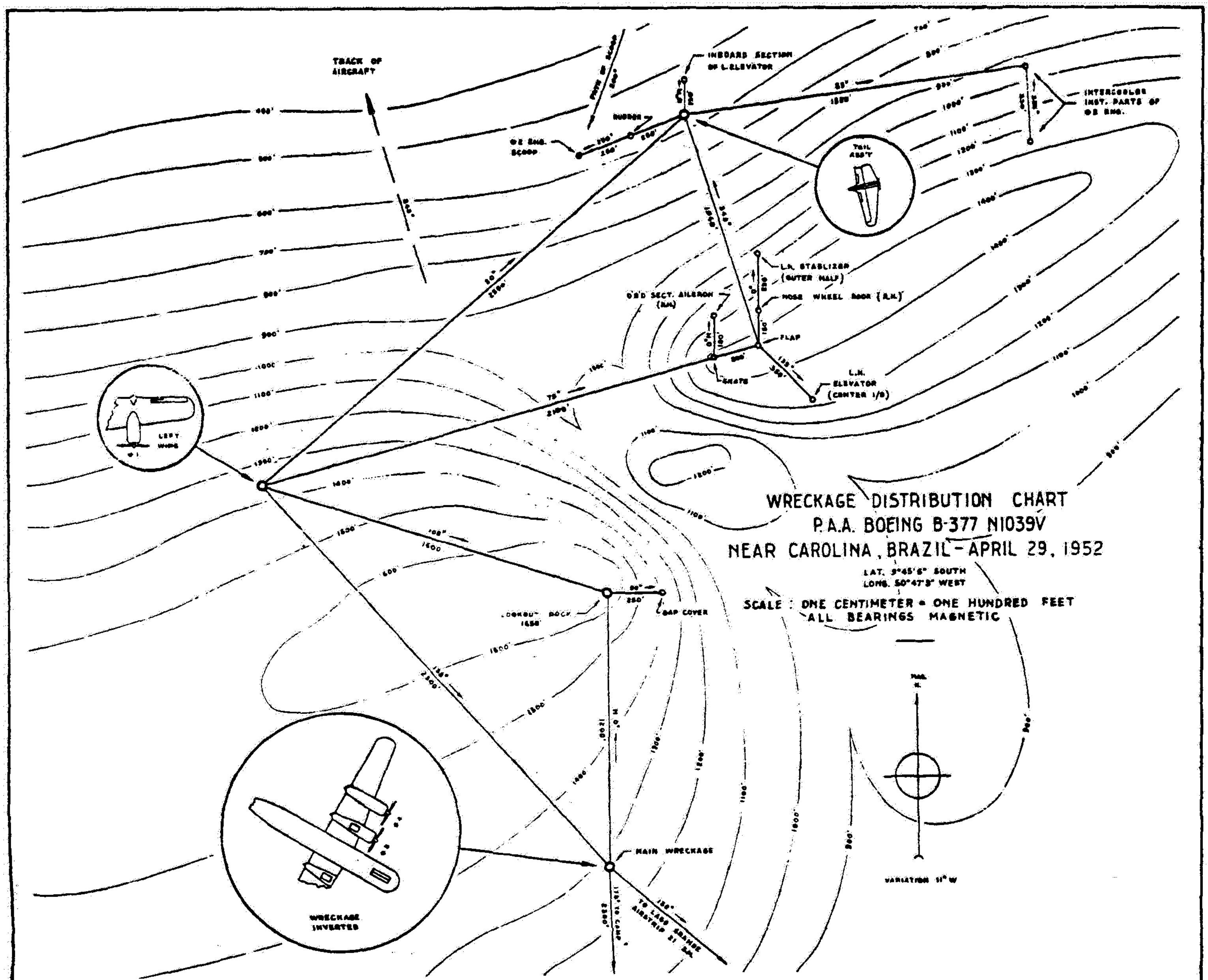
No evidence was found to indicate cowl flaps were in any way involved in the accident under discussion. However, this incident clearly shows the serious buffeting effect which may be induced on this model aircraft by any abnormal air flow such as undoubtedly existed following the loss of No. 2 engine.

Additional experience in several accidents to the same military model which involved extremely violent manoeuvres due to several causes brings to light a striking similarity in the failures on this aircraft. These include failure of the stabilizer at about the midspan, failure of the aileron at the outmost hinge, loss of wing gap seals, damage to the wing between the inboard and outboard nacelles, and, as mentioned above, loss of nose wheel well doors in violent slips.

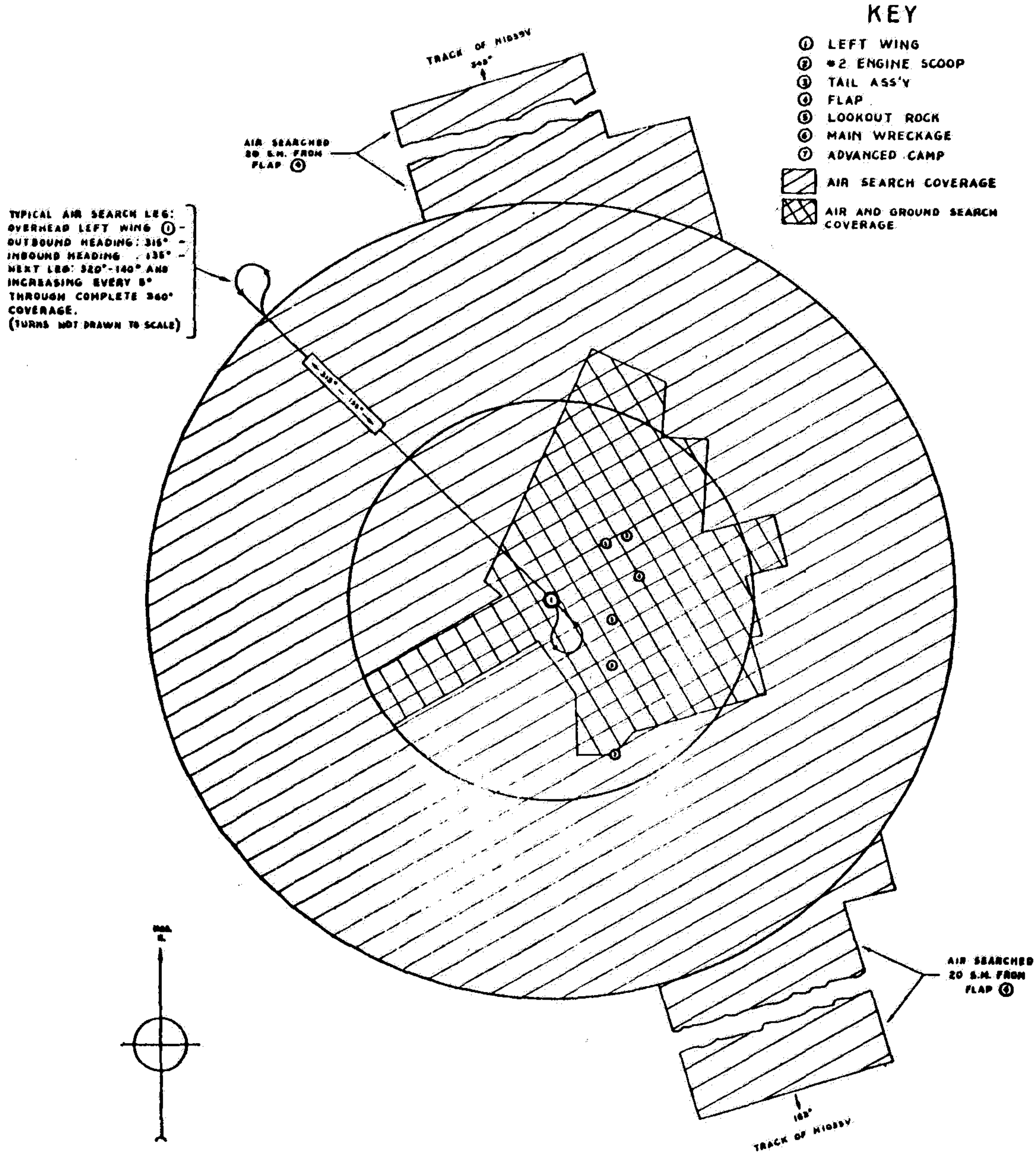
Probable Cause

The Board determines that the probable cause of this accident was the separation of the No. 2 engine and propeller from the aircraft due to highly unbalanced forces, followed by uncontrollability and disintegration of the aircraft for reasons undetermined.

ICAO Ref: AR/263



WRECKAGE DISTRIBUTION CHART
P.A.A. BOEING B-377 N1039V
NEAR CAROLINA, BRAZIL - APRIL 29, 1952
SCALE: ONE CENTIMETER = ONE HUNDRED FEET
ALL BEARINGS MAGNETIC
TRACK OF AIRCRAFT
INBOARD SECTION OF L. ELEVATOR
RUDDER
TAIL ASS'Y
L.H. STABLIZER (OUTER HALF)
NOSE WHEEL DOOR (R.H.)
FLAP
L.H. ELEVATOR (CENTER 1/3)
LEFT WING
LOOKOUT ROCK
GAP COVER
MAIN WRECKAGE
WRECKAGE INVERTED



AIR-GROUND SEARCH FOR #2 ENGINE-N1039V

SCALE: 3" = ONE MILE
DIAMETER INNER CIRCLE: TWO MILES
DIAMETER OUTER CIRCLE: FOUR MILES

No. 20

Gold Belt Air Services Ltd., aircraft Noorduyn Norseman IV, CF-PAA made emergency forced landing due to engine failure on Lake Mondor, P.Q. - 9 May 1952

Circumstances

At about 1015 hours EDST on 9 May 1952, Aircraft CF-PAA, owned by Gold Belt Air Services Ltd., took off on a test flight from Lac à la Tortue, P.Q. with five passengers on board.

The aircraft climbed on a northwesterly heading to about 2 100 feet when, after an elapsed time of about ten minutes, the engine failed. The emergency forced landing which was attempted on the nearest lake (Lake Mondor), appears to have been made downwind. The first contact with the water was made approximately in the middle of the lake which was about three-quarters of a mile long. The aircraft bounced, settled on the water again about 200 feet from the east end of the lake and then ran up on the shore. In the ensuing collision it was substantially damaged by trees and a small cottage. Minor injuries were sustained by two of the passengers.

Investigation and Evidence

Examination of the aircraft disclosed that it was equipped with a front belly tank in addition to the normal wing tanks and that the placard plate for fuel tank selection gave no indication that a belly tank was installed. Examination of the fuel lines and selector valve established that when the selector in the cockpit indicated "both on", the selector was on the belly tank.

A few days before the accident, 5 gallons of gasoline was put into the belly tank when testing the tanks for leaks. It was established that no further fuel was put in the belly tank before the accident althouth the wing tanks were filled. The aircraft was test flown on 8 May, and fuel was used from all three tanks. On the last flight of the aircraft on 8 May, fuel was used from the belly tank only.

It was established that the pilot was not aware that the aircraft was fitted with a belly tank and that in selecting "both on" he believed that he had selected both wing tanks. Examination of the belly tank after the accident showed it to be empty and undamaged.

There was no evidence of failure or malfunctioning of the airframe, engine or controls.

Weather was not a factor in the accident.

Probable Cause

After an emergency forced landing caused by the exhaustion of fuel from the belly tank the aircraft hit obstructions on the shore line. A contributing factor is considered to have been misleading information given by the placard on the fuel selector valve.

ICAO Ref: AR/234

No. 21

Cessna 140, N-72505 aircraft, crashed from steep climb following take-off on 12 May 1952 at Philip Billard Airport, Topeka, Kansas. CAB Accident Investigation Report No. 3-0276 Released 9 December 1952

Circumstances

The Cessna 140, occupied by a student pilot and one passenger made a normal take-off from Philip Billard Airport after being given clearance by the tower. Shortly after becoming airborne the pilot observed a Trans World Airlines Martin 202A approaching from the north-west. His first impression was that the Martin was descending for a landing on Runway 13. Believing that collision was imminent he continued on the same heading but placed the Cessna 140 in a steep climb, intending to pass over the apparent flight path of the Martin. Within seconds the Cessna 140 stalled, then crashed on Runway 35. Both occupants were critically injured and the passenger died later.

Investigation and Evidence

At the time the Cessna crashed there were three* other aircraft operating in the immediate vicinity of the airport. Investigation disclosed that none of the three aircraft in radio contact with the tower was advised of other traffic in the area of the airport traffic pattern.

The pilot of the Cessna 140 was not using his radio and received permission for take-off by a green light from the tower.

The Martin 202A was on a six-months' captain instrument check and had requested permission from the tower to carry out simulated ILS approaches. Subsequently, on a check from the tower the captain of the Martin advised that a landing was required and the necessary clearance was given by the tower.

The Martin carried out a simulated ILS approach and two landings. Following the second take-off, the flight proceeded to the ILS outer marker. A procedure turn was made and the flight reported inbound when the outer marker was again intercepted. The airport traffic controller replied, "TWA TWO ELEVEN OUTER MARKER INBOUND RUNWAY THREE ONE WIND IS NORTH VARIABLE NORTHWEST SEVEN ALTIMETER THREE ZERO ONE ONE." The captain stated that he considered this a clearance to make the approach; the airport traffic controller, testified that it was clearance to make ILS approach and enter the field traffic pattern for landing, but did not constitute clearance to land. All contacts with the tower, both transmitting and receiving, were on VHF.

The flight continued the second simulated ILS approach to a point 300 feet above the ground at the middle marker. The captain stated that retraction of the gear and flaps was begun upon reaching 300 feet, shortly before arriving at the middle marker. The simulated ILS approach was made without the instrument hood installed. The captain on check transferred his attention from simulated instrument flight to visual reference to the ground at the middle marker whereupon the captain, in the first officer's seat, advised him to maintain his altitude, calling his attention to a Cessna 170 about 200 feet above and 3 000 feet to the left of the Martin 202A. According to the testimony of the pilots, a slight left turn was initiated to turn to the proper heading for return to Kansas City. The captain stated that he was about to advise the airport traffic controller that they were leaving the traffic pattern when he saw a Cessna 140 at about 100 feet altitude and an estimated 1 000 feet to the right as they passed the intersection of Runways 35 and 13 at 300 feet altitude. The Cessna was in an extremely steep climb. When the

* The aircraft in the vicinity besides Cessna 140 were the Martin 202A, a Cessna 170 and a Cessna 195.

Martin was well past the intersection, the captain saw the Cessna 140 apparently stall, then strike the ground at is passed from sight beneath the right wing of the Martin. Neither pilot saw the Cessna 195 at any time. The TWA flight proceeded to Kansas City, and the captain reported his observations to the company after landing there at about 1650.

While the Martin was proceeding inbound on the second simulated ILS approach, the airport traffic controller cleared a Cessna 170 for take-off on Runway 35 from the intersection of Runways 35 and 4. The pilot, was transmitting on VHF and receiving on low frequency. He saw the Martin at about the time he passed the north end of Runway 35 with the Cessna 170 at an altitude of 200-300 feet and the Martin in an approach between the middle marker and Runway 13 at about the same altitude. At about the same time he heard the airport traffic controller clear a Cessna 195, for take-off on Runway 31. Making a climbing turn to the left at about 500 feet altitude, the pilot could see all of Runway 13-31, observed the Cessna 195 become airborne at about the intersection of Runways 31 and 4, and make a sharp turn to the right at low altitude. Returning his attention to the Martin, he saw that it was apparently continuing its approach. Only a few seconds later, the Martin appeared to make a sharp turn to the left at approximately the intersection of Runways 35 and 13. At the same time, the pilot of Cessna 170 noted the Cessna 140, which for a few moments appeared to be climbing. It stalled, then fell to the runway in a partial spin.

After carefully checking for any aircraft which might be approaching to land on Runway 31, the pilot, in a Cessna 195, took position for take-off on Runway 31. Clearance to take off was granted by the airport traffic controller. The pilot was using a low frequency transmitter and receiver in his contacts with the tower. At about 50 feet altitude he saw the Martin inbound from the northwest, about one-half mile from the approach end of Runway 13, apparently in final approach for landing on Runway 13. He made a 45-degree right turn to clear the path of the oncoming TWA aircraft, then, turning left, paralleled the runway about one-fourth mile to the north. The left turn to parallel the runway was made at about 75 feet altitude, and he continued to climb, passing the Martin at about the northwest corner of the airport when his aircraft was at an altitude of from 350 to 400 feet and the Martin at an estimated altitude of 100 feet. He then made a 90-degree left turn, followed by a 45-degree right turn out of traffic.

Both TWA captains and the pilot of the Cessna 195 testified that, in their opinion, there was no imminent danger of collision between any of the aircraft which they observed, since they felt that vertical and horizontal separations were adequate in all of those instances. The pilot of the Cessna 170 testified that, in relation to the Martin, there was no danger of collision between the Cessna 195 and his aircraft, but observed that the Cessna 140 and the Martin appeared to be very close at the time he was in the traffic pattern to the west of the airport. In addition to the senior controller, the assistant controller stated that there was no imminent danger of collision between the Martin and the Cessna 140. Investigation disclosed that separation between the Martin and the Cessna 140 was in excess of 600 feet horizontally and 100-200 feet vertically. However, the pilot of the Cessna 140 stated that he believed there was danger of collision between his aircraft and the Martin.

Test flights established that the control tower and other buildings on the west side of Runway 35 would prevent a pilot on that runway from seeing an aircraft at or near the middle marker and at 300 feet altitude, until the line of sight was elevated following take-off; naturally, the converse also applies.

The pilot of the Cessna 140 would not have been placed in this traffic situation had the airport traffic controller taken more positive action in carrying out his responsibility for the issuance of clearance and information to the various aircraft for the purpose of avoiding collision. The resultant hazardous condition was the underlying factor in causing the pilot of the Cessna 140 to climb his aircraft at too steep an angle. In addition to assuming what the Martin might do, he failed to advise the Cessna 170 and Cessna 195 of this essential traffic and cleared them for take-off, nor did he hold the Cessna 140 until he was positive that the Martin presented no collision hazard. The Board was cognizant of the fact that the controllers must exercise considerable initiative in control of air traffic; their training, however, stresses that they are to know at all times the position of aircraft in the vicinity and have a clear understanding as to what the pilot wishes to do. It is understandable that the controller expected the Martin to make the same pattern it had made in the first simulated ILS approach. The subsequent transmission, based on this belief, in effect, constituted approval to enter the traffic pattern for landing on Runway 31. On the other hand, the pilots of the Martin should have notified the tower well before reaching the middle marker that they did not intend to land and desired permission to make a pass over the field. Thus the controller would have been fully cognizant of the traffic situation. By making the low pass without authorization, the TWA pilots violated good flying practice and contributed materially to the hazardous situation. The Board did not wish to infer that it considers the controller alone to be at fault. There was considerable opportunity for the Martin to notify the tower of modified intentions.

The Board once again desired to emphasize that it is the direct responsibility of any pilot, regardless of clearance issued by a tower, to be vigilant in looking for other aircraft and to fly in such a manner that he does not create a hazard to others in the area. All too often it appears that pilots become complacent about other traffic after receiving a clearance, particularly in an airport control zone.

Violations were cited against the pilot (a student pilot) of the Cessna 140 for carrying a passenger in violation of Civil Air Regulations and for piloting an aircraft not endorsed on his licence.

On 2 and 11 June 1952, a circular* was published reiterating the need for other personnel to be particularly vigilant in handling simulated instrument approaches. The circular pointed out that if the pilot does not advise the controller of the type of simulated approach he plans to execute, the controller is to ascertain the type of approach and intended flight path prior to the time the aircraft begins approach altitude using any of the several standard approach procedures.

Additionally, the circular contained the following: "Controllers were further instructed to issue a specific clearance for each simulated instrument approach prior to the time the aircraft reaches a position which might be in conflict with other aircraft in the vicinity of the airport, whether or not airborne. Essential traffic information is to be given to aircraft concerned to insure safety and facilitate handling of traffic by the controller. Should traffic conditions not permit the completion of the approach, the controller should issue appropriate instructions to abandon the approach or take other necessary action. Phraseologies utilized by controllers shall conform to prior instructions and the word 'practice' should precede the type of approach approved, as: 'Cleared to practice ILS approach'. Pilots are to be requested to make certain position reports, as required, in order that the controller might know the approaching aircraft's position relative to other traffic. Co-ordination shall be effected between air carrier and airport traffic personnel in order that misunderstandings shall not exist as to the purpose of training flights and radio procedures which will be employed by the pilots and the controllers."

In addition, it pointed out that it is imperative that controllers maintain observation of an aircraft during a simulated instrument approach to insure that the pilot conforms to the clearance issued and to avoid conflict with other air traffic.

Following this accident, TWA issued instructions on 3 June 1952, that all pilots are to keep tower operators fully informed of their plans and anticipated manoeuvres during training flights in the vicinity of an airport. Standard low-approach procedures are to be used at all times, unless variance might be indicated for reasons of wind, airport, traffic, or other factors.

Probable Cause

The probable cause of this accident was the action of the Cessna 140 pilot in climbing the aircraft too steeply at low airspeed, resulting in a stall from which recovery was not effected.

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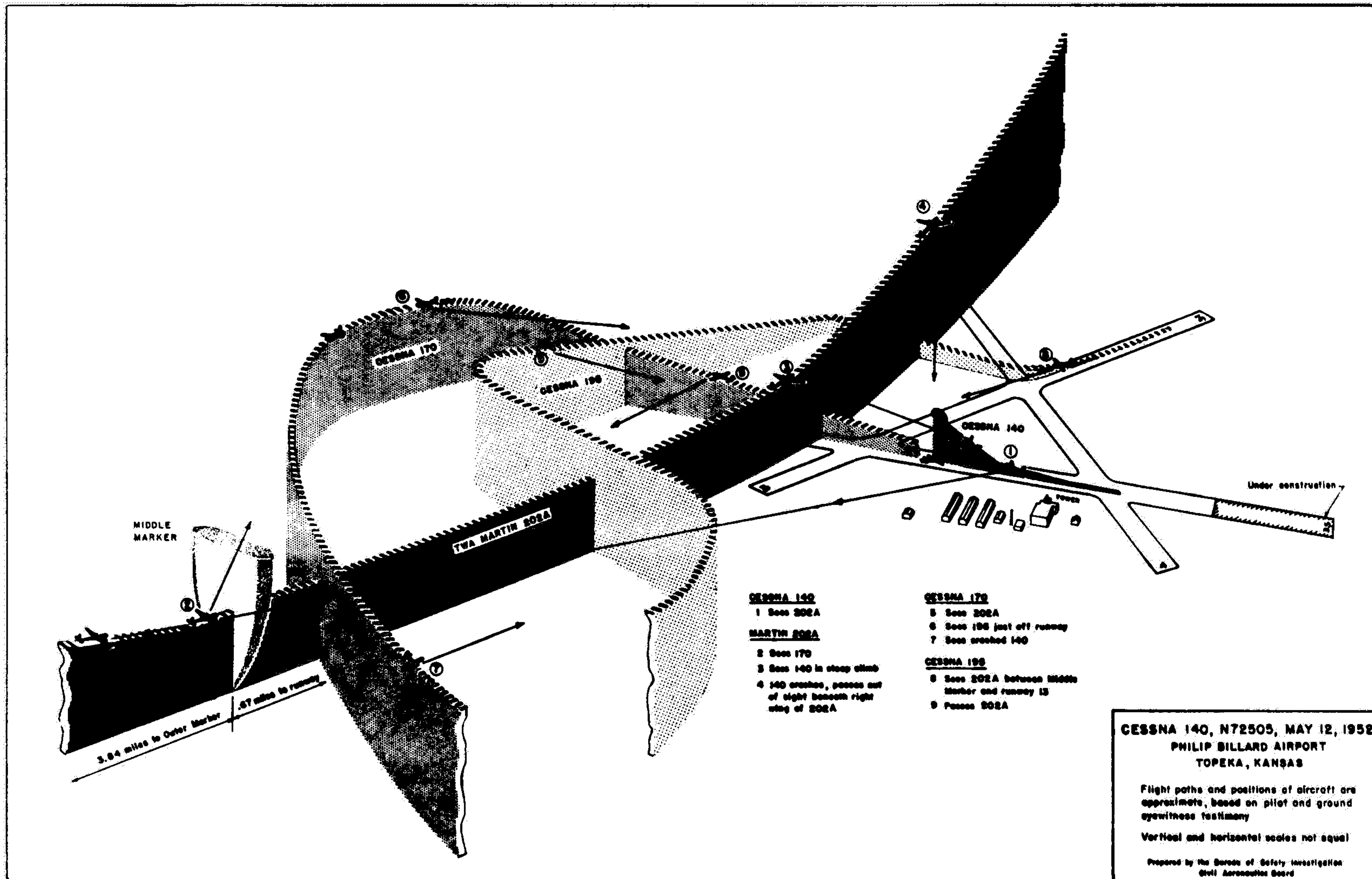
* Division Circular 545/ANC/51, Subject: Handling of Practice Instrument Approaches by Towers/TOWACS.


MIDDLE MARKER
TWA MARTIN 202A
CESSNA 170
CESSNA 190
CESSNA 140
Under construction
3.84 miles to Outer Marker
.67 miles to runway
CESSNA 140
1 Sees 202A
MARTIN 202A
2 Sees 170
3 Sees 140 in steep climb
4 140 crashes, passes out of sight beneath right wing of 202A
CESSNA 170
5 Sees 202A
6 Sees 190 just off runway
7 Sees crashed 140
CESSNA 190
8 Sees 202A between Middle Marker and runway 13
9 Passes 202A
CESSNA 140, N72505, MAY 12, 1952
PHILIP BILLARD AIRPORT
TOPEKA, KANSAS
Flight paths and positions of aircraft are approximate, based on pilot and ground eyewitness testimony
Vertical and horizontal scales not equal
Prepared by the Bureau of Safety Investigation
Civil Aeronautics Board

No. 22

Maritime Central Airways, Consolidated PBY-5A, CF-FAN made a wheels down landing in Sandwich Bay near Cartwright Harbour, Labrador - 18 May 1952

Circumstances

At 1317 hours on 18 May 1952, the aircraft took off from Gander, Newfoundland, with a crew of three, and a cargo of freight, on a charter flight to Cartwright, Labrador.

The aircraft was seen approaching to land in Sandwich Bay near Cartwright Harbour with the main undercarriage extended. The aircraft appeared to come to a sudden stop immediately after the wheels touched the water and the tail of the aircraft was seen to rise to a vertical position and settle back at an angle of about 45 degrees. The crew were killed.

Investigation and Evidence

The aircraft was operating under a temporary authority pending the issue of a Certificate of Airworthiness. There was no evidence of malfunctioning of the airframe, engines or controls.

Weather was not a factor in the accident.

The aircraft departed from Gander without filing a flight plan but the Air Traffic Controller was informed that the destination was Goose Bay, Labrador. The only radio control with the aircraft was the normal taxying and take-off clearances and receipt of the aircraft's ETA at Cartwright by a private radio station.

Eye witnesses, who had some aviation experience, saw the wheels-down approach and landing of the aircraft but had no means with which to warn the pilot of the danger.

It was established that the all-up weight of the aircraft was within the prescribed limits at the take-off but at the time of the accident exceeded the authorized landing limit by about 500 lbs.

Probable Cause

The aircraft crashed on the water through failure on the part of the pilot-in-command to ensure that the main undercarriage was retracted.

ICAO Ref: AR/235

No. 23

BOAC HERMES IV. Forced Landed in French West Africa on 26 May 1952

(Note.- The inquiry was conducted by France in accordance with Annex 13 of the Convention of ICAO)

Circumstances

The aircraft took off on a scheduled service from Tripoli to Kano with a crew of eight and ten passengers. The weather forecast indicated fine weather en route and thunderstorms in the Kano area. Due to faulty use of the variation setting control on the Gyrosyn compass and the inability of the crew to determine the aircraft's position properly by the standard methods, the aircraft, with practically no fuel and over the desert, made a wheels-up landing in a wide depression littered with shifting sand-dunes surrounded by rocky escarpments. The port wing was torn off and the remainder of the aircraft slewed left and came to a standstill without breaking up. No fire resulted and all passengers and crew were evacuated without difficulty. Six were slightly injured but the First Officer died five days later as a result of exhaustion brought about by strain and heat.

Investigation and Evidence

The weather forecast for the flight, drawn up by the meteorological office at Castel Benito, indicated fine weather en route and thunderstorms in the Kano area. On the whole, reports of actual weather received from the aircraft during flight bore out the forecast. The report adds that weather conditions had no direct bearing on the accident, apart from the fact that thundery conditions caused atmospherics which greatly hampered radio communications.

Ground facilities available for the flight included (in British territory) non-directional beacons and radio direction-finding at Accra, Castel Benito, Jos, Kano, Lagos and Wheelus, radio responder beacons at all the airports mentioned with the exception of Jos, and radio range at Wheelus. Ground aids primarily available in French territory included the following:

> Atar (non-directional beacon and MF/DF), Bomako (MF/DF), Dakar (radio range, non-directional beacon, MF/HF DF, responder beacon, locator beacon and approach control), Gao (non-directional beacon and MF/HF DF), Niamey (non-directional beacon, MF/DF and locator beacon), Port Etienne (non-directional beacon, MF and HF/DF), Tunis (non-directional beacon, radio range and HFMF and VHF direction finders). Secondarily, and only on request or on several hours' prior notice, further aids were available at other airfields in French territory. Airborne navigational aids carried by the aircraft were as follows:
>
> > (radio) Marconi HF standard STR VHF, Marconi ADF, RAF homing and approach, Ultra intercom: (navigational) Hughes periscopic sextant, buttle sextant MK. 9B, CL2 Sperry Gyrosyn compass, P. 12 reflecting magnetic compass, and drift-meter. In addition to the appropriate maps, charts and operating manuals, the aircraft carried a start chart, airspeed correction table, Air Almanac (May-August, 1952), rapid navigational tables and star tables for air navigation.

Outlining the ground aids used in the flight and discussing their efficiency, the report says that the identification signal on the Gao beacon was received but the strength was not sufficient to allow a bearing to be taken. The Port Etienne beacon and DF aids at Bamako, Port Etienne and Dakar, however, had provided a large number of valuable position data and bearings. The station at Tamanrasset had acted on its own initiative as a relay between the aircraft and Kano, but was not asked for a bearing; the radio operator had even entered an interrogation mark in his log against this (to him) unknown station - which was nevertheless shown on the airborne navigation chart. The investigator comments that "the scarcity of radio facilities on the Tripoli-Kano desert route casts celestial navigation for an important role on this sector and should, at all events, prompt the fullest possible utilization of the conveniently contactable radio facilities at the point of take-off".

The investigator continues: "We note, however, the existence of available radio facilities which were not utilized, in particular those at Tripoli, use of which might have prevented the aircraft from going astray at the outset, and those at Atar aerodrome which, at a pinch, the aircraft might have been able to reach".

On the functioning of telecommunications the following comment is made: "Serious difficulties in radio communications were encountered both by the aircraft's radio operator and by the ground stations. They were due mainly to the heavy atmospherics resulting from the thundery conditions that night, intensified in the aircraft's case by an unsuspected remoteness due to its error in navigation and complicated at the critical moment of daybreak by the familiar anomalies in propagation".

After normal briefing at Castel Benito, at which the only outstanding points were the possibility of thunderstorms (as mentioned previously) and unreliability of the Kano non-directional beacon, the aircraft took off at 2203 hrs (GMT). On levelling out at 12,000 feet the captain noticed a 25-degree difference in the readings of the two compasses and asked the navigator to check the true course by astral observation. The navigator reported that the CL2 (201 degrees) was correct and the P.12 (226 degree) was in error. Meanwhile the captain and engineer tested, without result, the various electrical circuits which might have caused deviation in P.12. No attempt was made to check, by means of radio aids, track made good. The captain decided to proceed with the flight, steering by means of the CL2 compass and rejecting the P.12 as unserviceable. At 0124 hours, after a series of star fixes, the aircraft was thought by the crew to be about 12 miles east of the direct track and a little over halfway between Tripoli and Kano. By this time the difference in compass reading had increased to 54 degrees but the P.12 readings were being ignored. At 0324 hours, a two-star fix indicated that the aircraft was 100 miles west of Kano and as the ETA was 0402 hours, the navigator attempted to tune in to the MF beacon but without success. Meanwhile, the radio officer had been passing the hourly Pomars to Malta and Kano and had received meteorological information from the latter airport which indicated that it was experiencing electrical storms; no storms were, however, seen by the crew.

At approximately 0400 hours the engineer officer noticed that the variation setting control on the CL2 Master Unit was set at 60 degrees W. The navigator, it was discovered, was under the impression that the setting was 6 degrees W. The VSC which enables true courses to be steered, is not normally in use. On this occasion, however, the navigator did use it but had mis-read the graduation and had initially set 30 degrees W., increasing progressively to 60 degrees W. during the flight. The error was immediately reported to the captain and when the VSC was reset to zero the reading of the two compasses agreed. Throughout the flight of six hours the navigator's astro-shots had been made on the wrong stars; this, the report notes, should have been indicated by the difficulty he had experienced in lining up on pre-computed settings. (The periscopic sextant gives a limited field of vision and it is necessary to know the approximate position of the aircraft to calculate altitude and azimuth of a given star from the astro-navigation tables.)

Reconstruction of the flight shows that the aircraft was then probably about 900 miles N.W. of Kano, 800 miles E. of Port Etienne and 400 miles N.W. of the airfield at Gao, with sufficient fuel aboard for about four hours' flight at cruising power.

A dead-reckoning position had been estimated, but this had indicated that the aircraft was very much further north than it actually could have been, since it was based on a 60-degree course-error instead of an error increasing progressively from 27 degrees to 54 degrees. The first recorded alteration of course came at 0444 hours, when the captain decided to fly east. At about this time he instructed the engineer officer to reduce power in order to conserve fuel.

The following summary gives the sequence of events as reconstructed in the report in approximate order. 0454 hours, Course altered to 55 degrees. 0515 hours, Course altered to 180 degrees; no decisive action taken during this time. 0535 hours, Decision apparently taken to head for Port Etienne (whose beacon was picked up on the radio compass) although navigation chart carried aboard Hermes stopped over 600 miles short of Port Etienne. 0438-0554 hours, Aircraft called successively Accra, Lagos and Kano on various frequencies but received no reply. 0532 hours, Emergency procedure adopted. 0557 hours, Gao confirmed that MF beacon was switched on. 0558 hours, SOS procedure adopted; Hermes probably still within 400 miles of Gao heading west. No acknowledgment of first SOS message although stations at Niamey, Kano and Tessalit were communicating with one another on the subject of the Hermes. 0615 hours, First reply (from Accra and Kano) to distress message from Hermes stating its estimated position and that it had two hours' fuel left and was heading for Port Etienne. 0621 hours, Accra accepted control of aircraft at request of radio operator. 0658 hours, Aircraft stated that it was one hour from coast "thereby completely upsetting any calculations which might have been made regarding its progress". 0722 hours, Aircraft first contacted Dakar; thereafter true bearings were passed regularly by Bamako, Dakar and Port Etienne. 0812 hours, Dakar logged first distress signal from aircraft "which had at last realized the impossibility of its reaching the coast". 0845 hours, (approximately), Aircraft descended and after a circuitof a native village belly-landed at a point approximately 71 miles SSE of Atar (the captain had asked the engineer to warn him when there was only enough fuel for descent, two overshoots and landing, which was made when this moment arrived).

Discussing the evidence, the report states that identification of the stars actually shot by the navigator and the utilization of the corresponding measured altitudes should have permitted a close reconstruction of the route flown. This was attempted but without complete success... "It is to be feared that the 1st/Officer was content with shooting stars of minor importance provided merely that he succeeded in lining them up with his presetting."

The aircraft's estimated position at 0600 hours, which was already too optimistic, was 460 miles from Port Etienne. At 180 kt (the speed given in the distress message received at Accra and Kano at 0615 hours) the aircraft would not have been able to reach Port Etienne until 0835 hours, yet the message stated that it had only two hours' fuel left. Having accepted control of the aircraft at 0621, Accra (the report implied) should have warned the captain that his chance of reaching Port Etienne was slight and should have told him of the possibility offered by Atar. This omission, says the report, "is the more inexplicable in that Kano ATC - later on, it is true - specifically drew Accra ATC's attention to this point in a message at 0730 hours". The highly optimistic DR positions given by the aircraft during this period are not explained by the shots first on Jupiter and subsequently on the sun.

As the Hermes did not send a repetition of its state of urgency until 0812 hours, the latter control centre had no apprehensions regarding the disastrous inadequacy of the aircraft's range. However, Accra, for its part, did not make sure that Dakar was acquainted in time with all the factors in the problem or that the aircraft possessed information about the potential usefulness of Atar; moreover, Accra's request that the aircraft should communicate with it by R/T for nearly an hour precluded the use of radio bearings during that period.

Summing up, the report states "the investigation has established that the aircraft, crew and Corporation were in order with respect to the legislation in force, that the airworthiness was not in question but that, in varying degrees, the aircrew members, with the exception of the engineer officer and cabin personnel, did not display the full measure of competency required for the accomplishment of their mission. There is no doubt that defective telecommunications constituted a circumstance promoting the occurrence of the accident".

Causes of the accident, in chronological order, are set out by the report as follows:

(1) Faulty use by the navigator of the variation setting control on the CL2 Gyrosyn compass.

(2) Faulty checking of compasses by incorrect astral bearing and without the aid of radio bearings.

(3) Incorrect inference drawn by the captain in pronouncing the CL2 Gyrosyn compass correct and the P. 12 magnetic compass unserviceable.

(4) Fault on the part of the captain in not returning to Tripoli when the P. 12 compass was regarded as unserviceable (in breach of BOAC regulations).

(5) Inability of the crew to realize that astro shots were being taken on the wrong stars.

(6) Inability of the crew to determine the aircraft's position properly by the standard methods when the VSC setting error was discovered.

(7) Lack of decisive action on the part of the captain once he knew he had lost his way.

(8) Ignorance, on the part of those on board, of the assistance which could have been afforded by Atar airfield.

The report makes nine recommendations, as follows:

(1) The graduation of an instrument should not cause confusion and if the figures indicate tens instead of units, it is desirable that this should be clearly indicated by a characteristic sign. (The VSC of the CL2 compass on board was marked in tens but did not have the sign "X10", which the manufacturer on his own initiative had added on the more recently manufactured instruments).

(2) Use of the periscopic sextant, which has a very restricted field of vision, should form the subject of special precautions with a view to the certain identification of the stars shot.

(3) In-flight checking of a compass by an astral bearing should rest only on a reliably identifiable star.

(4) On long-range aircraft the carrying of a second magnetic compass of simple and robust design would constitute a wise precaution in anticipation of difficulties similar to those which were the source of the loss of G-ALDN.

(5) The captain should always be competent to judge the quality of the navigator's work.

(6) Possession of an official navigator's licence by a member of the crew* should be required for long-range flights over areas indifferently equipped with ground aids, such as those we have been considering. (At present, United Kingdom regulations require the carriage of a licensed navigator for a flight over water of at least 1 000 nautical miles or for a non-stop flight of more than 1 500 nautical miles over land. The distance from Tripoli to Kano is 1 264 nautical miles.)

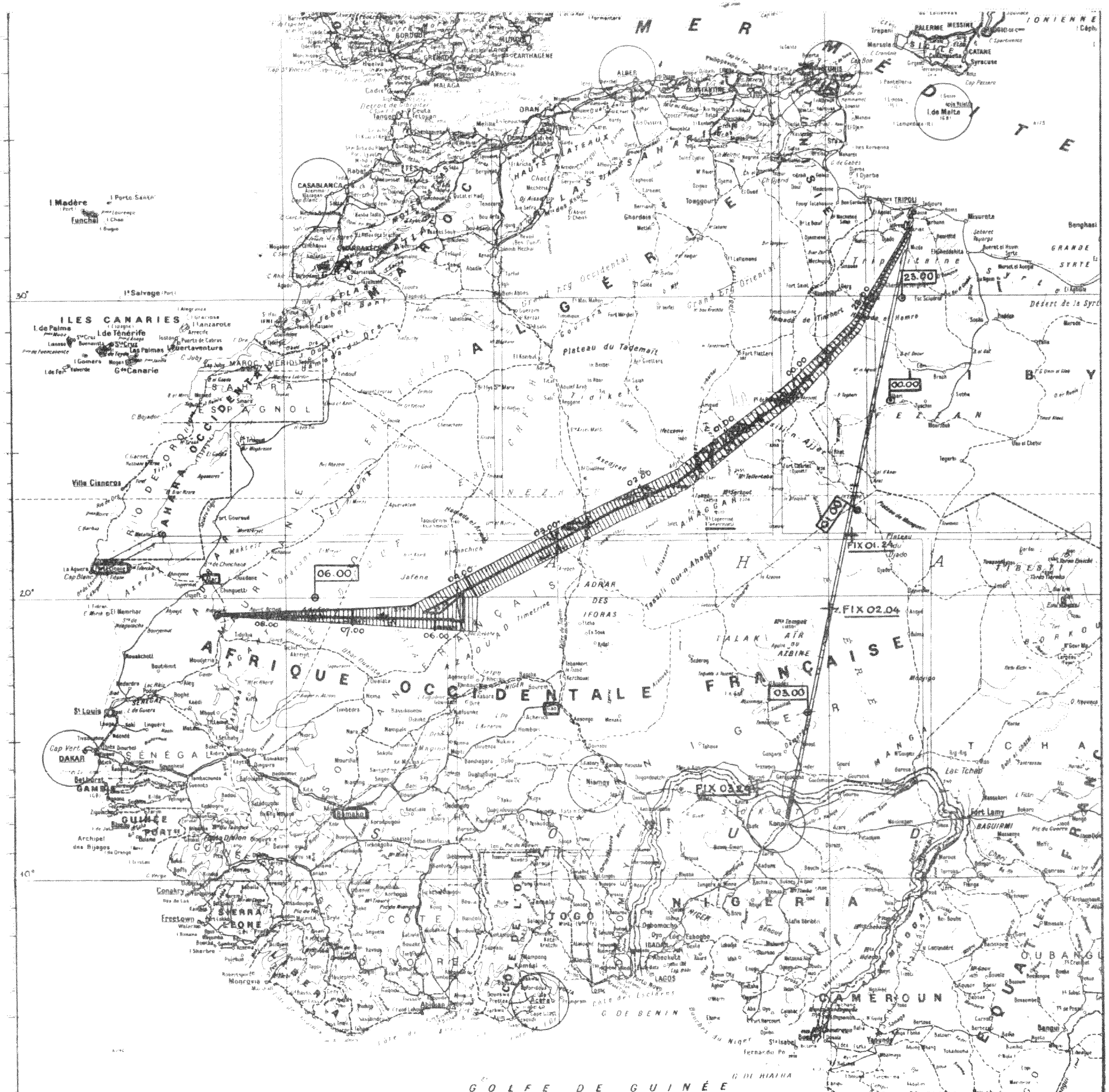
(7) An increase in the number of ground aids on the Tripoli-Kano stage is desirable. The practical realization of the projects to equip Rhadames, Rhat and Agades with continuous-operation radio beacons would meet the requirements revealed by the abnormal flight discussed in this report.

(8) Against the preceding recommendation it must be pointed out afresh that any inadequacies in the equipment of an air route render it incumbent on users to make the best possible use of the existing facilities available, which, in the present instance, was not done in respect of the radio aids at Tripoli on take-off.

(9) Examination of the communications exchanged between the ground radio stations reveals the need for closer liaison between the British and French control centres in Africa. Thus the failure to make use of the possibilities presented by Atar airfield appears to have been the result of insufficient co-operation between Kano, Accra and Dakar.

* The navigator held a Commercial Pilot's Licence with Instrument rating. He had failed to obtain the Navigator's Licence on the Senior Commercial Pilot Licence but he held a navigating officer's certificate issued by BOAC.

ICAO Ref: AR/277



18. CHART SHOWING ROUTE FLOWN

Flight by the Hermes aircraft G-ALDN which was involved in an accident on 26th May, 1952.

Main fixes obtained by aircraft.

Approximate reconstruction of route actually followed.

18. CARTE INDIQUANT LA ROUTE SUIVIE

Voyage du Hermes G-ALDN, accidenté le 26 mai 1952.

Principaux points faits à bord.

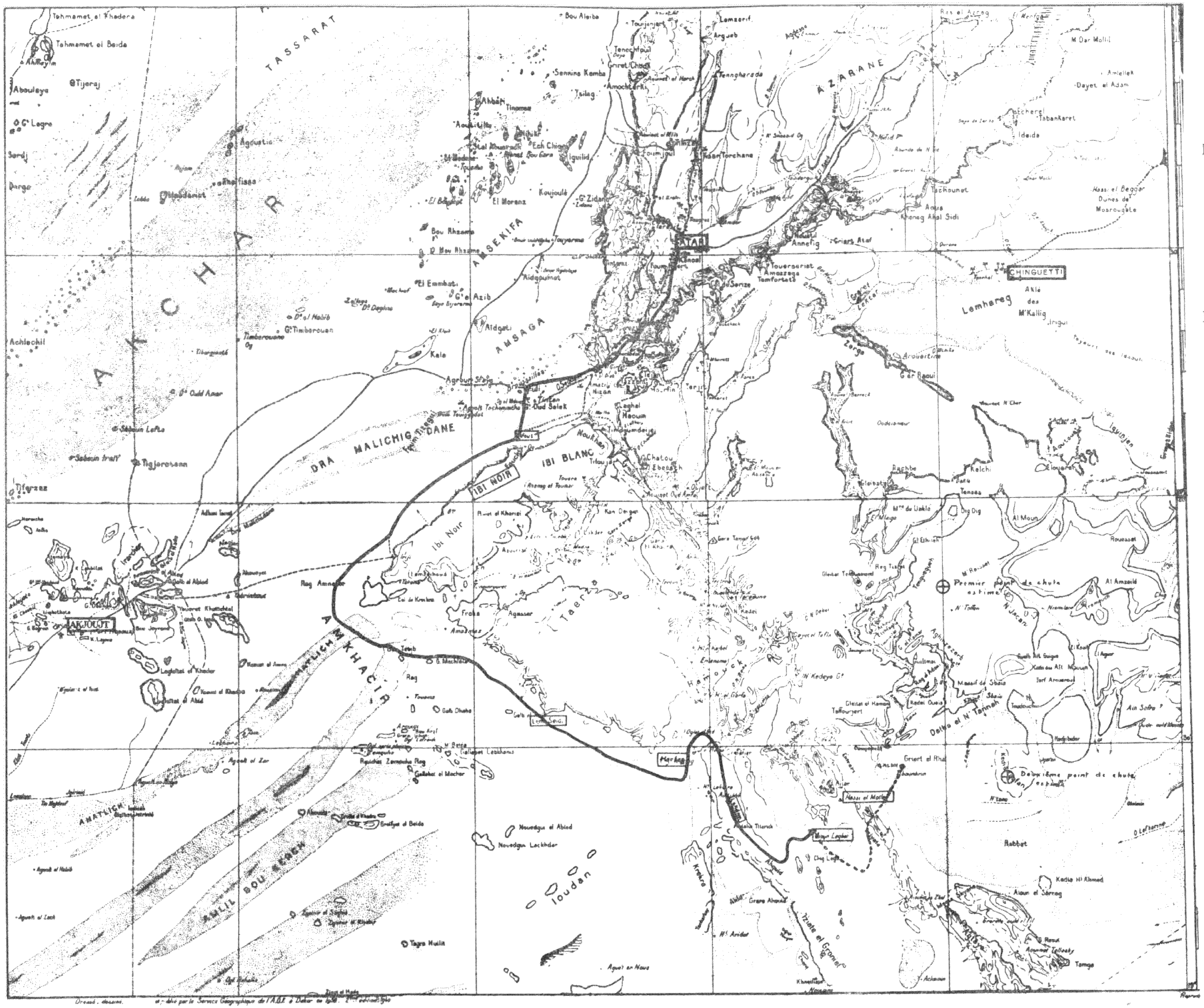
Restitution approximative du trajet réel.

18. MAPA EN QUE SE INDICA LA RUTA SEGUIDA

Viaje del Hermes G-ALDN, cuyo accidente ocurrió el 26 de mayo de 1952.

Principales posiciones obtenidas por la aeronave.

Restitución aproximada del trayecto real.



19. CHART SHOWING ENVIRONS OF SCENE OF ACCIDENT

Stage by lorry. ————

Stage on camel-back. – – – – –

19. CARTE INDIQUANT LA SCENE DE L'ACCIDENT

Trajet en camion. ————

Trajet à dos de chameau. – – –

19. MAPA EN QUE APARECEN LOS ALREDEDORES DE LA ESCENA DEL ACCIDENTE

Trayecto en camión. ————

Trayecto en camello. – – – – –

Scale - Echelle - Escala : 1:500.000

SCENE OF ACCIDENT TO HERMES AIRCRAFT G-ALDN.

DESERT OF MAURITANIA (FRENCH WEST AFRICA).

No. 24

Morton Air Services Ltd., Consul G-AHFT, ditched in the English Channel after failure of one engine, 14 June 1952 - Accident Report MCAP 110

Circumstances

The aircraft, a twin-engined Consul, was on a charter flight from Croydon, England to Le Mars, France with seven passengers and the pilot. The flight was without incident until shortly after crossing the English coast in the vicinity of Brighton at about 0855. The starboard engine gave one or two bangs which the pilot thought might be due to carburettor icing. The engine quickly recovered, however, and the flight proceeded. At about 0915 the starboard engine again began to cough. This time it did not recover. The aircraft was then twenty-two nautical miles from the nearest aerodrome, namely Le Havre on the French coast while the nearest English aerodrome was Shoreham, fifty-seven nautical miles in the opposite direction. The pilot elected to turn back to the English coast and make a 180 degrees turn to port. The aircraft continuously lost height and finally ditched twelve miles south of Brighton at 0949 hours. There were only two passenger survivors who were picked up two hours later.

Investigation and Evidence

The pilot, the seven passengers and their baggage were weighed and the Load Sheet made out. This showed that the all-up weight was 8,241 pounds, which was 9 pounds less than the maximum permissible.

The passengers were conducted to the aircraft by an employee of the Company, who instructed them in the use of safety-belts, but made no mention of the lifebelts carried in the aircraft. Six passengers were seated in the normal passenger cabin and the seventh occupied the right-hand seat in the pilot's cockpit, which is normally the radio officer's seat.

Because no radio officer was carried, the pilot asked this passenger if he would operate the VHF frequency switch as it was difficult for him to reach it himself. The passenger occupying this seat had been a Battle of Britain pilot. He fortunately survived the accident and the Court was greatly assisted by his evidence.

At 0834 the aircraft was cleared by Croydon Control to take-off, leaving the Control Area seven miles south-west of Dunsfold, and crossing Dunsfold at 2 000 feet. At 0835 the aircraft was airborne and at 0836 Croydon asked the aircraft to report over Dunsfold. At 0834 the pilot informed Croydon Control that he estimated his position as being 10 miles south of Dunsfold, which is about 22 miles south of Croydon, but having regard to the performance of the aircraft and the prevailing winds, the Court was of the opinion that the pilot must have been mistaken in giving this position.

When crossing the coast, according to the witness seated beside the pilot, the aircraft was flying at 140 miles per hour and at a height of 1 800-2 000 feet. Shortly after leaving the coast the starboard engine gave one or two bangs, and for a very short time ran roughly. From a remark made by the pilot it appears that he thought this was caused by carburettor icing and he, therefore, moved the "hot and cold air" control lever. According to evidence, the lever was down in the "hot" position at the time and the pilot moved it up, although it was clearly his intention to inject hot air.

The starboard engine very quickly recovered, and under these circumstances the Court saw no reason to criticise the pilot's decision to continue the flight.

At a time estimated as twenty minutes or half an hour after crossing the coast, and which the reconstruction of the flight indicates as being about 0915, the starboard engine started coughing. The pilot opened the throttle and pumped it several times but without result, and the revolution counter for that engine fluctuated between zero and 1 600 rpm. The pilot adjusted the rudder trim, and a little later opened the port throttle to 2 000 revs. He continued to fly in this manner for a period estimated as anything up to five minutes, during which time he may well have been assessing the relative advantage of going on or turning back. At about 0920 hours he made a turn of 180 degrees to port.

The decision to turn was a vital one, and much evidence and argument ensued as to whether the pilot was right in making it. At the time the aircraft was about 57 nautical miles from Shoreham, the nearest English aerodrome, and about 22 nautical miles from the nearest French aerodrome, which was Le Havre. On the assumption that a forced landing was inevitable, the convenience of passengers and the effecting of necessary repairs to the aircraft must have weighed strongly in favour of returning to England.

In addition, among other factors which may have influenced the pilot in favour of turning back are the following:-

(a) He had recently experienced the weather conditions in England but had only the forecast to rely upon for the conditions along the coast of France. At the time the turn was made the pilot was in cloud and could see nothing which would suggest that the weather in France was better than in England. In these conditions he may have considered it preferable to return to England where the coastline was comparatively flat in the vicinity of Shoreham, whereas near Le Havre and Deauville there are high cliffs.

(b) He had given Deauville as his alternate and it is therefore probable that had he decided to go on, he would have made for that aerodrome. However, in view of the weather, and the fact that he had previously failed to contact Deauville by radio, he may well have felt apprehensive about attempting an IFR landing there.

(c) A belief that the aircraft, with the power available, would be able to reach an aerodrome in England.

This belief may have been based on tests which he underwent with the Ministry of Civil Aviation for his instrument rating when he was required to fly a Consul with one engine throttled back to 1 200 rpm. This test, however, was not carried out at full load and there is no satisfactory evidence that the pilot had ever flown a Consul asymmetrically at full load.

(d) Further, it was suggested that since the Channel shipping lanes lay nearer to the English coast than the French, the chances of rescue were better on the English side of the Channel if ditching became necessary. However, the Court has some doubt as to whether it would be proper to assume that the pilot had any knowledge of the shipping lanes, and that this factor therefore entered into his calculations. As against these, however, and assuming that the pilot was aware of his approximate position, the following points should have been present in his mind:-

(a) His greater proximity to the French coast.

(b) The prevailing wind, which would have been about astern of him had he continued towards France.

(c) According to the meteorological forecast the weather on the coast of France would have been no worse than in England and should have improved the further inland he got.

(d) The possibility of the complete failure of the starboard engine which would make it doubtful whether the aircraft could reach England.

As events turned out, if the aircraft had continued on its course the accident might well have been avoided, since the aircraft maintained height long enough to enable it to have made a landing somewhere in France. But the Court is not prepared to hold that the pilot's decision, taken as it was in an emergency, was wholly unjustified.

After the turn, the starboard engine continued to cough and bang with the rpm. fluctuating up to 1 600 rpm. for about a quarter of an hour, after which it ceased working altogether and the propeller merely windmilled. During this period a speed of about 120 miles per hour was maintained, no alteration was made to the throttle of the port engine and the aircraft slowly lost height. After the starboard engine failed completely, the aircraft then being at a height of about 1 000 feet, the pilot opened the throttle of the port engine to the gate, but made no adjustment to the mixture control. From shortly before the turn until the aircraft ditched, the pilot flew at 120 miles per hour, except for a very short time when, at about 300 feet, he reduced speed to approximately 90 miles per hour. This failure to reduce speed and to put extra boost on the port engine is significant, as tests carried out subsequently by a test pilot in conditions simulated as far as possible to those of the accident, revealed that if the speed had been reduced to about 90 miles per hour as soon as the starboard engine faltered, and the maximum continuous boost had been applied to the port engine, the rate of the descent would have been substantially reduced and the aircraft would probably have made the English coast. Whether the pilot's failure in this regard was due merely to lack of knowledge of this type of aircraft or to his confusion in the emergency, it is not possible to determine.

The actual ditching of the aircraft occurred at about 0949 at a position about 12 nautical miles south of Brighton, as far as can be estimated from the spot where the survivors were picked up some two hours later.

Some criticism was directed at the manner in which the ditching procedure was carried out. There was evidence that the port engine was still under full power when the aircraft struck the water and that the ditching took place at 120 miles per hour, whereas it should have been carried out at about 80 miles per hour. Moreover, it was established that the pilot took no steps to warn the passengers that ditching was imminent and to instruct them to put on their life-jackets and tighten their safety-belts. Since, however, all the passengers were able to get clear of the aircraft, which remained afloat for about ten minutes, the Court did not attach great importance to these matters as possible causes of loss of life.

None of the passengers were injured in the ditching, but the pilot received a cut over one eye and appeared somewhat dazed.

RECOMMENDATIONS - At present no regulation prescribes the height at which aircraft may fly on short sea crossings. In the case of twin-engined aircraft which at take-off weight are unable to maintain height in the event of the failure of one engine, it is considered that greater safety might be achieved if they were compelled to fly at such a height that at any stage of a flight over water they could make land if deprived of the use of one engine.

According to the present regulations, the display in the aircraft of a notice depicting the method of use of life-jackets is all that is required.

It is considered that this regulation might well be extended to provide that passengers should be briefed before take-off as to the stowage of life-jackets, their proper method of use, and the position of escape hatches.

Mention has been made, as a possible cause of the accident, of the pilot's unfamiliarity with the type of aircraft he was required to fly. To avoid such a risk in future, it is considered that operators should never put a pilot in charge of an aircraft for hire or reward, until he had done at least one "operational" flight under the supervision of one of the operator's regular pilots. Such a system would also ensure that operators gained some knowledge of the new pilot's capabilities in "operational" conditions.

It is considered essential that whenever the radio equipment is to be operated by the pilot, all the controls of such equipment should be within his easy reach. It is most undesirable that the pilot should have to enlist the co-operation for this purpose of the occupant of the seat next to him, and particularly so when that occupant happens to be a passenger.

It is considered that there should always be provided a type of microphone which can be operated by the pilot without requiring him to remove his hands from the aircraft and engine controls.

It was suggested that every aircraft flying over water should be equipped with some form of wireless telegraphy capable of working on the International Distress Frequency, and should carry a radio operator. The Court does not feel that the evidence justifies any recommendation in that regard.

Probable Cause

The probable cause of this accident was primarily the failure of the starboard engine, and, thereafter the disaster must be attributed to errors on the part of the pilot.

ICAO Ref: AR/268

No. 25

Temco Swift & American Airlines Inc. DC-6, collision at Dallas, Texas, 28 June 1952. CAB Accident Investigation Report File No. 1-0045. Released 4 March 1953

Circumstances

At 0656, 28 June 1952, two employees of Central Airlines, Love Field, Dallas, departed Denton for Love Field in a privately-owned Temco Swift-N-3858K.

The DC-6, American Airlines Flight 910 originated at San Francisco, Cal., at 2305 on 27 June 1952. The DC-6 carried fifty-five passengers, and five crew members.

At 0650 the DC-6 reported over the Fort Worth radio range station at 5 000 feet MSL. The flight descended to 2 000 feet MSL south of Grapevine, Texas; the Dallas tower was contacted and clearance received to approach for landing on Runway 13. The First Officer was making the final approach down the ILS glide path and localizer and was maintaining visual reference to the ground. During the final approach the pilots and flight engineer heard the tower give instructions to a light aircraft. At an altitude of 400 feet the First Officer sighted the Swift as it came into view from under the fuselage of the descending DC-6, almost abeam of his side cockpit window and slightly lower. For the fraction of a second remaining before the collision, he had insufficient time to take effective evasive action. The Swift fell in a left spin, striking the ground 4 410 feet northeast of the approach end of Runway 13. Both occupants of the Swift were killed. The DC-6 landed safely and no one on board was injured.

Investigation and Evidence

The pilot of the Swift had been commuting to work from Denton, which is about 33 miles from Love Field and almost in a direct line with Runway 13. While the Swift was approaching Love Field, a broken transmission was received by the controller in which only the words, "straight-in approach" were heard. The aircraft was between the outer and middle markers at the time this transmission was made and less than 4.15 miles from the airport and appeared to the controller to be at about 500 feet altitude and to be about one-half mile behind the higher DC-6 then in its final approach. The controller called the unidentified aircraft as follows: "Aircraft called Love Tower be number two to land follow the American six there ahead of you. Runway one three wind south southeast ten." This transmission was made immediately after the DC-6 was cleared to land No. 1. The DC-6 and the Swift appeared to be converging rapidly. Owing to the distance and the fact that the aircraft presented a head-on view against the clear sky, he believed the Swift was a Beechcraft Bonanza. Concerned about the convergence and still of the belief that the Swift was overtaking the DC-6 from the rear, the controller, only a very few seconds before the collision, advised as follows: "Bonanza give way to your right or left. Make a right or left turn immediately there." This transmission was made after the Swift had crossed the path of the DC-6 from left to right. The controller did not see the cross-over. By the time he realized that there was imminent danger of collision, he had no opportunity to transmit precautionary advice to the pilots of the DC-6, in addition to the last instructions which he had given to the pilot of the smaller aircraft. It appeared to the controller that the pilot of the Swift immediately made an abrupt left bank following this transmission, and collision occurred immediately. He stated that the Swift appeared to be flying at constant altitude at all times before the crash. The controller testified that he did not learn that the Swift had not overtaken the DC-6, as was his impression, until investigation revealed that it was in front of the DC-6 during the entire period he had the Swift in sight.

Observation by two eye witnesses, passengers in the DC-6 and both United States Air Force Pilots, established the Swift crossed the course of the DC-6 from left to right before the collision.

The proximity of the two aircraft just before the collision, combined with the closing speed, made it impossible for the pilot of either aircraft to take effective evasive action. It is questionable whether the pilots of either aircraft could definitely have seen one another between the outer marker and point of collision. Their actual relative positions cannot be conclusively established between these two points.

The Swift pilot either failed to indicate his intention to land while still some distance from the airport, ot was unsuccessful in attempting a transmission to the tower. In any event, information necessary for initiation of positive traffic control was not received by the controller. A position report by the Swift would have enabled the controller to be apprised of the aircraft, its position, and approximate speed; thus he would have had time to properly space the two approaches. It could be expected that had the controller known the actual relative positions of the two aircraft, he would have been less likely to have made an error in depth perception (reversing the actual positions of the two aircraft).

The Swift was assigned No. 2 landing sequence shortly after the DC-6 passed over the outer marker and was given clearance to land No. 1. No further transmissions were made by the controller until he instructed the smaller aircraft to turn right or left and the accident occurred immediately thereafter. It is about three miles from the outer marker to the scene of the accident. There is no indication that the pilot of the Swift took adequate measures to locate the DC-6 either by a query addressed to the controller or efforts to clear the area visually. If the crossover (prior to the controller's final message) was made with the intent of locating the DC-6 it did not satisfy that purpose for the Swift pilot thus placed his aircraft in a position where collision was inevitable.

Since the Swift pilot had been commuting to Love Field for a number of months, he should have been aware of the local airport traffic rules, as required by Civil Air Regulations. One of these rules requires aircraft equipped with a transmitter to call the tower while 10 minutes from the airport. Had the Swift pilot done this, there would have been ample time for him to comply with the tower's instructions to land No. 2 behind the DC-6. His message, transmitted somewhere between the outer marker and point of collision, indicated by the words "straight-in approach" that he intended to make such an approach. Owing to indications that the transmitter in the Swift was intermittedly inoperative, it is not known whether an earlier transmission was attempted. The DC-6 radio contacts were made in accordance with approved operating procedures for the route.

If two-way radio contact could not be established, owing to radio failure, it was the duty of the Swift pilot to approach the traffic pattern with caution, complying with air traffic rules for VFR flight. Since two-way radio contact was not established, he should have proceeded with due regard to the possibility that other aircraft were in the area. It appears, however, that he proceeded inbound past the outer marker toward Runway 13 without exercising reasonable prudence in his approach.

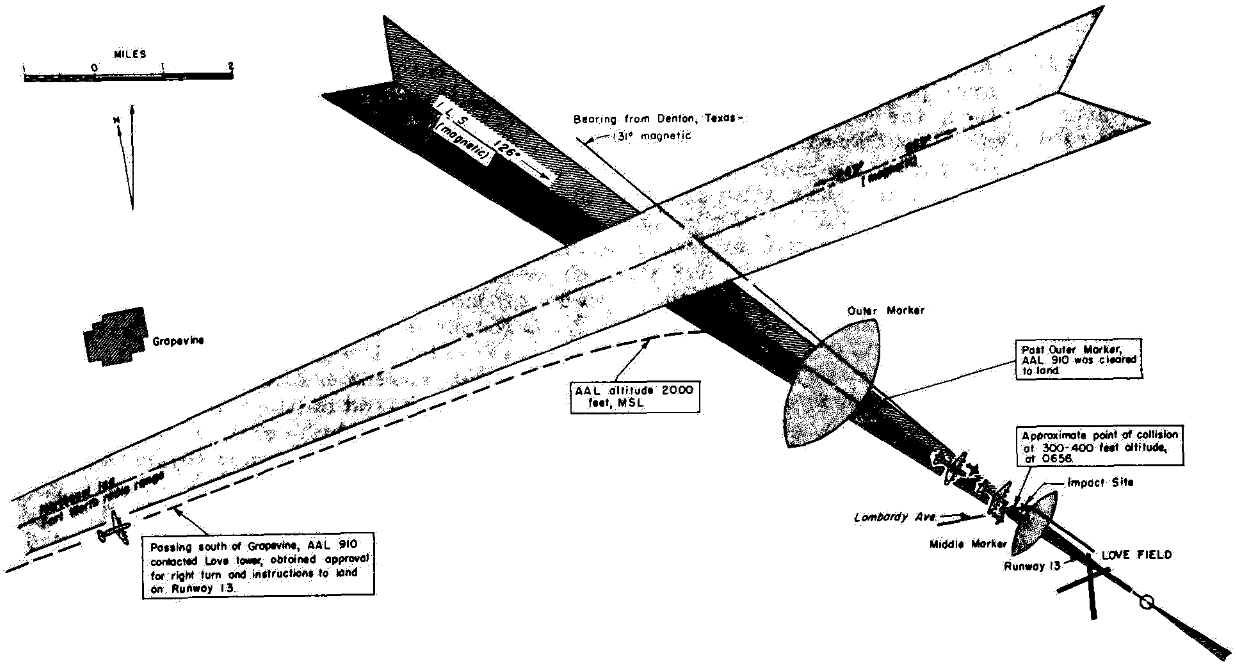
Although the sun offered some restriction to visibility, the line of sight from the DC-6 during the period between Grapevine and the right turn to final approachwould have been slightly downward rather than directly into the sun. Owing to the small size of the Swift and the distance, the aluminum skin probably blended into the light-colored terrain to an undetermined degree, thus making the Swift difficult to see.

During the right turn of the DC-6 the Swift could very well have been in a blind area to the crew. From this point on, cockpit structure and the nose of the DC-6 presented considerable, restriction to vision. Investigation indicated that the Swift would not have been visible to the crew of the DC-6 until only a second or two before collision. The Swift's exact altitude, heading, and speed cannot be accurately ascertained. The pilots of the DC-6 were not aware of the presence of another aircraft in the area until they had reached the outer marker and had received clearance for landing. In the short time taken to fly from the outer marker to the point of collision, the pilots of the DC-6 tried to sight the other aircraft, but the Swift apparently remained in a blind spot forward and below the DC-6 nose structure, especially during the crossover. The Swift was in such a position relative to the DC-6, especially as the situation became more critical, that the pilots of the larger aircraft were unable to see it. Furthermore, from the time the controller advised the smaller aircraft to turn right or left there was insufficient time for the DC-6 pilots to search properly the area ahead, below, and to the sides of their aircraft. The first officer was, of necessity, directing most of his attention to instruments within the cockpit, since he was practising an ILS approach without a hood. After the Swift made the crossover, it was continuously in a blind spot to the captain until only an instant before collision, when evasive action was impossible.

The DC-6 had received clearance to land No. 1, and such clearance is an indication from the tower that the approach path is clear. This is one of the basic functions of airport traffic control. The crew of the DC-6, therefore, could reasonably have expected to be able to complete their approach and landing without interference from other aircraft. A clearance does not relieve a pilot of the responsibility for maintaining vigilance. However, it appears that the crew of the DC-6 was maintaining an alert lookout, and did not act in a manner inconsistent with their responsibilities in failing to observe the other aircraft.

Probable Cause

The Board determines that the probable cause of this accident was the Swift pilot's failure to exercise reasonable prudence in his approach; error in judgment of the situation on the part of the controller was a contributing factor.



PROBABLE FLIGHT PATHS AND APPROXIMATE RELATIVE POSITIONS
OF AMERICAN AIRLINES DC-6, N 90750,
AND TEMCO SWIFT, N 3858 K,
DALLAS, TEXAS-JUNE 28, 1952

ICAO Ref: AR/257

No. 26

La Tuque Air Services Ltd., Republic RC-3 made a forced landing on Lac en Coeur, Quebec due to engine trouble, 2 July 1952

Circumstances

At about 0945 hours EST on 2 July 1952, the aircraft took off from Lac à Beauce, Quebec, and proceeded to Lake Long, Quebec, about ten miles away, where it landed without incident.

At about 1010 hours EST, after taxying for about ten minutes, the aircraft took off for Lac à Beauce with three passengers on board. The aircraft then circled the lake gaining altitude, until at 2 600 feet, the pilot levelled off and set course for Lac à Beauce. One or two minutes later the engine sputtered and stopped. The mixture control was put into the "full rich" position and the engine picked up momentarily and then stopped again. The aircraft was then turned toward a small lake that was within gliding distance. Due to the height of the aircraft and the geographical features of the area, the pilot decided to conduct the forced landing downwind. With flaps down, the aircraft was still high on reaching the edge of the lake, and the pilot dived to the lake in an attempt to lose height. The aircraft was levelled off at about 2-3 feet, however, due to the excess speed gained in the dive, the aircraft did not sink but continued to "float". The nose of the aircraft was then eased down until the hull touched the surface of the water.

The aircraftwas then about three-fifths of the distance across the lake and the pilot attempted to turn the aircraft in to a small bay which he had glimpsed on the left. The aircraft became airborne again but the pilot eased it back on to the water just before striking the trees on the northeast edge of the lake. The pilot and two passengers received minor injuries and the aircraft was substantially damaged.

Investigation and Evidence

Examination of the aircraft failed to reveal any evidence of malfunctioning of the airframe or controls. Tests were made on the engine in an attempt to establish the cause of its failure but without success, since it functioned normally throughout these tests.

Weather was not a factor in the accident.

Conclusions

Through failure of the engine, the cause of which was undetermined, an emergency forced landing, downwind, was conducted on a small lake which resulted in the aircraft striking trees on the shoreline.

ICAO Ref: AR/236

No. 27

Photoflight Ltd., (Elstree, Herts) Auster V-G-ALBW aircraft crashed on 24 July 1952 at Booker Airfield, Bucks.

Circumstances

The pilot took off alone from Elstree at 1210 hours to obtain aerial photographs of a factory at Melksham, Wiltshire. When returning 2-1/2 hours later the plane crashed to the ground from a low altitude killing the pilot.

Investigation and Evidence

The aircraft carried enough fuel to allow a cruising endurance of approximately 4-1/2 hours.

An oblique camera was installed but a vertical camera was not carried and a witness stated that he saw a breeze block on a circular metal disc over the aperture in the cabin floor when he was talking to the pilot at Elstree prior to take-off. (It has not been possible to determine if this "circular metal disc" accorded with Auster modification No. 1633.)

At about 1330 hours the plane was seen to land on very rough ground in a field near the factory at Melksham and to take off shortly after. At approximately 1500 hours a witness saw the aircraft flying at approximately 250 feet in an easterly direction close to Booker airfield. The engine noise suddenly ceased and shortly afterwards the aircraft dived steeply to the ground.

Examination failed to reveal any pre-crash failure.

There seems little doubt that the aircraft finally stalled from a low altitude after a sudden reduction of engine power. This, however, presupposes a lack of effective action by an experienced pilot. Consideration was given to the possibility that the pilot may have been affected by inhaling carbon monoxide from the engine exhaust gas. It was known that the pilot was in the habit of placing a breeze block on top of the vertical camera aperture blanking plate to hold it in position. Furthermore, it seemed quite possible that this breeze block and blanking plate may have become displaced as the result of the severe rocking the aircraft received after landing at Bradford-on-Avon. If, in fact, this had taken place it is feasible that exhaust gas may have entered the cabin via the uncovered or partially uncovered vertical camera aperture.

Flight trials were carried out in the same type of aircraft similarly modified to test this theory. The results are as follows:

"From tests simulating the circumstances of the flight there is definite evidence that under most conditions there would have been undue concentration of carbon monoxide in the cabin air. In the worst case, it would be possible to have recorded blood saturation of carbon monoxide of at least 20 per cent. It can therefore be suggested that carbon monoxide inhalation from exhaust gas is at least a contributory factor in the accident since increase of blood content of more than 10 per cent may lead to errors of judgment in flight."

The evidence indicates that immediately prior to the accident there was a sudden reduction of engine power. It is significant that had the main fuel tank been selected throughout the flight from Elstree its contents would have exhausted at about the time of the accident.

Probable Cause

The accident was the result of the aircraft striking the ground while in an uncontrolled dive following loss of engine power due to fuel starvation.

That the pilot's faculties were adversely affected by the inhalation of carbon monoxide which entered the cabin through the vertical camera aperture in the floor seems the most likely cause.

The cover for this aperture had not been properly secured before the flight commenced.

ICAO Ref: AR/250

No. 28

Pan-American World Airways, Inc., Boeing 377, N-1030 aircraft, lost passenger on 27 July 1952 near Rio de Janeiro, Brazil. CAB Accident Investigation Report. No. 1-0062. Released 31 October 1952

Circumstances

Flight No. 201 originated at New York International Airport (International), its destination being Buenos Aires, Argentina, with stops scheduled at Port-of-Spain, Trinidad, B.W.I., Rio de Janeiro, Brazil, and Montevideo, Uruguay. There were eight crew members and nineteen passengers. The aircraft landed uneventfully at Rio de Janeiro and was serviced and loaded for the next portion of the flight. No difficulties had been experienced although the purser later remarked that he had "noticed a slight difficulty in locking the door, which is not uncommon on the B-377".

At about 1446 GMT the main cabin door of the aircraft opened suddenly during pressurized flight and the out-rushing air blew overboard a woman passenger in seat No. 33 closest to the door. The aircraft was at an altitude of about 12 000 feet and was pressurized to a differential of 4.1 pounds per square inch. At the time the aircraft was over ocean outbound about 18 minutes from Rio de Janeiro, Brazil. The Brazilian Government instituted an intensive search for the missing passenger. This search was unsuccessful.

Investigation and Evidence

From Idlewild to Port-of-Spain the flight was routine, with no reported difficulty in the functioning of the main cabin door except for the purser's later statement. "I found the door handle to be quite difficult to open or close".

The same type of routine operation was experienced on the second leg of the flight, from Port-of-Spain to Rio de Janeiro, again with no reported difficulty in the functioning of the main cabin door except that the purser on this leg later stated, "The only thing noticed was a slight difficulty in locking the door which is not uncommon on the B-377". Neither purser, however, considered the door handle difficulty of sufficient importance to report. The aircraft landed uneventfully at Rio de Janeiro and was serviced and loaded for the next portion of the flight.

After the aircraft was loaded, the main cabin door was closed and supposedly locked by ground personnel and the position of the inside handle checked by the purser, as was routine practice. During the cockpit check, prior to starting the engines, a cockpit warning light remained "on" indicating that one or more of the cabin doors (two cargo, one galley and the main cabin) was not locked. Accordingly, the flight engineer inspected the two cargo doors and the main cabin door. (The galley door was inspected by ground personnel and pronounced locked, via interphone.) The flight engineer noticed that the handle of the main cabin door was not in the horizontal (locked) position. He opened the door, closed it, and turned the handle as far as it would go toward the horizontal (locked) position. He estimated that the handle was within about 25° of the locked position. The flight engineer testified that he used a flashlight to check the positions of the four bolt mechanisms and the pressure lock visible through their respective inspection windows on the inside of the door. All seemed normal. He then reported to the captain that all doors were locked. The engines were started, and the aircraft left the ramp and took off at 1428. During this time the door warning light remained on.

A climb was started, as was cabin pressurization. At an altitude of about 12 000 feet and with a cabin pressure differential of 4.1 pounds per square inch, corresponding to a cabin altitude of about 2 000 feet, the purser heard a loud hissing noise at the cabin door. He went to the flight deck and stated to the captain, "We should depressurize because I think the door is open".

The captain ordered the flight engineer to inspect the door. (The door warning light was still on.) The first officer assumed the station of the flight engineer who went aft with the purser. Both inspected the door while the captain stopped the aircraft's climb. The flight engineer did not make a visual inspection through the door windows but placed his hand along the top edge of the door, whereupon the noise decreased. He then instructed the purser to place wet towels in that area to reduce the air leak and the noise. At this time the door handle was still not in the locked position, the flight engineer estimating that it was still about 25° from being in the horizontal position and the purser estimating it to be only about 19° from the vertical, or fully unlocked position.

The purser then went aft in the cabin to procure towels. The flight engineer returned to his station and reported to the captain that the door seal was leaking but everything seemed normal. The captain elected to continue. The door warning light was still on.

Within a minute or two, at 1446, the cabin door blew open. As stated, a woman passenger in seat No. 33 nearest the door, went through it. None of the other occupants was injured although many of them experienced temporary ear discomfort as would occur following a rapid depressurization. The depressurization, of an explosive violence, caused damage throughout the cabin, blowing loose ceiling panels and many sections of sound-proofing and upholstery and tearing off the door of the ladies' lavatory. Fog, caused by condensation at the lower pressure, temporarily filled the cabin.

The aircraft was immediately turned back to Rio de Janeiro where it landed uneventfully at 1513, forty-five minutes after taking off. During the entire flight the weather was good, with little or no turbulence. The door opened while the aircraft was on course for Montevideo and about seven minutes after passing abeam of Santa Cruz.

Cabin Door and its Locking Mechanism

The door opens outward and is hung on two hinges at its forward edge. It has both an external and an internal locking handle. The external handle is approximately nine inches long and is mounted at its centre on the locking shaft. The internal handle is a lever about nine inches long mounted at one end on the same locking shaft. Normally, these two handles remain parallel. The door is completely unlocked when the handles are approximately vertical with the internal handle upward. It is fully locked when the handles are approximately horizontal, i.e., when the internal handle is turned counter-clockwise to a horizontal position.

The outside of the door is marked with two curved arrows showing the directions to turn the door handle, "to unlock" and "to lock". The inside of the door has a single arrow curved clockwise, marked "turn handle - opens out".

Rotation of the door handle shaft actuates a mechanism that extends or retracts 13 locking bolts, commonly called bayonets, placed around the edge of the door. There are two of these bolts on both the top and the bottom of the door edge, five on the forward edge and four on the aft edge. These bolts are extremely hard and are polished. Their full travel from the unlock position to the lock position is approximately 1-3/8 inches. The outer approximate halves of all 13 bolts are tapered in both width and thickness.

Around the door frame are 13 receptacles which receive the bolts. Each is capped with a striker plate with an orifice into which the fully extended bolt fits snugly.

The inside of the door is fitted with five clear plastic windows. One, located on the lower rear, allows visual inspection of the door's pressure lock. The other four, two at the top and two at the bottom of the door, allow visual inspection of the positions of the mechanism actuating the four bolts (bayonets) located immediately adjacent to the bases of the bolts.

The Pan American B-377 operations manual, carried aboard the aircraft, describes completely the locking mechanism of the various exterior doors of the aircraft and their safety devices*. A description of the main entrance door locking mechanism is quoted as follows:

> "1. Pressure lock: To prevent anyone from inadvertently opening the door when the cabin is pressurized, the pressure lock acts to prevent movement of the lower cable system. The lock is energized continuously when cabin pressure differential exceeds 2" H_2O. Engagement of the pressure lock may be checked through the square window on the lower aft portion of the door.
>
> 2. Latch dog lock: This lock prevents damage to 13 latch dogs by locking all dogs in the retracted position when the door is opened and thus prevents slamming door closing on the open latch dogs. This lock is automatically operated by a small striker plate in the upper forward portion of the door.

* PAA B-377 operations manual, aircraft description of exterior doors, item 87.011 (1) and (2), published August 14, 1951.

3. Vibration lock: To prevent the door latching dogs from working loose due to vibration, the vibration lock automatically engages a locking pin in the door handle sprocket when the door handle is turned into the locked position. During the first 30 degrees of unlatching, the rotation of the door handle acts to disengage the vibration lock pin from the door handle sprocket.

4. Anti-rotation latch: This is a spring catch type anti-rotation latch installed under the lining of the door handle shaft. It serves to prevent rotation of handle toward the unlocked position due to vibration, serving the same purpose as the vibration lock.

Bungee cord: In the event of failure of the vibration lock the bungee cord applies sufficient tension to the door handle to maintain it in the locked position and thus prevent the locking mechanism from working loose due to vibration.

TO CHECK MAIN CABIN DOOR PROPERLY LOCKED

Handle Position	Handle should be horizontal, and against internal stop. If handle is not horizontal when it is against stop, write up for maintenance action.
Bungee cord	Cord should be attached from rear end of handle to the lower portion of the door.
Pressure lock	When pressure differential exceeds 2" H_2O, dogs should be in position to prevent cable from being moved sufficiently to actuate door latches. The locking dogs are viewed through square window in aft lower portion of door.
Door latches	Door latches may be viewed through the four circular windows, two at the top and two at the bottom of the door. Latch mechanisms should be in locked position.

WARNING

1. In event of main entrance door air leakage, the area in front of the door should not be used for food service cleaning purposes.

In event of main entrance door air leakage, do not touch the door handle. Any attempt to adjust handle during pressurized flight can only lead to further opening of the door."

There is installed in the B-377 aircraft a door warning system. It is designed to alert the crew to any malfunction of the main entrance cabin door, forward cargo door, rear cargo and the galley loading door by means of a warning light in the cockpit. At the main door there are two door-closed micro-switches installed in the door frame, one for the upper cable system and the other for the lower cable system, and one door-locked warning switch under the door lining, actuated by the vibration lock. These micro-switches are installed to cover not only the complete travelling action of the locking door bayonets, or bolts, but also to cover the complete rotation of the door handle to ensure that the vibration latch and the anti-rotation latch are completely secure. These switches are so located that they can be readily inspected at all times.

The B-377 operations manual "Aircraft Description Exterior Doors" also includes instructions when the door warning light comes on in the cockpit. These instructions, in part are as follows:

"If the warning light remains illuminated after all doors are closed and locked, the following should be checked O.K. prior to take-off:

Main entrance door
1. Four latches fully closed (check through 4 windows)
2. Door handle in locked position
3. Bungee cord attached."

After the accident an examination of the cabin main entrance door was made at Rio de Janeiro. Damage to the door was confined to downward distortion of both hinges, a cracked lower hinge and three rivets missing from the lower hinge. The forward edge of the aluminum metal window frame in the door was distorted rearward, and a small section of upholstering fabric at the centre rear edge was missing. A deep indentation and slight displacement of the rubber door seal near the door's upper rear corner was found and there was a small indentation of the rubber seal near the door's lower rear corner.

Damage to the door frame was confined to a slight depression of the frame metal near the upper rear corner. The rubber seal across the top of the frame was missing. The remainder of the frame's rubber seal appeared to be somewhat deteriorated.

The mating indentations in the door and its frame were of such size and nature that they were obviously caused by the loosened and wedged door frame seal.

No evidence of failure or malfunctioning of the main entrance door locking mechanism was found. All rigging adjustments that could be checked were found to be within acceptable tolerance. This included the micro-switch actuator adjustments, the bayonet extensions, and all other checks except the cable tension check, the pressure switch pressure check and the anti-vibration lock plunger clearance check.

It was established that there was no malfunctioning of the door or any of its locking mechanisms or safety devices, and it is thus clear that the accident was caused by the crew's failure to recognize the hazard of an incompletely locked cabin door, due to jamming by a loosened door frame seal. None of the safety locking devices can function unless the latching mechanism and the door handle are in the fully closed position.

The crew should have been aware of the danger because of three fully independent warnings of imminent trouble. First was the warning light that remained on. Second was the noise of pressurized air escaping around the top of the door. And third, and possibly the most important, was the fact that the door handle never was in a position to more than partially extend the locking bolts (bayonets).

The first of these three warnings, the light, was plain and continuous. The second, the escaping air, was brought to the flight crew's attention by the purser. The third, the door handle's position, should, in itself have been enough to indicate to the flight engineer what was due to happen. In fact, the flight engineer's act of attempting to force further the door handle during pressurized flight could well have precipitated the blow-out. The company's operating manual plainly states that in the event of door leakage the door handle shall not be touched because any attempt to adjust it during pressurized flight can only lead to further opening of the door. The flight engineer was aware of this specification but ignored it. Furthermore, when he first checked the door handle on the ground and found, after opening and reclosing the door, that the handle would still not go to its locked (horizontal) position, he could readily have learned whether the locking mechanism was working properly by reopening the door and turning the door handle to the closed position while observing the travel of the locking bolts. This he did not do.

The flight practice of ignoring a door warning light, despite frequent false warnings, is certainly subject to criticism. In this case the warning light was a true warning.

As one result of this accident, the carrier is installing indicators on the B-377 four latching mechanisms that are now visible through the corner windows of the cabin door. These indicators, extending to the windows, will be conspicuously coloured - red for open, green for locked. Pending this installation the latching mechanisms themselves have been painted conspicuously to allow their positions to be more readily determined. The moving cap portion of the pressure switch has been marked for alignment. These marks are visible through the pressure switch window.

Also, the carrier is in the process of changing the warning light system in its B-377's. This change will involve placing a warning light at each of the four exterior doors. The single cockpit warning light will remain to indicate that any of the four doors are improperly locked, and the individual door lights will allow immediate isolation of the trouble.

A few days after this accident the company, issued all personnel concerned a directive to follow procedures published and in effect at the time of the accident, applicable to the main cabin door of the B-377. These included:

1. No take-off permitted if door warning light is on unless cause of warning is definitely established as warning system malfunction.

2. No take-off permitted unless bayonet locks are observed to be in fully extended position and door handle is in full locked position.

3. Main door secure inspection to be made before take-off and again after pressurization by pilot or engineer personnel properly safeguarded to determine that door handle bayonets and pressure locks are properly engaged.

The same directive carried these additional items which were not in effect at the time of the accident:

4. If door warning comes on or air leak is noted at main entrance door in pressurized flight, the following action is required:

a) Move passengers from two left-hand seats just forward of main entrance door and have one flight crew member guard area at all times at safe distance and conduct any desirable investigation with proper safeguards from safe distance.

b) If door handle or bayonets not in place, as soon as conditions permit descend to safe altitude, depressurize, and properly engage door locks. Pressurized flight may be resumed if lock can be engaged.

5. Use guard rope in main door area at all times.

6. Thorough maintenance investigation of any flight item on main door warning system at next station to insure maximum dependability of warning system; also strict adherence to established door rigging and inspection procedures at routing services.

On 15 September 1952, the company issued an Operations Information Bulletin for insertion in all B-377 operations manuals. It included the above directives and the following:

"RESPONSIBILITY FOR DOOR INSPECTION:

1. When there is one flight engineer aboard, the Captain shall be responsible to assign a qualified crew member to make the after-pressurization check covered in Item (4) above*. The flight engineer shall be responsible for all ground checks of all hatches for security. Where there are two flight engineers on board, the flight engineer shall be responsible for all air inspections and checks of all hatches for condition and security. Where there is one flight engineer on board the flight engineer shall be responsible for all air checks of all hatches for security and after inspection by a qualified pilot has initiated a report of any abnormal condition or malfunctioning of any door engaging mechanism. The procedure outlined in the first section of this memorandum must be followed for all these inspections and check."

Probable Cause

The probable causes of this accident were, (a) the flight engineer's failure to recognize an unsafe condition of the cabin door despite three completely separate warnings of that condition; and (b) the captain's action in continuing flight while pressurized despite the several warnings that the main cabin door was not properly locked.

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* For the purposes of this report "Item 4 above" is in substance items 3 and 4 above.

No. 29

I.A.S. London Ltd., Rapide (DH.89A) G-ALBB Aircraft, crashed at London Airport on 1 August 1952

Circumstances

The aircraft was approaching to land at London Airport on runway 23L after a five-minute local pleasure flight. It was coming in after a Stratocruiser and had reached a point between the beginning of the runway approach lighting and the Bath Road when it encountered turbulent air at a height of 300 feet. The pilot lost control and the aircraft crashed just inside the aerodrome and 475 yards from the threshold of the runway. On impact with the ground the nose of the aircraft disintegrated and the pilot was thrown out and severely injured. Five of the eight passengers received injuries of a lesser degree.

Investigation and Evidence

By arrangement with the airport authorities these pleasure flights are dovetailed into the routing traffic and generally the second half of the runway in use is used for take-off and the first half for landing.

After a normal take-off the pilot proceeded to carry out a right-hand circuit. During this, Control informed him by R/T that he was No. 2 in the traffic pattern, No. 1 being a Stratocruiser which was on a long final approach to runway 23L. In reply, the pilot asked if he could land after the Stratocruiser and was told to make a long down-wind leg and take up a position behind the Stratocruiser. After the Stratocruiser had landed and had reached the intersection of runways 23L and 15L (i.e. 1 000 yards from the threshold of 23L), Control gave the pilot of the Rapide permission to land at his own discretion and this was acknowledged. The pilot states that after making a long down-wind leg he proceeded towards runway 23L keeping well to its right in order to be clear of the Stratocruiser's slipstream. On receipt of permission to land he noted that the Stratocruiser was near the end of the runway, so reduced power and turned to the left to line up for landing. He also states that at this time he was at a height of about 300 feet and was approaching at 100 mph at half throttle, slowly losing height. Almost immediately after starting a turn severe turbulence was encountered and the pilot lost control.

In a rapid movement the aircraft was lifted to the right on an even keel and violently rocked several times. Eye witnesses state that the aircraft started to assume abnormal attitudes when it was between the beginning of the runway approach lighting and the Bath Road. The pilot immediately increased engine power to regain control but the aircraft was now violently thrown to the left, still on an even keel. It then started to lose height rapidly in a left wing low attitude. As it was now near the ground the pilot throttled back and tried to level out. The aircraft started to respond but before recovery was complete it passed over the Bath Road, almost hitting a street lighting standard, and then struck a wire fence bordering the aerodrome and crashed. Inspection at the scene of the accident showed that the aircraft had struck a six-foot high wire fence on the aerodrome boundary with the port wing and had then bounced on its nose and come to rest on the perimeter track 475 yards from the threshold of runway 23L. The port wing assembly, the undercarriage and the fuselage were extensively damaged. The front portion of the fuselage had disintegrated and all but the three rear seats had torn adrift from their anchorages. The attachment fittings of the pilot's safety belt had been torn out but the bolt was intact and fastened.

A detailed examination of the airframe and engines did not reveal any pre-crash defect.

In view of the circumstances surrounding this accident inquiries were made to ascertain if any similar occurrences have taken place. The information obtained shows that there are numerous cases on record where light aircraft have been put out of control after encountering turbulence created by the propeller wash of large aircraft either during a take-off or during a landing approach. In some instances small aircraft have encountered turbulence of such a nature as to cause a flight hazard at distances exceeding one mile from the other aircraft. It appears that in conditions of little or no wind the turbulence is likely to persist near the ground for an appreciable time.

Probable Cause

The accident was due to the pilot losing control of the aircraft after encountering turbulent air which had been caused by the Stratocruiser.

ICAO Ref: AR/240

No. 30

Lake Central Airlines, Inc., Beech Bonanza crashed on approach-to-land at Indianapolis, Indiana, on 21 August 1952. Accident Investigation Report No. 1-0061 - Released 10 April 1953

Circumstances

A Beech Bonanza, operated as Flight 4 departed Connersville, Indiana, at 1451 on 21 August 1952, on the last portion of a scheduled flight from Indianapolis to Cincinnati, Ohio, and return.

During final approach-to-land at Indianapolis, the Bonanza, following an Eastern Air Lines Constellation, was suddenly thrown into approximately a right vertical bank. This occurred at about 75 feet altitude and some 350 feet from the threshold of Runway 31. The aircraft struck first on the right wing tip, then described a partial cartwheel towards Runway 31. The aircraft was demolished and the three occupants, pilot and two passengers, seriously injured.

Investigation and Evidence

The gross weight of the Bonanza was approximately 2 344 pounds with two passengers, the pilot, 72 pounds of mail and baggage, and approximately 24 gallons of fuel. The gross weight was less than the allowable certificated gross take-off weight of 2 650 pounds, and the load was properly distributed with relation to the centre of gravity of the aircraft.

The aircraft, when about five miles southeast of Indianapolis Airport, was given landing instructions for Runway 27 by the airport tower, and shortly thereafter, the aircraft reported over Stout Field and on a straight-in approach to Runway 27.

At the same time an Eastern Air Lines Constellation was approaching the airfield from the southwest and at the time the Bonanza reported over Stout Field the Constellation had been cleared to land on Runway 31. Shortly after, the controller changed the landing instructions to the Bonanza to follow the Constellation to Runway 31.

The Bonanza immediately changed course and made several S-turns in order to increase the time interval between the two aircraft. The Bonanza began the turn to final approach as the Constellation landed.

The pilot of the Constellation stated that both the approach and landing were normal and were made in accordance with Eastern Air Lines procedures. Manifold pressure was reduced to 20 inches prior to starting a left turn to base leg and final approach. During the descent, the power settings were increased to 22-25 inches and 2400 RPM maintained. Flaps were extended to the 60 per cent position when downwind, 80 per cent at 700-800 feet altitude, and 100 per cent at 300-400 feet, when one-fourth mile from the end of the runway. Speed was reduced from 175 miles per hour on the downwind leg to 150 miles per hour on the base leg, and 120-125 miles per hour was maintained during final approach to Runway 31. The aircraft experienced no gusts or turbulence.

The weather at the time was; broken strato-cumulus clouds at 1 800 and 6 000 feet with an overcast of alto-cumulus clouds at 10 000 feet; visibility 12 miles; surface wind from the west at 11 miles per hour. The wind was steady, with no gusts reported. There was little or no turbulence from natural causes.

The pilot of the Bonanza estimated that the closest horizontal separation between the two aircraft while the Bonanza was in final approach was about 3 000-4 000 feet, a separation that he would normally maintain in any approach.

He also testified that he had previously experienced turbulence in this and other aircraft during approaches for landing, but had always been able to maintain control. He could not recall having experienced turbulence in the wake of a Constallation prior to this incident. The possibility of such turbulence occurred to him during the approach, he said, but no difficulty was anticipated since the distance and time separation seemed adequate. He felt that additional altitude would have enabled him to recover, but that "quite a lot of airspeed" would have been necessary to effect recovery.

The chief pilot of Lake Central Airlines testified that pilots for the Bonanza operation were taught to make approaches for landing at 80 miles per hour indicated airspeed with landing-gear down, flaps extended, and a slight amount of power. The aircraft manufacturer's handbook likewise recommends that 80 miles per hour indicated airspeed be maintained on final approach, with landing-gear down and flaps fully extended.

Following the accident, Board investigators timed, with stop-watches, a number of approaches and landings of Constellations from a point about 300 feet from the end of the runway to the time the aircraft turned off the runway. Most of the observations were made on aircraft which had landed on Runway 31 and turned at the intersection of Runway 9. Only those landings in which propeller reversing was not used were clocked. The time spread was from 31 to 38 seconds. It was thus ascertained that the time separation between the approaches of the Bonanza and the Constellation was one-half minute or more.

Investigation disclosed that the Beech Aircraft Corporation had made a study of turbulence induced by aircraft. This study was completed shortly before the accident. Lake Central Airlines received a copy of the Beech report four days after the incident. It revealed that severe turbulence can be caused by any type of aircraft, but that the more frequent cases were reported by pilots who had experienced the phenomenon in either landing or taking off behind large aircraft.

The Beech safety bulletin advised pilots that the induced turbulence is caused, basically, by the vortex from each wing tip and the swirling propeller wash. One report commented that the turbulence created by jet aircraft is considerably higher than that produced by propeller-driven aircraft. A number of persons reported conditions almost identical to those experienced by the captain of the Bonanza. Several pilots had encountered severe turbulence while flying larger aircraft such as the Lockheed Lodestar, Douglas A-20, B-26, DC-3 and others.

Investigation by the Board showed that wing tip vortices are caused by the air at increased pressure under a wing tending to flow outboard around the tip to the area of reduced pressure above the wing. The magnitude of the vortices is dependent on several factors including the shape of the wing, the amount of lift being produced, and the angle of attack at which the wing is operating. The relationship of these factors is such that a large, heavy aircraft breaking its descent to flare out for a landing, causes very powerful wing tip vortices. Extended wing flaps also can cause powerful vortices. Severe turbulence may be induced by the propellers, wing tips and flaps, the severity depending upon the combination of circumstances and the aircraft involved.

Following receipt of these reports, another circular* was prepared and distributed to all Regional Administrators a week subsequent to the accident. This latter circular stated that the various regions had reported numerous incidents in which small aircraft had encountered turbulence both on the ground and in flight when following or crossing the thrust streams of multi-engined or jet aircraft. Control tower personnel were cautioned to be alert to situations which, if properly recognized and acted upon, could prevent such accidents. The circular pointed out that there are so many variables concerning large aircraft turbulence that it would be almost impossible to delineate specific procedures to cope with the problem.

Probable Cause

The Board determines that the probable cause of this accident was the fact that the final approach of the Bonanza was made so closely behind that of the Constellation that the Bonanza encountered an area of severe turbulence created by the preceding multi-engine aircraft and became uncontrollable, side-slipping to the ground.

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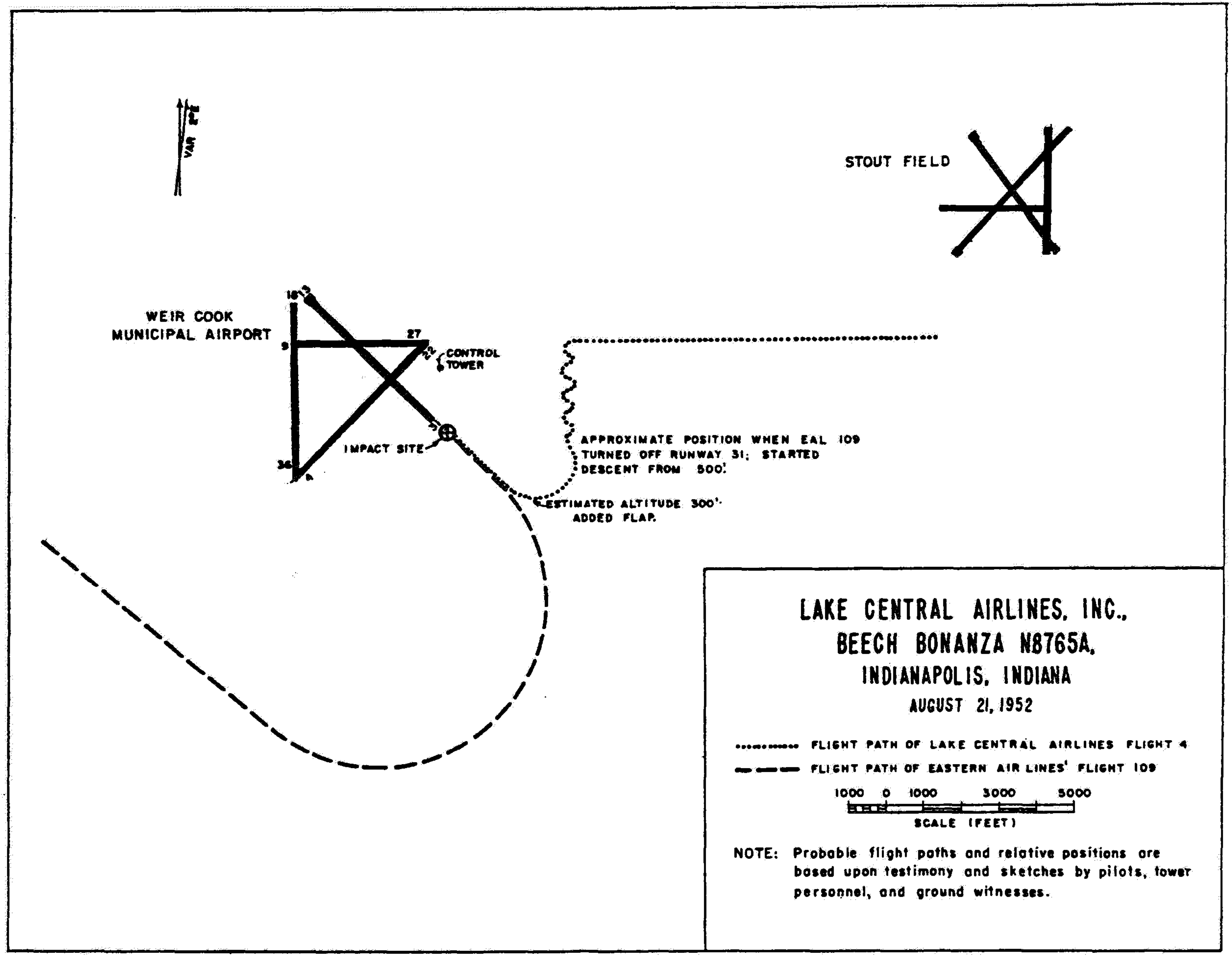
* Circular Letter -380-213 from the Chief, Airways Operations Division, CAA, Washington, D.C., to all CAA Regional Administrators.

Subject: Effect of Large-Plane "Turbulence" on Other Aircraft.

(Secretariat Note - See reproduction of Safety Bulletin No. 187-53, "Keep Your Distance" Page 173)



LAKE CENTRAL AIRLINES, INC.,
BEECH BONANZA N8765A,
INDIANAPOLIS, INDIANA
AUGUST 21, 1952

FLIGHT PATH OF LAKE CENTRAL AIRLINES FLIGHT 4

FLIGHT PATH OF EASTERN AIR LINES' FLIGHT 109

1000 0 1000 3000 5000

SCALE (FEET)

NOTE: Probable flight paths and relative positions are based upon testimony and sketches by pilots, tower personnel, and ground witnesses.

No. 31

Air Work Limited, HERMES 4-A, ditched between Port of Trapani and the Island of Formica on 21 August 1952 (This investigation was conducted by Italy in conformity with Annex 13 of the Convention of the International Civil Aviation Organization. The report was also prepared in accordance with the Accident Report form contained in the Manual of Aircraft Accident Investigation. ICAO Doc 6920/AN-855 Appendix "B")

Circumstances

The aircraft, engaged on a non-scheduled flight from Blackbushe, England to Wadi Seidna, Khartoum, via Malta, took off from Blackbushe Airport at 1925 hours GMT on 24 August 1952 with 51 passengers and 6 crew. The flight was normal until 0025 hours GMT when the aircraft reached a position about 20 miles West of Trapani. At this time, No. 2 and No. 3 engines showed signs of abnormal functioning and were deliberately shut down and the propellers feathered. Without electrical power except from the batteries which were depleted of their charge by use of the radio equipment for emergency signals, Nos. 1 and 4 engines began to show signs of abnormal functioning. At approximately 0100 hours GMT, a ditching was carried out on the sea between the Port of Trapani and the island of Formica. Four passengers were drowned and two missing, one stewardess was also missing.

Investigation and Evidence

According to statements of crew members, the failure of No. 2 engine (over-speed) occurred less than one minute after No. 3 engine was shut down. The inquiry examined the possibility of an error in manipulating the engine controls while No. 3 engine was being shut down and feathered. It was pointed out that the flight engineer's panels were inverted since the flight engineer's post faces the back of the aircraft. There is also an unsymmetrical arrangement of some of the control levers. The limited experience of the flight engineer, - a total of 954 hours flying to his credit and only 154 on the Hermes type aircraft, - lent further strength to the probability of a manipulating error. From the evidence available, it was further assumed by the inquiry that failure occurred in No. 2 engine only, and that No. 3, to which all the symptoms of an abnormal functioning had been mistakenly attributed, was shut down unnecessarily. The inquiry found difficulty in determining the nature of the failure of No. 2 engine although it was decided that the failure was of a similar type to that which had occurred in earlier incidents with this type of engine.

Since the only two generators on the aircraft were connected to engines 2 and 3, after a failure of these engines the electrical equipment was supplied by batteries only which were insufficient for the supply of power, even for the most essential services for any length of time. (The S.O.S. on VHF was not completed for lack of sufficient power.) This prevented any successful communication with the aircraft and Search and Rescue operations were thus hampered by lack of information on the location of the ditching.

After the failure of Nos. 2 and 3 engines, Nos. 1 and 4 engines were increased to maximum continuous power to maintain the aircraft in flight. However, a few minutes later, the Engineer reported decreasing oil pressure on the remaining Nos. 1 and 4 engines, although their temperatures remained almost constant. In view of the doubt on the two remaining engines and the complete lack of radio communication required for prolonged navigation, the Captain decided to return to Trapani, where, on arrival, a red Very cartridge was fired. Although the Captain was aware that the Trapani airport was not equipped for night traffic, he nevertheless proceeded to the airport area in the hope of drawing the attention of the ground personnel and having them light up a runway with whatever means were available. A few minutes later, it having become apparent that it would be impossible to land at Trapani, and under the impression, shared by the crew, that the two remaining engines 1 and 4 had started vibrating and were showing signs of improper functioning, the Captain definitely decided to ditch the aircraft and warned the crew of this decision, with the presumed intention that they should also warn the passengers. The probability of a ditching had already been envisaged earlier, but the final warning was given between five and eight minutes before the ditching actually occurred. Another Very cartridge was fired while the aircraft was over Trapani, descending towards the sea. The ditching manoeuvre was brilliantly performed in complete darkness with the lights of Trapani as sole reference and using only the airspeed indicator and altimeter which were read out loud continuously by the First Officer. The aircraft ditched between the Port of Trapani and the island of Formica at about 0100 GMT.

The landing gear and flaps were in the retracted position and the speed of impact was estimated at about 120 knots.

The impact tore off the landing gear legs and the detachable portions of the spar. The fuselage probably commenced to flood through the damaged portion of the under nose skin. The aircraft floated for about 10 minutes, then remained half submerged in the vertical position with the tail up for another few minutes and finally sank.

Although malfunction of engines 1 and 4 was indicated, the Board, however, considered that the working limits of this type of engine were not exceeded and the flight could have been continued for a longer period.

The passengers were warned of the engine trouble either by the abnormality of the engine noises and vibrations, or by the changes in the intensity of the lighting or by the alarmed appearance of the two hostesses. About 25 minutes prior to the ditching, the hostesses suggested to the passengers, that they should strap themselves in their seats, not smoke, awaken those who were asleep, put their seats in the upright position, take out their life-jackets, etc. in order to be ready for any emergency.

These suggestions apparently were not made in the form of instructions and statements addressed to all the passengers generally and were therefore not heard and fully appreciated by everyone. One hostess asked how the life-jackets should be put on and used; she did not seem to be very sure. In spite of this, the passengers found and put on the 47 life-jackets located under each seat; a few passengers read the instructions for the use of these jackets, which were posted in the cabin.

It appears from the statements of the passengers, as well as from the findings of the Commission, that there was some difficulty in inflating the life-jackets, either by means of the CO_2 flask or by mouth. The difficulty was due partly to the inadequate instructions given to the passengers on the use of life-jackets, and partly to certain defects of the jackets themselves, which, as a result of this accident, have led the Air Registration Board to issue Notice No. 39 of 15 September 1952.

From statements made by passengers it was also determined that certain defects (imperfect watertightness, flash lights ineffective, etc.) could be attributed to the improper maintenance of the life-jackets and their accessories.

Dinghies

Since the number of life-jackets (54) was smaller than the number of persons on board (57), some other emergency equipment had to be carried. (4 young children were not provided with life-jackets because they were not occupying separate seats.) The most suitable were the dinghies which are provided especially for the benefit of children and infants. Although some evidence indicated that two "K" type dinghies were on board, there was conflicting evidence that they were not on board. In any case, dinghies were not released or used.

One hostess managed only at the last moment to find and put on a life-jacket while the other hostess remained without one, in spite of the fact there must have been two others on board.

No serious consequences on ditching (except a few cases of shock, contusion, temporary fainting, etc...) were reported by the passengers, who, in spite of the total darkness on board had got out of the aircraft through the main door and the smaller doors located near their seats without disorder or panic.

In the sea, the passengers generally had difficulty in inflating their life-jackets, many of which had to be manipulated by members of the crew and some of the passengers who had gone through similar experiences previously, before they were of any use.

In view of the inadequacy of the sole, incomplete distress signal intercepted by Malta and of the fact that four red flares fired by the aircraft were spread over a very large area of

Western Sicilia, the determination of the point of ditching was made very difficult, and the search and rescue facilities could not be directed to the spot immediately.

However, rescue operations were begun shortly after 0200 GMT when a survivor hailed motor fishing vessels passing through the area and by 0500 GMT 53 persons including 3 dead had been recovered.

Probable Cause

The probable cause of the accident lay in a failure of one or both of the two inner engines Nos. 2 and 3. The reason for the failure was undetermined.

The contributory causes were;

a) State of mind arising from the knowledge of another accident, only a short time before, to an aircraft of the same type, which was proved to have been due to power-plant failure.

b) Failure of electrical generators when No. 2 and No. 3 engines stopped.

c) Batteries inadequate for ensuring normal flight functions and not even sufficient for satisfactory transmission of distress messages.

d) Limited experience of the crew and of the hostesses on this type of aircraft.

e) Limited training of the crew.

f) Emergency procedures not properly followed, particularly by the hostesses.

g) Life rafts either missing or not used.

h) Failure of lifebelts.

The Commission was of the opinion that only one of the two inner engines (Nos. 2 and 3) failed of its own accord and that the stoppage and failure of the other one was caused by an error of the flight engineer.

RECOMMENDATIONS

1. Power-plants - Several previous cases of serious failure similar to the present one having been confirmed, it was recommended that, in addition to the measures already being taken, all necessary steps be taken to prevent recurrence of further incidents of this nature.

2. Generators - The provision of only two generators on a four-engined aircraft such as the HERMES appears to be insufficient. Installation of a third generator - which has already been undertaken - was supported and recommended by the Commission.

3. Flight engineer's station - It was recommended that, with a view to making the engineer's control movements and handling more instinctive, consideration be given to modifying the flight engineer's control panel on board HERMES aircraft to make the position of the various control levers reflect the position of the various controls and to arranging the levers in series for each engine.

4. Number of lifebelts - Strict compliance was recommended with the ICAO Standards (Annex 6 paragraph 6.3.2.2)* which provides that landplanes shall carry "one life-belt or equivalent individual floatation device for each person on board".

5. Location of lifebelts and rafts - Strict compliance was recommended with the ICAO Standards (Annex 6 paragraphs 6.3.2.2 and 6.3.3 a)* which provide that lifebelts shall be "stowed in a position easily accessible from the seat of the person for whose use it is provided", and shall be "stowed so as to facilitate their ready use in emergency". It was further recommended that the location of this emergency equipment be clearly indicated in the HERMES and in the flight manual thereof and that the stowing of this equipment be checked in order to ensure compliance with the above-mentioned standards.

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* References to Annex 6 are to the Third Edition of that document, issued in May 1952.

6. Lifebelts - It was recommended that, in addition to the measures adopted by the Air Regulations Board in its Notice No. 39 of 15/9/53, the method of automatic and mouth inflation of the lifebelts be considerably improved in order to make them safer and more practical to use.

7. Emergency procedures - It was recommended that those concerned comply strictly with the ICAO Standards on emergency procedures and, in particular, with paragraphs 4.2.7.5, 4.2.8, 4.2.8.1 and 4.2.8.2 of Annex 6*.

8. Documents associated with the Certificate of Airworthiness - With reference to paragraph 4.2.3 of Annex 6*, it was recommended that the flight manual, even if only a document associated with the certificate of airworthiness, and not an official document forming a part thereof, as in the present case, should always be maintained valid and up-to-date.

9. Maintenance - It was felt justifiable to recommend greater care in the inspection and maintenance of aircraft, engines and accessories.

10. Composition of crews - It was considered desirable that, in forming aircrews, the following factors be taken into account:

a) Assigning together individuals who have a minimum of experience of the particular aircraft type;

b) Assigning together individuals who have already done a minimum of flying together. The above "minima" should be established mainly on the basis of the complexity of the aircraft type and of the total accumulated flight time of the individual crew members.

11. "Status" of the hostess - It was considered desirable to define the "status" of the hostess as being a member of the flight crew. Pending such definition, it was considered desirable that at least the requirements for a licence be established.

12. It was considered desirable that in the cases (Annex 6 paragraphs 6.3.1 and 6.3.2) where equipment with lifebelts only is required, a raft should also be provided, capable of carrying at least:

- the first aid kit specified in paragraph 6.2 a) of Annex 6;

- the sea anchor specified in paragraph 6.3.1 c) of Annex 6;

- the equipment for making pyrotechnical distress signals, specified in paragraph 6.3.3 a) of Annex 6;

- the portable self-buoyant radio transmitter specified in paragraph 6.3.3 b) of Annex 6;

- two persons to operate the above equipment.

Such a raft could be called a "service raft" (Battellino di Servizio). In this connection, it should be noted that if the crew of the aircraft had been able, on ditching, to use a portable radio transmitter and pyrotechnical distress signals, all the rescue facilities, both organized and unofficial, could have been directed immediately to the scene of the accident.

13. Lifebelts for infants - It was considered desirable:

a) To adopt as "equivalent individual floatation device" (Annex 6, paragraph 6.3.2.2) special lifebelts for children, since they cannot use those normally worn;

b) That, in the absence of such children's lifebelts, a sufficient number of life-rafts be carried, capable of carrying at least all the children on board.

In this connection, it was pointed out that, in this accident, out of a total of 11 children on board, 2 (aged 3 and 6 years) were found dead with their lifebelts deflated, and two others (infants without lifebelts) were missing.

* References to Annex 6 are to the Third Edition of that document, issued in May 1952.

14. Rafts for all occupants - According to paragraph 6.3.3 of Annex 6, this HERMES was not compelled to carry life-saving rafts for all the occupants when flying across the Mediterranean, irrespective of the route flown, in view of the speed of the aircraft.

This accident shows, however, that if the aircraft had been at a more unfavourable point in the Mediterranean, instead of at the tip of Sicily, it might have ditched at a distance from the coast such that the time required to bring means of assistance would have exceeded the physical endurance of the occupants of the aircraft.

It was considered desirable, therefore, that the above-mentioned paragraph 6.3.3 be modified and made more restrictive. In this connection, the Italian authorities have laid down that Italian aircraft shall be equipped with life-saving rafts for all occupants on flights of 250 km or more from shore. The Italian authorities have specified this distance rather than a flight time, because they consider that, in cases of this type, the speed of the rescue units is of more importance than the speed of the aircraft.

ICAO Ref: AR/278

No. 32

Douglas DC-2, ZS-DFX Damaged in Forced Landing 20 Miles west of Bulawayo, South Africa on 27 August 1952

Circumstances

The aircraft took off on a non-scheduled flight from Palmietfontein at 0340 hours on 27 August 1952, to fly to England via Lusaka etc., together with another DC-2 of the company, which subsequently also crashed (see accident report 32). The aircraft carried a cargo of Karakul pelts. The pilot got lost, ran out of fuel, and made an unsuccessful forced landing on a field causing substantial damage to the aircraft but no injury to personnel.

Investigation and Evidence

After take-off at Palmietfontein, the Captain turned the aeroplane on to a heading of approximately 350°M. The magnetic track from Palmietfontein to Lusaka is 019°M, thus the Captain initially made an allowance of 29° for drift. When over Pretoria he calculated that the aeroplane was drifting considerably to starboard so he altered course to 330°, thus adding a further 20° to his drift making a total of 49° which represented a wind in excess of a hundred knots. The meteorological route forecast from Palmietfontein to Lusaka which was handed to the pilot mentioned that 10° of drift to starboard should have been allowed. The actual weather conditions pertaining to this route at the time would have placed him slightly more off the course to an extent of 4°.

The Captain stated in evidence that at 0415, Warmbaths was sighted 8 to 10 miles to starboard. Having regard to the actual course which he had set and maintained, and the drift involved, it seems reasonable to suppose that the lights seen were not Warmbaths but those of Thabazimbi. The aeroplane was flying at 10 000 feet, and after estimating he had passed the Waterberg range he descended to 9 500 feet. The Waterberg range extends from the east of Warmbaths to a point northeast of Thabazimbi.

At approximately 0445 the Captain requested the Flight Radio Operator to obtain a bearing on the Bulawayo Beacon. An aural bearing was obtained which showed Bulawayo some 40° to port, this was ignored as it was considered unreliable due to static. Some 15 minutes later, a further bearing was obtained which put Bulawayo 10° - 40° to starboard. The aeroplane continued on a course of 330° until sunrise, about 0545, but no landmarks could be identified due to the smoke haze. At approximately 0550 a reasonably accurate bearing was obtained on Bulawayo of 075° to starboard.

The course of 330° was held for a further hour and rivers were observed running north as they do on the track from Palmietfontein to Lusaka when approaching the Zambezi.

At about 0700 hours a position was given by W/T as over the Zambezi River. The Captain did not realize his mistake in navigation until a few minutes later the Makarikari Pans were identified and a course of 030° set for Livingstone. The Captain then calculated he was nearer Bulawayo than Livingstone and as the fuel appeared to be running low he altered course for Bulawayo at 0730, giving an ETA of 0815.

The aeroplane homed on the Bulawayo beacon and at 0815 when the Captain estimated he was 5-8 miles from Bulawayo both engines cut when flying at 2 000 feet above ground level. An unsuccessful forced landing was made in a field about 20 miles to the West of Bulawayo, the aircraft sustaining major damage to the rear fuselage.

It was established that:

1) Insufficient attention was paid to weather information supplied prior to the commencement of the flight.

2) Insufficient fuel was taken on for the safe operation of the flight as planned.

3) Endurance of aircraft as stated on the Flight Plan as 6-1/2 hours was incorrect.

4) The aeroplane was overloaded to the extent of approximately 3 500 pounds.

5) Failure to make proper pre-flight arrangements for the provision of existing radio navigation facilities for IFR flight.

6) Improper documentation in respect of the Flight Plan, the Load Sheet and the Cargo Manifest.

7) Licences of both pilots not endorsed with type rating for this aeroplane and the licence of the co-pilot was not valid at the time the flight was undertaken.

8) The aeroplane held a valid Certificate of Airworthiness.

Probable Cause

1) Navigation of aeroplane

a) The Captain having taken off from Palmietfontein at night in accordance with an IFR Flight Plan assumed a definite drift on two separate occasions without recourse to available weather information or by use of proper navigational procedure.

b) Had the Captain planned to overhead Bulawayo with the radio navigational aids there, instead of attempting to fly on a direct route, he would never have misjudged his ground speed and his subsequent position as being over the Zambezi.

2) Forced Landing

a) In view of the available airfields in the area where the pilot finally located himself in daylight, an attempt should have been made to execute an emergency landing at one of these airfields rather than take a calculated risk of being able to reach Bulawayo, resulting in a forced landing having to be made in an unprepared field after fuel was exhausted.

b) At the time of landing, the aeroplane was overloaded. Having consumed 2 088 pounds in fuel and oil, the aeroplane was nevertheless approximately 1 500 pounds above the maximum authorized landing weight at the time the forced landing was executed, which could have been the reason for the damage to the aeroplane on landing.

Contributory Factors

1) The Operator

The operators of the aeroplane are responsible in the opinion of the Board for:

a) overloading the aeroplane; and

b) faulty air carrier operational procedures, the minimum requirements of which are prescribed in Chapter 2, ICAO Annex 6, Operation of Aircraft and in particular subparagraph h) on non-scheduled operations.

2) The Captain

The Board finds that the Captain:

a) did not ensure that his licence or that of his co-pilot were valid or properly endorsed for the type of aeroplane flown;

b) did not ensure that the documents necessary for the flight were properly compiled and accurate;

c) did not adhere to the rule for quadrantal altitude when flying under IFR conditions;

d) did not personally submit the flight plan as required by paragraph 2.7 of the Air Navigation Regulations;

e) did not satisfy himself as to the accuracy of the cargo manifest which he had signed. This cargo manifest reflected the weight of cargo as 2 990 pounds whereas the true weight was 2 990 kilograms. This document is required by law to be completed by the operating company, yet where the Captain had signed the manifest the document was prepared and otherwise completed in the offices of the agents Messrs. German South West Africa Airlines. The weights reflected on the loadsheet were inaccurate and in respect of the freight grossly understated. As the Captain of the aeroplane is the managing director of the operating firm having full prior knowledge of this cargo, he must be held jointly responsible for the inaccuracies of his document.

Recommendations

The Board made the following recommendations:

i) The National Transport Commission should investigate the question of the cancellation or suspension of the Air Carrier Licence of the Company in terms of Section 17 of Act 51 of 1949.

ii) In view of i) above and of the relationship of the Captain of the aeroplane to the company i.e., Managing Director, it is felt that no further punitive action be taken against him, in his personal capacity.

iii) This decision was arrived at in view of the fact that, normally speaking, only a Court of Law after conviction may suspend or cancel a pilot's licence. Had the commissioner for Civil Aviation powers of precautionary suspension of licence, the Board may well have made a recommendation in this regard.

iv) In respect of all non-scheduled international flights, Air Traffic Controllers should ensure that all safety regulations are complied with, that licences of aircrew are in order and that flight plans and relevant documents are accurate in detail.

v) Inspectors of Aircraft should be instructed to effect test checks of the gross load weight of cargo of air carriers licensed under the Air Services Act 51 of 1949.

vi) In view of doubts apparently existing in the minds of the operators, it is recommended that whenever foreign aircraft are brought on to the Union Register, steps should be taken to ensure that the documentation involved leaves the operator in no doubt whatsoever as to the maximum permissible all-up weight of such aeroplanes which are registered in the Union.

ICAO Ref: AR/244

No. 33

Douglas DC-2 ZS-DFW aircraft, crashed on 29 August 1952 at Kosti Airfield Anglo-Egyptian Sudan. No. 38/52. J.LO/2/679

Circumstances

The aircraft took off on a non-scheduled flight from Palmietfontein Airport to Southend Airport, England, by Lusaka, Tabora, Juba, Khartoum, Wadi Halfa and other places en route, with a crew of four, two passengers and a load of Karakul pelts. The passengers left the aircraft at Bulawayo, deciding not to complete their journey. The aircraft started in company with another of the same operator which also crashed en route (see report No. 32). On attempting a diversion landing at Kosti at night without suitable ground aids, the aircraft ran off the runway and collided with a steel support for a windsock and afterwards with trees causing major damage. Two crew were killed and two injured.

Investigation and Evidence

Both pilots held valid Airline Transport Pilots' Licences, but neither licence was endorsed for DC-2 aircraft. The co-pilot, however, was entitled to fly in such a capacity without a DC-2 rating. The airplane was overloaded at take-off from Palmietfontein, and was still overloaded at take-off from Juba, the weight at landing at Kosti being above the permissible landing weight.

The Captain stated that the airframe and both engines were serviceable up to the time of collision with the obstruction on Kosti airfield.

On departure from Juba for Wadi Sudna at 1545 on 29 August, the aircraft had not received a route weather forecast, however, two Tafot reports were sent from Khartoum stating that thunderstorms were developing in the Khartoum area and the aircraft was asked whether it could overfly to Wadi Halfa and stated that diversion could be made to Kosti if required. Khartoum suggested that the aircraft land at El Obeid. At 2040 the aircraft stated there was not enough fuel to make El Obeid and a landing would be made at Kosti and at 2047, signalled that a dummy run would be made over Kosti with landing lights to attract attention, in view of the fact that Khartoum was unable to contact or alert Kosti. At 2103 the aircraft sent the following message: "Going in to land now, will call again, now over Kosti, will call again from the ground". No flare path had been laid out. The aircraft touched down on the NE-SE runway from the SW and ran off the runway striking a strong steel tubular support for a windsock, careened along into trees causing major damage.

Probable Cause

The primary cause of the accident was that extremely bad weather forced the Captain of the aeroplane to divert from his original destination. No proper preparation had been made for a possible landing at an alternate airfield prior to commencement of flight. The secondary cause was due to the Captain's attempt to execute a landing at Kosti aerodrome which was not equipped with night landing facilities. The Captain landed on the runway but was unable to align himself with the centre line and in consequence ran off the runway and struck a steel windsock support and thereafter struck various obstructions such as trees which lay in the path.

Contributory Causes

Because of radio interference due to a storm, proper use could not be made of the radio navigational facilities carried on the aircraft.

The lack of appreciation by the Captain of his final responsibility for the operational control of the aircraft, which includes diversionary action, and his apparent failure to appreciate the purely advisory responsibility of Khartoum as a flight information centre.

Recommendations

All aeroplanes operating in the public transport category at night should be equipped with parachute flares.

ICAO Ref: AR/243

No. 34

The Unit Export Co. Inc., Douglas C-46F made wheels-up landing shortly after take-off at Prescott, Arizona on 31 August 1952. Accident Report No. 1-0009. Released 12 May 1953

Circumstances

The aircraft, a Douglas C-46F was engaged on a Civil Air Movement flight with 36 passengers and 3 crew, from Oakland, California to Keesler Air Force Base, Biloxi, Mississippi. A stop at Prescott was made to refuel. Immediately after take-off at Prescott the right engine failed, and although the right propeller was feathered, the aircraft was unable to maintain height. A wheels-up landing was made on open land, 4:7 miles north of the airport, without injury to passengers or crew.

Investigation and Evidence

Take-off was started at about 1508 Mountain Standard Time. The power settings used were normal with both engines indicating a manifold pressure of 44 inches of Hg. and 2 700 rpm. At an indicated airspeed of 115 mph the aircraft left the runway and, according to the crew, the wheels were braked and retracted.

At an altitude of about 75 feet and an indicated airspeed of 125 mph, the aircraft passed over the end of the runway and the Captain signalled his co-pilot to reduce power. As the co-pilot reached for the propeller controls, a loud noise was heard seemingly in or from the right engine and simultaneously the rpm fell from 2 700 to 1 500. The right propeller was feathered as soon as possible thereafter, and single-engine procedure was set up with take-off power maintained on the left engine.

The aircraft was turned slightly to the left and the altitude of 75 feet was maintained to avoid rising terrain ahead.

At the time the aircraft was steadily loosing airspeed and a crash appeared inevitable. The right propeller was unfeathered in the hope that partial power could be obtained from the right engine. None was obtained. While the propeller was windmilling it was noted that the oil pressure read "zero" and the full pressure rose to only 8-10 psi (pounds per square inch), even with the fuel booster pump in the high position.

It was decided to make a wheels-up landing. Both throttles were closed at an altitude of about 15 feet and an airspeed of 80-85 mph. The aircraft skidded about 500 feet before coming to rest in open land about 4. 7 miles north of the airport. Both cockpit controls for the firewall valves were immediately closed, mixtures cut, fuel valves closed and switches turned off.

The aircraft was raised and it was found that both cables in the right wheel well, which actuate the firewall shut-off valves, had been pulled out of position and broken. This movement of the cables closed the fuel, oil and hydraulic valves at the firewall. Considerable other damage resulted in the right wheel well as a result of the violent motion of the cable.

Marks on components within the wheel well showed conclusively that the tire of the retracting right wheel, still rotating, fouled the cables, closing all three valves.

The crew stated that the wheels were braked and their rotation presumably stopped before retraction. But it was clearly apparent from the nature of the damage within the right wheel well that the right wheel must have been rotating when it fouled the cables.

The damage destroyed all possibility of determining if the cables had been unduly loose or otherwise misrigged. Had the cables been loose enough to have appreciable slack, the fouling could have occurred in that manner. This seems to be the most likely probability because fouling of the cables occurred during retraction of the rotating wheel. If the cable support system had been improperly located or aligned at the time of installation so that the cables were dangerously close to the tire, and had the wheels not been braked during retraction on previous take-offs, the fouling of the cables would probably have occurred long before. Secondly, the retracting mechanism is of such design that a latching device prevents overtravel of the wheel following retraction; therefore, properly rigged cables would not have been contacted by the tire.

The crew testified as to a loud noise, seemingly in or from the right engine, at the time it lost power. However, the noise did not originate within the engine but occurred when the wheel well shut-off cables were yanked violently enough to pull their supporting pulley bracket loose from its wall, as well as to break the cables themselves. With both fuel and oil shut off from this engine, the engine would normally act exactly as this one did. Almost simultaneously with the shutting off of the source of fuel, the engine's speed would drop down to windmilling speed, which, in this case, was approximately 1 500 rpm, while the fuel pressure gauge would drop to a reading of approximately 8-10 psi, as occurred in this instance.

According to the CAA Approval Airplane Flight Manual, the airplane should have been able to continue climbing at a rate of approximately 105 feet per minute after the right engine failed and the propeller was feathered under the atmospheric temperature and pressure conditions existing at the time and place of the accident - if the indicated airspeed of the airplane was 130 miles per hour.

However, unlike aircraft certificated in the transport category, for which the field length required to clear a 50-foot obstacle is based on take-off at the single-engine climb speed, the C-46F was certificated under Part 3 of the Civil Air Regulations and is approved for take-off at an indicated airspeed of 105 miles per hour and a climb to 50 feet with an airspeed of 123.5 miles per hour indicated, while the en route single-engine climb speed is 130 miles per hour indicated. At the indicated airspeed of 123.5 miles per hour, the single-engine climb performance of the C-46F is less than at 130 miles per hour. In addition, the propeller of the dead engine will produce a high drag during the short critical interval until it is feathered, seriously reducing the climb performance during this interval. Extrapolated transport category performance data determined by the CAA indicates that with the aircraft weight and atmospheric conditions existing at the time and place of the accident, and with the inoperative propeller windmilling, the aircraft has a rate of descent of several hundred feet per minute at the optimum single-engine climb speed for this configuration. Any variation from this speed results in a further increase in the rate of descent. In view of the above, it is apparent that when the right engine ceased producing power, the aircraft needed either a considerable margin of speed above 130 miles per hour to sacrifice in maintaining altitude until the propeller was feathered, or considerable altitude to sacrifice in maintaining or gaining a speed of 130 miles per hour during this interval. It is most significant to determine, therefore, whether or not the aircraft could be expected to have been flying under one of the above conditions when the right engine ceased producing power.

According to the approved Slick Flight Manual, the aircraft should have been able to reach a 50-foot altitude at an airspeed of 123.5 miles per hour at a point approximately 6 150 feet* from the beginning of the take-off run under the conditions existing at the time and place of the accident, except for the neglect of the ground wind and runway slope. Although data on the effects of these variables are not available for the C-46F, because of certification under Part 3 instead of the transport category requirements, examination of the data for other twin-engine aircraft certificated in the T-category indicates that the effects of the one per cent downward slope of the runway on shortening the take-off run approximately cancel the effects of the reported 12-mile-per-hour tail wind on lengthening the take-off and climb to 50 feet. It appears, therefore, that these two variables can be disregarded with small error.

The maximum additional two-engine climb possible with gear up from the 50-foot point to the end of the 7 600-foot runway, approximately the point at which engine failure was reported to have occurred, is calculated to be approximately 100 feet. This makes a possible height above the ground of approximately 150 feet at the end of the runway, at an indicated airspeed of 123.5 miles per hour. However, the aircraft was reported to have reached an altitude of only 75 feet at this point. Assuming that the best piloting techniques were used from the beginning of the take-off run until the end of the runway was reached, it is calculated that the excess horsepower resulting from the climb to the reported altitude of 75 feet at less than the maximum rate of climb could accelerate the aircraft to an indicated airspeed of approximately 130 miles per hour. The crew reported that the aircraft had reached an indicated airspeed of

* Other approved data based on an airspeed of 126 miles per hour in the climb indicate a distance of 6 900 feet. However, the shorter distance of 6 150 feet, which is more favourable to the aircraft, is used throughout the remainder of this analysis.

125 miles per hour as it passed by the end of the runway when the power loss occurred. Therefore, it is evident that the power developed by the engines during the take-off and initial climb was very close to the maximum possible and that during this period the crew used techniques which extracted nearly the optimum performance from the aircraft.

In explanation of the above, the approved data for the distance required to climb to a 50-foot altitude after take-off were computed on the assumption of no ground effect and of a constant indicated airspeed of 123.5 miles per hour from the beginning to the end of the climb. Relative to the first assumption, ground effect very appreciably decreases drag and the power required to fly at a given airspeed when the aircraft is very close to the ground. However, when the height of the aircraft wing is greater than approximately one-half of the wing span above the ground, 54 feet for C-46F aircraft, the beneficial ground effect drops to a negligible value. Relative to the second assumption, the approved take-off speed of 105 miles per hour for the C-46F is less than the speed at which climb to the 50-foot altitude was computed with the result that the rate of the climb will be adversely affected until the speed approaches 123 miles per hour. Since the effects of these two assumptions tend to counteract each other, it appears that the assumptions do not introduce significant conservatism in the approved take-off climb data for the C-46F aircraft.

It is apparent also that there was no appreciable ground effect on the climb performance of the aircraft from the time it climbed above the 50-foot altitude until it descended to within 50 feet of the ground beyond the confines of the airport, where ground effect cannot be depended on to assist the aircraft unless it can be flown over water or flat terrain free of trees, power-lines, buildings and other obstructions.

It is to be noted that the single-engine rate of climb of 105 feet per minute at an indicated airspeed of 130 miles per hour, mentioned above, is based on full throttle operation of the engine at the maximum continuous rpm of 2 550. Power curves for the engine indicate that full throttle operation at the take-off rpm of 2 700 would produce approximately 75 additional brake horsepower under the conditions existing at the time and place of the accident if the cylinder head temperature did not exceed the approved maximum. However, the transport category performance data determined by the CAA indicate that at an indicated airspeed of 130 miles per hour, operation of the engines at the maximum continuous setting causes the cylinder head temperatures to exceed the maximum allowable by an average of 19°F during flight at the maximum outside air temperature anticipated by the Civil Air Regulations. The reported outside temperature at the time and place of the accident was 9°F higher than the maximum anticipated by the regulations, which tended to further increase the excess cylinder head temperatures. Operation at any airspeed lower than 130 miles per hour, or at any power demand greater than maximum continuous, would further increase the head temperatures. The excess temperatures decrease the volumetric efficiency of the engine and the resultant horsepower output is less than that shown on the power curves. Although readings of the actual engine temperatures on the aircraft at the time the right engine ceased producing power are not available, both test data and operational experience indicate that they probably exceeded the maximum allowable and that the attempt of the crew to continue single-engine operation at the maximum possible power increased the excess temperature with the result that the actual power developed by the left engine was appreciably less than that indicated by the power curves. As a result, little if any increase in the rate of climb over that indicated by the approved data could be achieved by single-engine operation at 2 700 rpm.

It is apparent that the 8 000-foot density altitude at the time and place of the accident adversely affected the aircraft's single-engine performance and the aircraft could not be expected to continue flight.

Probable Cause

The probable cause of this accident was complete loss of power from the right engine shortly after the aircraft became airborne at an altitude of approximately 75 feet above terrain, with an indicated airspeed of 125 mph and at a density altitude of 8 000 feet, under which circumstances the aircraft would not maintain single-engine flight. This loss of power resulted from the closing of the emergency shut-off valves due to the fouling of their actuating cables by the right tire.

ICAO Ref: AR/265

No. 35

Dakota ZS-AVI aircraft, made a forced landing on 15 September 1952 at Carolina, Tvl. South Africa, Aircraft Accident Report No. 43/52 J. 10/2/685

Circumstances

The aircraft carrying a crew of 5 and 14 passengers, took off from Livingstone Airport to Palmietfontein on a non-scheduled flight on 14 September 1952. Atmospheric conditions were abnormally bad and communications generally were affected adversely. Towards the end of the flight the captain was completely lost and crashed whilst attempting to land at an unlighted airport. There were no fatalities or injuries.

Investigation and Evidence

Approximately ten minutes after take-off, course was altered to 135°M to circumvent a storm. This heading was maintained for approximately 15 minutes. The course was then altered to 30 degrees to starboard for a further 15 minutes to regain track. The aircraft was then climbed to 1 500 feet above the ground to a flight level of 9 500 feet AMSL, which was attained at 1745 on a compass course of 177°M.

A ground speed and position check carried out at 1755 gave a ground speed of 173 mph and this was obtained between the following two positions 18°50'S 26°05'E and 20°00'S 26°22'E. At this stage darkness was setting in and the Captain requested the Radio Officer to obtain a fix (QFT). This fix was not obtained because the Radio Officer was changing over to the night frequency.

After changing over to night frequency (3105 kcs.) the Radio Operator tried several times to contact Salisbury and Germiston from 1800 to 1840, with negative results. He changed back to 6510 kcs. and from 1840 to 1850 he again tried to contact Salisbury and Germiston with negative results. At 1900 he changed back to night frequency and then he was successful in contacting Germiston but reception was poor in both directions.

A second check was obtained at 1909 when the aeroplane passed over a town illuminated by electric light on a railway line and which the pilot assumed to be Mahalapye. This assumption placed the aeroplane 18 miles starboard of track which gave a ground speed of 178 mph and a revised ETA for Palmietfontein of 2040 which was transmitted to Palmietfontein. No alteration of course was made at this point because the meteorological report indicated a gradual backing of wind from this stage onwards. Darkness and numerous veld fires made map reading difficult.

At 1938 the aeroplane passed between two towns which were assumed to be Warmbaths to the right and Nylstroom to the left. This assumption was based on the fact that at this time flying conditions, which had been relatively smooth, suddenly became turbulent from which the Captain deduced he was passing over high ground. This further assumption, together with his knowledge of Warmbaths, made him reasonably confident of his position, and in view of this an alteration of course of 22° to starboard was made. Hartebeestpoort Dam beacon was then picked up on the radio compass and indicated that the Beacon was 30° to port of his heading; his reaction to this was that it could not be possible since his previous assumption already made the position of the aeroplane 40-50 miles to port of track. He then attempted to contact Palmiefontein on VHF to obtain a homing so that his position could definitely be established but contact could not be made.

Whilst attempting to get this homing, the first officer drew the Captain's attention to the fact he had again picked up the "HB" coding signal of the Hartebeestpoort Dam beacon. The Captain then switched over to the "Aural" (Antenna) position and heard the "B" of "HB". On switching over to the "Visual" (Compass) position the radio compass needle again pointed steadily 30° to port.

The Radio Officer, however, informed the Captain that the Johannesburg English Programme was broadcast on a frequency of 782 kcs. and that he should use this frequency in order to get a bearing on Johannesburg. This was done and the reading obtained gave a bearing of

30° to starboard. Of the two bearings obtained, the Captain decided that the "HB" Beacon was the nearer, and was also the check point for entering the corridor for Palmietfontein and altered course to 160°M which brought the radio compass needle to zero. He then instructed the Radio Officer to obtain any sort of bearings from any ground stations.

This course of 160°M was maintained for approximately 15 minutes, during which time the Radio Officer informed the Captain that Palmietfontein and Germiston were unable to give him any bearings whatsoever because the aeroplane signals could not be heard at the HF/D F station at Palmietfontein.

The Captain then attempted to locate his position by map reading, and at the same time kept a look-out for the glow of lights from Pretoria. After a while he became convinced that the radio compass was not leading him to the "HB" Beacon, firstly, because there was no sign of the lights, and secondly, he had by nowdecided that the signal obtained from the Johannesburg broadcast station was, in all probability, stronger than the signal received from "HB". Also his amended ETA for Palmietfontein was 2015 and it was now 2010.

The fuel reserves were then calculated, and it was ascertained that he had approximately 160 (Imperial) gallons left. He immediately went into long range cruise. The Captain then turned onto a course of 200°M and again attempted to obtain a bearing of Johannesburg broadcast station on 782 kcs. The radio compass indicated a reading of 30° starboard so he altered course to 230° and the compass needle indicated a heading of 270° towards the Broadcast station.

The Captain then turned towards the lightest part of the sky, this gave him a reading of 280°M on the aeroplane's compass.

A last attempt was made to obtain a bearing from either Germiston or Palmietfontein, and the bearings obtained indicated that these stations were behind him. The Captain then noticed lights to his left and slightly behind the aeroplane, and he immediately turned towards these lights and arrived over a town at 2025.

A red Very light was fired to indicate to the people on the ground that the aeroplane was in distress. It was then noticed that several cars were heading in a certain direction; these cars eventually stopped and formed a semi-circle with their headlights.

The Captain carried out a circuit, did a low approach over the cars and noticed a wind sock. Several dummy runs were completed and he decided to land. The Radio Officer transmitted an SOS signal with the message that they were going to land.

With the gyro instruments aligned, and after turning from "Base Leg" to "Final" the aeroplane struck high ground on a heading of 206°M. The aeroplane ran through an outcrop of rocks, burst both tires, damaged the undercarriage, and the tips were broken from the port propeller blades.

The Captain then, opened up the engines, the aeroplane struck a built-up ridge of a donga, became airborne again, and cleared telephone wires about 25 feet high which were 70 paces distant from the donga.

The aircraft then flew straight ahead for approximately one minute, vibrating excessively, during which time the Captain switched on the landing lights for the first time and carried out a landing on the aerodrome, in the direction indicated by the headlights of the motor cars. The aeroplane touched down on three points and after running 142 paces the port undercarriage collapsed, the port engine broke away, and the aeroplane tipped onto its nose and slewed to the left.

The crew escaped through the emergency exit and the roof of the cockpit, and the passengers and air hostess left the aeroplane through the main exit door in the cabin.

Comments

1. The Captain took off from Livingstone at 1645 for Palmietfontein, and the accident occurred at Carolina at 2103. He received a meteorological report and submitted a flight plan which was cleared by the Air Traffic Control Officer at Livingstone for flight under VFR conditions with Pietersburg and Germiston as alternates.

2. The Captain did not request extended hours of radio service facilities at Pietersburg.

3. On the flight plan the endurance of the aeroplane was given as 6.00 hours yet after flying for approximately 4.18 hours (1645 to 2103) the calculated fuel reserve was estimated as 1-1/4 hours. The fuel remaining in the aeroplane after landing at Carolina was 132 Imperial gallons.

4. The track from Livingstone to Palmietfontein is 166° true (plotted on Plotting Chart and calculated mathematically). The mean variation en route is 15°W. The magnetic track is therefore 181°M. The deviation according to the deviation card found in the aeroplane was shown as - 1 on a Southerly Heading. This indicates that in conditions of no-wind a compass course of 182° would have to be steered to make good the desired track.

5. The upper winds shown on the meteorological report and as handed to the Captain for the section Livingstone to 23°00'S 300°/30K for 8 000 feet AMSL and 300/35K for 10 000 feet AMSL. Therefore the compass course to steer to make good the desired track was 189° and the computed ground speed was 211 mph. (These figures are based on 173 TAS mph temperature + 7°C at 10 000 feet AMSL. The Captain states he steered a compass course of 177° and did not calculate his ground speed or drift in accordance with available meteorological reports. He commenced and continued the flight with an initial error of 5° in heading to port and based all his calculations on still air conditions which were 38 mph less than the actual ground speed.

6. Air Traffic Control at Palmietfontein had been informed on 13 September 1952 by South African Airways of the proposed flight to Livingstone on 14 September and return from Livingstone on 15 September at 1630.

7. The departure signal from Livingstone was received at Palmietfontein at 2020 on the night of 15 September. The first news received at Palmietfontien that ZS-AVI was en route from Livingstone to Palmietfontein was received at 1910. A position report originated by the aeroplane at 1997 gave the position at Mahalapye at 1905 flying at 9 500 feet and ETA Palmietfontein 2040.

8. The aeroplane radio equipment was found to be serviceable on inspection after the accident and aeroplane to ground tests conducted on 16 September 1952 revealed the equipment to be normal.

9. On the night of 15 September atmospheric conditions were abnormally bad and communications generally were affected adversely. The Captain, towards the end of his flight, was completely lost but at no time declared an emergency only stating he was lost and did not know that he was, in fact, flying over Carolina until after he landed.

10. The aeroplane struck the ground 138 feet higher than the aerodrome and at a distance of 7 500 feet from touchdown on the aerodrome. This gives an approach slope of one in fifty-four which is well within the limits of a first-class aerodrome.

11. The locality of the aerodrome was only indicated to the pilot by a semi-circle of motorcar headlights which did not conform to any recognized pattern used for night flying. The willingness displayed by the inhabitants of Carolina and their endeavours to assist the pilot to carry out an emergency landing is to be highly commended.

12. The forecast weather report furnished to the Captain of the aeroplane compared favourably with the actual conditions prevailing at the time of the flight.

13. In reconstructing the flight and taking due regard of the upper winds prevalent at the time, it would appear that Potgietersrust may have been mistaken for Mahalapye and furthermore any two towns in the Middleburg-Bethal-Machadodorp area for Warmbaths and Nylstroom. The Pietersburg and Carolina Beacons were not scheduled to function and thus were not operating during the time of flight.

Probable Cause

Primary

The primary cause of the accident was faulty navigation on the part of the Captain of the aeroplane inasmuch as he set off on an incorrect course and thereafter his visual identification of towns en route was incorrect and based purely on assumptions. Had he checked his assumed ground speed between what he assumed to be Mahalapye and Warmbaths he would have found this to be approximately 318 mph which check would have alerted him.

Secondary

The failure of those responsible to alert Pietersburg Aeradio Station and Beacon and the excessive degree of radio interference on the Rand on the evening of 15 September due to electrical storms.

Tertiary

An attempted landing on a unidentified and unlighted aerodrome, of which the altitude was not known. Thereafter in a low approach the wheels of the aeroplane struck a rock outcrop approximately 1-1/4 miles from the aerodrome.

Recommendations

1. It should be customary for a non-scheduled operator in planning a flight to make available to the Captain of the aeroplane and Air Traffic Controller, all operational details in precisely the same manner as is done for his scheduled operations. Such a course would have completely eliminated the apparent lack of liaison between the operator and the Air Traffic Controller at Palmietfontein.

2. The inordinate lapse of time of about four hours between the filing of the flight plan at Livingstone and the receipt thereof at Palmietfontein is most disquieting and should be investigated. The aeroplane would, under normal circumstances, have been in the vicinity of Hartebeestpoort Dam when the flight plan became available to the Air Traffic Controller at Palmietfontein.

3. In view of the confusion that may arise from endeavouring to navigate by visual reference to the ground while flying at night, it appears that all public transport operations during the hours of darkness should be conducted in accordance with Instrument Flight Rules.

4. On 7 August 1952, the Department of Transport issued a notice purporting to be a Notam involving the cancellation of extended hours and radio facilities. This circular had no heading and caused confusion regarding the availability of Pietersburg Radio Station. It is recommended that all Notices to Airmen issued by the Department of Transport should be printed on officially headed paper, to obviate any confusion between notices and circulars. The preparation, proper supervision and circulation of such notices must be regarded as a most important function of the Department.

5. If this aeroplane had carried flares for which it was equipped, the use of such flares may have prevented the unsuccessful emergency landing.

6. All radio aids to navigation in the Union, save those on 24-hour services, should open and close at the same regular fixed times and terms such as "to suit flying" be discontinued in regard to hours of operation.

ICAO Ref: AR/245

No. 36

Piedmont Airlines - DC-3, Damaged whilst landing at
Greensboro-High Point Airport, North Carolina, 20 October 1952
Accident Report No. 1-0089. Released 10 June 1953

Circumstances

The aircraft was on a scheduled flight between Cincinnati, Ohio, and Wilmington, North Carolina, with eight intermediate stops. The aircraft carried 13 passengers and 3 crew. Whilst landing in a strong, gusty cross-wind at Greensboro-High Point Airport, the aircraft contacted the runway, tail low, and control was lost. Both landing-gears collapsed and the aircraft came to rest within the boundary of the airport.

Investigation and Evidence

The aircraft called Greensboro Tower for landing instructions. The tower replied: "Piedmont 20 in sight over Kernersville, two eight (1228) VFR. Cleared left turn in runway five, wind north, varying both sides two zero to three zero (20-30 mph). Occasional gusts up to four five (45 mph). Over."

The flight acknowledged this message and the tower replied, "Piedmont twenty cleared to land." The Captain then asked if Runway 32 would be more nearly aligned with the wind. The tower replied, "It's varying thirty to forty (mph) at the present time. North varying both sides. According to my indicator up here it's holding -- just holding on -- well it's favouring 5 (Runway 5) most of the time but the tets (tetrahedron) swinging free -- you can see it." The Captain replied that he would use Runway 5, the tower said "OK", and then transmitted, "Varying twenty-five to thirty (mph) now". Just before the flight crossed the airport boundary the tower gave the wind as 27 mph. This was acknowledged.

Previously, about four miles from the airport, the landing check had been made and the landing-gear extended and locked. At about three miles from the approach end of Runway No. 5 the aircraft was turned to the left into final approach. The airspeed at the time was about 120 mph, and the altitude about 500 feet. Wing flaps were then lowered to the 1/4-down position. Airspeed was decreased by gradual reduction of power and further extension of flaps. The Captain estimated that the airspeed was about 100 mph upon passing over the end of the runway, by which time the flaps were fully lowered.

Approximately 200 feet beyond the approach end of the runway the aircraft touched down in a three-point attitude, or nearly so. The crew stated that it did not contact the runway; competent witnesses on the ground stated that they believed it did. The Captain estimated an airspeed of 85 mph at that time.

In either event, the aircraft rolled on the runway, or flew extremely close to it, for the relatively short distance of about 300 feet when the left or windward wing started to rise. The right wing dug into earth on the downwind side of the runway; the Captain decided to go around, applied full power and ordered the gear and flaps up. The co-pilot complied at once, starting the gear and flaps up. He stated that the flaps were retracted at short-spaced increments. However, the left wing then went down until it struck the ground at a point about 700 feet from where the right wing struck.

The aircraft skidded nearly sidewise to its right for a short distance before coming to rest within the boundary of the airport. Evacuation of the 13 passengers was quick and orderly, and via the main cabin door.

At the time of the accident, the ceiling and visibility were unlimited and the wind was from the north, 20 mph with strong gusts up to 38 mph. Investigation into the attitude of the aircraft at the time of touchdown, or near touchdown, revealed the following: The Captain stated that the aircraft was struck by a gust from the left just prior to touching down, and that this gust dropped the tail, as well as the right wind, the latter sufficiently to touch the ground. Two tower operators, both of them commercial pilots as well as certificated controllers, and three airline pilots in the cockpit of a scheduled aircraft awaiting take-off on Runway No. 5 testified that the aircraft actually did touch down, in a tail low or nearly three-point attitude, about 200 feet down the runway. They further stated that the right wing went down while the tail was in this low position. These five witnesses were in extremely advantageous positions to observe precisely what happened at or about the time of touchdown.

Investigation also revealed that the raising of the flaps was not done in accordance with the company's operating procedure. The company operations manual specified that at the start of a go-around flaps be raised over a 60-80 second period. A computation of the distance, speed and the consequent time interval from when the Captain ordered the flaps up until the aircraft came to rest with them fully up, indicated that they must have been raised practically without interruption.

Piedmont Airlines' operations manual states in part:

"5. Cross-Wind Landing

a. Keep the nose of the airplane lower than usual during the final approach.

b. Lower the windward wing, or crab the aircraft, head the airplane toward wind sufficiently to maintain a course parallel to the runway.

c. Make a tail-up landing.

d. When the wheels contact the ground lower the airplane's nose slightly, idle the leeward engine, and retract the wing flaps.

NOTE: The airplane is much less affected by horizontal wind gusts when the wing flaps are retracted.

e. Increase the power of the windward engine as necessary in order to maintain the directional course of the airplane."

The company's operations manual does not set forth maximum cross-wind components for landing. (This is not required under the CAA type certification of the company's DC-3's although some DC-3 operators do specify such maxima.) Rather, the decision to land or not is entirely at the Captain's discretion. The actual method of making cross-wind landings is also a matter of the techniques of the company's individual pilots, subject, of course, to the above general rules.

In reference to the use of wing flaps during the subject landing, the following seems pertinent:

The Captain used flaps as prescribed in the company's pilot training manual. It stated that one of the common faults made during cross-wind landings is using too little flap. It further advocated the use of from 3/4 to full flap during a cross-wind landing.

During this approach the cross-wind was not only unusually high but was accompanied by reported gusts of 45 mph. Under those conditions the use of a large amount of flaps is questionable. Common practice and good operating procedure would call for the use of little if any flap, a tail high touchdown and immediate retraction of flap, if any. The entire subject of flap usage should not be set forth in an inflexible manner in the company's training manual, but should be a matter of flight training.*

Although the company did not specify a maximum cross-wind component for DC-3 landings, and was not required to do so, it is now considering adding such data to its operational manual.

Probable Cause

The Board determines that the probable cause of this accident was loss of control of the aircraft while attempting a landing during strong, gusty cross-winds.

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* As a result of this accident the carrier has revised its operations and training manuals as follows:

5. "Cross-Wind Landing:

a. Keep the nose of the airplane lower than usual during final approach and not more than half flaps are to be used when landing in cross-winds of more than 12 mph. The only variation from this is to be when landing area makes use of all flaps necessary. The judgment of whether to use more than half flaps will remain with the pilot at the time of landing, taking all circumstances under consideration."

ICAO Ref: AR/260

No. 37

BOAC Comet D.H. 106 aircraft accident during take-off on 26 October 1952 at Ciampino Airport, Rome

Circumstances

The aircraft was operating a scheduled passenger service from London to Johannesburg. The flight from London Airport to Rome was without incident. During the take-off from Rome on the second stage, the aircraft's normal speed failed to build up and after becoming airborne for a few seconds, the Captain's immediate reaction was that there was a lack of engine thrust. He throttled back the engines at the same time as the aircraft came to rest near the airport boundary, and the aircraft sustained considerable damage and two passengers were slightly injured.

Investigation and Evidence

For take-off the aircraft was taxied to Runway 16 and lined up on the centre line; all pre-take-off checks were made and the elevator, aileron and rudder trim were set at the neutral position. The Captain's estimation of runway visibility was 5 miles but with no horizon. The flaps were lowered to 15° and the windscreen wipers were both operating. The engines were opened up to full power and the isolation switches were set to "Isolate". The RPM were checked at 10 250 on all engines; fuel flows, engine temperatures and pressures were reported to be correct. The brakes were released and the aircraft made a normal acceleration. At an IAS of 75-80 knots, the nose wheel was lifted from the runway and a slight tendency to swing to starboard was corrected. At an IAS of 112 knots, the Captain lifted the aircraft from the ground by a positive backward movement of the control column and when he considered that the aircraft had reached a safe height he called for "undercarriage up". At about the same instant the port wing dropped rather violently and the aircraft swung to port; the controls gave normal response and lateral level was regained. At this point the Captain realized that the aircraft's speed was not building up, although he made no reference to the ASI. A pronounced buffeting was felt which he associated with the onset of a stall and in spite of two corrective movements of the control column the buffeting continued. Before the First Officer had time to select undercarriage up, the aircraft came down on its main landing wheels and bounced. It was now plainly evident to the Captain that the aircraft's speed was not increasing and he was convinced that there was a considerable loss of engine thrust. He was also aware that the aircraft was rapidly approaching the end of the runway and a decision to abandon the take-off was made. The undercarriage struck a mound of earth as he was closing the throttles and the aircraft slid for some 270 yards over rough ground. The main undercarriages were wrenched off and considerable damage resulted; a large spillage of fuel occurred but fire did not break out. One passenger suffered slight shock and another sustained a cut finger.

Subsequent interrogation of the crew confirmed that all engines had given their maximum power and that fuel flows, temperatures and pressures had all been normal during the take-off. It was the belief of the First Officer that the nose wheel was lifted from the ground in the usual manner although the control column appeared to be "a fair way back". He also thought that the "unstick" was made by moving the control half way back from the neutral position and that it was held there until the port wing dropped. He also stated that he was unable to determine the attitude of the aircraft after the bounce as no runway lights were visible to him.

Due to darkness and due also to rain, no ground witness had a clear view of the take-off. One, however, who observed it from a point opposite the half-way position of the runway, considered that the aircraft's attitude was "critical" as it passed him. He continued to observe it as the nose was exceptionally high and he was not aware that the aircraft became airborne.

An inspection carried out at the scene of the accident showed that the aircraft came to rest about 270 yards from the upwind end of runway 16 and 10 yards from the boundary fence; considerable damage had resulted. A large spillage of fuel from the port wing integral tanks had occurred but fire did not break out. Both inertia switches had tripped. The two crash switch operating levers functioned correctly and the methyl fire extinguisher bottles had discharged. The seats and their attachments in the crew and passenger compartments were undamaged. The crew's forward entrance door and the passenger's entrance door functioned normally as also did the emergency hatches. The flaps were in the lowered position of about

15° and this corresponded to that indicated in the cockpit. The elevator, aileron and rudder trim indicators were in the neutral position. Wheel marks on the runway showed that the main landing wheels had been in contact with the runway over the last 30 feet of its length. The next contact was made on two mounds of earth; when this occurred the undercarriages were wrenched off and parts of these units damaged the tailplane. The port main plane hit the runway direction indicator which is mounted on concrete blocks and the wing tip and pitot head were torn off. The starboard inner engine steady strut had become detached at its forward end when the attachment bracket rivets had sheared due to impact forces. This detachment allowed the engine to rotate on its mounting trunnions through the mainplane skin and in a nose-down direction. The nose wheel was forced upwards into its housing and the tail bumper unit was torn from the rear portion of the fuselage. The bumper attachment bracket was subsequently found in the wreckage trail. An examination of this bracket showed that the shoe was missing and that the bracket was deeply scarred. A search made along the runway revealed evidence of tail bumper marks which varied in length from 3 feet to 40 feet. These marks extended along the last 650 yards of the runway and showed that the aircraft's track was inclined a few degrees to starboard of the runway centre line.

The BOAC Training Manual recommends the following take-off technique:

"At 80 knots the nose should be lifted until the rumble of the nose wheel ceases. Care should be taken not to overdo this and adopt an exaggerated tail-down attitude with a consequent poor acceleration."

The normal fuselage incidence during the take-off ground run is about 2° to 3° after the nose wheelhas been raised just clear of the runway. To do this a backward stick movement of about 4 inches is required which is then reduced to 1-1/2 inches. The attitude of "unstick" is approximately 6° to 6-1/2° and to attain this the required stick movement at the time of leaving the ground is of the order of 6 inches back from the neutral position, after which the stick must be returned towards the pre-take-off position.

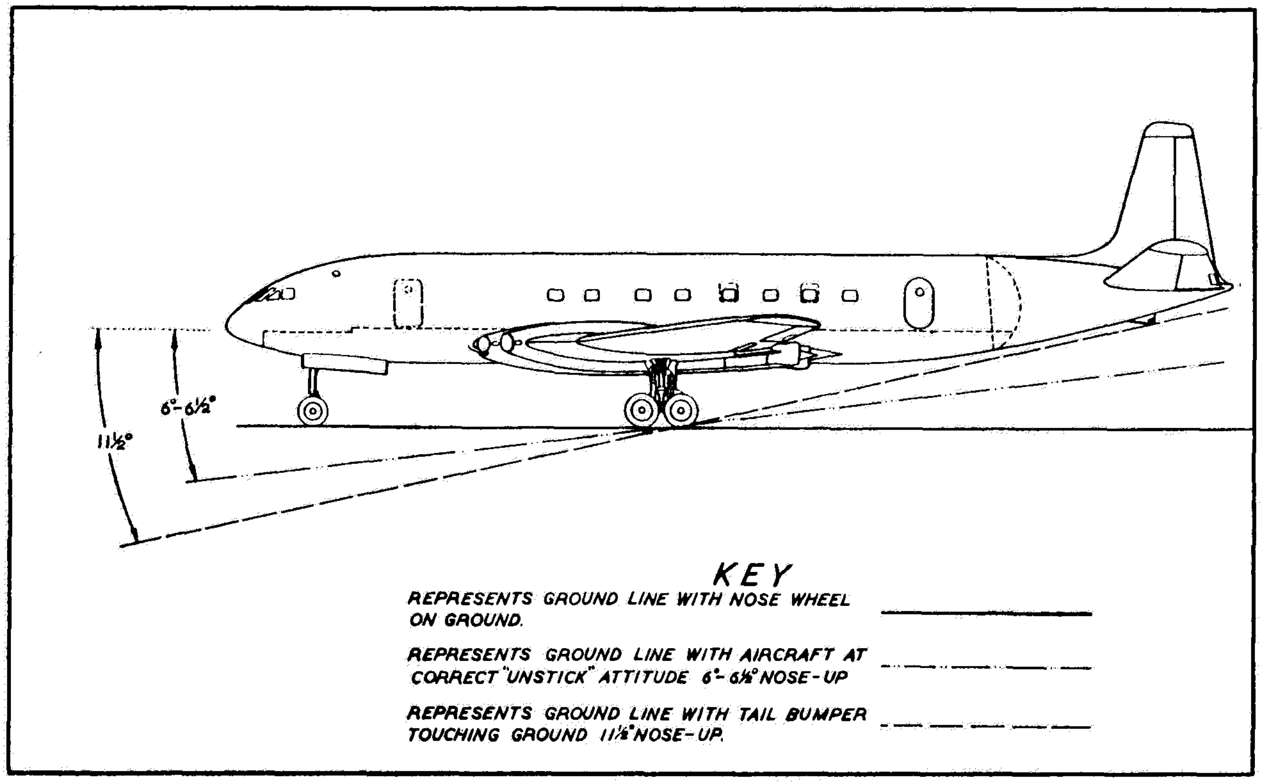
Take-off by the manufacturers have shown that a constant 6° incidence of fuselage during the ground run gives good results for distance run and for climb-away behavior. They have also shown that an increase of incidence to 9° results in a partially stalled wing giving high drag which appreciably affects the aircraft's acceleration, and that the symptoms are noticeable to the pilot as low frequency buffet. The aircraft recovers from its semi-stalled position if the nose is pushed well down.

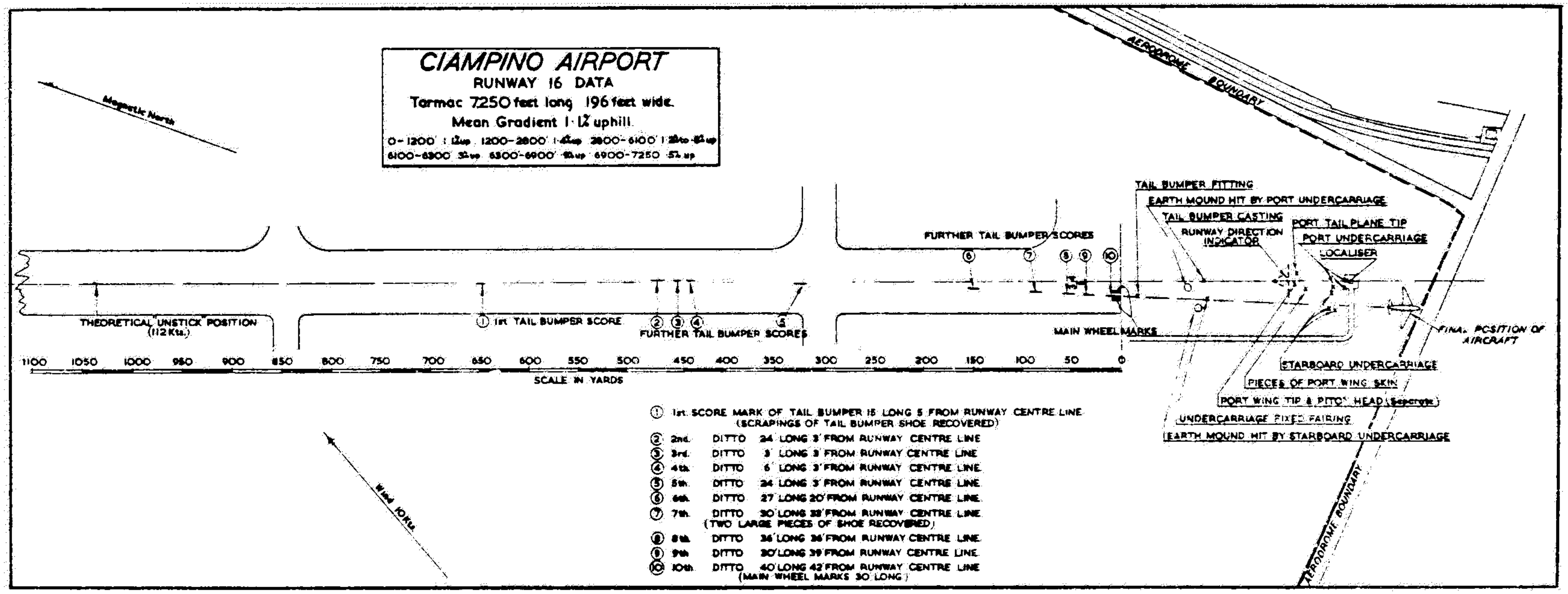
Figure shows a diagrammatic representation of the nose-up attitude of the aircraft in the correct position of unstick, i.e., 6° - 6-1/2° nose up. The Appendix also shows that for the tail bumper to touch the ground an angle of at least 11-1/2° is required.

Probable Cause

The accident was due to an error of judgment by the Captain in not appreciating the excessive nose-up attitude of the aircraft during the take-off.

ICAO Ref: AR/246


6°-6½°
11½°
KEY
REPRESENTS GROUND LINE WITH NOSE WHEEL ON GROUND.
REPRESENTS GROUND LINE WITH AIRCRAFT AT CORRECT "UNSTICK" ATTITUDE 6°-6½° NOSE-UP
REPRESENTS GROUND LINE WITH TAIL BUMPER TOUCHING GROUND 11½° NOSE-UP.


CIAMPINO AIRPORT
RUNWAY 16 DATA
Tarmac 7250 feet long 196 feet wide.
Mean Gradient 1·1% uphill.
Magnetic North
Wind 10Kts.
AERODROME BOUNDARY
THEORETICAL UNSTICK POSITION (112 Kts.)
1st. TAIL BUMPER SCORE
FURTHER TAIL BUMPER SCORES
FURTHER TAIL BUMPER SCORES
MAIN WHEEL MARKS
TAIL BUMPER FITTING
EARTH MOUND HIT BY PORT UNDERCARRIAGE
TAIL BUMPER CASTING
RUNWAY DIRECTION INDICATOR
PORT TAIL PLANE TIP
PORT UNDERCARRIAGE
LOCALISER
FINAL POSITION OF AIRCRAFT
STARBOARD UNDERCARRIAGE
PIECES OF PORT WING SKIN
PORT WING TIP & PITOT HEAD (Separate)
UNDERCARRIAGE FIXED FAIRING
EARTH MOUND HIT BY STARBOARD UNDERCARRIAGE
1100 1050 1000 950 900 850 800 750 700 650 600 550 500 450 400 350 300 250 200 150 100 50 0
SCALE IN YARDS
① 1st. SCORE MARK OF TAIL BUMPER 15 LONG 5 FROM RUNWAY CENTRE LINE (SCRAPINGS OF TAIL BUMPER SHOE RECOVERED)
② 2nd. DITTO 24 LONG 3′ FROM RUNWAY CENTRE LINE
③ 3rd. DITTO 3 LONG 3 FROM RUNWAY CENTRE LINE
④ 4th. DITTO 6′ LONG 3′ FROM RUNWAY CENTRE LINE
⑤ 5th. DITTO 24 LONG 3′ FROM RUNWAY CENTRE LINE
⑥ 6th. DITTO 27′ LONG 20′ FROM RUNWAY CENTRE LINE
⑦ 7th. DITTO 30′ LONG 33′ FROM RUNWAY CENTRE LINE (TWO LARGE PIECES OF SHOE RECOVERED)
⑧ 8th. DITTO 36′ LONG 36′ FROM RUNWAY CENTRE LINE
⑨ 9th. DITTO 30′ LONG 39′ FROM RUNWAY CENTRE LINE
⑩ 10th. DITTO 40′ LONG 42′ FROM RUNWAY CENTRE LINE (MAIN WHEEL MARKS 30 LONG)

No. 38

Trans World Airlines, Inc., Lockheed Constellation 1049 damaged during an emergency landing at Fallon, Nevada, on 7 December 1952 - Accident Report 1-0104. Released 13 July 1953

Circumstances

The aircraft, a Constellation 1049, was on a flight from New York to San Francisco, California, with one stop at Chicago, Illinois. Departure from Chicago was at 1020. The aircraft carried 35 passengers and 5 crew; gross weight and centre of gravity were within the allowable limits. At about 1740, No. 3 engine failed and 25 minutes later No. 4 engine failed and an emergency was declared. A decision to land at Fallon Air Station was made but while landing the aircraft veered to the left of the runway into soft dirt and several piles of gravel when Nos. 1 and 2 propellers were put in reverse pitch. The aircraft came to rest after extensive damage had been done. Evacuation was carried out in two minutes and there were no personal injuries.

Investigation and Evidence

The flight was routine until near Lovelock, Nevada, when, at about 1740 and at an altitude of 16 000 feet MSL, a complete power loss was experienced from No. 3 engine. While the flight engineer was attempting to restart that engine it overspeeded. The Captain then reduced airspeed to about 170 miles per hour, and No. 3 propeller was feathered. Weather at Reno, about 95 miles ahead, was 2 000 feet scattered, overcast at 20 000 feet. San Francisco weather, about 260 miles ahead, was 20 000 feet and 10 miles.

The Captain decided to continue on three engines to San Francisco, the destination.

About 25 minutes after the failure of No. 3 engine, No. 4 engine failed. Power could not be restored, and at 1829, No. 4 propeller was feathered and an emergency was declared. At this time the flight was about 10 minutes east of Reno, Nevada, and the weather there was checked at once. It was found to be 1 500-foot ceiling and 3 miles visibility with snow (below minimum) so the flight turned back for Fallon, about 40 miles away.

The flight contacted the CAA radio station at Fallon and ascertained the landing conditions. These included unlimited ceiling and visibility and a northeast wind of five or six miles per hour. This wind was nearly aligned with Runway No. 7, which was to be used, and which is 7 000 feet long.

Fallon Airport is at an altitude of 3 840 feet MSL, and the flight arrived in the area at an altitude of 9 000 feet MSL. The Captain decided to use wing flaps at the take-off position while circling Fallon, and sent the flight engineer to the cabin to crank the flaps down manually. The flight engineer went to the cabin, but before he was able to locate the necessary crank, he was recalled to his station when the Captain decided to dispense with flaps. Meanwhile, the first officer had manually pumped down the landing-gear which extended fully and was locked.

On orders from the flight deck, the hostesses had reseated some passengers in accordance with the "Buddy" system for emergency landings. This, briefly, means placing an able-bodied male close to, and alerted to help in the evacuation of those who might need help, such as infants-in-arms, children, and elderly people. Passengers seated near emergency exits were briefed in their use. Six male passengers were reseated near the main rear cabin door and instructed in the use of the emergency evacuation chute. All safety belts were fastened and checked.

The aircraft made contact about 126 feet down the runway and at an airspeed of about 150 miles per hour. The Captain immediately put the nose wheel on the ground to effect steering and attempted to apply the brakes. He discovered at once that he had neither nose wheel steering nor brakes. The hand pump selector valve was set on "Brakes", the brake selector valve was left on "Normal" and the first officer used the hand pump in an attempt to get hydraulic pressure.

Almost concurrently the Captain placed Nos. 1 and 2 propellers in reverse pitch. The aircraft veered to the left and off the runway. Propeller controls were moved to restore forward pitch on Nos. 1 and 2 propellers. The aircraft continued to the left of the runway, into soft dirt, through a ditch two and one-half feet deep and through several piles of gravel. The right wing with the right landing-gear was torn from the fuselage at the wing fillet. A part of the right empennage was torn free.

Fire trucks were alongside the aircraft within a matter of seconds and prevented a possible fire by applying fire extinguisher (Foamite) at places where fire might develop. The cabin lights had gone out but the emergency lights were turned on manually and the main cabin door was quickly opened. Because of the aircraft's tail low attitude, the bottom of the door was close to the ground. This allowed most of the occupants to leave from that door without need of ladders or chutes. The other occupants left through the forward right hand door via chute. The entire evacuation was orderly and lasted about two minutes despite the fact that the aircraft's attitude, tipped laterally down about 30 degrees to the right and also tipped down aft, created somewhat adverse conditions in reaching the exits.

Nos. 3 and 4 engines were disassembled. This model engine has two cam drive gear trains for each of the front and rear row cams. Each train consists of a drive, intermediate and pinion gear. Teeth of the intermediate gears of both front cam gear trains of both these engines had failed causing immediate and full power loss. Other gears in these drive trains suffered damage to a lesser degree. These engines had accumulated a total time, since new, of 5 243 hours and 3 127 hours, respectively. The failures appear to have been due to the design, the manufacturing and the inspection of these gears. The specific cause of the teeth breakage was the faulty configuration and/or the surface finish of root radii of the teeth.

There had been similar failures, previously, in other engines of this model. As a result, the engine manufacturer had started, prior to this accident, a modification program to incorporate a four pinion cam drive for the original two pinion drive. Its purpose is to distribute the load and thus lessen the stress on individual gears. Each of the four engines has a hydraulic pump.

Hydraulic System - Those on Nos. 1 and 2 engines furnish jointly (or individually, in the event of failure of either Nos. 1 or 2 engines) hydraulic pressure to supply boost for the aircraft's flight controls and for certain other purposes. This is known as the primary hydraulic system.

Pumps on Nos. 3 and 4 engines furnish jointly (or individually, in the event of failure of either Nos. 3 or 4 engines) hydraulic pressure to effect wheel braking, nose wheel steering, wing flap motion, landing-gear extension or retraction, and certain other purposes. This is known as the secondary hydraulic system. It can supplement the primary hydraulic system but the reverse is not possible. If Nos. 3 and 4 engines are inoperative, there is no means of obtaining nose wheel steering, wing flaps must be cranked down manually, and landing-gear must be lowered with the hydraulic hand pump. However, normal wheel braking can still be effected by pressure from two accumulators instantly available by merely positioning the brake selector valve from "Normal" to "Emergency". TWA's Model 749 Lockheeds had two positions for the brake selector valve marked "Accumulator #1" and "Accumulator #2", enabling the crew to divert pressure from the hand pump to either accumulator as needed simultaneously supplying pressure directly to the brakes commensurate with the demand.

Lockheed's Airplane Operating Manual for the 1049 aircraft, which has CAA approval and was aboard the aircraft, includes the following relative to emergency brakes:

"f. BRAKES, EMERGENCY OPERATION . . .

2) The brakes may be applied in the following ways:

a) On secondary hydraulic system, brake selector in NORM.

b) On secondary hydraulic system, brake selector in EMER.

c) With secondary hydraulic system inoperative, brake selector in EMER., pressure supplied by accumulators . . ."

The accumulators, mentioned above, were noted by the crew to be fully charged (1 500-1700 pounds per square inch) prior to landing. It was also found that they were nearly charged when checked a few days after the accident.

The proper braking procedure, therefore, as stated under 2) c) above, was to have placed the brake selector on "Emergency". This was not done, the captain attempting to obtain braking pressure from the hand pump rather than from his fully charged and instantly available accumulators. These accumulators store enough for 10 full applications of brakes if the system is free of air; in practice, with the system not completely bled, there are at least six brake applications available.

Before landing at Fallon the crew went through the company's cockpit check list for normal operation. It did not have emergency braking procedures specified although the manufacturer's check list on the engineer's table included abbreviated emergency braking procedures. In the subject model aircraft, the flight engineer's station is several feet aft of the two pilot seats and at right angles to them. Thus the flight engineer cannot readily see either the accumulator pressure gauge or the brake selector valve. The positioning of the brake selector valve is primarily a pilot function. On this model aircraft the flight engineer has no specific duties in connection with use of the emergency braking system - during an emergency he acts upon the Captain's order. Therefore, the flight engineer would have had no reason to believe, or way of knowing, that the emergency braking system was not being utilized properly.

On board the aircraft was TWA's Operating Manual for Constellations but it applied primarily to the two earlier models. At the time of this accident, TWA's Operating Manual for the Model 1049 did not contain instructions relative to correct braking under the subject condition. TWA was in the process of bringing this manual up-to-date for the Model 1049. However, there was a Lockheed Operating Manual and check list for the Model 1049 aboard the aircraft. They contained explicit emergency braking procedures that, if followed, would have provided normal braking.

The aircraft's secondary hydraulic system completely lost its source of energy with the feathering of Nos. 3 and 4 propellers. However, there was no malfunctioning of that hydraulic system as such, nor was there malfunctioning of any component of that hydraulic system, including the mechanism for emergency braking. The simple fact of the case is that the emergency braking mechanism was not used.

The Captain attempted to brake as he should have done, and as would have been proper and successful, with predecessor type Lockheeds (Models 049 and 749) on which he was highly experienced. His transition training for the Model 1049 included four days of ground training and four hours of flight. This flight training included a landing and braking with Nos. 3 and 4 propellers windmilling and consequently with the secondary hydraulic system operative, furnishing adequate braking pressure without use of the accumulators.

The reason the emergency braking system was not used can rest only in the fact that the company's transition training to Model 1049's was omissive in that it did not emphasize sufficiently the difference in the operation of emergency brakes. This is evidenced by the Captain's statement that he tried to brake the aircraft with the brake selector in the "normal" position whereas it should have been in the "emergency" position. He demonstrated his unfamiliarity with the hydraulic system in that he attempted to brake the aircraft immediately upon touchdown and then, and only then, did he realize that he had no hydraulic pressure on his brakes.

The Captain's unfamiliarity with the hydraulic system of the 1049 is further borne out by his statement that immediately after touching down he attempted to steer the aircraft with the nose wheel. On this model aircraft a loss of secondary hydraulic pressure results in loss of nose wheel steering.

Since the company's own operating manual for the 1049 was not complete and did not include emergency braking procedures, the company should have specifically instructed crews to use the Lockheed Operating Manual and check list, aboard the aircraft, which did contain the correct procedures. Had these latter been followed, the accident would probably have been avoided.

Although the company may be criticized for not issuing the afore-mentioned specific instructions relative to the new model aircraft, this, in itself, does not relieve the Captain of his responsibility of assuring himself that he is thoroughly familiar with the aircraft he commands, its systems and their proper use.

Of course the circumstances of this accident were extremely unusual. It was at night, on an airport with which the crew was not familiar and with two engines on the same side stopped and with their propellers feathered, a highly unusual contingency. Putting the aircraft on the runway as short as the Captain did was a creditable performance.

The Board also commended both stewardesses for the most efficient manner in which they carried out the cabin emergency procedures.

Probable Cause

The Board determined that the probable cause of this accident was improper use of the emergency braking system during the course of an emergency landing. This landing was necessitated by complete loss of power from the Nos. 3 and 4 engines due to the failure of their cam drive gears.

A contributing factor was inadequacy of the company's Lockheed 1049 transition training program from the former model aircraft concerning the difference in emergency procedures.

ICAO Ref: AR/262

No. 39

Lake Central Airlines, Inc. DC-3 and Private Cessna 170 collided while approaching to land at Richmond, Indiana on 15 December 1952. Accident Report No. 1-0099. Released 20 May 1953

Circumstances

Lake Central Airlines aircraft, a DC-3, with five passengers and four crew aboard, was on a scheduled flight between Grand Rapids, Michigan and Cincinnati, Ohio, landing at Richmond, Indiana as an intermediate stop. A private Cessna 170 was on a flight from Effingham, Illinois and at approximately 0951 the Cessna was observed approaching Richmond Airport turning left for a landing on Runway 28. At the same time the DC-3 was landing on Runway 23 and at the intersection of these two runways the aircraft collided, the Cessna crashed and the pilot was killed. The DC-3 received only minor damage and none of the occupants was injured.

Investigation and Evidence

At 0940 the DC-3 advised the company at Richmond that it was in range and requested the local weather which was given as: "Ceiling estimated 500 feet overcast, light snow showers, fog, visibility 5 miles and wind from the southwest at 18 miles per hour". The aircraft reported over the Richmond "MH" marker (a non-directional homing beacon) at 0944 and proceeded outbound on a heading of 234 degrees. A standard D/F approach was immediately begun.* A few minutes prior to and during the approach the aircraft began picking up ice; accordingly the propeller and windshield de-icers and the windshield wipers were turned on. A normal approach was made and the aircraft made visual contact approximately one mile southwest of the airport at an altitude of about 400 feet above the ground.**

The company's agent, who was monitoring the approach*** from the ground, advised the flight that he had it in sight and that there was no other traffic.

Because the tetrahedron showed the wind to be from the southwest and nearly aligned with Runway 23, the Captain made a right and then a left turn to make a close-in approach to this runway. When starting flare-out for the landing a few feet above the ground, the company's relief dispatcher seated on the jump seat (between and to the rear of the two pilots' seats) momentarily observed an aircraft approaching from the left. He immediately shouted to the Captain to look out. Power was applied at once, but almost instantly thereafter the two aircraft collided.

The DC-3 yawed to the right and for a few seconds was difficult to control; however, the right main landing gear wheel made contact with Runway 23 some distance from the collision point and the aircraft rolled off the runway onto the grass. After rolling approximately 800 feet the Captain was able to return the aircraft to the runway and stop. All occupants immediately deplaned; there was no fire.

The DC-3 crew testified that during the approach to the airport it was necessary to use windshield wipers, windshield de-icers and propeller de-icers and that after contact was established windshield de-icing fluid was turned off. However, a rapid accumulation of ice on the windshields made it necessary to immediately turn the de-icing fluid on again. They said also

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* Special authorization from the Administrator of Civil Aeronautics is required for anyone to use an "MH" facility as a means of making an instrument approach to an uncontrolled airport if the instrument approach procedure is not published in the Flight Information Manual. Lake Central Airlines was the only party authorized to make such an approach at Richmond, Indiana.

** The company's minima at Richmond are, ceiling 400 feet and one mile visibility.

*** The Richmond Municipal Airport does not have a control tower.

that the rear one-third of the cockpit side windows was covered with a heavy frost and this together with alcohol swirls obscured their vision approximately 25 per cent. Both pilots said that throughout the entire approach they were on the alert for other aircraft.

The Richmond station agent stated that he was the only company employee on duty at the time Flight 21 was making its approach, and that after talking to the flight during the initial stages of its approach he went outside and stood on the ramp approximately 15 to 20 feet in front and to the side of the Administration Building. From this vantage point, he watched the DC-3 break through the clouds and proceed in a generally easterly direction. He then returned to the office and told the flight it was in sight and that there was no other traffic. Following this conversation he again returned to the ramp and observed that the DC-3 was then on the downwind leg of the traffic pattern and no other traffic being in sight, he returned to the office to perform other duties. A short time later he glanced through the office window and saw the DC-3 over Runway 23, between the boundary of the airport and the intersection of the runways. Suddenly he saw the Cessna about to land on Runway 28. He reached for the microphone to advise Flight 21 of the presence of the small aircraft. However, collision occurred before the message could be transmitted.

According to the company's Operations Manual, the agent is instructed to use a sixty-foot microphone extension located on the outside of the building during the monitoring of the flight in the local area.* This was not done.**

The evidence indicates that when the two aircraft approached the airport the Cessna was behind the DC-3 and possibly slightly lower. The distance between the aircraft (not accurately known) and the shorter radius of turn to Runway 28 made by the Cessna brought them together at the intersection of Runways 23 and 28.

Under normal conditions the pilot of the Cessna should have seen the other aircraft when approaching the airport and prior to turning on final. It is probable, however, that his windshield was partially covered with ice, impairing forward vision. Several things point toward this conclusion. There is a discrepancy of forty minutes in the time of the Cessna's flight from Effingham to Richmond. It took two hours and twenty-three minutes to fly a distance of 203 miles which, at normal cruising speed (120 miles per hour), should have been flown in one hour and forty-three minutes, with zero wind or even less with the prevailing quartering tail wind. Where the pilot was during that time is not known, but it is possible that he was in the icing area for a considerable time. Also, Runway 28 was chosen by the Cessna pilot for his landing despite the fact that the tetrahedron clearly indicated that a landing on Runway 23 would be into the 18 miles per hour wind. If ice did obscure his forward vision appreciably, the pilot would look through his left side window most of the time and therefore might not see the DC-3.

It is not known why the pilots of both aircraft did not see each other. With the Cessna to the rear of the DC-3, the crew of the latter aircraft would not be apt to see the other aircraft until their turn to final or on final approach. It is difficult to explain why the smaller aircraft

* Operations Manual - Lake Central . . . Part 4.520 - B. <u>When approaching Station on instruments (RID and OKK)</u> . . .
"2. Approximately 10 minutes before estimated time of approach over a station not having a range or tower facility, the Captain shall contact the LCA ground station giving his ETA over the station in a manner similar to that in the above procedure; however, advising also the trip's intention to make an approach to the field. NO APPROACH WILL BE INITIATED OR EFFECTED UNLESS TWO-WAY RADIO CONTACT IS ESTABLISHED PRIOR TO APPROACH, AND SUCH APPROACH WILL BE DISCONTINUED SHOULD SUCH TWO-WAY CONTACT BE LOST.
3. Upon receipt of the information that the flight anticipates instrument approach, the ground agent will utilize the outside microphone extension made available for this use, and place himself in a position to view the approach from the let-down facility and notify the flight that his path from the facility to the field appears to be clear for the approach. Should conditions arise that make the let-down hazardous in the estimation of the ground agent, the flight will be immediately contacted, and the approach abandoned."

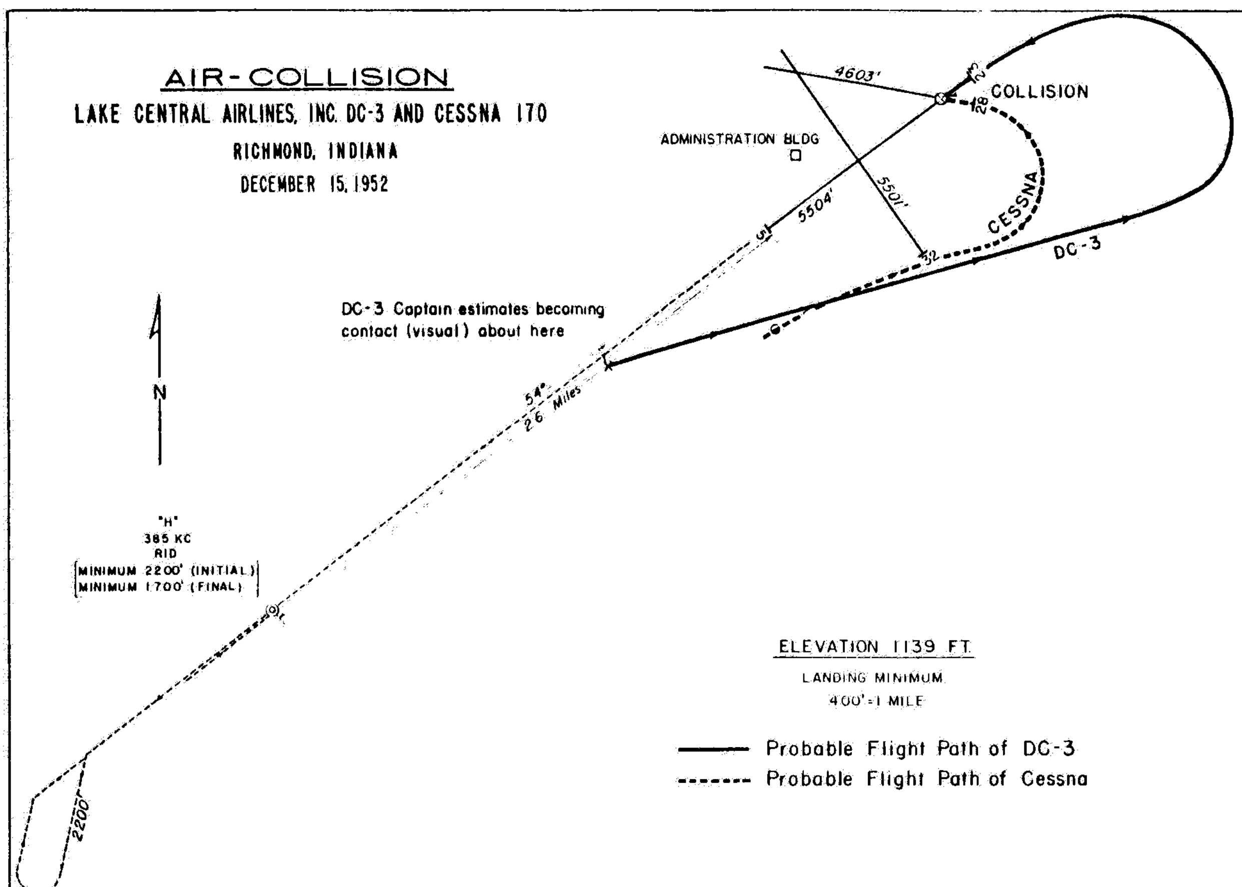
** CORRECTIVE ACTION: As a result of this accident Lake Central Airlines is now instructing its personnel at uncontrolled airports to monitor all instrument approaches from the time the aircraft first approaches the facility until it is actually on the ground. VFR flights are to be monitored in a similar manner if the prevailing visibility is 5 miles or less. In order that the agent may make no error as to his position during the monitoring of flight, microphones have been placed at locations where the entire horizon is visible.

was not seen by the crew of the DC-3 during this turn and on final approach except for the fact that the DC-3 pilots must, at that time, have been advised by the station agent that there was no other traffic, which, together with the fact that with such a low ceiling traffic would not normally be expected, may have created a sense of false security. This may have contributed to some extent; however, there were three persons in the DC-3 cockpit and all said they did not see the approaching Cessna aircraft until it was too late to avoid the collision. The rear one-third portion of the side cockpit windows being opaque from frost or ice did not prevent the pilots from having complete coverage of their normal field of vision during the final approach.

The instructions to the station agent pertaining to the ground monitoring of an approach to the Richmond Airport, as set forth in the company's Operations Manual, are there solely in the interest of safety and to cover situations such as existed this day. The fact that these instructions were not strictly adhered to in that the agent did not properly scan the entire area and did not use the outside extension cord and microphone and therefore did not contact the aircraft from outside the Administration Building may have contributed to his non-observance of another aircraft in the immediate area. Since the collision occurred at the intersection of runways converging at 50 degrees and since ground witnesses observed the Cessna closely following the DC-3 when these aircraft were approaching the airport, it is evident that at the time the agent monitored his flight, the Cessna must have been close by and should have been visible to him. As a result of this accident, the Civil Aeronautics Board and the Civil Aeronautics Administration are making a study of both IFR/VFR traffic conditions at uncontrolled airports so that corrective action can be taken to better control such traffic.

Probable Cause

The Board determines that the probable cause of this accident was the failure of the pilots of both aircraft to observe and avoid each other. The action of the Cessna pilot in cutting in and attempting to land contrary to the prevailing wind direction, and the inadequate monitoring of the DC-3's flight from the ground contributed to the accident.



No. 40

Aer Lingus-Téoranta DC-3 landed in a field at Spernall, Warwickshire, on 1 January 1953

Circumstances

At 0936 hours on the 1 January 1953, the DC-3 aircraft took off from Dublin Airport en route for Birmingham. The aircraft was manned by a crew of three and carried 22 passengers. The take-off weight of the aircraft was 11 433 kg. as against an authorized maximum take-off weight of 12 227 kg.

The route chosen was by way of Point Lynas, Wallasey, Whitegate and Lichfield to Birmingham. The flight was without incident as far as Lichfield, which was reached at 1056 hours.

Shortly after Lichfield both engines lost power when flying at a height of about 5 000 feet and the aircraft made a forced landing in a field at Spernall, Warwickshire, 14-1/2 miles SSW of Elmdon Airport. The aircraft was extensively damaged, but all passengers and the crew with the exception of the co-pilot escaped without serious injury.

Investigation and Evidence

The calculated fuel required for the flight was 105 Imperial gallons plus 10 Imperial gallons for taxying, run-up and take-off, a total of 115 Imperial gallons. A further 50 Imperial gallons was calculated as required for diversion to an alternate airfield leaving a reserve of 135 Imperial gallons. The total available fuel quantity of 300 Imperial gallons was considered more than sufficient for the flight.

The Captain and the First Officer went through the pre-starting check-list, the First Officer reading out the items and the Captain checking them. In the case of the fuel quantity check, the First Officer turned the selector switch while the Captain watched the gauge.

The check of the cockpit fuel selectors was read out by the First Officer, who himself moved the starboard selector to the right main position. The Captain states that he then moved the port selector to left main and checked the starboard selector in the Right Main position by putting his hand across and feeling it.

The aircraft was then taxied out to the runway, where the run-up and pre-take-off check was completed, and, after receiving its clearance, the aircraft took off at 0936 hours.

Shortly after take-off the First Officer made out the technical log which was completed at 0946 hours and, according to the evidence of the Captain, then checked the fuel quantity.

After passing the mid-channel position clearance was obtained from Preston Control to proceed under Instrument Flight Rules at a cruising altitude of 5 500 feet, the aircraft ascending to this altitude under Visual Flight Rules.

At this stage the flight conditions were as forecast with broken cloud mainly below the aircraft. The aircraft position was checked on several occasions and the record kept on the flight log.

The Captain stated that he checked the fuel quantity when approaching the Wallasey Fan Marker while the First Officer was out of his seat, obtaining a Gee fix.

In the vicinity of Whitegate the cloud increased as the meteorological forecast had indicated and the aircraft was flying almost continuously in stratified cloud. Both pilots gave evidence that only slight rime ice was encountered at any time during the flight. No carburettor hot-air was applied.

The Lichfield radio beacon was passed to port at 1056 hours still flying at an altitude of 5 500 feet. This was reported to Preston Control who cleared the aircraft to descend to 4 500 feet and to change frequency to Birmingham approach on 126.9 Mc/s.

Until the Lichfield beacon was passed the aircraft and its engines functioned normally and without any indication of trouble.

At 1057 hours the First Officer established contact with Birmingham approach, making his position report. This was acknowledged by Birmingham who instructed the aircraft to call overhead at 4 500 feet and gave the actual weather report of Elmdon of 1055 hours:- Surface wind 360°/14 knots, visibility 3 000 yards, cloud 8/8 at 800 feet, 7/8 at 600 feet, QFE (aerodrome barometric pressure) 998.2 mbs.

Some time between 1059 hours and 1100 hours the starboard engine cut suddenly without any previous indication or rough-running. Almost immediately (the Captain's estimate being 6 to 7 or perhaps 10 seconds) after the loss of power on the starboard engine, the port engine cut in the same way. The altitude at that time was approximately 5 000 feet.

At about 1101 hours, the aircraft sent the following message:- "Emergency, both engines giving trouble, may I commence immediate descent". Birmingham approved an immediate descent to 2 500 feet. At 1105 hours Birmingham requested the aircraft's altitude to which the aircraft replied:- "Now at 2 000 feet, will call you overhead". A little later Birmingham was called:- "Now 1 500 feet both engines out" and requested a QDM (magnetic course to steer to the station in zero wind conditions) to which Birmingham Homer, which had started taking bearings as soon as the aircraft had established radio contact, answered "QDM 030". The aircraft continued giving the altitude until just about on the ground.

At the time of the complete loss of power the aircraft was quite near the Elmdon Airport and at some stage of the descent passed close to the Inner Marker beacon of the SBA. As the cloud base was given at 600 feet and the Captain was aware of the proximity of HT cables and other obstructions near the aerodrome, he decided, when left without power, to fly away from Birmingham on a southerly heading, and the Inquiry accepts, in view of his knowledge and experience of the locality, that this decision was justified. The ultimate landing of the aircraft demonstrated that he had chosen one of the few places - if not the only one, apart from the airport - where he could hope to land with any degree of safety.

The aircraft descended rapidly through cloud at about 90 knots and came into the clear at approximately 600 feet. The Captain then saw a wood on a small hill, which he left to port, and to starboard three small fields with trees and rising ground beyond. He put the aircraft down in the first of these at a speed of about 80 knots, wheels and flaps retracted.

After touching down the aircraft slid along towards a gap in the far hedge when the Captain noticed a large tree ahead. He put on some right rudder and skidded the aeroplane through the gap in the hedge, across a road into the next field where it came to rest with the nose across a ditch. In the skid that followed this manoeuvre the tail hit the tree, the fuselage sustaining severe damage.

Having considered the symptoms of the failure:- absence of rough-running or other previous indication, in each case the sudden and complete loss of power, the drop of the fuel pressure on the only occasion when the fuel pressure gauge was observed after the first engine lost power, and the power surges after the booster pumps were put on, the Inquiry was quite satisfied that the cause of the failure of each engine was due to a complete and immediate cessation of fuel supply to the fuel pumps.

There was no suggestion that the failure was due to carburettor icing and the Captain himself was satisfied that the engine loss of power did not result from this condition.

The only contentions put forward for the cessation of fuel supply were:-

a) By the Captain, First Officer and Airline Pilots' Association: the possibility of water in the fuel resulting in either blocking the fuel supply by freezing or starving the engine of fuel by displacement of the fuel.

b) By the Company: a tank or tanks becoming exhausted through mis-selection by the crew so that both engines were running off the same tank.

Contention a) involved examination of the refuelling system at Dublin Airport and the refuelling of the aircraft prior to the flight in question.

The Inquiry was satisfied that the aircraft was, on the morning of the 1 January, properly refuelled with petrol of the required grade and free from water contamination. The submission was made that water formed by condensation in the aircraft's tanks prior to her last refuelling, while the aircraft's tanks were much depleted during the period, could have caused water contamination. The Inquiry accepted evidence that at between 2200 and 2300 hours a half-pint of liquid from each of the three tank sumps was drained off and that no abnormal quantity of water was found on this check. (The certificate signed by this witness for check 2 shows that he also ran off the fuel filter sumps and this check was formally proved by him in evidence.) The possibility of water contamination could only arise from condensation taking place after 2200 hours on the night of the 31 December.

Having regard to the absence of any significant quantity of water, the stage of the flight at which the power failure occurred, the air temperatures prevailing at the time of failure, and the absence of water in the carburettors or filters, the Inquiry was satisfied that all possibility of loss of power due to water contamination of the fuel system must be ruled out. Again the symptoms observed at the time power was lost were not characteristic of contamination of fuel by water or restriction of the fuel supply by water.

The only possibility of fuel starvation resulting from exhaustion of a tank or tanks was mis-selection of the fuel selector valves in such a way that both engines were running throughout the flight on the same tank. This involved the finding that the crew took off from Dublin with engines drawing from the same tank, that tank being the right main tank.

The Captain's evidence did not show that he clearly recollects actually seeing the port cockpit selector on the left main tank position: it went no further than that he moved the selector lever and no doubt believed, he had moved it to that position. The evidence in regard to the fuel contents gauge reading at or about Wallasey was unconvincing. The Captain was clearly not sure of what tank dials he read and it appeared to the Inquiry as having been no more than a rapid glance as he switched over the gauge selector. The Captain could not afterwards state positively any reading and it is clear from his evidence that he did not take a reading but merely contented himself with the needle movement which indicated to him at the time that he had what he took to be a normal quantity of fuel for that stage of the flight in whatever tank or tanks were represented by the pointer. The Inquiry was unable to determine whether the Captain at this stage actually observed the dial in relation to one tank, two tanks, or all tanks. The Inquiry had to take into consideration that in a rapid switching movement and reading by the Captain from his position in the left seat and the flicking of the needle, the "upright position" of the pointer which he mentions could be anywhere between 90 and 130. The Captain said that it was a quick check. This check cannot be relied upon for more than an indication that the tanks checked contained fuel.

The fuel contents gauge check made by the Captain on the first engine cutting gave him the impression that whatever tank was then showing on the dial contained about 50 Imperial gallons or thereabouts. Again the evidence cannot be relied upon as giving the quantity of fuel in that tank. In the first place the Captain did not know and did not ascertain whether the gauge selector was turned to the tank supplying the starboard engine. In the second place it was no more than a glance at a time when the Captain was glancing around at every instrument.

Calculation based on the actual conditions of the flight and the time from departure to when the port engine cut, shows that the fuel consumed totals 115 Imperial gallons. This was the amount in fact carried in the right main tank, so that two engines drawing throughout on that tank would exhaust its fuel at the time when the first engine cut.

Reference may here again be made to the fact that both engines cut practically simultaneously.

The Inquiry had evidence of two tests carried out by the Company in which DC-3 aircraft were flown with two engines selected to the right main tank until fuel supply failed. There was no material difference in either test between the nature and symptoms of the engine cuts and those experienced on the occasion of the accident.

Probable Cause

The primary cause of the accident was loss of engine power due to fuel starvation. The Inquiry found that this was caused by selecting the port engine to the right main tank to which the starboard engine was also selected.

The loss of engine power alone was the sole cause of the accident, which could have been avoided had the crew diagnosed the cause of the trouble and changed the fuel feed to another tank.

The failure to diagnose fuel starvation was probably due to the circumstances: i.e. first, the lack of co-ordinated effort by the Captain and First Officer after the engines cut; second, the knowledge of the crew that ample fuel for the flight was on board and their belief that the engines were drawing from their respective main tanks.

The actual forced landing of the aircraft in conditions of low cloud, poor forward visibility and unfavourable terrain was skilfully executed and resulted in the passengers escaping unharmed.

ICAO Ref: AR/272

No. 41

BEA Viking crashed while approaching to land at Nutt's Corner, BELFAST, 5 January 1953

Circumstances

Viking G-AJDL took off from Northolt on 5 January 1953 for a scheduled flight to Nutt's Corner, Belfast; carrying thirty-one passengers and a crew of four. Its take-off weight was near to, but under, the maximum permissible. At about 2053 hours the Viking came under the control of Nutt's Corner. While making the approach the aircraft struck the approach lighting, the SBA van and the ILS building before breaking up. Twenty-four passengers and three crew were killed and seven passengers and one crew injured.

Investigation and Evidence

Under Nutt's Corner GCA the aircraft was brought down to within three miles of touch-down on Runway 28, at which point "rain clutter" on the radar screens obscured the image of the aircraft and the Captain received the instruction: "If you are not visual, overshoot on your present heading to 3 000 feet." Cloud at 2139 hours (just after the accident) was estimated at 6/8th at 1 300 feet, 7/8th at 1 800 feet and, possibly, fragments of cloud at a lower level; slight rain was falling and visibility was 4 400 yards.

Thirty seconds after receiving this instruction the aircraft announced: "We can see the lights now". At about this time a witness in the control tower saw the lights of the aircraft as it broke cloud at height estimated at 1 000 - 1 500 feet. Its approach looked slightly steeper than normal, and when it looked dangerously close to the ground he sounded the alarm bell. The Viking maintained the same angle of descent down to the pole carrying No. 6 approach light (the top of which was 113 feet below the glide path), which it struck, and appeared to level out. Subsequent investigation showed that it touched down some 250 feet further on, ran along the ground for about 82 feet, rose again, struck the SBA van, came down again and struck the ILS building before breaking up.

In the report, the accident is reconstructed as follows:

When the talk-down ceased the Captain had for about 40 seconds no guidance from the ground and he may well have allowed his flight to increase above the glide-path in this period. He then saw the aerodrome lights, probably realized that he was exceptionally high, and steepened his descent. In doing so he made an over-correction and descended more steeply than was necessary and then failed to check the descent before the aircraft had reached a position within 18 feet of the ground when still about 1 800 feet short of the runway. He failed to realize, either from observation of the lights or from examination of his altimeter, that he was going dangerously low until he struck the pole carrying No. 6 approach light, or possibly a very short time before this. He then opened his throttles and, although he touched down, succeeded in getting the aircraft off the ground again.

The balance of probability is that weather conditions were such that when the Captain was able to see the aerodrome lights his vision was somewhat blurred but not to such an extent as to be seriously misleading to a pilot with normal eyesight, visual judgment and experience in flying in varying weathers. He should have been able to adjust his angle of descent so as to land on the runway. Even after he had started to descend too steeply, he should have realized, when he was still several hundred feet from the ground, that he was on a path which would bring him down short of the runway and have levelled out earlier than he did. In these respects he made errors of judgment which indicate some falling short in the degree of perception and ability to act correctly in an unusual situation which can be expected of an experienced pilot. The Inquiry, however, did not consider that any moral blame should be attached to the Captain.

Referring to the presence of obstructions on the approach to Runway 28, the report makes the following observations and recommendations:

There would probably have been no major disaster if the aircraft had not struck in succession five poles, the SBA van and the ILS building. In particular, it was probably the impact with the SBA van which put an end to the aircraft's chance of reaching the runway and it was probably the impact with the ILS hut which made a major tragedy inevitable. In this sense these various obstructions contributed to the accident. But none of them would have constituted a danger except in the most exceptional circumstances; they were not, when erected, in contravention of any accepted standards and it would not have been practicable or reasonable to remove them when new ICAO Standards came into force in June 1952. The following specific conclusions and recommendations are made:

a) The lights on the poles were, for convenience of maintenance, a considerable distance (8 feet) from the top of the poles. It is highly unlikely that if they had been at the tops it would have made any difference to the aircraft, but a small increase in safety, probably sufficient to compensate for the increased difficulty of maintenance, has been obtained by moving them nearer to the tops of the poles since the accident and it is recommended that they be retained in that position.

b) The SBA van was not intended to be a permanent installation and it would not be reasonable to require exceptional measures to deal with the remote risk attached to its being in the line of approach to the runway.

c) It is undesirable that a permanent installation such as the ILS building should be in such a position as was occupied by the ILS building at the time of the accident. It is recommended that the plan for rebuilding it on a site offset from the runway be proceeded with and that the effects on its efficiency as an aid to pilots of its being off-centre be carefully studied. Meanwhile, it is desirable that investigation into the practicability of putting such installations underground should be pursued.

The Captain, whose flying experience totalled over 5 100 hours, had landed in command at Nutt's Corner 15 times by day and 20 times by night. Of these landings four by day and four by night had been on Runway 28. He was described as a pilot of average standard among BEA captains, but as a captain of above-average standard. Extracts from check-flight reports confirmed the view that, though competent and conscientious, he was not "what one would call a natural pilot". The First Officer, who was not shown to have taken any part in the events leading up to the accident, was described as entirely competent. Although BEA were not at fault in allowing the Captain to continue as a pilot, the report found that it would have been better if, after defects had appeared in the course of checks, he had been given short refresher courses followed by further checks, and if he had not been allowed to go for so long a period as seven months from May 1952 without a check.

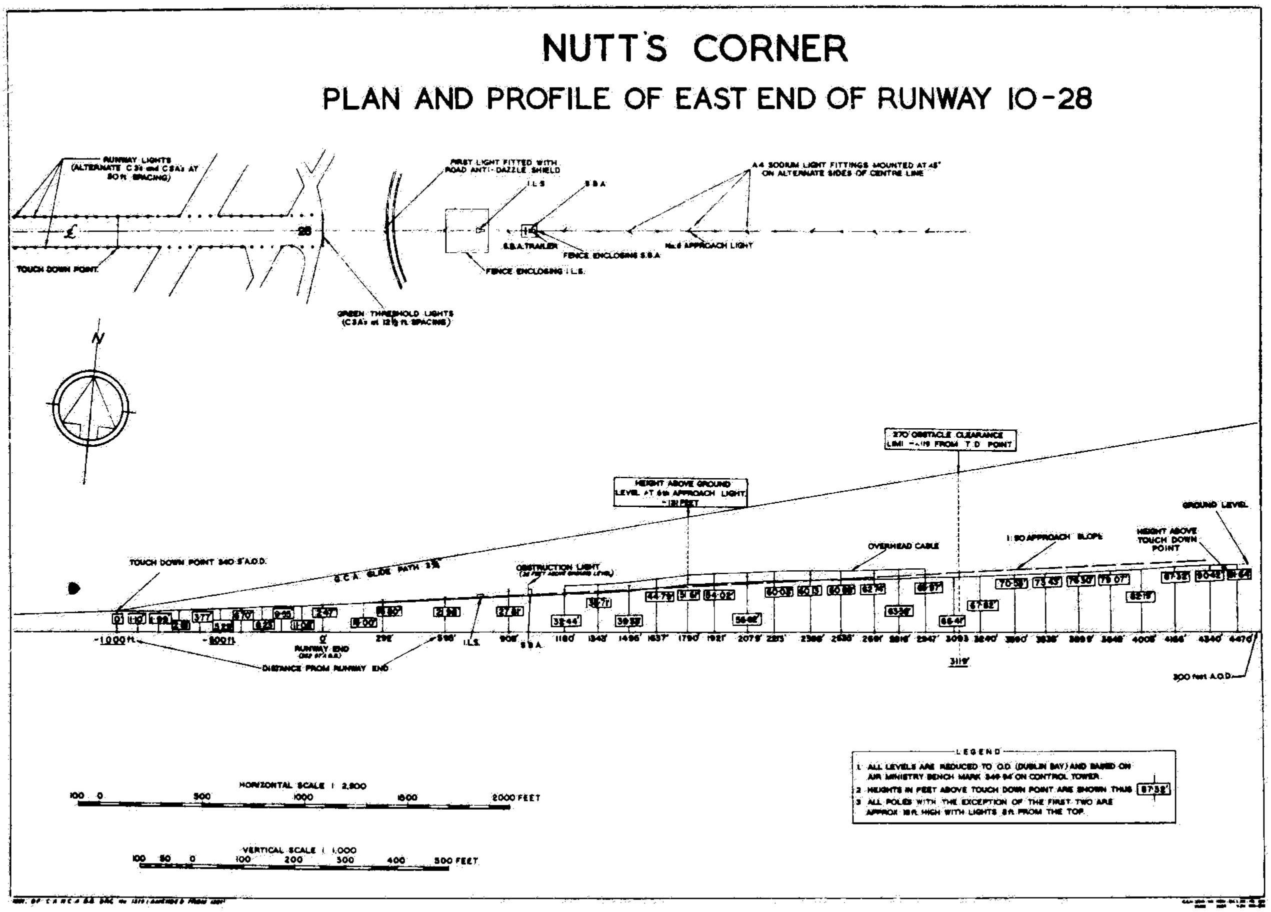
Of the ten sodium lights marking the approach to Runway 28, one (actually that nearest the threshold) had been screened to prevent road dazzle, and was afterwards discovered to have been invisible to the pilot. This deficiency, however, "would make no appreciable difference to the effectiveness of the line of lights ....." The Nutt's Corner lighting system was described as superior to that found at many aerodromes all over the world. Plans have been made for eventually replacing it with Calvert "cross-bar" approach lights, but although this would give the pilot additional assistance in judging his position and would give him additional information on his angle of descent, the report found that there was no justification for giving Nutt's Corner special priority in this respect.

Mr. E.S. Calvert expressed the belief that some previous accidents might have resulted from pilots' inability to judge their angle of descent in conditions of poor visibility, and that, "very roughly", this might happen once a year somewhere in the world. There was no known system of lighting which could entirely eliminate the risk of misjudgment when cloud obscured the lights nearest the pilot, but cross-bars would increase the margin of safety.

Mr. Calvert thought that a system of coloured approach light indicating departure from the glide-path (more elaborate than the system of this type used in the past) might be of assistance. In order to overcome the special difficulty of judging the angular distance of the point aimed at above the low cut-off line of the Viking, he also suggested that there might be a fine wire across the windscreen which could be heated to show red at night. If a similar wire, the report adds, were placed in a fore-and-aft direction, below the level of the pilot's eye so that it would appear to him as a vertical line, the two wires would then help to indicate changes in pitch, roll and yaw. The report recommended that experiments should be carried out to investigate both Mr. Calvert's suggestions.

Probable Cause

The Inquiry found no indication of mechanical failure. The documentation of the aircraft was in order, the crew were properly qualified, and control procedures were correctly carried out. The Inquiry found that on the evidence available there existed such conditions as could properly be described as deceptive to the pilot and the conclusion was that the primary cause of the accident was an error of judgment on the part of the Captain.



No. 42

The Flying Tiger Line, Inc., - Douglas DC-4 crashed two miles south of Issaquah, Washington, 7 January 1953. Investigation Report No. 1-0001 Released 19 June 1953

Circumstances

The aircraft, a Douglas DC-4, was on a flight from Burbank, California, to Seattle, Washington. The flight was routine to San Francisco except for a false fire warning shortly after take-off. The flight departed San Francisco at 1737 with three crew and four non-revenue passengers for Boeing Field, Seattle. On arrival the flight was cleared to make a standard range approach at Boeing Field. At approximately 2055, the aircraft crashed about 11 miles east of the Seattle range station at the base of Squak Mountain. All seven occupants were killed and the aircraft was demolished by impact and the ensuing fire.

Investigation and Evidence

Normal en-route position reports were made by the flight and at 1947 it reported being over Eugene, Oregon, at 11 000 feet. Seattle ARTC then cleared the flight to descent to and maintain 9 000 feet until passing Portland, Oregon, and from this point, to descent to and maintain 7 000 feet, to contact Seattle Approach Control immediately and advised that no delay was expected. Contact was immediately made with approach control; the flight was then cleared to make a standard range approach to Boeing Field and requested to report leaving each 1 000-foot level during the descent. The following weather information was given the flight at this time: "Boeing Field - 1 800 scattered, 2 200 overcast, 8 miles, wind south-southeast 22, gusts to 30, altimeter 2925; Seattle-Tacoma - measured 1900 broken with 3100 overcast". Flight 841 acknowledging this reported being over the outer marker and leaving the 6 000-foot level. No report of leaving the 5 000-foot level was made and at 2045 the flight advised it was leaving 4 000 feet. When the latter was acknowledged by approach control the flight was further advised as follows: "If you're not on VFR by the time you reach the range you can shuttle on the northwest course at 2 000 feet, it's possible you'll break out in the vicinity of Boeing Field for a south landing". The flight acknowledged at 2050 and said it was leaving 3 000 feet.

At the time the aircraft was making the approach to Boeing Field, a Pan American DC-4 aircraft was also approaching this airport from the northwest. The latter aircraft had been advised by approach control that it was No. 2 to land behind the Flying Tiger aircraft in the traffic pattern. The Pan American aircraft was making a routine let-down on the northwest leg on the Seattle range and at 2054 reported being at the 3,000-foot level and VFR. Immediately after receiving this altitude report,approach control called the Flying Tiger aircraft and advised: "You're clear to contact Boeing Tower on 118.3 for landing instructions". This was acknowledged by "Roger" and was the last known contact with the aircraft. At approximately 2055, it crashed about 11 miles east of the Seattle range station at the base of Squak Mountain.

The aircraft first struck a high tree on a mountain ridge at an elevation of 1 620 feet. The location of the impact was approximately one-half mile east of the summit of Squak Mountain (elevation 1 980 feet MSL) on which radio towers are located. Following impact with the tree, the aircraft continued and finally struck the ground in a canyon 1 500 feet below.

Examination of the wreckage revealed that the landing gear was fully retracted and that the wing flaps were in the 25-degree down-position when the accident occurred. Because of the damaged condition of the cockpit it was impossible to obtain control settings or instrument readings. A subsequent tear-down and inspection of the propeller hubs and engines indicated that all propellers were in the cruise range at impact and that all engines were rotating. Unused cabin fire extinguishers were found in their respective brackets; however, the brackets had been torn from their mounts. All CO_2 bottles had broken necks and two of these bottle necks were recovered with their seals unpunctured. No evidence was found which indicated the existence of fire, structural failure, or malfunctioning of the aircraft or its components prior to impact with the tree.

There are three airports in the immediate Seattle area. When approaching from the south, Seattle-Tacoma is the first airport encountered. Seattle-Tacoma is a large airport with four surfaced runways and lies to the west of the southwest leg of the Seattle range, approximately four miles southwest of the range station. Boeing Field is located on the northwest leg of the Seattle radio range, 2.1 miles from the range station. Renton Airport is located approximately two miles east of the range station on the southeast leg of the range. Both Boeing Field and Renton have single runways oriented northwest to southeast. Boeing Field is equipped with high intensity runway lights and Renton has a low intensity runway lighting system.

Two witnesses who were working at the Renton Airport at the time the subject aircraft was making its approach, stated that a large four-engined aircraft crossed that airport at a low altitude and that it disappeared from their view in a northeasterly direction. Other ground witnesses at various locations north and northeast of this airport reported seeing a large aircraft flying toward the north or northeast*. In each instance, the aircraft sighted was flying at a low altitude with engines operating in a normal manner, and there was no indication of fire aboard the aircraft. Several witnesses stated that after seeing the aircraft, they saw, in the direction it had flown, a large orange glow, which appeared to them as if a ball of fire was falling toward the earth. Some of these witnesses also heard an explosion. Those witnesses in the vicinity of the scene of the accident said that the lighted radio towers located on Squak Mountain were not visible to them because of clouds, and that at the time of the accident a heavy rain was falling which was accompanied by strong gusty surface winds.

The low frequency receiver of the aircraft was found tuned to 260 kcs., the frequency of the ILS (Instrument Landing System) middle marker for the Seattle-Tacoma Airport, and the VHF communications transceiver was tuned to 119.5 kcs., the frequency of Seattle Approach Control.

The inquiry concluded that a study of the known facts, conditions and circumstances surrounding this accident pointed to but one conclusion - that it was operational in character. To summarize briefly: first, the ceiling of the clouds, the wind, the mild turbulence and the visibility were such that a safe approach and landing should have been consummated; second, the radio facilities available for navigational purposes were functioning in a normal manner and static interference at the time was negligible; third, there is no evidence which indicates a fire or any malfunctioning of the aircraft or its components prior to first impact; fourth, the company's approved Low Frequency range approach procedure for an approach from the south to Boeing Field is both safe and correct. If executed properly, a turn to the right or east should not be made after once aligning the aircraft with the southwest leg of the range inbound except for possible slight corrections.

There is no reasonable explanation to account for the presence of the aircraft in the sector where the crash occurred, which is approximately 11 miles to the right and east of the range station. It is possible that the pilot became confused and for a few moments thought Renton Airport, which lies slightly to the right of course, was Boeing Field; however, following such a mistake, corrective action would not permit a course to be taken in a northeasterly direction which would lead the aircraft toward the mountains, instead of an immediate turn to the left should have been made to contact the northwest leg of the range. In fact, such instructions had already been issued the flight in the event it was not visually contact upon reaching the range. Pilots unfamiliar with the area have, in the past, under similar conditions, mistaken Renton Airport for Boeing Field; however, if the approach procedure to Boeing Field had been correctly followed this could not have occurred.

Probable Cause

The probable cause of this accident was the flight's deviation from the established approach procedure to Boeing Field.

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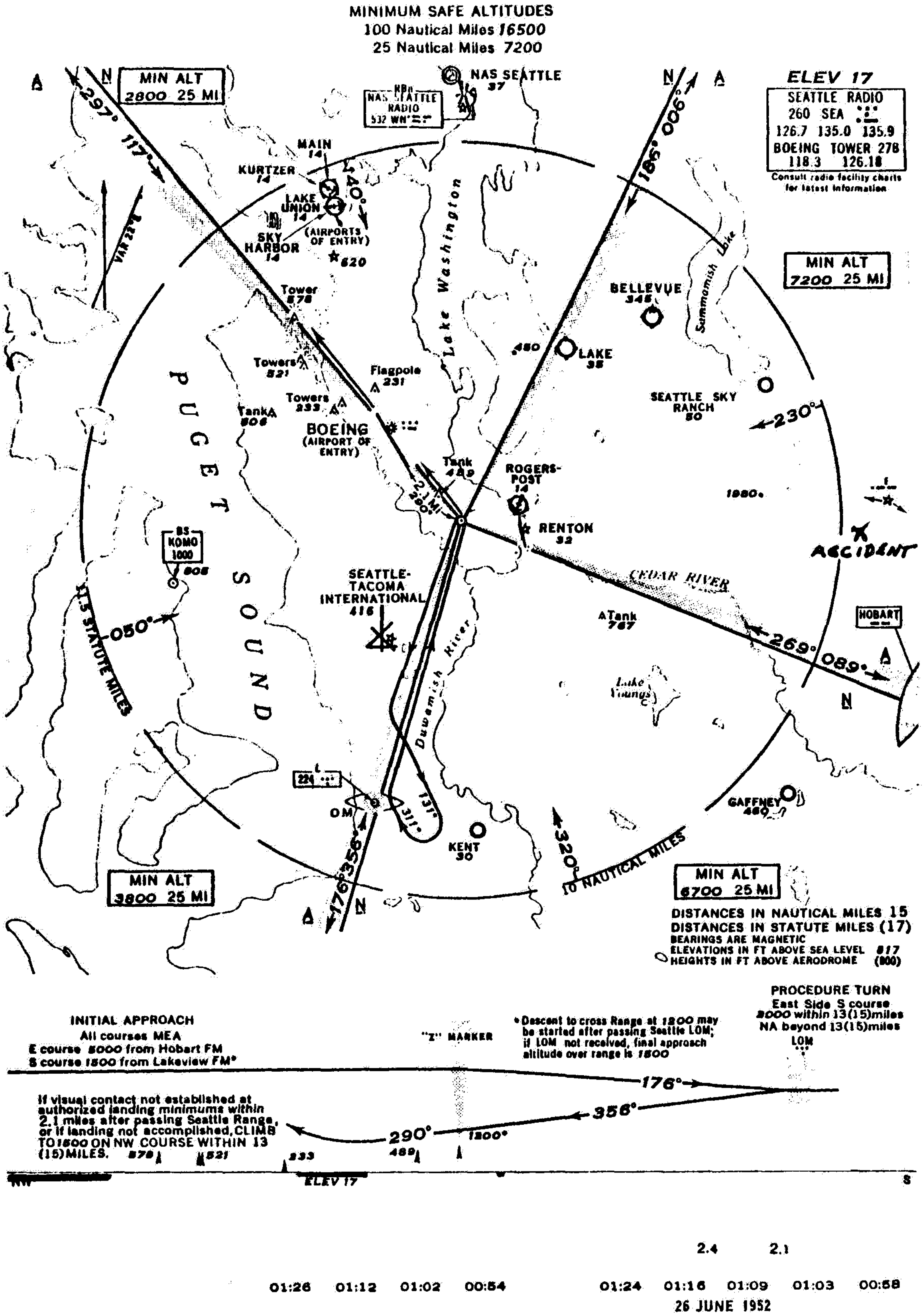
* The accident occurred approximately nine miles east and north of Renton Airport.

ICAO Ref: AR/259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25 Nautical Miles 7200
MIN ALT 2800 25 MI
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NAS SEATTLE RADIO
ELEV 17
SEATTLE RADIO
260 SEA
126.7 135.0 135.9
BOEING TOWER 278
118.3 126.18
Consult radio facility charts for latest information
MAIN 14
KURTZER 14
LAKE UNION 14
SKY HARBOR 14
(AIRPORTS OF ENTRY)
620
Lake Washington
MIN ALT 7200 25 MI
BELLEVUE 345
Sammamish Lake
Tower 578
Towers 521
Flagpole 231
Towers 333
Tank 506
LAKE 35
450
SEATTLE SKY RANCH 50
BOEING (AIRPORT OF ENTRY)
PUGET SOUND
Tank 489
ROGERS-POST 14
RENTON 32
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SEATTLE-TACOMA INTERNATIONAL 416
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ELEVATIONS IN FT ABOVE SEA LEVEL 817
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PROCEDURE TURN
East Side S course
3000 within 13(15)miles
NA beyond 13(15)miles
LOM
INITIAL APPROACH
All courses MEA
E course 5000 from Hobart FM
S course 1500 from Lakeview FM*
"Z" MARKER
*Descent to cross Range at 1200 may be started after passing Seattle LOM; if LOM not received, final approach altitude over range is 1500
If visual contact not established at authorized landing minimums within 2.1 miles after passing Seattle Range, or if landing not accomplished, CLIMB TO 1500 ON NW COURSE WITHIN 13 (15)MILES.
578 521 333 489 1200*
NW ELEV 17 S
2.4 2.1
01:26 01:12 01:02 00:54
01:24 01:16 01:09 01:03 00:58
26 JUNE 1952

No. 43

Northeast Airlines, Inc. Convair 240 crashed while landing at La Guardia Field, New York, on 6 February 1953. Accident Report No. 1-0005. Released 26 June 1953

Circumstances

The aircraft, a Northeast Airline Convair 240, took off from Boston on a scheduled flight to New York with 41 passengers and 3 crew. Gross take-off weight and the centre of gravity were within the permissible limits. The flight was routine to New York but while on final approach and just short of the field boundary at about 100 feet altitude, an unusual noise was heard from the starboard side. At the same time the aircraft pulled sharply to the right, control was lost and an instant later the aircraft struck the runway causing considerable damage before stopping after skidding 765 feet. No one was injured.

Investigation and Evidence

The Captain testified that he was approaching at 130 miles per hour. The propellers had been set at approach r.p.m. of 2 300 and 25 to 27 inches manifold pressure. The rate of descent had been stabilized at approximately 600 feet per minute. At the time the sound was heard and the aircraft pulled sharply to the right, the Captain immediately applied left rudder and aileron to counteract the effect of the yaw, which rapidly worsened. Almost simultaneously, at about 50 feet altitude, he applied power on both engines. The yaw became worse; the throttles were closed but the aircraft was uncontrollable and struck the runway. One witness stated he associated the sound with reversal of one or both propellers.

Examination of both engines revealed that they were in good operating condition and capable of developing power at the time of the accident.

Normally, the propellers cannot be put in reverse pitch until the aircraft is on the ground. The contacts on an electrical switch on the left main landing-gear are closed when the aircraft's weight is on the wheels, causing a solenoid to energize. This, in turn, unlocks the throttle reversing mechanism on the pilot's pedestal, and permits rearward movement of the throttles into the reverse quadrant.

The throttle locks can also be released manually by either pilot by pulling a manual override control handle, one for each pilot conveniently located on each side of the pedestal. Outward movement of this control has the same effect on the throttle lock as does the energizing of the solenoid. The solenoid plunger and the manual override control mechanism are spring-loaded. Thus it is necessary for the pilot to hold the handle out to enable him to pull the throttle into the reverse range while the aircraft is airborne. The throttle cannot be retarded past the idle position when the handle is on the "in" position.

As a result of a previous incident involving an unwanted reversal of both propellers while airborne, Northeast Airlines added an item to the before-landing check list to make positive determination that the override control was in. It was found during check rides that some pilots checked this item by "snapping" the manual override handle. This was an improper procedure, as the company operations manual showed, and was brought to the attention of all pilots by memorandum issued by the Assistant Chief Pilot on 16 October 1952, instructing that it should never be operated in flight.

Both pilots testified that they were cognizant of these instructions and the reason for their issuance, and therefore were positive that they had not operated the manual override control handle throughout the flight or during the final approach, and had checked visually to ascertain that it was in the "in" position while completing the before-landing check list.

Since there was a likelihood that the right propeller might have reversed during final approach for landing, the propeller investigation was planned with this possibility in mind. Prior to removal of the aircraft to a nearby hangar, considerable examination and testing of control units and wiring were made. Additional functional tests and visual examinations were made in more detail at the hangar. Various units were tested and clearances measured at the Curtiss Wright factory, the Northeast Airlines shops, and the U.S. Bureau of Standards laboratories.

All three blades of the right propeller were bent and curled aft from the leading edge toward the face side to approximately the 48-inch station. After removal of the blades, gear teeth marks were observed on each barrel shelf. By matching blade gears to these impact marks, it was found that they represented a blade pitch position of plus 3.1 degrees with reference to the 42-inch station. Examination of the power-unit, after removal, revealed that it had traveled past the increase r.p.m. limit switch toward reverse pitch to a position representing a blade angle of minus .3 degrees with reference to the 42-inch station. This seeming discrepancy is explained by the difficulty of determining the precise blade angle at impact. The two methods of measuring blade angle at impact showed, however, that the blades were in nearly flat pitch position.

The power-unit was tested after re-installation on the aircraft and its operation proved normal in all respects. In all instances the r.p.m. limit switch opened the circuit as intended. The power-unit did not overtravel the high r.p.m. limit at any time during these tests. The unit was subjected to functional tests under load at the Curtiss Wright factory and at the overhaul base of Northeast Airlines; the results of these tests showed satisfactory operation.

The increase r.p.m. limit switch was cycled numerous times both while on the aircraft and after removal for more detailed examination. It functioned normally in all instances.

Functional tests of the synchronizer, made at the Curtiss Wright factory, revealed no significant discrepancies in its operation.

The brush block connector was tight, as it should be, and was removed from the aircraft. An ohmmeter check at this location revealed that the increase r.p.m. limit switch was "open"; the other limit switches were in the "closed" position. Resistance measurements at the brush block and slip ring were satisfactory. Upon removal of the brush block, practically all of the brushes were found to be broken; however, the power-unit had operated satisfactorily prior to removal and none of the brushes showed any wear or abrasion such as could be expected if they had been broken and were out of position at the time the engine was operating. No abnormal condition was revealed during disassembly and examination of the brush block and slip rings. Relocation of the reverse slip ring had been accomplished in accordance with a factory recommendation.

The reverse switching, reverse pitch, and normalizing relays were subjected to an internal examination. The condition of the contacts was satisfactory, and they exhibited no tendency to stick when the relays were actuated. No foreign matter was found. All relays functioned normally during checks of the system. Both reverse pitch relays were checked prior to removal of the aircraft from the scene, and were found to be in the normalized, or unlatched, position.

All system wiring was checked with an insulating tester which utilized 50 volts for faults to ground, or between adjacent wires; satisfactory resistance measurements were obtained in all cases, and all filter capacitors showed satisfactory resistance values. Voltage was applied to the system but nothing abnormal was revealed. Detailed examination of the wires along their entire length revealed no abnormalities, nor were any shown in examination of disassembled connectors.

The lower cargo terminal rack, filter boxes, relay boxes, and pull boxes were examined for loose or mislocated terminals, foreign objects, or chafed wires; no significant irregularities were observed.

Close attention was given to the high r.p.m. limit switch, for malfunction of the switch could result in overtravel of the power-unit toward reverse pitch. One of the two stationary contacts was worn more than the other and its curved contour was somewhat altered. A black deposit was also observed, but was found to be non-conductive. During numerous operations of the switch, it functioned correctly in all instances. A laboratory examination of the switch indicated no evidence of malfunctioning.

The switch controlling the primary throttle lock mechanism and its circuit, operated by the left landing gear, was in a normal condition. The throttle lock mechanism in the pedestal, including the manual override control, operated freely. In flight configuration, it was not possible to pull the throttles past the stops even when abnormally high throttle forces were used. The throttle lock solenoid had been modified to minimize the effects of residual magnetism. Wiring in the pedestal was adequately secured to prevent chafing; the terminals were secure and properly positioned and no loose or dangling wires were observed. The manual override control warning lights functioned properly. Maintenance records for the speed reducer and motor and brake assembly installed on the right propeller were examined but there was no evidence found which would indicate that there was any relation to the possible cause of this accident.

Detailed examination of the entire right propeller and its control system failed to reveal the reason for overtravel past the high r.p.m. limit switch position of plus 26 degrees, nor was any mechanical or electrical malfunction found.

The power-unit of the left propeller was at the full increase r.p.m. limit, with the limit switch open. There was no indication that the left propeller had malfunctioned.

In general, the right propeller blades overtraveled the low pitch stop through one of two reasons; namely, malfunction of the right propeller or improper operation of the propeller controls.

Every known probability was explored to determine whether electrical or mechanical malfunction of the propeller or its control mechanism could have occurred. As previously shown, detailed examination of the right propeller and its entire control system failed to reveal the reason for overtravel past the low pitch blade limit. No evidence was found during investigation of the propeller system and the throttle lock system which would indicate that an unwanted propeller reversal resulted from malfunction of any unit. Considerable attention was devoted to the low pitch (high r.p.m.) limit switch, since failure of this switch to open the circuit at low power would cause the propeller to move into the pitch range below the high r.p.m. limit. Although this switch had been in operation for a longer period of time than was recommended by the manufacturer and one of the stationary contacts exhibited considerable wear, the switch when first checked was "open" and opened as intended when actuating numerous items. The pilot's testimony that as power was progressively reduced the r.p.m. of both engines was observed to drop below the r.p.m. of 2 300, rules out the possibility that this switch failed to open, for had this occurred, the r.p.m. of the right engine should have been maintained at 2 300 by the propeller synchronizer.

The reverse pitch relays of both propellers were in the normalized position. Had the right propeller been reversed by movement of the throttle rearward past the idle stop, the reverse pitch relay would have been actuated to the "latched" position and would have remained latched until the normalizing relay was actuated. In normal operation, this latter condition occurs when a ground is furnished to the normalizing relay coil by the closing of the high r.p.m. limit switch, which happens when the propeller is returned to the high r.p.m. limit position of 26 degrees, positive. The position of minus .3 degrees at which the power-unit was found indicates this did not occur. A momentary short-to-ground of the automatic and manual increase r.p.m. circuit would have normalized the reverse pitch relay. It is possible that such a short could have occurred at the location of separation of the wires when the wing broke off or at the brush block when the brushes were broken. The first possibility is unlikely, since the portion of the circuit connected to the normalizing relay remained connected to the disconnected plug and was undisturbed. Also, a resistance and functional check of the brush block prior to its removal did not indicate any irregularity.

Both pilots testified that they did not pull the manual override handle out at any time during the flight, had not touched it during the La Guardia pre-landing cockpit check, and as part of this check ascertained that it was in the "in" position. Since the handle will automatically return to the "in" position when released, it would have been necessary for one of the pilots to hold it out while either one or both throttles were pulled past the detents into the reverse range. Both pilots stated that they took care not to pull the handle.

Following the accident, Northeast Airlines initiated a rewiring program on aircraft equipped with electric propellers to completely isolate the reversing circuit between the control pedestal and the propeller power-unit. The company also modified its policy of retiring the low pitch limit switch after 1 600 hours' flight time (which corresponded to the overhaul time for a propeller) to 800 hours. The company had originally retired these switches after not more than 1 000 hours of flight operation in accordance with the manufacturer's recommendation but had extended the retirement time early in 1952 from a maximum of 1 000 to 1 600 hours on the basis of operating experience. This extension of retirement time was given tacit approval by the CAA.

Probable Cause

The Board determines that the probable cause of this accident was loss of control of the aircraft during final approach due to high drag from the right propeller. This drag was induced by the right propeller blades moving beyond the high r.p.m. limit stop since the blades were found in approximately zero geometric pitch. The cause of this unwanted propeller action could not be determined.

ICAO Ref: AR/264

No. 44

Eastern Air Lines Inc., Constellation L-1049, damaged on landing while making a scheduled landing at Midway Airport, Chicago, 3 March 1953. Accident Report No. 1-0007. Released 10 July 1953

Circumstances

The aircraft was on a scheduled non-stop flight from Miami, Florida, to Chicago, Illinois with 6 crew and 77 passengers. While landing on Runway 13 at Chicago and approximately over the threshold of the runway, the aircraft made a steep turn followed by a right turn for alignment. The turn completed, the aircraft was observed to touchdown near the intersection of Runways 31L and 4L. Immediately after touchdown, the aircraft was seen to skip and then settle, veer off the runway to the left and come to rest on the bottom of its fuselage just beyond the end of the runway. There was no fire, all passengers were quickly evacuated, one passenger sustaining superficial injury.

Investigation and Evidence

At 1333, when the flight was nearing Chicago at 5 500 feet MSL, it was cleared by Air Route Traffic control to the Kedzie low frequency radio beacon, to cross Lansing Intersection at 5 500 feet and to contact Midway Approach Control after passing Lansing. Ten minutes later, at 1343, the flight reported over Lansing at its assigned altitude. At this time radar contact was established and routine vector and descent instructions were issued by approach control. The flight was established on course, nine miles southeast of the airport, and at 1350 it reported over the Kedzie marker at 1 500 feet. At this time the flight was cleared to land on Runway 31 Left and the local weather was given as: "Ceiling 700 feet, visibility one mile*. Immediately after passing the Kedzie marker, the check list having been completed, the landing-gear was lowered, the three greenlanding-gear position indicating lightscame on indicating that the gear was fully down and locked, and the hydraulic pressure gauge showed that the pressure was normal. When approximately one and one-fourth miles from the end of the runway, the radar operator, who was monitoring the approach, observed the aircraft had deviated approximately 800 feet to the left of course. The flight was immediately advised and the aircraft was observed to start a right corrective turn. During this turn the aircraft became visually contact and the captain said that he saw the tall chimney of the Cracker-Jack (2 200 feet from the end of the runway on a bearing of 179 degrees) and had the runway clearly in sight. When the aircraft was approximately over the threshold of the runway, a steep left turn followed by a right turn was made for alignment. Competent witnesses said that this latter turn was made at an altitude of approximately 200 feet above the ground and the speed of the aircraft seemed to be in excess of that usually used by similar type aircraft approaching to land. The turn was completed and the aircraft was observed to touch-down near the intersection of Runways 31L and 4L, which point is approximately two-thirds of the way down Runway 31L.

The Captain stated that considerable power was maintained until landing; that the touch-down was normal except for a slight bounce; that immediately following touch-down he applied reverse thrust to all four engines and that the four amber propeller reverse pitch warning lights came on. The co-pilot said, "the next thing I knew we were getting these prop nicks on the runway". Both the Captain and Pilot said that they did not touch the landing-gear control lever after the gear was lowered during the approach.

Midway Airport has an elevation of 618 feet. Runway 31L is macadamized and is 175 feet wide and 6 410 feet long. The distance from the approach end of this runway to the northwest or far side of its intersection with 4L is 4 000 feet. It was established that the aircraft touched down on the wet runway near this intersection. At a point approximately 2 000 feet beyond, it skidded off the left side of the runway and across a broad taxi strip, coming to rest on the belly of the fuselage a few feet beyond and to the left of the end of the runway. Many marks made by propeller blades were found on the runway; these were first noticeable at a point 315 feet from the far side of the intersection some of which extended 1 430 feet farther on.

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* The company's landing minima (day) for a straight-in ADF approach to Runway 31L are ceiling 400 feet, visibility one mile.

When the investigator entered the cockpit, a few minutes after the accident, the landing-gear control lever was in the "down" position and the flap indicator showed the flaps to be 80 per cent down.

All doors of the main landing-gear were damaged. The main landing-gear was found fully retracted but the hydraulically-operated wedges, which complete the final locking of the gear, were not in place*. The nose gear doors were damaged and the nose gear was retracted to within six inches of the full "up" position.

Examination of the landing-gear and components disclosed nothing which would have an adverse effect on their normal operation.

According to the information furnished by the manufacturer of the subject aircraft, the approximate minimum stopping distance on a wet macadamized runway, gross aircraft weight 98 500 pounds**, indicated airspeed 110 miles per hour in landing configuration, is 3 320 feet with maximum braking effectiveness. The nearly cross-wind of 13 miles per hour from the north-northeast, as was the case when this aircraft landed, can be considered negligible as far as it affected stopping distance. Under the same conditions the maximum stopping distance would be reduced about 50 per cent to 1 660 feet if maximum reversing and braking effectiveness were both obtained.

From a study of the testimony of the crew, it is apparent that the approach to Chicago was not made in accordance with the company's approved approach procedure. The company's flight manual states, in part, that when executing an IFR straight-in approach the landing-gear will be extended when approximately 10 miles from the airport. In this case, the gear was not lowered until the aircraft was over the Kedzie marker, 3.8 miles from the airport. Lowering the gear this late might not allow sufficient time to stabilize airspeed, power settings, and rate of descent for a smooth coordinated approach. This may account for the wide range in airspeeds (100-125 knots) and throttle adjustment which followed. The manual further states that for a gear-down descent in final letdown (from Kedzie) 22 inches of manifold pressure and an airspeed of 120 knots will establish a rate of descent of 400 feet per minute, also, that 30 inches manifold pressure and 130 knots should be maintained for level flight following the descent. It is apparent that the pilot was not following established procedure since the captain deemed it necessary, because of low airspeed, personally to add power immediately following the aircraft's return to level flight.

The fact that the aircraft was permitted to deviate 800 feet to the left of course shows lack of alertness on the part of the crew since such a deviation would be clearly indicated by appreciable deflection of ADF needles. In addition, when close in to the airport the ILS localizer needle would indicate a full deflection to the left, or blue. Under these conditions the Captain should have taken over the controls.

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* Report No. 7788 - Maintenance Instructions Manual - Lockheed Aircraft Corporation, Hydraulic Operation. Main and Nose Gear Retraction. With the landing-gear selector valve in the "UP" position (not possible with the weight of the airplane on the gears) secondary pressure fluid is directed simultaneously to the downlocks, uplocks and piston-rod end of the gear actuating cylinders. The fluid enters each main gear actuating cylinder through a runaround valve attached to the cylinder. The downlock strut is free to move away from the lock shaft after the downlock release piston retracts and rotates the latch release sleeve against the spring-loaded latch. As the gear completes its up travel, the lug on the strut engages the uplock assembly. The spring-loaded jaws close around the lug and hold the gear up. At this point, hydraulic pressure forces the wedge assembly of the uplock cylinder into the scissors-like opening at the back side of the uplock jaws. The nine steel balls within the uplock cylinder are forced into position behind the wedge. The gear is held and locked mechanically since the uplock jaws cannot release until hydraulic pressure is applied to the extension or "down" side of the uplock cylinder to withdraw the wedge. Hydraulic flow is unrestricted during retraction or "up" movement of the gear.

The hydraulic sequence of operation for the nose gear is identical to that of the main gear.

** The estimated gross weight of the aircraft on arrival at Chicago.

Furthermore, as visual contact was established at an altitude of 400 feet above the ground, approximately 2 200 feet from the end of the runway and since the aircraft was not properly aligned with the runway, it would appear that a missed approach procedure should have been immediately initiated. The dual handling of the power settings, the Captain's statements, "better step on it" and "we might have to go around", coupled with the necessity for close-in steep turns for alignment with the runway thereby requiring the application of considerable power until touch-down, all demonstrate the lack of complete crew coordination.

According to the crew, the landing-gear was in the "down" position and locked at the time of touch-down as indicated by the three green landing-gear position indicating lights, and the gear control level was not touched after it was placed in the "down" position. Since comprehensive tests of the landing-gear system made subsequent to the accident showed it to function in a normal manner, it is difficult to reconcile the crew's statements with what actually occurred. According to the manufacturer's maintenance manual, it is necessary for hydraulic system to remove the down locks, thus permitting the gears to be raised. This is normally accomplished by moving the control lever to the "up" position.

Since no malfunctions were found which would cause the gears to retract when once down and locked, it appears that in this case, the landing-gear control lever must have been raised by some member of the crew. Also, this action must have been taken when sufficient weight to actuate the safety switch was not on the gears; i.e. during the skip (bounce).

Probable Cause

The Board determines that the probable cause of this accident was an improperly executed approach resulting in excessive speed and a landing too far down the runway to permit normal stopping.

ICAO Ref: AR/261

No. 45

BOAC COMET AIRCRAFT G-ALYV, crashed and was destroyed near the village of Jagalgori about 24 miles from Dum Dum airport, Calcutta on 2 May 1953. MCAP Report 112

(This Inquiry was carried out by India in accordance with Annex 13)

Circumstances

The aircraft took off from Calcutta Airport, Dum Dum, on 2 May 1953, at 1059 hours GMT, for Delhi, carrying 37 passengers and 6 crew.

The take-off was normal. However, six minutes after its take-off, radio-communication contact with the aircraft was lost. At about 1105 hours GMT, witnesses saw the aircraft coming down in a blaze of fire through a severe thunderstorm and rain, finally crashing into a nullah. There were no survivors.

Investigation and Evidence

The aircraft contacted Dum Dum Aerodrome Control on radio-telephony frequency 118.1 Mc/s. and obtained clearance to taxy and later to take off from runway 19. After take-off the aircraft was cleared to change over to Dum Dum Approach Control frequency 119.7 Mc/s. The aircraft reported to Approach: "Departing Dum Dum on course to Delhi".

The aircraft contacted Area Control at 1102 hours GMT on wireless-telegraphy and reported: "Departed from Calcutta 1059 hours - Estimated time of arrival Palam 1320 hours-- Climbing to 32 000 feet".

A warning of the expected storm was issued by the Area Control Officer, which was received by the Station Officer of the BOAC, and passed on to the Captain of the Comet. It was to the effect that a thunderstorm accompanied by squalls from the northwest with speed reaching 50 knots was expected over Dum Dum and neighbourhood between 1200 hours and 1600 hours GMT (1730 hours and 2130 hours IST).

The actual conditions at Dum Dum at the time of take-off were well above this minima and as regards the en-route weather minima, no specific instructions are issued, and it is left to the discretion of the Captain of the aircraft. The Captain of the Comet, following his discussion with the Meteorological Officer, decided to take off, and taking off at 1059 hours GMT (1629 hours IST), he encountered the squall within six minutes thereafter. About half an hour later a KLM Constellation flew from Dum Dum Airport to Karachi and though the storm was encountered at a distance of 12 or 15 miles from Dum Dum, it was safely passed through at an altitude of 4 500 feet. However, the aircraft was going in a slightly different direction. Briefing by the Meteorological Office at Dum Dum was that there was a system of cumulo-nimbus clouds not far from Calcutta to the west. Unfortunately, the storm which the Comet encountered, as eye witnesses state, was unusually severe.

What happened exactly when the Comet encountered the storm and what the crew did, is difficult to say. According to one eye witness, there was a thud of something falling behind a hay-stack and he saw that it was like shining metal. Evidently, it was part of the Comet's fuselage. He then saw a blaze of fire in the sky. Another eye witness saw a flash of light and looking up saw that a plane was on fire. He heard a bang in the sky and saw the plane split in two, one piece falling into a nullah and burning violently; the other falling to the ground and burning at some distance. He heard two more loud reports after a minute or two. In his opinion, the storm on that day was unusually violent.

The main wreckage was located 24 miles from Calcutta Airport, Dum Dum on the track from Dum Dum to Palam. It was lying in a water-logged nullah. The main wreckage consisted of the fuselage portion from the nose to cabin bulkhead No. 26 (half way down the passenger compartment), two stub wings up to rib No. 7 attached to the fuselage with the four engines in position. The rest of the components of the aircraft were found on a track 5-1/2 miles in length on a heading about 334° (T). The different components of the aircraft were found in the following order on the wreckage trail:-

Port outer elevator and port top skin starboard elevator together with starboard bottom mainplane skin, port tailplane with parts of rear cabin structure top fuselage skin, port inner elevator, starboard wing skin, sections of port fuselage side panel, starboard tailplane, fin and rudder, both outer wing panels, rear portion of the fuselage and the main wreckage in the nullah, as shown in the sketch on page 157.

The terrain on which the wreckage was found is flat, consisting of paddy fields.

There were no scratches on the soft ground where the different components of the aircraft had fallen which indicated that the pieces had fallen in almost a vertical direction with no forward velocity.

The main wreckage had been on fire. The main body of the aircraft had fallen into the nullah in an inverted position. There was severe damage on the structure of the aircraft due to impact and to fire. Some of the separated fuselage panels had no evidence of fire damage. The rear fuselage unit had been damaged by fire and the portion aft of the pressure dome indicated severe damage due to impact. The port and starboard extension wing had severed from the main wing outboard of rib No. 7. Part of the port wing tip had melted from fire damage. A deposit of smoke was found all along the leading edge of the flap and aileron, both on the port and on the starboard wings. The port aileron showed impact damage at three points on the trailing edge. The starboard wing had suffered severe impact damage at the wing tip. A small piece of the rear fuselage was found in the starboard wing. The leading edge of the starboard wing had suffered impact damage in the air between ribs Nos. 7 and 14, and there were metal scratches all along the leading edge from the place of the impact right up to the wing tip.

Examination of the wreckage indicated that -

i) The undercarriage and flaps were in the fully retracted position.

ii) The throttle levers were broken and jammed. All the four throttles were in the "half-open" position.

iii) High pressure and low pressure fuel cocks were "on".

iv) The flying control system changeover levers were in their normal positions.

v) The elevator and aileron trim settings were about normal. The rudder trim setting could not be determined.

vi) The cabin was being pressurized as disclosed by the spill valves.

vii) The fire extinguishers had not been operated, nor was there any evidence of any emergency procedure having been taken.

viii) Both the extension wings had failed at a station outboard of rib No. 7. On an examination of the wing panels it was noticed that the top panels had failed in tension while the bottom panels had failed in compression, indicating thereby a down-load failure of the wing. The top panels between ribs Nos. 7 and 12 indicated bending failure. The bottom panel consisting of several small pieces had sheared off at several points. The top and bottom panels on both the wings had severed from the main wing at rib No. 7. The aileron with its tab was in position on both the extension wings. The extension wing outboard of rib No. 12 with the aileron was found in one piece.

ix) Tailplane: The port tailplane had suffered heavy impact damage in the air right from the leading edge to the rear spar along its chord at a station close to No. 2 hinge bracket. The outboard tailplane had been completely severed from the inner unit at the above station due to impact. There was no structural damage on the tailplane panels outboard of No. 2 hinge bracket. The port inboard tailplane had broken off its attachment at the fuselage and at the front and rear spar points. The inboard piece had again broken into two pieces along the span somewhere in between the two spars. The No. 3 hinge bracket on the rear spar indicated an inboard side load. The No. 4 hinge bracket had sheared off at its centre. The starboard tailplane had suffered impact damage in the air at the inboard leading edge. The two front and rear spars had failed near the root attachment.

x) Elevators: The port elevator had been cut into two pieces along its chord close to the No. 2 hinge bracket. The inboard elevator piece indicated a skin collapse and had torn off its attachment to the operating torque tube. The elevator spar showed bending failure at a station in between No. 3 and No. 4 hinge brackets. It indicated a compression failure on the top flange and a tension failure at the bottom, that is, a down load failure. The mass balance appeared to have detached itself in a downward direction due to the inertia load. The starboard elevator spar had failed to bend significantly at the same point as on the port elevator. The compression failure at this point was severe and a collapse of the spar seemed to have sheared off the mass balance from its attachment to the elevator tip ribs. The No. 3 hinge brackets on the tailplane showed an outboard side load. The elevator had separated in two at a place in between the No. 2 and No. 3 hinge brackets. The inboard portion of the elevator had been torn off its attachment to the torque tube. There was no damage on the tailplane around the point where the elevator spar had failed to bend. The bending failure of the elevator spar was localized at a particular station and there was no evidence of impact damage at this section. The elevator skin panel had suffered diagonal wrinkles owing to tension field on a down load.

xi) Fin and Rudder: The fin had broken off its splice point at the insulation joint box. There was no structural damage on the fin panels. The top rudder hinge bracket had been twisted in a clockwise direction and the bearing had been sheared off its mounting on the bracket. The central rudder hinge bracket was intact and the hinge bolt had sheared off on the port side. The top rudder had broken at its jabroc attachment point to the lower rudder. The mass balance had detached from its attachment to the rudder tip. The lower fin and rudder had suffered extensive impact damage. The rudder operating torque tube had impact marks at several places.

xii) Fuselage: The fuselage had failed at frame No. 26 close to the attachment station of the fuselage to the centre section wing. The fuselage panels indicated tension failure at the top and compression failure at the bottom. Some of the loose panels aft of bulkhead 26 that had detached themselves from the main body were not burnt. The rear fuselage had been affected by fire in the cabin portion.

The Court of Investigation decided that there was no doubt that the aircraft suffered a complete structural failure in the air and thereafter the aircraft was on fire in the air. One of the assessors at the inquiry after careful inspection of the wreckage arrived at a deduction which is included at the end of this report. The Court decided that the reasons given in the conclusion are quite plausible, but maintained that a further prolonged and technical study of the wreckage was necessary to verify the deduction and determine the sequence of failures.

Probable Cause of the Accident

The accident was caused by structural failure of the airframe during flight through a thundersquall. In the opinion of the Court, the structural failure was due to overstressing which resulted from either:-

i) Severe gusts encountered in the thundersquall, or

ii) Overcontrolling or loss of control by the pilot when flying through the thunderstorm.

The Court recommends:-

i) That the wreckage should be transported as soon as possible to the State of Registry and its detailed technical examination be undertaken with a view to determining the primary failure and to consider if any modification in the structure of the Comet aircraft is necessary; and

ii) That consideration should be given to the desirability of modifying the flying control system of the Comet aircraft in order to give the pilot a positive "feel" of airloads exerted on the control surfaces.

Probable Cause of Structural Failure

(As deduced by Shri W. Srinivasan, Assessor at the Court of Investigation and attached as an Appendix to the Report).

A technical examination of the wreckage has supplied several significant features that indicate a structural failure during flight in stormy weather conditions. Fire is a subsequent occurrence that has spread from the wing tanks on to the main body of the airplane. A study of the different components and their nature of failures strongly suggests primary failure of the elevator spar in bending due to a heavy down-load imposed on a "pull-up" by the pilot when the aircraft encountered a sudden down-gust during its flight across a "nor'wester squall".

Weather Data

The Comet during its climb about 6 minutes after take-off met stormy weather conditions. The "nor'wester squall", according to meteorological experts, consists of a column of rising hot air currents in the "formative" stage covering an area varying between 30 and 40 square miles. The up-gusts created increase in speed as they rise in altitude towards the cloud base. The squall may even consist of many vertical cells at different stages of formation. Mixing with the cloud and the surrounding air, the "mature" stage starts with a downpour of rain and consequent down-gusts of velocities varying between 15 and 50 miles per hour. Definite data on the gust velocities occurring in these nor'wester squalls, so characteristic of the Calcutta region during May and April, cannot easily be obtained even with modern equipment and facilities. However, up and down gusts, varying in intensity from 15 to 50 miles per hour at different altitudes, are possible during stormy weather conditions. On evidence by experienced pilots, it has been noted that the best way to fly through a storm or squall is to cut across at 90° with manual controls (i.e., without auto-pilot). While flying through a thundersquall, the Captain takes over the controls and tries to maintain the attitude of the aircraft. The co-pilot keeps a watch on the ASI and controls the throttle with a view to not exceeding the specified limit manoeuvring speed.

Primary Failure

A close examination of the spar in either elevator shows a bending failure at a station in between the No. 2 and No. 3 outboard hinges. It is a down-load bending with compression at the top flange and tension at the bottom. It is significant that this failure is of a localized nature with no damage over the surrounding area either in the tailplane or elevator skin, despite the subsequent impact damage observed on other portions of the structure. This elevator down-load failure may have been due to a "pull-up". The down-load on the tail-unit seems to have caused a fuselage failure in bending at bulkhead No. 26. The top panels have failed in tension and the bottom panel in compression.

During flight in a down-gust, the aircraft not only loses altitude, but it takes a nose-down attitude. The airspeed increases. The pilot immediately reacts to maintain the attitude of the aircraft by a "pull-up" and the co-pilot throttles back the engines to reduce the speed and keep it within the specified limit. The wreckage reveals that all the four throttle controls were found in the "half-open" position. The aircraft had responded to the corrective action taken, but a sudden elevator failure must have imposed a heavy down-load on the wings with the resulting wing failure at about Rib No. 7. It is also significant that the extension wings have failed at about the same station points on both sides. The extension wing panels have tension failure at the top and compression failure at the bottom. The above structural failure must have been so rapid that the crew and the passengers were subjected to a high positive "G" first during the "pull-up" and perhaps a higher negative "G" on elevator failure. The inner panels of the outer wing between Ribs 7 and 12 have flapped up and down and detached themselves at Rib 7 by bending failure.

Probable Successive Failures

The detached wings lagging behind the main body of the diving aircraft may have impacted the tailplane on the port side and the fuselage on the starboard side. It is difficult at this stage to determine exactly the flight path of the two extension wings after separation in relation to the main body of the diving aircraft and say precisely which portion of the wing hit the tail-end of the fuselage and tailplane. The starboard extension wing has suffered heavy impact on its leading edge. There are indications to show that it has been hanging on to some metal panels chafing its leading edge right along the spar. The starboard tailplane has an impact damage on the inboard leading edge.

The rudder appears to have been torn off its support to the fin by an impact. The fin has broken at the insulation box. The fin and rudder do not have any evidence of structural failure due to air-loads. It is highly improbable for the surfaces to have sustained the air-loads that could damage the hinge bolts and brackets as seen on the wreckage. The direction of the broken hinge bracket piece indicates that the impact load has come from the operating side. The way the inboard elevators have sheared off their mounting on the torque tube also suggests their damage due to sustained impact loads from the control side. An examination of the tail portion of the fuselage reveals that it has suffered some impact in air from one of the wings. The starboard extension wing leading edge may have struck the fuselage tail and imposed the heavy loads on the elevator and rudder control torque tubes mounted at Bulkhead 52. These loads could have sheared off the rudder from its support, broken the fin also at the insulation box and broken the inboard elevators off its hinge support. A heavy impact on the torque tubes will naturally shear the control surfaces off their hinge supports. The port wing aileron trailing edge has impact marks at three places. It is difficult at this stage of the investigation to match any impact damage with that found on the tail-unit or any other component. But there are indications that the port wing has caused the damage on the port tailplane. Fuel from the outboard tank appears to have run along the wing span through the nose of the aileron right from Rib 7 to the wing tip. The detached extension wings with kerosene smeared all over, during their flight path across the jet blast have picked up fire. That explains the deposit of smoke on the wing at several places along the span.

The broken wings seem to have deposited smoke on the fuselage tail during its impact. This explains why the fuselage tail has deposit of smoke while the just forward fuselage panels have not. The fuselage initial failure has been at bulkhead 26. The fuselage panels have not. The fuselage initial failure has been at bulkhead 26. The fuselage panels (between bulkhead 24 and pressure dome) have opened out in flight and broken off their attachments at bulkhead 26. The aircraft with a stub wing and no tail-unit may have got into some type of auto-rotation during its fall and settled itself into the nullah in the inverted position with the nose pointing south-east.

Remarks

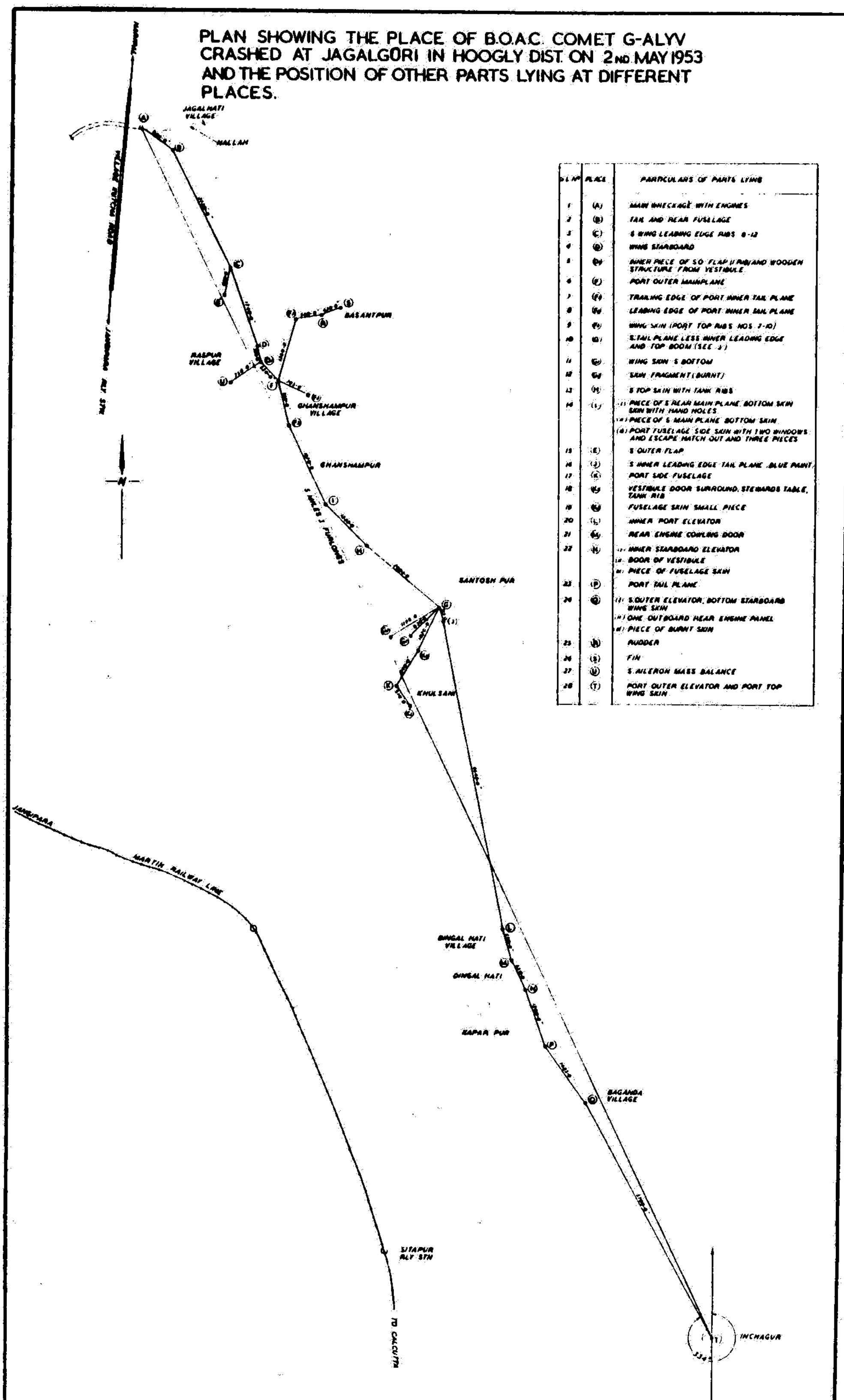
On an examination of the wreckage and the major components with the facilities available at the wreckage spot, it has been suggested that the primary failure may have been on the elevator. The metal elevator does not have a closed nose box to take the torsion loads. The triangular metal box aft of the spar forms, in fact, the only torsion resisting member on the elevator. The torsion will be resisted by the skin panels in tension field. There are indications on the starboard elevator to show that it has suffered a down-load and permanent diagonal wrinkles. The spar in between No. 3 and No. 4 hinges appears to have given way in bending. The spar, along with the normal air-load bending, will have a secondary bending induced by the tension field components on the skin panels. The elevators may have been stressed to the balancing and manoeuvring loads encountered during flight in gust conditions as per design requirements. A static test may also have been carried out to test the skin panels in tension field on a down or up load torsion in view of the absence of a closed nose section. In the absence of design details, it has not been possible to be definite on the comparative structural strength of the major components.

A sketch showing the distribution of the different components of the aircraft along the wreckage trail is appended to this report. Normally, it may be possible to plot the trajectories of the falling bodies and predict with a certain degree of accuracy, the primary failure of the aircraft. Since the aircraft disintegrated into several pieces while in the air with several successive failures and collision loads between parts and due to the fact that definite data on the wing velocities at the time of wreckage are not possible, no attempt was made to draw the trajectories and predict the primary failure.

It is understood that during the investigation the wing was subjected to a static test by the manufacturing firm in the development stage of the aircraft. On one test piece static and fatigue tests were conducted alternately. The wing failed in fatigue test and, after modification, was subjected to a static test. The wing failed again at 90 per cent of the ultimate load. The failure was attributed to the previous fatigue test. Modifications were carried out again and, without a re-test, it was found to be satisfactory for the ultimate load on theoretical considerations. The fatigue failure during static test occurred at Rib No. 7 where the cross-section changes from two heavy spars to an outboard shell construction. In this accident, again the wings have significantly failed at Rib 7. Whatever the load may be, the failure at Rib 7 may indicate the lack of proper diffusion of the wing loads on to the two spars at Rib 7. In the absence of design data, no definite comments can be made on the wing failure, but a further investigation on the above subject of load transfer at Rib 7 will be helpful.

It is extremely difficult during the short period of investigation, with limited facilities and data, to substantiate the primary failure with all details but there are strong indications on the wreckage to suggest the primary failure of the elevator during a "pull-up". The Comet has got an elevator control system operated with booster power with no feed-back arrangement for pilot feel. It is quite probable that the pilot, who is accustomed to a sort of "feel" on the controls during manoeuvres had over-controlled the aircraft beyond the limit that would impose the design loads on the aircraft. In this respect any modification to incorporate a control "feed-back" in the elevator system will be a definite improvement.

ICAO Ref: AR/267


PLAN SHOWING THE PLACE OF B.O.A.C. COMET G-ALYV CRASHED AT JAGALGORI IN HOOGLY DIST. ON 2ND MAY 1953 AND THE POSITION OF OTHER PARTS LYING AT DIFFERENT PLACES.
JAGALHATI VILLAGE
NALLAH
BASANTPUR
RAJPUR VILLAGE
GHANSHAMPUR VILLAGE
GHANSHAMPUR
5 MILES 3 FURLONGS
SANTOSH PUR
DINGAL HATI VILLAGE
DINGAL HATI
BAGANDA VILLAGE
INCHAGUR
MARTIN RAILWAY LINE
SITAPUR RLY STN
TO CALCUTTA
N
SL No | PLACE | PARTICULARS OF PARTS LYING
1 | (A) | MAIN WRECKAGE WITH ENGINES
2 | (B) | TAIL AND REAR FUSELAGE
3 | (C) | S WING LEADING EDGE RIBS 8-12
4 | (D) | WING STARBOARD
5 | | INNER PIECE OF S.O. FLAP (1 RIB) AND WOODEN STRUCTURE FROM VESTIBULE
6 | (F) | PORT OUTER MAINPLANE
7 | | TRAILING EDGE OF PORT INNER TAIL PLANE
8 | | LEADING EDGE OF PORT INNER TAIL PLANE
9 | | WING SKIN (PORT TOP RIBS NOS 7-10)
10 | | S.TAIL PLANE LESS INNER LEADING EDGE AND TOP BOOM (SEE J)
11 | | WING SKIN S BOTTOM
12 | | SKIN FRAGMENT (BURNT)
13 | (H) | S TOP SKIN WITH TANK RIBS
14 | | (i) PIECE OF S REAR MAIN PLANE BOTTOM SKIN SKIN WITH HAND HOLES
(ii) PIECE OF S MAIN PLANE BOTTOM SKIN
(iii) PORT FUSELAGE SIDE SKIN WITH TWO WINDOWS AND ESCAPE HATCH OUT AND THREE PIECES
15 | (E) | S OUTER FLAP
16 | (J) | S INNER LEADING EDGE TAIL PLANE (BLUE PAINT)
17 | (K) | PORT SIDE FUSELAGE
18 | | VESTIBULE DOOR SURROUND, STEWARDS TABLE, TANK RIB
19 | | FUSELAGE SKIN SMALL PIECE
20 | | INNER PORT ELEVATOR
21 | | REAR ENGINE COWLING DOOR
22 | | (i) INNER STARBOARD ELEVATOR
(ii) DOOR OF VESTIBULE
(iii) PIECE OF FUSELAGE SKIN
23 | (P) | PORT TAIL PLANE
24 | (Q) | (i) S.OUTER ELEVATOR, BOTTOM STARBOARD WING SKIN
(ii) ONE OUTBOARD REAR ENGINE PANEL
(iii) PIECE OF BURNT SKIN
25 | (R) | RUDDER
26 | (S) | FIN
27 | (U) | S.AILERON MASS BALANCE
28 | (T) | PORT OUTER ELEVATOR AND PORT TOP WING SKIN

No. 46

AIR INDIA DC-3 Aircraft crashed a few minutes after take-off from Palam Airport on 9 May 1953. Government of India Report

Circumstances

The aircraft, engaged in a scheduled night air service Delhi-Ahmedabad-Bombay, took off at approximately 0123 hours on 9 May 1953 with 5 crew and 13 passengers on board.

At 0128 a large fire was observed a short distance from the aerodrome. The wreckage of the aircraft was located scattered over an area approximately 1-1/3 miles southeast of the airport. There were no survivors.

Investigation and Evidence

There were three pilots in the crew; Captain, First Officer and a supernumerary pilot who obtained the Communication Navigational, Meteorological and Air Traffic Control briefing and clearance at Palam before the flight. The weather conditions were good, with visibility steady at 4 nautical miles and surface wind less than 10 knots.

The aircraft proceeded to the end of runway 09. At 0122 hours the aircraft contacted Air Traffic Control, Palam, on radio telephony and requested permission to take-off. Permission was granted and the aircraft took off immediately. At 0125 hours, after the aircraft had taken off and was airborne, Air Traffic Control, Palam, received on radio telephony a request from the aircraft for permission to execute a starboard turn and change over to Safdarjung Approach Control. The permission was granted and acknowledged.

Thereafter there was no contact between the aircraft and Palam Air Traffic Control. At, or immediately after, 0126 hours Palam Air Traffic Control attempted to establish contact with the aircraft by calling it on radio telephony four times but no reply was received. The Duty Officer at Approach Control at Safdarjung, who was informed by Air Traffic Control, Palam, shortly before 0126 hours that the aircraft had taken off, started calling the aircraft immediately after 0126 hours on Approach Control frequencies but could not get any response.

At 0128 hours the Palam Control Tower was lighted with a glow. The officers on duty looked out and saw clouds of smoke and a huge fire burning a little distance away. The crash siren was sounded and rescue services were put into operation.

The aircraft was last seen flying by an eye witness just about 30 seconds before it crashed. At that time the aircraft was stated to be at a height of about 400 to 500 feet and was turning round at a rather steep bank with its right wing down. There was nothing else that the eye witness considered unusual with regard to its flight at that moment.

The aircraft had sufficient fuel on board, no mechanical trouble or snag was detected during inspection of the aircraft before it took off; there was no report of any irregularity or emergency from the pilot due to malfunctioning of the aircraft;there was no mechanical interruption to the flight and the meteorological conditions were fair.

The Inquiry considered various factors as possible causes of the accident as follows: Operational safety of Dakota aircraft, structural failure, engine failure, damage during storm, caged artificial horizon, cockpit failure, auto pilot in 'on' position, faulty loading, fire, lightning, hitting an object in the air, shortage of fuel, intoxication of the members of the crew, sabotage, locked ailerons, crew fatigue, sensory illusion, pilot's error or judgment.

Except for the last, all these factors were rejected, there being no evidence that they were contributory causes.

However, with regard to pilot's error or judgment, the Inquiry considered an important piece of evidence.

At the time of the departure of the aircraft, the supernumerary pilot was seen occupying the First Officer's seat, whereas the crew member who was scheduled to fly as First Officer, was observed standing behind the pilot's seat. This fact was brought out in the evidence of a Traffic Assistant of Air India Ltd., who was in charge of loading and was present near the aircraft at the time of its departure. From amongst the other employees of Air India who were examined by the Court, no one could either corroborate or deny the fact of having seen the supernumerary pilot in the First Officer's seat. This may be attributed to their lack of observation.

The Inquiry accepted the evidence because undoubtedly it was the supernumerary pilot, who went for communication, navigational, meteorological and air traffic control briefing. According to the instructions given in Notices to Airmen, issued by the Director General of Civil Aviation and also in accordance with the Company's regulation., all briefing should be received personally by the Captain of the aircraft. Neither the Commander of the aircraft, nor the First Officer obtained the briefing personally.

The supernumerary pilot, although an experienced pilot with his licence endorsed for Viking aircraft, had only an hour's experience on a Dakota and that was during a day flight. He was neither competent to fly a Dakota aircraft nor scheduled to do so. The fact that he was occupying the First Officer's seat and went for all the briefing shows that the Captain's intention was that the supernumerary pilot should be permitted to fly the aircraft. It appears probable that the Captain after the take-off, when the aircraft had become airborne and reached a height of about 400 to 500 feet, let the supernumerary pilot take over the controls.

For the reason stated above, it seemed likely that it was the supernumerary pilot who was operating the controls shortly before and during the execution of the starboard turn.

It was the conclusion of the Inquiry that inexperience with Dakota type of aircraft had much to do with this unfortunate disaster. An important piece of evidence is the testimony of a witness who saw the aircraft, about 30 seconds before the crash, turning at a steep bank of about 45 degrees with its right wing down. He observed the aircraft for a few seconds and saw it gradually go lower and lower at the same angle.

There is, therefore, every reason to believe that having gone into a very steep starboard turn and being unfamiliar with the type of aircraft he was flying, the supernumerary pilot was not able to come out of the overbanked turn in time because of the low altitude. The Captain sitting by his side was unable to take corrective action or, if he attempted to do so at the last moment, was too late for it. The aircraft could not have been at a height of more than approximately 500 feet. The elevation at the scene of the wreckage is about 45 feet above the Palam level. Thus, with only about 450 feet or perhaps less, between the aircraft and the ground, it should not have taken more than a few seconds for the aircraft to collide with the ground.

Recommendations

With a view to the preservation of life and the avoidance of accidents in future, the Court of Inquiry made the following recommendations:

a) The existing rule that unlicensed personnel should not fly the aircraft should be strictly enforced and any one acting in contravention or in abetting thereof should be dealt with severely.

b) Although satisfied in this case that the crew took no alcoholic drink, provision should be made in the Indian Aircraft Rules that none of the operating crew of an aircraft have any alcoholic or intoxicating drink, sedative, narcotic or stimulant drug or preparation within twelve hours of the commencement of the flight or during the flight.

c) The existing regulations, that the captain of the aircraft (or the flight despatcher where a company employs such an officer) should obtain briefing personally, should be strictly enforced.

d) The briefing should be given to the members of the crew personally by the competent officers.

e) A senior officer of the operator should be present at the time of departure of a scheduled service from a terminal station, to ensure that both the engineering and operational staff of the operator carry out their respective duties in accordance with the regulations and procedures laid down.

f) The Proficiency or Instrument and Route checks of pilots should be carried out frequently by Government Check Pilots. The number of Government Check Pilots should be increased to enable them to cope with the thorough and frequent checks of pilots.

g) Co-pilots should receive an Instrument or Proficiency check once a year. New Captains, that is, those with less than one year's service as commander should be given a Proficiency or Instrument check at frequent intervals, roughly every quarter. In the case of Captains with over one year's service as pilot-in-command, proficiency and Instrument Checks may be less frequent, say once every six months. The procedure of checking to be followed for these checks may be laid down by the Civil Aviation Administration.

h) The Check Pilots appointed by the Government should be qualified, experienced and competent to fly the type of aircraft on which the check is to be carried out. They should themselves be subjected to checks at least once a year by independent and competent Check Pilots.

i) It should be ensured that proper use is made of cockpit check lists by the pilots. A pilot should not be permitted to rely on his memory rather than the cockpit check lists. These lists should be as detailed and thorough as possible and should include all critical items and emergency procedures. Disciplinary action should be taken against pilots not making proper use of cockpit check lists.

j) Adequate link training equipment and a sufficient number of instructors should be made available in India for airline pilot training. The cost of training during the course of an actual flight has, at times, proved to be a deterring factor and considering the reduced cost in link training, its provision will encourage airlines to devote greater attention to increasing pilot proficiency.

k) Uniform standards and procedures of training should be maintained in respect of civil aviation personnel throughout the country. Therefore, the Directorate of Training of the Civil Aviation Department should be strengthened along the latest trends that obtain in other parts of the world.

l) Standards and Recommended Practices of the International Civil Aviation Organization relating to Personnel Licensing, as laid down in Annex I to the Convention on International Civil Aviation should be implemented by India.

m) Every opportunity should be utilized to send officers abroad for training and familiarization of the techniques, procedures and standards which prevail in other countries. Opportunities for training in the International Civil Aviation Organization and such other organization should also be explored.

n) The Accident Investigation Branch of the Civil Aviation Department should be strengthened to enable them to initiate a thorough study and detailed analysis of causes of accidents which occur in India and other parts of the world.

o) A provision should be made to ensure that the Certificate of Safety for Flight issued by an Aircraft Maintenance Engineer of the operators should be handed by him personally to the pilot.

Probable Cause

The probable cause was an error of judgment on the part of the supernumerary pilot, flying as First Officer, who executed a steep starboard turn and could not come out of the overbanked turn in time because of the low altitude.

Inexperience of the pilot with the type of the aircraft which he was flying is deemed to be an indirect cause of the accident.

ICAO Ref: AR/273

No. 47

Iranian Airways DC-3 crashed near Mehrabad Airport during a training flight on 30 June 1953

Circumstances

The aircraft, engaged on a co-pilot's check in instrument flying and one engine flying, took off from Mehrabad Airport at 0909 LT with a Captain acting as check pilot, four co-pilots under test and a flight engineer. Difficulties were met in feathering and unfeathering during the first flight and the aircraft returned to the apron for advice. The aircraft took off again at 1048 LT for further checks.

At approximately 1129 LT and at 6 700 feet the port propeller was feathered. A few minutes later the port propeller overspeeded when the Captain tried to unfeather it and, despite repeated efforts, the crew did not succeed in unfeathering or refeathering it and it continued to windmill at about 2100 RPM.

Height could not be maintained and the aircraft crash landed in open country 1 500 metres short of Runway 11 at Mehrabad Airport. The aircraft was wrecked causing serious injuries to three occupants and minor injuries to the other three.

Investigation and Evidence

The aircraft took off from Runway 29 at 0909 LT, 30 June. A co-pilot, who was being tested, was in the left pilot seat, and the Captain was in the right-hand seat. The flight engineer, (aircraft maintenance engineer (Class II) no flight engineer licence) and at least one of the three remaining co-pilots were standing immediately behind the pilots' seats during the greater part of the flights, until the accident occurred. When approximately 1 500 feet above the runway, the blind flying curtains were drawn in front of the co-pilot, and he was instructed to fly on instruments and to continue climbing on a heading of 180 degrees. Having reached 8 000 feet, he was told to fly level for about 5 minutes on a heading of 240 degrees, and then again on a heading of 180 degrees, after which he did a rate one turn to the right through 260 degrees. He was then required to give the heading to steer in order to return to Mehrabad and his ETA there. The blind flying curtains were then pulled back when he was over the airport.

Similar tests in mental dead-reckoning were given later on to the other co-pilots and following the test in instrument flying and mental dead-reckoning, it was the Captain's intention to give each co-pilot a handling test of the aircraft with one engine stopped. In the case of the first co-pilot tested, the Captain attempted to feather the left engine but apparently did not know the correct procedure to follow because most of the witnesses agreed that he did not touch the left propeller pitch lever before pressing the feathering switch. Neither did he put the mixture control into the "idle cut off" position afterwards. The flight engineer then told the Captain that he had not followed the correct procedure, and reset the throttle and mixture controls of the left engine. He then instructed the Captain to press the feathering switch, but still the left-hand propeller did not feather, apparently because the pitch control had not been adjusted.

By that time the aircraft was losing height at about 500 feet per minute, because the power on the right-hand engine had not been increased to compensate for the windmilling propeller on the left. The Captain then tried to unfeather the left propeller and again seemed to follow the incorrect procedure so that the left propeller started to overspeed. This was corrected by throttling back the left engine, but the left propeller was still windmilling. Power was eventually increased on the right engine by the co-pilot, who then carried out a single engine landing on Runway 29. By the time the aeroplane had landed, it appeared that the manifold pressure on the left engine was normal and apparently the left propeller feathered and unfeathered properly when tested shortly after landing. Nevertheless, as a precaution, the Captain taxied in and asked the Company Chief Engineer to carry out a further check. The left propeller was feathered and unfeathered twice without difficulty and the correct procedure to be followed explained to both the Captain and Flight Engineer.

The aircraft took off on Runway 29 for the second flight at 1018 LT with the second co-pilot in the left seat. He was required by the Captain to carry out the same exercise in mental dead-reckoning as previously completed by the first co-pilot. The aircraft was heading south at an altitude of 8 500 feet when the Captain throttled back the right engine. According to the evidence, the Captain pulled back the left mixture control and the left propeller pitch control. Seeing this and not thinking, or perhaps forgetting, that the right engine had been throttled back, the co-pilot switched off the left engine and did not realize for a short time that neither engine had any power. However, the co-pilot quickly switched on the left engine and the Flight Engineer pushed forward the left propeller and left mixture levers, so that power was restored on that side. The Captain then feathered the right engine, which functioned normally and the co-pilot adjusted the trim. By that time the aircraft had lost 700 feet, the indicated airspeed being 120 MPH, and was flying towards Mehrabad. The Captain started to unfeather the right engine, but the Flight Engineer sensing that it was going to overspeed, asked if he could take over the engine controls. He reported that he was successful in unfeathering the right engine but according to the co-pilot, the right engine did not pick up again until several minutes afterwards, apparently continuing to windmill at about 2500 RPM until the aircraft landed on Runway 29 at 1053 LT. The Captain then checked the feathering and unfeathering of the right propeller and apparently it worked normally.

The third co-pilot then took his place in the left pilot seat and took off on Runway 29 at 1103 LT and completed the same test in instrument flying and mental dead-reckoning as previously carried out by the two other co-pilots. With the aircraft still heading 270 degrees, the Captain throttled back the left engine and pulled back the left propeller pitch lever. The Flight Engineer pulled back the mixture control and the Captain pushed the left feathering button and the left propeller feathered normally.

At this time (estimated to be 1129 LT) the aeroplane was approximately 2-1/2 miles north-west of the Aeroclub aerodrome and approximately 3-1/2 miles west of the threshold of Runway 11; the altitude at the end of the feathering operation was 6 700 feet. After about half a minute, still flying on a heading of 270 degrees, IAS 120 MPH the Captain attempted to unfeather the left propeller. He put the left throttle about one-quarter forward and moved the left mixture control to auto-lean. The Flight Engineer then switched on the left engine and pulled out the left feathering switch. The left engine overspeeded and apparently made a high screaming noise. The Flight Engineer then pulled back the left propeller pitch lever which was about three-quarters forward, and eased back the left throttle and pressed the left feathering button. The noise of the left propeller decreased but it still appeared to be overspeeding. Assuming that no more height had been lost since feathering, the altitude could not have been more than 6 700 feet at that time (between 1129 LT and 1130 LT).

As soon as the left engine had overspeeded, the Captain took over the controls and started a turn to the right at about rate one, with the intention of landing on Runway 11. He noticed that the aircraft was losing height very rapidly and said he opened up the right engine to 2400 RPM and manifold pressure 40 inches, but that this did not seem to check the abnormal rate of descent. This has been estimated at approximately 1 000 feet per minute during the turn and the approach to Runway 11. The Captain and co-pilot both reported that they did not feel any unusual pressure on the rudder controls. However, the co-pilot said that he did not think that the rate of descent became unusually steep until about two minutes after the left engine overspeeded just as if the right engine suddenly lost power at that time. He maintained that he made an adjustment to the rudder trim to the right when the left engine revs. were reduced immediately after overspeeding, and about two minutes later he adjusted the rudder trim to the left, the setting being at about normal after this second adjustment. This was not confirmed by the Captain who said that he put the rudder trim to zero himself, immediately after he took over control from the co-pilot at the time the left propeller started overspeeding.

During the turn to the right, the Captain said he was sure that he did not touch any of the engine controls because his full concentration was needed to fly the aircraft. Apparently the Flight Engineer was carrying out the necessary adjustments to the engine controls and was acting under his orders. He urged the Flight Engineer to try to do something with the left engine as the left propeller was still windmilling at about 2100 RPM, but the Flight Engineer said he was unable to feather or unfeather it, and that he finally closed the left engine throttle and mixture control completely and switched off the left engine. This was done at a time estimated to have been 1131. (The left mixture control was found in the auto-rich position immediately after the accident, during the initial examination of the wreckage.) As the aeroplane completed its right-hand turn, still losing height very rapidly, it seems that all the occupants were convinced that they would be unable to reach Runway 11. This was about 1130-1/2 and approximately two minutes before the crash. The Captain said that he carried out a quick visual check of the engine controls and noticed the right throttle fully open, the right mixture control in the normal position, 40 inches of manifold pressure and RPM 2100. According to the co-pilot who was still watching the altimeter closely, the altitude was 5 800 feet when the turn was completed and the heading approximately 110 degrees,i.e. towards Runway 11.

The Captain told the Tower that he would be unable to make it and would crash and then throttled back the right engine when he was about 10 or 20 metres above the ground. This must have been about 20 or 25 seconds before the aeroplane came to rest. He said that the landing direction seemed clear and he did not notice the ghanats ahead. The Flight Engineer then turned off the petrol selector to the right engine, switched off the ignition and cut the master switch and those of the generator and battery. The aircraft landed with its wheels and flaps up, It maintained a straight heading until it struck a six-foot ghanat.

Recommendations

In spite of this unfortunate accident, Iranian Airways should be urged to continue its programme of pilot training.

The Company's pilots-in-command and co-pilots, including the Captain when he is again fit for flying duties, should be tested, by a well qualified and experienced DC-3 check pilot, particularly in emergency procedures. This is an urgent requirement and should be done as soon as possible. A copy of the check pilot's report should be passed to the Department General of Civil Aviation.

The duties of each member of the flight crew should be clearly defined in the Company's Operating Manual and continuing training and drill should be carried out in these duties.

Iranian Airways Company should take the necessary steps to keep adequate records of aeroplane accessories.

Facilities should be provided by the Department General of Civil Aviation for the examining and licensing of flight engineers and suitably qualified engineers of Iranian Airways Company, should be given an early opportunity to be examined for the issue of flight engineers' licences.

The procedure for sending the latest meteorological data to the air traffic controller in the Tower, should be improved and cognizance taken of Recommendation No. 1 of the ICAO Meteorological Division made at its third session (Paris, March 1950).

The attention of the appropriate authorities should be drawn to the fact that no drugs were available at the Pahlevi Hospital on 30 June, to ease the pain of the injured members of the crew. If remedial measures cannot be taken by those authorities, a stock of suitable drugs should be kept at Mehrabad Airport.

Probable Cause

The Investigation Committee finds that the probable cause of the accident was that, with the left propeller windmilling, the right propeller did not develop sufficient thrust to enable an emergency landing to be carried out on Runway 11 at Mehrabad Airport.

The Committee has concluded that this was caused by mishandling of the controls by one or more of the flight crew members since the Committee has not found any evidence of malfunctioning of the right engine or of its propeller.

ICAO Ref: AR/276

PART II

List of Laws and Regulations of the Contracting States containing provisions relating to "Aircraft Accident Investigation or Inquiry"

1. Corrigendum to Aircraft Accident Digest No. 2 - Circular No. 24 AN/21-1952:

UNITED KINGDOM

The Air Navigation Order, 1949 shall read as follows:

1949 March 4	The Air Navigation Order, 1949 (S.I. No. 349), as amended up to 1952: Article 68 - Application of accident regulations to aircraft belonging to or employed in the service of His Majesty.

The Statutory Instruments number of the Civil Aviation (Investigation of Accidents) Regulations, 1951 shall read S.I. No. 1653 instead of S.I. No. 563.

2. Addendum to Part II of the Aircraft Accident Digests Nos: 2 and 3

FRANCE

1953 Jan.	Instruction ministérielle relative à la coordination de l'Information judiciaire et de l'enquête technique et administrative en cas d'accident survenu à un aéronef français ou étranger sur le territoire de la Métropole et les territoires d'outre-mer.

IRELAND

1953 April 27	The Investigation of Accidents (Direction of Formal Investigation) Order, 1953.

UNITED KINGDOM COLONIES
BRITISH GUIANA

1952 Aug. 18	The Air Navigation (Investigation of Accidents) Regulations, No. 19/1952. These Regulations revoke the Air Navigation (Investigation of Accidents) Regulations, 1938.

SOUTHERN RHODESIA

1952	Air Navigation Regulations, 1952: Part 18. - Investigation of Accidents.

PART III

Section 1

PUBLICATIONS AND REPORTS

SENSORY ILLUSIONS

In this paper which won for its author the 1952 Flight Safety Foundation Award, PROSPER COCQUYT, Sabena chief pilot, discusses a possible reason for certain puzzling aircraft accidents broadly classified as "pilot's error".

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Enormous progress has been made in the field of aviation safety. The results are particularly evident in the services of scheduled airlines. This has been accomplished through the amazing developments of science and industry, by the considerable, but little known, efforts of the ICAO and IATA in the field of commercial aviation and, last but not least, as a product of the experience of all those engaged in operating aircraft.

Despite this progress, accidents due to navigation and piloting errors are still occurring. After an accident the board of inquiry is often confronted with a difficult task and is at times unable to ascertain the actual causes; in such cases the conclusion is usually reached that the accident is due to an error of judgment on the part of the pilot, and even when the pilot survives he is, in most cases, unable to offer a valid explanation.

More than 30 years of personal experience - and study started in 1931 - lead me to the conclusion that the causes of a certain category of flight accidents ought to be sought in a phenomenon still extremely vague for most people concerned with aviation: that is, sensory illusions, and in particular optical illusions. There are a number of psychological works treating the description of sensations and perceptions. I am convinced that a thorough examination of these questions in relation to the piloting of aircraft could reveal the explanation of many flight accidents.

Some Psychological Principles

Lifeis full of illusions; in the majority of cases, human conceptions are purely imaginary. From birth, man, influenced by heredity, faces the outside world through the five senses: feeling, seeing, hearing, tasting and smelling. Each time a man is subjected to a sensory stimulus, an impression is made on him which gradually fades away. All these impressions shape the man and, combined with his hereditary character, form the base of human individuality.

Each new stimulus may set up a vision and give rise to a reaction; however, the resulting action will not be necessarily in direct relation to that quality of the stimulus, but may also be influenced by the state of mind of the affected individual. Effect of sensorial stimuli is normally predominant; however, in many cases, it is the intelligence which will have a predominant bearing on the effects of the visual stimuli.

Figure 1 gives a typical example; this, of course, is merely a few ink lines on a piece of paper. Visual stimuli are always identical; however, according to the state of his mind, the observer can imagine such different objects as a square with two diagonals, a group of four triangles, a pyramid with square base, a pyramidal well with square top, etc., etc. Each of these figures may be imagined with different sizes but only one figure can be seen at a time.

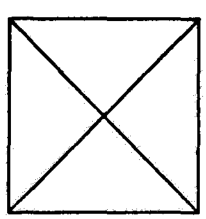


Figure 1

Observation of stars is another obvious example. To the uninformed observer, the stars appear as points of light scattered over a celestial dome. The astronomer on the other hand, sees these same points of light arranged in different planes, and can calculate their position in space, their size and special characteristics.

Another example: three lights emitting the same quantity of light energy are seen simultaneously by the pilot in a normal flight from the same angle of separation. Provided that the pilot's visual organs are perfect, these three lights ought to be seen on a circle passing a vertical plan, the radius of which equals $I = \frac{W}{4\pi}$ when I = intensity of light and W = quantity of light energy. Now a threshold differential of intensity of visual stimuli is imperative for evoking a perception. As a result, in certain circumstances, particularly where there is no previous knowledge of their position, these three lights can be seen on all planes which cut the visual rays (Figure 2).

There is an infinity of illusions. Some are quite impressively and perfectly produced in music-hall shows and conjuring exhibitions.

Some Aspects of Pilots' Psychology

The pilot locates himself in space by observing landmarks outside the aircraft or by observation of applicable instruments. Proper reading of these instruments will give the pilot a correct estimation of the aircraft's position whereas observation of reference points may, under certain circumstances, be quite inadequate.

Here are some examples showing what can happen if the pilot neglects to consult his instruments. Under conditions of poor visibility over an area without landmarks (sea, desert, even ground - more particularly when covered with snow, forest, ect.), the pilot is unable to determine the position of the aircraft with relation to any of the three axes of freedom (Figure 3).

In the case of a flight over an unknown area, it is impossible to determine the position of the aircraft with relation to the yaw axis, whereas the position with respect to the rolling and pitching axes will be readily observed. At night, observation of a remote light provides an accurate sensation of its direction (yaw axis) whereas awareness of the horizontal attitude (rolling and pitching axis) and of height can be non-existent.

In the case of landing on a level surface of water, many accidents have been caused by misjudgment of height; the visual stimuli given by the observation of such a surface do not provide the pilot with adequate information for correct estimation of his relative height. Accidents occurring before reaching an airport which does not possess the appropriate landmarks in the approach sector, belong also to this category. From the above, we may infer that the nature of the visual stimuli must be such that the resulting sensation shall provide the pilot with instantaneous knowledge of his true position.

In the foregoing examples, it is assumed that the pilot is flying at a constant speed and is subject only to the force of gravity. However, in the course of certain flights, he may be subject to accelerations modifying his sensory perception of gravity force. The combined effect of the forces - i.e., gravity and acceleration - could deprive the pilot of any exact knowledge of his position in space and lead him to make errors as great as 180° in both directions, with relation to the three axes of freedom of the aircraft. It will be noted that man has no sense which allows him to discriminate between the relative effects of these two forces.

Fig. 2.

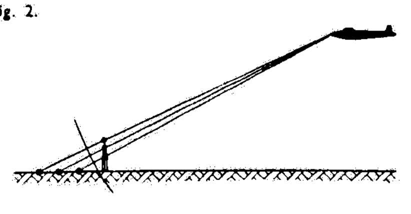
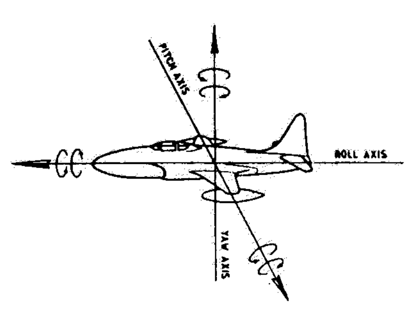


FIG. 3. AIRCRAFT'S AXIS OF FREEDOM



An error of 180° with respect to the yaw axis will lead the pilot in a direction exactly opposite that which he imagines. I have myself seen several cases in which a pilot was completely out of direction. An error of 180° with relation to the rolling or pitching axis will result in inverted flight when the pilot believes his attitude to be normal. Indeed, a roll (rolling axis) or a loop (pitching axis) may eventually develop an acceleration of two g when upside down; the resulting force acting on the pilot's body is thus equal to 1 g and induces the same cenesthetic sensation as a normal horizontal flight. Numbers of errors of this nature were made in the early days of aviation when pilots flew in cloud or in other zero visibility conditions without blind flying instruments.

Nowadays, this type of error still occurs frequently, and is generally due to malfunctioning of flight instruments or to their lack of response to certain abnormal manoeuvres of the aircraft. When flying blind, the pilot is always more or less conscious of his position in respect to the ground. Without the help of his flight instruments, he may have a certain cenesthetic sensation of his position but is unable to determine it accurately. On emerging from cloud under such conditions, the visual stimuli of the ground will normally give the pilot definite indications of his true position. No readjustment is required if the initial imaginary position corresponds to the true position.

On the other hand, if the position as originally envisaged is false, a conflict arises between the initial sensation and the new one set up by the visual stimuli. If the visual stimuli are of such a nature that they eradicate the false impression, the illusion will disappear instantly, but if the stimuli are not sufficient to establish the true position, the illusion may persist.

Here is an illusion which frequently occurs: a pilot has the sensation of flying horizontally, while, in fact, his aircraft is banked. Looking at the ground he sees the houses, the trees and other objects in a position which does not match his imagined horizon. Immediately the visual stimuli of the houses, trees and so on, whose position he knows, induce the sensation of his true position, and the false impression he previously had is instantly eliminated. The duration of the conflict between these two sensations is always extremely short.

Personal Experiences

More than twenty years ago, I realized that optical illusions might be responsible for a number of aviation accidents. On 11 September 1930, an accident occurred to an aircraft of our Company. A tri-motored Fokker VII operating a night mail service with a pilot and flight engineer on board, turned back several minutes after take-off from Croydon, probably because of bad visibility; it crashed on the starboard wing near the airfield and caught fire.

A few months later, on 9 January 1931, a second Fokker bound for Croydon crashed at Melle, on the right of the Ghent-Brussels road, after radioing that the aircraft was returning due to bad visibility. Conditions of the accident were similar but the aircraft did not catch fire. What struck me most was the fact that the flight engineer was found dead with both hands in the pockets of his jacket. This led to the conclusion that the crew had no advance warning and that the accident took place without any reaction on the part of the crew.

This called to mind an incident during a night flight I once made with a pilot I was training on the Croydon-Brussels route. When passing Dungeness, I made a turn to the left around the lighthouse to fly towards Folkestone. I was flying below the clouds at an approximate altitude of 150 metres in light rain and a visibility of 1 to 2 kilometres. After this turn, I met certain difficulties in following the coastline as my aircraft developed a tendency to turn to the right, but I did not attach any importance to this at the time. I descended somewhat to improve my observation when the co-pilot suddenly pulled the stick, shouting that I was flying very low; he could see the reflection of the green navigation light on the sea. I estimated my altitude to be 100 metres approximately, and told him he was mistaken as I had a definite view of the coastline.

In comparing this incident with the two accidents described above, I was convinced that I must have had my aircraft banked to the right and that the co-pilot had made a correct estimation of the height in judging from the reflection of the green light in the water. My estimation of the distance to the coast was correct, but my estimation of the height above the water was completely wrong, as I had indeed the sensation of flying the aircraft in a normal attitude although it was undoubtedly banked to the right. This is the typical optical illusion with respect to the rolling axis (Figure 4).

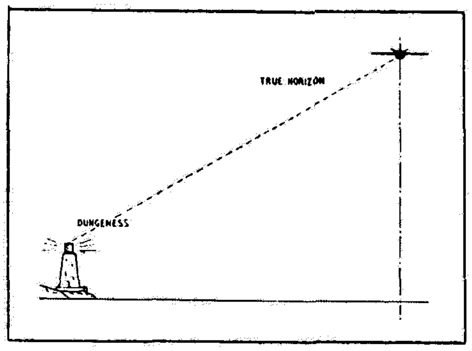
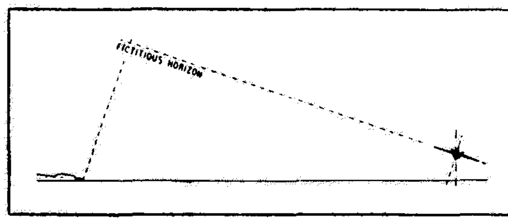


FIG. 4A (left) NORMAL FLIGHT PASSING THE LIGHTHOUSE OF DUNGENESS AND LOOKING LEFT

FIG. 4B (below) FLIGHT ALONG THE COAST AT AN ESTIMATED HEIGHT OF 300 FT.—ILLUSION OF 20° TO THE RIGHT



Another case of optical illusion about the rolling axis was experienced by another crew which, on arriving at Croydon at night in good visibility about 3 to 5/10 low stratus cloud, mistook the lights of Purley for stars (Figure 5).

At about the same period, a similar accident occurred to one of our crews in course of a night flight. After leaving the British coast and flying in good visibility towards the lighthouse of Cape Gris-Nez, the pilot reduced the engine power setting to keep below clouds. The aircraft gradually lost altitude until the trailing antenna struck water. The crew did not realize that the angle of incidence was greater than before throttling back and therefore viewed the lighthouse below its fictitious horizon. The light gave the pilots a wrong sensation of their height, whereas the shock felt whenthe antenna struck the water warned them of their true position (Figure 6).

FIG. 5. 10° ILLUSION TO THE LEFT OF THE ROLL AXIS

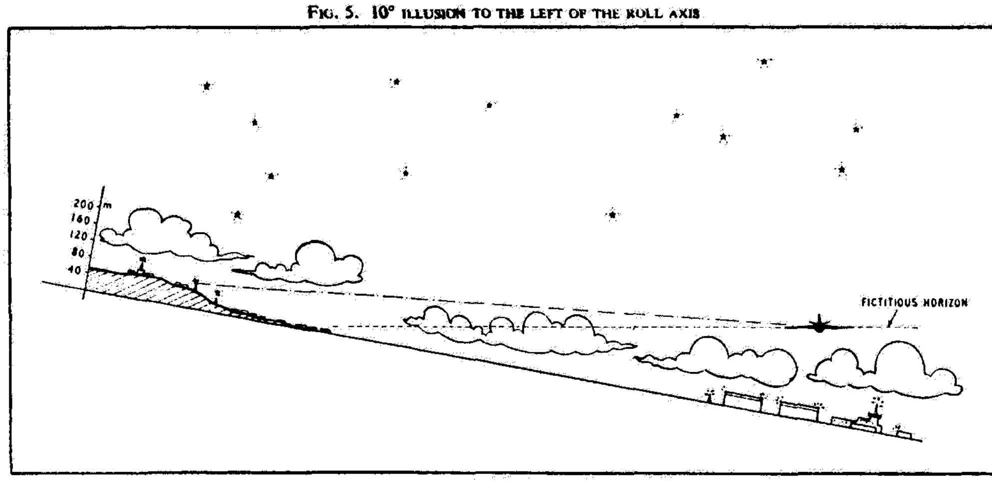
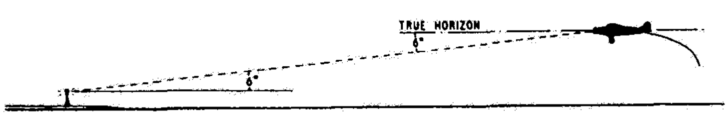
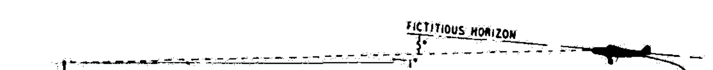


FIG. 6. NORMAL FLIGHT LOOKING AT THE LIGHTHOUSE AT AN ANGLE OF 6° BELOW THE HORIZON



(A)

5° ILLUSION ON THE PITCHING AXIS



(B)

About the same period, I studied approximately ten other night flying accidents. They had one point in common, crashing on the starboard wing after completion of a 180° left turn. Unfortunately, at that time I was unable to find a convincing explanation and my first report in connexion with this problem did not throw any new light on the matter. Since such accidents occurred repeatedly, I was convinced that many of them could have been caused by optical illusions, but I was still unable to prove it. In 1950, I prepared a second report, following a series of commercial aviation accidents. This paper attracted the attention of many aeronautical authorities, particularly after it was translated and published by the "Flight Safety Foundation" in New York.

Later the study of several recent accidents led me in January 1952 to a satisfactory mathematical explanation of the effects of illusions arising in relation to the rolling and pitching axes.

Optical illusions are always created in the course of manoeuvres when the pilot does not follow the sequence of movements of his aircraft; under such conditions, the imagined position differs from the true position. In the foregoing I have already explained how a pilot can make errors as great as 180° in both directions with respect to the three axes of freedom, when he is deprived of the knowledge of his actual position in the space. In controlling his aircraft when unwarned of his true position with relation to the three axes of freedom, the pilot will have wrong reactions which are the potential cause of accidents resulting from illusions. Nevertheless, incorrect estimation of the relative height is chiefly due to illusions about the rolling and pitching axes and is the cause of most commercial aviation accidents.

To give rise to optical illusions, the observed reference points should be presented by objects without relief and located in surroundings without relief. However, flush landmarks, when grouped to create peculiar geometrical figures, may allow proper determination of the horizontal plane.

In observing landmarks the pilot determines his relative height by estimation of the distance D to the landmarks, and the angle α between the direction of observation of the landmarks and his horizon. Angle α is normally positive as the landmarks are usually observed below his horizon; it will, however, be negative if the observed landmarks are located above his horizon. Theoretically angle α may take any value between 0 and $\pm$ 180°. The angle α is always included between the direction of the observed landmarks and the pilot's true horizon. If the estimation of both the distance D and the angle α is correct, the value of the true height H may be expressed by

$$H = D \sin \alpha$$

The true height is proportional to the distance from landmark D and to the sine of the angle α: for a given distance its variation is thus given by a sinusoid (Figure 7). This condition could also be represented by a cone of vision wherefrom the top corresponds to the eye of the pilot and the base coincides with the horizontal ground plane.

When the imagined position is not a reflection of the true position, the landmark is observed at an angle $(\alpha + \theta)$, θ being the angle included between the true and the imagined horizon. This angle may also vary between θ and $\pm$ 180°.

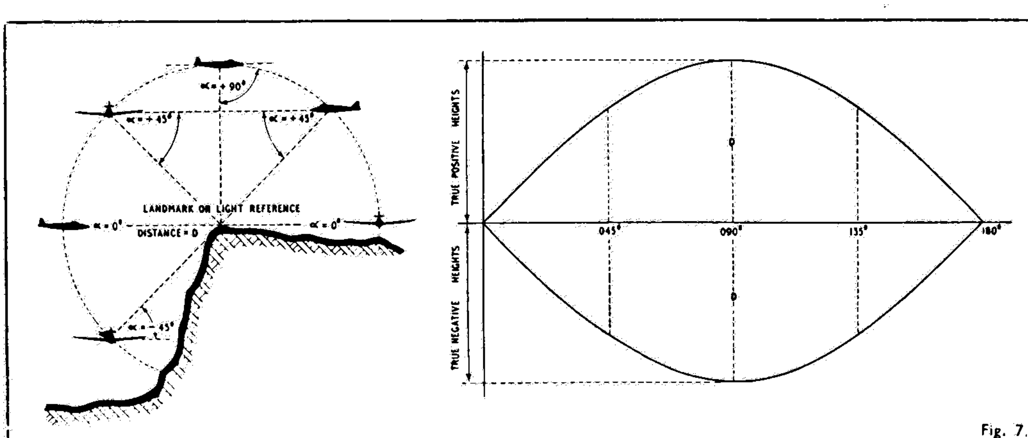


Fig. 7.

The angle θ creates an imaginary height, which is the distance to the imaginary horizontal plane (perpendicular to the imaginary plane). The planes of the imaginary ground necessarily intersect the plane of the actual ground at the observed landmark. A row or a group of landmarks parallel to the direction of the aircraft would result in the same effect as a single landmark.

We know that the produce of the sine by the cosecant of an angle is equal to the radius of the trigonometric circumference; in this case, the radius represents the distance to the landmark. Intersection of the true with the imaginary plane divides the horizon in two equal parts; it may be created in any direction; however, as already stated above, errors due to optical illusions are most likely to occur with relation to the rolling and pitching axes. Effect of illusion is maximum when observation is made perpendicular to, and minimum (zero) when it is made parallel to the intersection of the two planes (Figure 8). In this case the top of the cone of vision always corresponds to the eye of the pilot but the base of the cone is now tilted and interests the true horizontal ground plane on the observed landmarks.

Figure 9 represents the errors in height estimations resulting from optical illusions about rolling and pitching axes with respect to a landmark or a row of landmarks; this figure clearly shows the effects of these illusions. Imaginary heights H' are proportional to distance D of landmark (as the true height) and to sine of angle ($\alpha + \theta$).

$$H' = D \sin (\alpha + \theta)$$

Imaginary heights are positive or negative with respect to the true height of the aircraft, positive heights will be found for a positive angle of 180° - 2α (Figure 10). The ratio of imaginary height H' to the true height may be written:

$$\frac{H'}{H} = \frac{D \sin (\alpha + \theta)}{D \sin \alpha}$$

This expression will take determined value for α values other than θ° and 180°, thus:

$$H' = \frac{H \sin (\alpha + \theta)}{\sin \alpha}$$

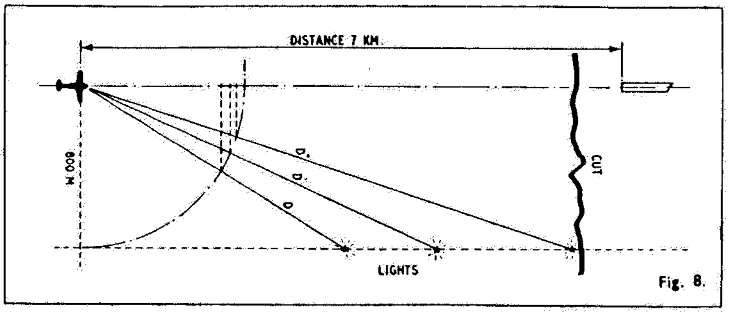


Fig. 8.

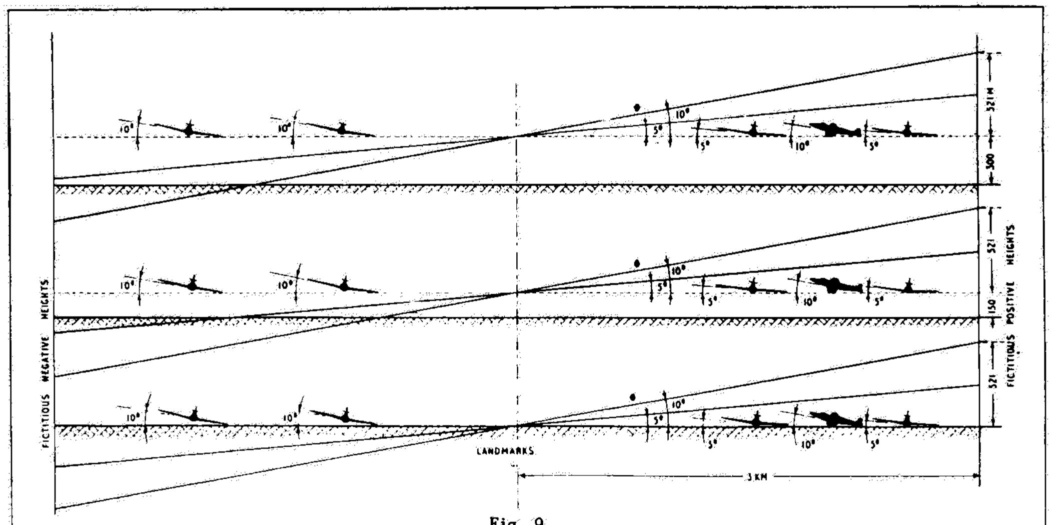


Fig. 9

This shows that usually the maximum effect of positive imaginary height is met when the true height is equal to zero. In this case the positive imaginary height H' = D sin θ (positive). However, for negative true heights, maximum effect will be obtained for α = —90°. Effect of positive imaginary heights decreases proportionally to sine of angle α (positive), this height has already decreased 50% at 30° (Figure 11) and become zero at 90°.

When imaginary heights are positive, the pilot has the sensation of flying higher than his true height. Imaginary ground is above the actual ground beyond the landmarks. Thus, in case of night flight the pilot may see stars below his imaginary ground and mistake them for ground lights. Under these conditions he may also see the runway sloped down. Serious hazard exists if an optical illusion resulting in positive imaginary height arises and persists in course of the landing procedure; for the pilot keeps on with his let down until he reaches the ground and at this point still has the sensation of flying at a height equal to H' = D sin θ. The value of this imaginary height may reach impressive figures even for relatively small angle differences. Thus, for a landmark observed from a distance of 1 km with an illusion angle of 10°, the imaginary height will be 174 metres.

When imaginary heights are negative, the pilot has the sensation of flying lower than he actually is; under these conditions, the imaginary ground is below the actual ground beyond the landmarks and the pilot may see, at night, the ground lights above his imaginary ground and mistake them for stars. He may also see the runway sloped up.

A particular illusion will arise when the pilot believes he is flying above a row of landmarks. True height is then equal to imaginary height H' multiplied by sine of angle of illusion θ, thus distance D will be equal to H' cos θ. (Figure 12).

When a pilot is subject to an optical illusion in relation with the axis of roll and he imagines himself flying in a horizontal position, although he is flying in a rolled position, the following situation may occur:

1) Flying just over a row of lights: α With an angle of roll to the right: In this condition the projection of his vertical plane on the ground (depending on the angle of roll and the height of his aircraft) is on the left side of the row of lights. The pilot's aim is to line up with the row of lights because this is the easiest way to follow a row of lights.

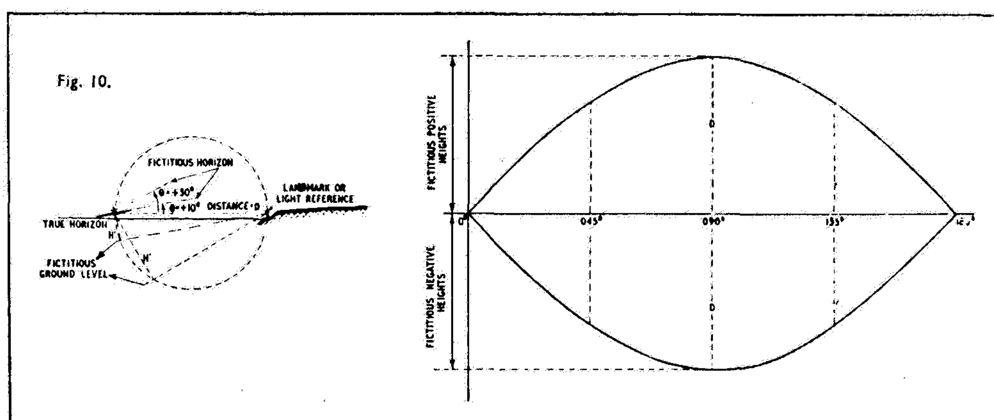


Fig. 10.

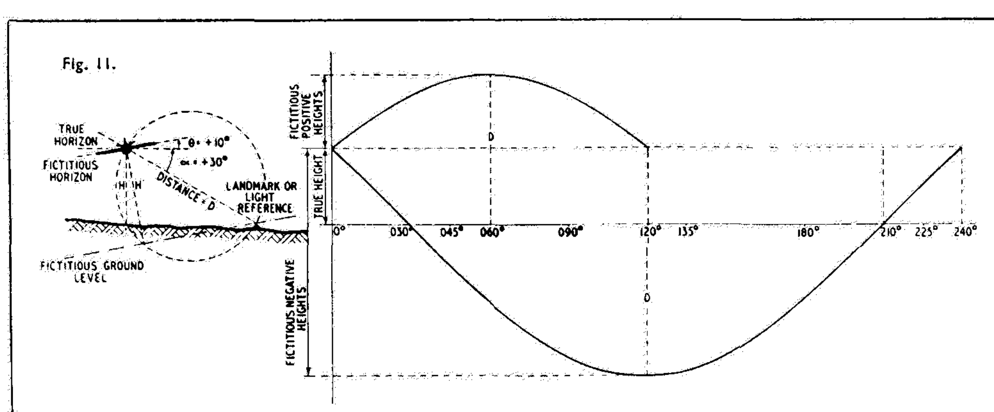


Fig. 11.

By attempting to line up the pilot will steer his aircraft still further to the right and increase the hazardous condition already existing. b) With an angle of roll to the left the same conditions as in a) occur with "right" for "left" and vice versa.

2) Flying on the right side of the row of lights with a right angle of roll: In this condition the pilot cannot determine the part "distance to the right side of the row of lights" and the part "projection of his vertical plane." Three conditions may occur: a) The projection of his vertical plane is to the left side of the row of lights: By attempting to line up the pilot will steer further to the right and increase the hazardous condition already existing; b) The projection of his vertical plane is upon the row of lights: The pilot will not react in this condition but his aircraft will have a tendency to swing to the right. With certain aircraft the pilot may follow the row of lights with the angle of roll by holding the direction with the rudder, but normally the aircraft will swing to the right and the pilot will react by steering to the left. By doing this he will decrease the hazardous condition already existing; c) The projection of his vertical plane is to the right side of the row of lights: By attempting to line up the pilot will steer to the left and decrease the existing hazardous condition.

3) Flying to left side of a row of lights with a left angle of roll: the same conditions as in 2), a), b), c) may occur with "left" for "right" and vice versa.

Apparently optical illusion about the yaw axis could not take place as landmarks cannot possibly be seen in more than one direction. Nevertheless many accidents, mostly navigation errors, resulting from sensory illusions with relation to aircraft path have occurred. In the course of level flight, the aircraft path is determined by movements in relation to the yaw axis. A number of stimuli of various kinds give rise to such illusions. The stimuli do not appear seriously to affect the sensations of position; the pilot's intelligence has an overriding influence on this sensation.

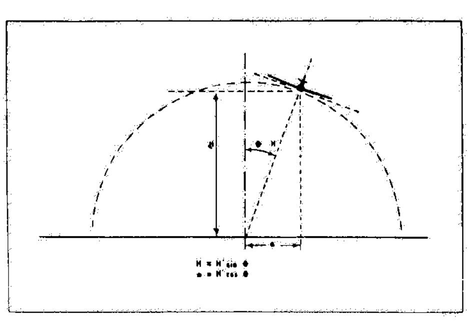
Optical illusions give rise not only to errors in relation to the horizontal plane, i.e., errors in the height estimation but also in relation to the true vertical plane, i.e., in the estimation of the horizontal distance from the landmark. Imaginary horizontal distances may also be determined by a sinusoid; they are proportional to distance D of landmark and to sine of angle $(\alpha + \theta)$. It seems that imaginary horizontal distances are not as hazardous as imaginary heights; nevertheless they also lead the pilot to wrong reactions.

My Conclusions

The human element is always responsible for these accidents. If these could always be foreseen, he would naturally take adequate measures to prevent their occurrence. As far as sensory illusions are concerned, these measures must be generally varied and complex, whereas the optical illusions of the pilot may be eliminated by taking account of a sensation exclusively when it is duplicated by instrument readings.

It is imperative to warn all pilots against such illusions. A good practice for landing which should become compulsory during the visual approach of the pilot is to call out the heights and speeds of the plane by a member of the crew who is keeping a permanent watch on the instruments. To this end it would be necessary to devote more time to the study of the problem and to disseminate reports covering this question. In my opinion however the best means would be to produce a film presenting some illusions of current life, the illusions to which one may be subject in flight, and statistical data of the accidents resulting from these illusions, stressing their importance. I am naturally unable to produce such a film myself and even less able to carry out a thorough study of the human element. The authorities responsible for this task would, in performing it, bring a further contribution to the realm of flight safety.

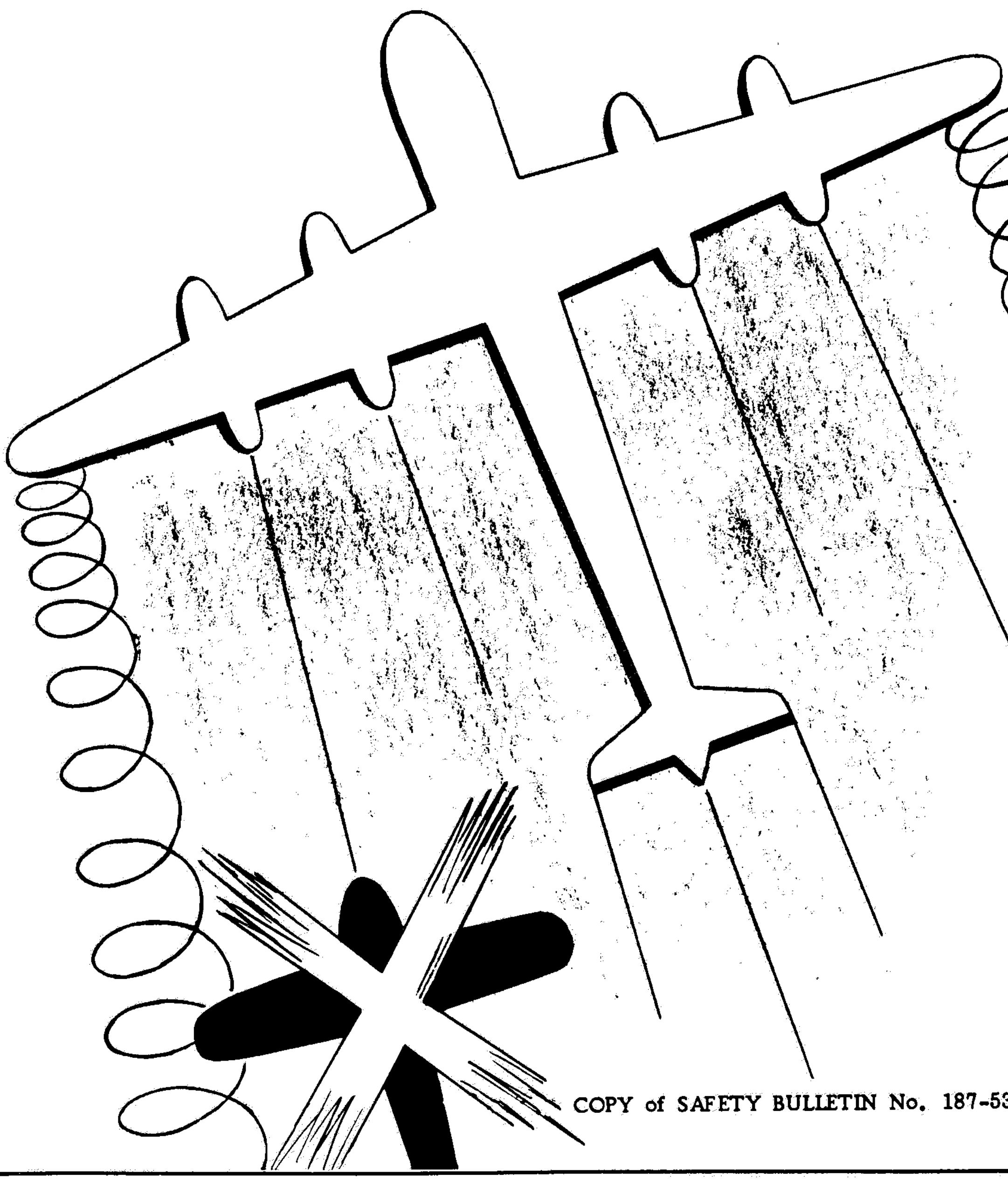
FIG. 12. ILLUSION ABOVE A LINE OF LIGHTS OR LANDMARKS



SECTION 2

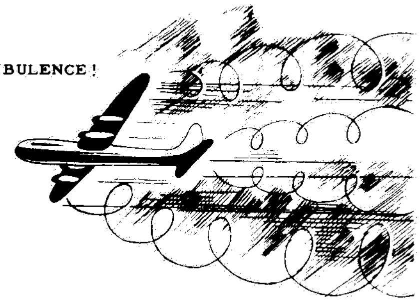
KEEP YOUR DISTANCE

U.S. SAFETY BULLETIN



COPY of SAFETY BULLETIN No. 187-53

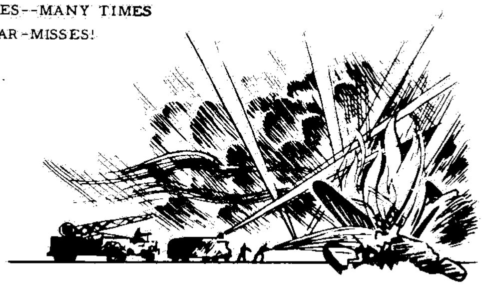
1. YOU CAN'T SEE TURBULENCE!



A MINUTE'S DELAY MAY SAVE YOUR LIFE . . .

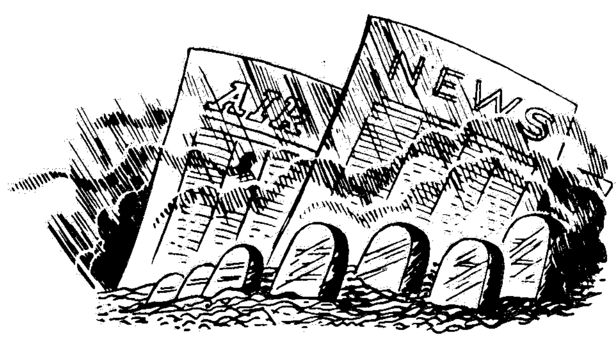
Pilots of small airplanes, or big ones for that matter, should be acutely aware of the turbulence in the wake of large airplanes, particularly when they are taking off or landing. A large airplane roughs up the air behind it tremendously. When this happens in calm air the vortices made by its propellers and wingtips may last locally longer than you think.

2. MANY CRASHES--MANY TIMES AS MANY NEAR-MISSES!



Pilots are generally aware of this danger. Nearly all of us are wary of flying close to the downwind side of hills, buildings or other sizable obstructions that cause turbulence. We should realize also that a greater and more violent disturbance swirls behind big aircraft. This problem has been recognized almost since the birth of powered flight, but a number of recent fatal crashes have brought it into focus.

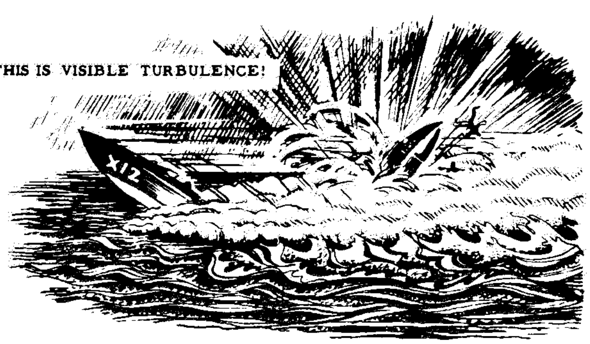
3. THIS SKETCH SPEAKS FOR ITSELF!



THERE HAVE BEEN A NUMBER OF FATAL CRASHES . . .

Light aircraft on final approach have been flipped over and into the ground, and their occupants into eternity, quicker than anyone could say "turbulence". Many light planes caught by this unseen turbulence were saved from a crackup only a few feet above the runway. Pilots have described these near misses as ". . . the wing went straight down with no warning . . . ," or ". . . full opposite control had no effect . . . ," and so on. There have been many similar graphic descriptions; all suggest the action of a cork caught in a maelstrom. Air turbulence is invisible and therein lies its great hazard!

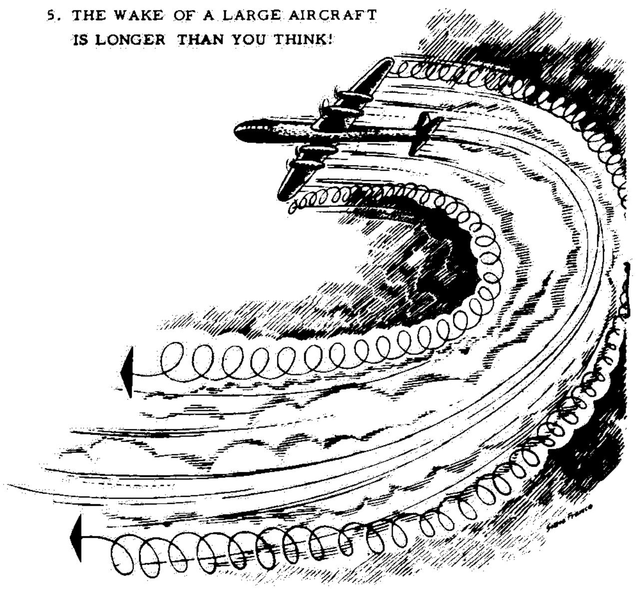
4. THIS IS VISIBLE TURBULENCE!



TURBULENCE IS A GREAT HAZARD . . .

Sometimes there's a tragedy or a near tragedy during a speedboat race when a driver maneuvers his craft too close to the boat ahead. The water behind the racing boat is greatly disturbed. No driver with any sense will get himself in a position where that wake can overturn him. A gold-cup contender of 2 000 horsepower moving at 100 miles per hour makes so much disturbance astern that one might well wonder if most of the power goes into beating up the water or propelling the boat.

5. THE WAKE OF A LARGE AIRCRAFT IS LONGER THAN YOU THINK!



CONSIDER THE BIG AIRPLANE . . .

Now consider the airplane of 8 000 or 10 000 horsepower moving faster than the gold-cup racer. Then consider the relative denseness of air and water. Volume for volume, water weighs about 840 times as much as air. It's easy to picture the magnitude of turbulence of air behind the big airplane if we remember what happens behind the racing boat and multiply that disturbance by 840. Although not holeproof, technically, this comparison may serve to point up the danger - doubly insidious because it can't be seen.

We all remember Cervantes' story of Don Quixote, the Spanish knight who fought windmills, and what happened to him. He and his horse were figuratively slung into the next county. Well, getting your light airplane close behind a large transport when it is landing or taking off is more or less like fighting a windmill. You can't win.

Have you ever held a burning cigarette in the slipstream of an electric fan? Then you know what happens to the smoke streamers even many feet away. The fan is of fractional horsepower - so imagine what happens behind multiengine transports. They approach, unlike light airplanes, with considerable power - and sometimes crowd on more for a short while. How far back can the influence of that several thousand horsepower extend? Compare it with your fractional horsepower electric fan. Or watch what happens when an airplane is warmed up on a field covered with light, dry snow, or with heavy dust on a desert runway. Then your slipstream turbulence can be seen as miniature tornadoes moving horizontally and persistently across the field.

Loop a plane properly and you will run through your own wash at about the bottom of the loop, and feel a series of quick, sharp jolts as you traverse that wash. And the same thing happens in a continuous tight turn where it's possible to stay in your own wash. Try this and convince yourself, but only at safe altitude, please, and with a suitable airplane.

Traffic controllers are trained to bring in air traffic as rapidly as possible consistent with preventing collisions in the air and on runways. Their operating rules are based largely on "sufficient separation". This is a highly elastic term from the turbulence viewpoint. It cannot be quantitative in terms of time or distance because the problem does not lend itself to formula. To prevent the danger of induced turbulence to the plane in back, "separation," therefore, becomes a matter of judgment.

REMEMBER THAT THE LIGHT PLANE GENERALLY APPROACHES AT A MUCH STEEPER ANGLE OF DESCENT THAN THE TRANSPORT AND STARTS ON FINAL APPROACH CLOSER TO THE RUNWAY. THEREFORE THE LIGHT PLANE BEHIND THE TRANSPORT WON'T ENTER ITS WASH UNTIL QUITE LOW - SO LOW THAT CONTROL ONCE LOST MAY NOT BE REGAINED IN TIME TO PREVENT A CRASH.

AND ALSO BEAR IN MIND THAT IF THERE IS ANY CROSS WIND ON THE RUNWAY YOUR BEST PLACE IN A LIGHT PLANE IS ON THE UPWIND SIDE OF THE RUNWAY BECAUSE THE UNSEEN TURBULENCE DRIFTS OFF THE DOWNWIND SIDE.

BUT THE BEST OVERALL ADVICE IS SIMPLE - DON'T GET CLOSE BEHIND ANOTHER PLANE. THE BIGGER THE SHIP AHEAD, THE FARTHER BACK YOU SHOULD BE. IF NECESSARY, ASK THE TOWER TO LET YOU DELAY YOUR APPROACH WITH A WIDE BASE LEG OR REQUEST CLEARANCE TO GO AROUND. EVER NOTICE THAT MILITARY PLANES IN FORMATION NEVER FLY DIRECTLY BEHIND ONE ANOTHER?

WAITING AN EXTRA MINUTE WON'T COST MUCH AND IT CAN SAVE YOUR NECK!

AIRCRAFT REFUELING HOSE TEST PROCEDURE

A Release of the Rubber Manufacturers Association
Technical Committee Mechanical Division

(Reproduced by kind permission of the Flight Safety Foundation Inc.)

The object of the following procedure is to detect weakness in the hose structure assemblies before these weaknesses cause failure in service.

When the hose is subjected to ordinary use, the frequency of hydrostatic tests should be once every 30 days for the first six months. Hose should be tested once a week thereafter. Hose that is subjected to severe usage, for example, regularly dragged over sharp rock surfaces, sharply bent in storage or continually exposed to weather, will deteriorate more rapidly than carefully handled hose. For this hose the weekly test frequency should be used from date of installation. Hose assemblies should also be tested immediately after the hose is subjected to abnormal abuse such as: severe end pull, flattening or crushing by vehicles, or sharp bending or kinking in sub-zero temperatures.

All physical tests should be made with the hose at operating temperatures. An inspection record card should be maintained on each hose describing the hose, manufacturer, type of service and handling conditions, type of storage, date received, purchase order number, and date of installation. The inspection record should be set up to permit the recording of results of the physical tests, and also a record of the total number of gallons pumped at the time of test. Each assembly could be assigned a station serial number which would be stamped on a coupling and would appear on the inspection record card.

TEST PROCEDURE

1. Hose should be subjected to careful visual inspection by those persons who actually handle it in service. Constant visual observation increases the chance of detection of weakness that will develop and cause failure of the hose in service. Hose failures occur from damage to the carcass through crushing, end pull, hose abrading causing a weakened carcass structure; weathering, and various other abuse damage. A periodic inspection of a visual nature is not considered sufficient, but carcass damage or coupling slippage can be observed. Personnel handling the hose should feel the hose for the first six inches immediately behind each coupling to check for a structure weakness, as this section of hose will usually fail first. Soft spots are easily detected by feel and pressing the hose.

2. Check the static wire bond for electrical conductivity with one 12-volt battery and a lamp of proper size. The hose assembly, with the wires attached to the coupling, is a conductor of the electrical circuit. Before the test, touch the leads together and note the brilliance of the lamp. When the leads are applied to the coupling and the lamp lights as brightly as before, the ground may be considered satisfactory. A broken ground wire is indicated when the light does not light or burns dimly.

3. Connect the hose to a hydrostatic test pump capable of producing 500 psi. Fit the opposite end of the hose with a cap having a small air bleeder valve. Be sure that all connections are tight and then introduce water into the hose (at main pressure) through the pump end. At the same time, elevate the capped end, with the vent valve open to bleed off air. When the hose is full of water, and all the air is eliminated (which will be indicated by a solid stream of water from the vent) close the vent valve.

4. Place hose in a straight line position and perform the following pressure test: Hose that has been in service will be subjected to hydrostatic pressure equal to 150% of the maximum working pressure as recommended by the hose manufacturer.

Raise the pressure in the hose to the proper pressure with the pump and check for leaks in the system. If the coupling leaks, release pressure, tighten the coupling clamps and again bring the pressure up as indicated above and hold for one minute. Test for static conductivity at the beginning and end of the pressure hold. Examine hose for leaks especially near the couplings and record the results. Retire for repair or replacement any length showing leakage of any amount.

5. While hose remains in a straight line position open the valve at one end of the hose and apply water pressure equal to the maximum working pressure of the hose. Open and close the valve a half dozen times to create surge pressures and observe behavior of the hose during this operation. Check for leaks at the couplings and check for static bend.

6. Coil the 1" I.D., 1-1/4" I.D. and 1-1/2" I.D. size hose into a circle approximately 18 inches in diameter. Coil the 2" I.D., 2-1/2" I.D., and 3" I.D. size hose into a circle approximately 34 inches in diameter. Apply water pressure at a rate not to exceed 1000 psi per minute and raise pressure to the maximum working pressure as recommended by the hose manufacturer. Inspect for leaks in the hose body after a five-minute hold at this pressure. Test for static conductivity at the end of the pressure hold.

7. Release pressure from the hose; drain off all water and remove test fixtures. Upon successful completion of these tests, the hose is considered satisfactory for further service. Complete the inspection record card indicating disposition of the hose, either to discard or return to service.

8. Hose that is to be returned to service should be internally washed with methanol to remove moisture.

September 25, 1953

IDENTIFICATION OF VICTIMS OF AIRCRAFT ACCIDENTS

(The following procedures for the identification of victims of aircraft accidents, agreed upon by the International Criminal Police Commission and the International Civil Aviation Organization, will be incorporated in the Third Edition of the Aircraft Accident Investigation Manual, Doc 6920-AN/855)

Rescuers and accident investigators must be made aware of the importance of taking all practical steps to facilitate identification of victims of aircraft accidents.

Identification is of great importance for permitting the issuance of a certificate of death necessary, in some States, to avoid serious legal consequences and complications for next of kin of a missing person. It is particularly important in accidents occurring in the territories of States different from that in which the victim's permanent residence is located.

Due to influence of climatic conditions, possibilities of dispersal of personal property and fading of evidence, it is essential that adequate steps for ensuring preservation of clues for identification be taken as early as possible from the beginning of the investigation.

The following procedures are based on recommendations by the International Criminal Police Commission and should be applied to any accident occurring to an aircraft on the territory of a State other than that to which the aircraft belongs. They will be applied as soon as possible and to the extent practicable under prevailing conditions and co-ordinated with the procedures recommended in the present Chapter of this Manual under "Examination of victims", "Medical Examination", "Causes of death and injuries sustained".

a) The bodies of victims should be placed in temporary coffins or such other adequate containers as might be available. Labels should be attached to articles and articles scattered around the bodies should be listed and kept for identification;

b) the bodies of victims should not be dispersed but brought together by the quickest means possible in a specialized establishment or, in the absence of such establishment, in the best suitable place capable of conserving them;

c) the bodies should be photographed. Their fingerprints should be taken. The description of each body and its special peculiarities (scars, moles, wen, teeth, etc.) should be registered on an identification notice;

d) in the case where there is no possible doubt as to the identity of the body, it may be buried. If, on the contrary, a doubt exists regarding the identity of the victim, or if other bodies have not been identified, the body may be temporarily buried and the families will be invited by the quickest possible means to furnish precise elements of identification to the chief of the Service responsible for the identification of the bodies. To that end, the families will have to fill in a questionnaire put at their disposal by the National Authorities or the carriers;

e) after identification of all the bodies, the latter should be sent back to the families. An identification notice, signed by the specialist who carried out the identification or a death certificate should be sent to the family.

Section 3

Around the World

Fascination

The Aero Medical Association Meeting held recently in Los Angeles dealt with the problem of "fascination", currently believed to be responsible for more than one unexplained crash. This is defined as "a state of narrowed attention associated with excess concentration on some object or task with resulting loss of voluntary control over response". A ground target, for instance, toward which a fighter pilot is diving may "fascinate" him and cause him to forget to "pull out". Or concentration on an engine difficulty, or on an approach altitude, may obliterate from the pilot's consciousness the warning blast of a landing gear klaxon -- and result in a belly landing. To circumvent these and other "fascination" errors, medical scientists pointed out that lives might be saved if they can devise a cockpit device which can blast loose a pilot's concentration on any "idée fixe" or an all-too-specific flight function at a critical moment.

Acoustic Wall

The British have been experimenting for some time with an acoustic wall at London Airport approximately 40 feet high and of U shape enclosing the forward portion of an aircraft. While the results are not complete, they indicate a sound attenuation of 25 decibels at 1 000 feet directly ahead of the aircraft and greater attenuation in other directions and at longer distances. The majority of the tests were made with a Viking twin-engined aircraft, although one test was made with the Comet. The results on the Comet were substantially equivalent to those obtained with the Viking aircraft, particularly on the higher frequencies. Tests are being continued and a more complete report should be available in the near future.

Operational Analysis

Dr. C.C. Furnas, Director of Cornell Aeronautical Laboratory, recently stated that "It is time to begin looking at the whole field of aircraft safety from the operations, or systems-analysis point of view. If it is thoroughly studied in that frame of reference, I am sure that illuminating and beneficial results will be forthcoming which can permanently turn the curve of aircraft accidents downward again". Cornell Laboratory is working on a program of operational analysis and has chosen the ILS approach and landing as the first point of attack. Results will not be available for some time, but should be of genuine value to the designer and operator.

Air Safety Digest, July 1953

Two Bottles of Beer = 22% Less Efficient

Brief excerpts on alcohol from Ross McFarland's "Human Factors in Air Transportation", McGraw-Hill. Its impartial analysis of the effects of alcohol and smoking on physical fitness is one of many safety items.

"If small quantities of alcohol are taken before meals, an increased appetite may result because of irritation of the mucous membranes in the mouth and digestive tract. The amount of hydrochloric acid in the gastric secretions is markedly elevated, accounting for the deleterious effects of alcohol on ulcers.

The Psychological Effects of Alcohol. The effects of alcohol on behavior can be understood best in terms of its influence on the central nervous system, especially the brain. Contrary to popular belief, its action on the nervous tissue is that of a depressant rather than a stimulant. After taking alcohol, a great majority of subjects manifest poorer performance in muscular skill, sensory acuity, memory and other measurable psychological functions.

The impairment of motor functions is attributed not to the direct effect of alcohol on the muscles but rather to their nervous control. Muscular reflexes such as the knee jerk and the protective eyelid reflex, show a decrease in speed and strength after only about 1 ounce of alcohol. Movements of the eye while reading or fixating on an object show significant variations in efficiency, averaging 21 per cent of the normal values after 1-1/2 pint of beer or one to two ordinary cocktails.

Sensory Effects. The influence of alcohol on sensory functions varies considerably from one function to another. The constriction of the visual fields is very pronounced and might impair a pilot in watching for planes in the periphery of his field of view. This phenomenon is clearly demonstrated when an intoxicated driver fails to see a car suddenly appearing from a side street. A pilot's ability to see at night or at low levels of illumination is adversely influenced by alcohol. One study revealed that, after ingestion of 180 cu. cm. of alcohol, there was such an impairment of the sensitivity of the eye that a light had to be twice as bright as originally in order to be seen.

In one experiment, telegraph operators receiving coded messages were found to be 22 per cent less efficient after the ingestion of two bottles of beer and 56 to 72 per cent after three to four bottles.

Obviously, a pilot who is under the influence of alcohol would be at a great disadvantage in remembering to check his instruments, in making complicated decisions, or in carrying out many other duties while flying modern high-speed aircraft. In aviation, there is not only the influence of alcohol alone to be considered but also the way in which altitude may accentuate these reactions.

Altitude Effects. Thus if an airman ascends to even a moderate altitude with alcohol in his blood, he would be especially vulnerable to the effects. For example, the alcohol in two or three cocktails would have the physiological action of four or five drinks at altitudes of approximately 10 000 to 12 000 feet.

In studies of problem cases among airline flight personnel, excessive drinking was often found to be related to personal or social maladjustment or to apprehension about flying."

Note: A jigger equals 1-1/2 ounces or 44.36 cu. cm. Two bottles of beer contain about 1 ounce of alcohol.

Flight Safety
Accident Prevention Bulletin 53-16

Landings in Wet Weather

Several times every year an air transport runs out of runway landing in rain. The pilot blames the brakes. The brakes check out satisfactorily. A possible explanation of this rather common occurrence follows, along with other comments.

In a typical case:

"1. a) The captain consciously maintained more than average speed to contact at nearly 100 mph I.A.S.

b) A wind shift noted by the weather bureau immediately after the accident gave the plane a 9 mph wind from the west. (The aircraft landed toward the SE.)

c) The contact point was established by back tracking the wheel marks. The contact point was in an area of many such marks. It was one of the long taper type.

2. Near the far (SE) end of the runway the wheel tracks veered slightly to the left but did not reach the runway's edge. Coincident with the start of this curve in the track the tail wheel track became visible. It swung over to within 5 feet of the right wheel track.

3. The investigator examined the wheel tracks of several aircraft, tracks which were made during unsuccessful efforts to stop within airport, or runway limits. In several cases those sets of tracks differed from other wheel tracks in the same area. In each of these several cases the overshoot occurred on a drenched runway, in each case the tracks were visible for days, even weeks after the accident occurred. Similar characteristics were noted on concrete runway and on black top in Illinois, Georgia and other States. The tracks made during the landing roll now under investigation are the only example I saw in which they could be traced clear back to initial impact marks that appeared to be connected with them.

A careful visual study of the wheel marks made by the flight disclosed that they consisted of a dusting of loosely attached sandy material, decidedly lighter in color than the runway surface. Rubbing with the fingers removed this loose sandy material and restored the original appearance to the runway surface. Except for these particular wheel tracks the entire runway surface was free from any sand or dust.

The runways at this airport seem to be made up of light coloured sand plus quartz or granite gravel plus a binder of asphalt-like material. It appears, therefore, that a localized washing by turbulent water under high pressure could remove most of the binding material from particles of sand at the surface. If the passage of a tire over the surface under certain conditions of water flooding produced such pressure and turbulence, it could produce the wheel marks observed. It seems reasonable to suppose, that aircraft wheels (rolling or locked) can, and sometimes do hydroplane over a film of water on a paved runway which is in a drenched condition. Such hydroplaning could conceivably cause the washing mentioned above. The same conditions, high water pressure and turbulence, could account for tracks of exactly similar appearance made on concrete by aircraft in the act of overrunning the runway. In this case accumulated discoloration caused by age and traffic could be washed from the porous surface of the concrete. This would duplicate the appearance of the above described track in everything except the loosely attached particles of sand. If this could be established definitely by test data, the white appearing wheel marks noted in this and other cases could be considered conclusive evidence that the tires were hydroplaning and that the brakes were ineffective even though they may be found to be in perfect mechanical condition.

Test data might produce knowledge which would permit hydroplaning to be anticipated. Conceivably, hydroplaning might be possible only when some particular relationship exists, such as some definite ratio of tire air pressure to total load, or of speed to depth of water film, etc. It should be noted that once this hydroplaning starts, it continues until the movement stops or the conditions (other than speed) change, as when the wheel leaves the pavement. This seems to indicate that speed itself is not the controlling condition.

Accidents such as this one have caused the loss of many lives and of many aircraft which are very valuable at present. Reducing these losses should be ample repayment for the cost of a lot of research work."

Comments:

1. New techniques for landing on wet runways are under development, especially in regard to use of control wheel for applying load on main gear.

2. The tendency to land too far down the runway can be counteracted by better marking of the threshold.

3. The amber coloured lights which are used to indicate the last 1 500 feet of the runway should be more distinctive than they are now.

Flight Safety
Accident Prevention Bulletin 53-15

Automatic Lights for Night Crashes

A crash at night carries with it the problem of adequate illumination of exits, aisles, emergency equipment to facilitate escape. For example: "The left wing struck a snow bank, causing the plane to skid into the piled snow in nose down position. Right main gear collapsed, fuel tanks ruptured and fire broke out around right wing. Emergency exits and equipment could not be located in the darkness". (Fortunately only five passengers were injured, 25 uninjured). There have been cases where the only illumination was provided by the gasoline fire!

Several airlines have installed inertia operated switches which turn the lights on by deceleration. The electrical circuits should be independent of the usual sources of current and should be protected against disruption in a crash. The independent battery for these lights should also be in a protected location, held firmly against high G loads (at least 10). It should also be installed high in the ship to be above the water line in a ditching (land-operated planes are vulnerable to ditching at many airports adjacent to bodies of water).

Flight Safety
Accident Prevention Bulletin 53-5

Accident Investigation and Reports

Oswald Ryan, Chairman of the Civil Aeronautics Board, in a statement on 18 March 1953 before the Committee on Interstate and Foreign Commerce of the U.S. House of Representatives, said:

> "The Board's findings and its reports as to the causes of large air carrier crashes, because of the widespread interest connected with them, are published and distributed to the public, the press, and the industry the moment our findings are concluded. There is no mystery as to the cause of practically all air carrier accidents in the history of the Board. Indeed, I am pleased to report to the Congress that since 1938, we have investigated 722 air carrier crashes, both fatal and non-fatal, and only 26 of these accident cases remain unsolved, or 3.5 per cent ..... On the basis of these investigations, actions are taken by the parties primarily concerned with the causes of the accidents. Design modifications are accomplished if needed, new training of personnel is accomplished, or new rules and regulations promulgated to eliminate the future accidents of this kind ..."

Safety Digest

Loss of DC-6B

An explosion apparently caused the crash of a Transocean Air Lines DC-6B 11 July, scattering parts of the transport and bodies of 50 passengers and 8 crew members over a wide area 350 miles east of Wake Island, a Naval rescue ship reported last week. Navy ordered a sea-air search discontinued four days after the crash when the rescue ship Barrett, which had picked up 14 bodies from shark-infested waters, radioed that there was "no possible chance of finding survivors alive".

News Digest
20 July 1953

Collision over Indiana

New York, 27 August - Two aircraft flying at 11 000 feet over Indiana last night touched each other but landed safely. Both aircraft were damaged but the 51 passengers and 6 crew in them were unhurt. The aircraft, both twin-engined Convairs, left Chicago about a minute apart. One, belonging to American Airlines, was travelling to Detroit, the other, owned by United Air Lines, Inc., was heading for Cleveland. The United Air Lines aircraft was punctured on top of the fuselage between the pilot's cabin and the passenger space. The aircraft belonging to American Airlines had a hole 3 feet long in its tail section. The United Air Lines aircraft made an emergency landing at South Bend, Indiana, and the other aircraft returned to Chicago. - "The Daily Telegraph and Morning Post".

Lloyd's Weekly Casualty Reports, 1 September 1953

Loss of Air France Constellation

Barcelonnette, 2 September - Forty-two people were killed when an Air France aircraft on its way from Paris to Hong Kong crashed late last night and burst into flames on Mont Cemet, in the French Alps. Air France announced in Paris today that all the 42 people on board the four-engined Constellation had lost their lives. Rescue columns of French Alpine troops reached the wreckage, smouldering 9 750 feet up the mountains, after a five-hour climb. They signalled by radio that they had found no survivors. The aircraft, which crashed shortly before landing at Nice Airport, carried 33 passengers and a crew of 9. The aircraft crashed into the rocky Alpine mountain side near the Col des Cayolles, near the summit of Mont Cemet, about 140 miles north-east of Nice. The crash occurred at 2233. Five minutes before the pilot had told the Aix-en-Provence control tower that everything was all right and that he was planning to land at Nice as scheduled.

Lloyd's Weekly Casualty Reports, 8 September 1953

Turkish Airliner Crashes - Four Dead

Ankara, 25 September (BUP) -A Turkish DC-3 airliner crashed when taking off for Van in south-eastern Turkey.

Three crew members and one passenger were killed. Seven were seriously injured and two others suffered lesser injuries. The stewardess, Miss Maria Cazyudyo, was praised for her action in saving, single-handed, eight of those on board.

BUP and AFP

An Air France Constellation on the Paris-Teheran run was reported to have force-landed on or beside the south coast of Anatolia. Messages had been sent from the Constellation to say that the two port engines had stopped and that a landing was to be made on the sea. Four of the 41 occupants were killed.

The Aeroplane - 7 August 1953

Crash near Albany, New York

Albany, N.Y., September 16 - An American Airlines' Convair crashed, exploded and burst into flames near the Albany Airport today, killing all 28 people on board. The Convair, flying from Boston to Chicago, crashed into a small field near the Albany-Schenectady highway, about three and a half miles from the airport. The cause of the crash is not yet known. Witnesses said the 'plane struck the central tower of a radio station, but this was not officially confirmed. The 'plane had been circling for 15 minutes waiting for clearance from the airport's control tower. Fog cloaked the runway. Firemen extinguished the blaze which spread to a nearby shed. - Reuter.

Lloyd's Weekly Casualty Reports, 22 September 1953

Crash near Rhein-Main Airport, Germany

Frankfurt, Germany, 14 October 1953 - A Belgian Sabena Airlines Convair crashed near Rhein-Main Airport today, killing all 40 passengers and 4 crew. The Convair had come from Salzburg, Austria, and was taking off for Brussels.

The plane took off normally, and, after gaining an altitude of 100-200 feet, its engines appeared to fail; it faltered and plunged into thick woods near the airport and burst into flames.

An airport employee who saw the crash, stated that he saw the plane picking up until it was half-way down the runway. He then noted that one motor seemed to have slowed down; the pilot kept going and the engine picked up and lifted the plane off the ground at the end of the runway. When the plane was about half a mile beyond the end of the runway, it dipped and dropped from sight. It went almost vertically downwards. The witness declares that he then saw "a burst of flames from the forest and a huge column of smoke".

United States Air Force and German fire brigades found the fire burning fiercely; the fire was extinguished by them.

Montreal Daily Star, 14 October 1953

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United Kingdom Experiment. Ministry of Civil Aviation, Information Circular No. 97/1953

London Control Area: Special Experimental IFR/VFR Procedures

1. A Working Party set up by the Ministry of Civil Aviation has recently concluded a study of the problem of near misses between civil aircraft in marginal IFR/VFR weather conditions. The Working Party consisted of representatives of the airlines, pilots and operators associations and the Ministry of Civil Aviation.

2. The main factors giving rise to complaints of near misses were found to be as follows:

a) pilots on an IFR flight plan in VFR weather conditions might observe VFR traffic closer than permitted by IFR separation standards;

b) pilots having cancelled an IFR flight plan might encounter weather conditions below VFR limits shortly afterwards;

c) one pilot might consider the weather conditions appropriate to IFR and fly on instruments on an IFR flight plan, while another pilot might consider the same conditions as appropriate to VFR;

d) in certain conditions of light, the visibility observed in one direction might be greater than the VFR limit, while in another direction it might be less; e.g., one aircraft flying into the sun, the other flying away from it.

3. In an effort to reduce the number of near misses between civil aircraft to a minimum it is proposed in the near future to introduce experimental procedures for adoption in the London Control Area* and Zone in line with Recommendation No. 15 of the ICAO 3rd EUM RAN Meeting, the text of which is reproduced below:

> "It is recommended that special local procedures governing VFR flights in control areas or control zones be developed, where traffic congestion and the simultaneous application of instrument flight rules and visual flight rules create situations which justify their application. Such local procedures should cater for all aircraft using the airspaces to which those procedures apply."

4. The procedures have been developed in the knowledge that, during the past two years, there has been a decrease in the number of incidents between civil aircraft coincident with an increasing tendency on the part of pilots to file and remain on IFR flight plans during marginal IFR/VFR weather conditions enabling a more effective control to be applied to civil aircraft.

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* Note: The London Control Area is shown in the United Kingdom "Air Pilot" on page ATC 81.

5. The procedures therefore include a requirement that all civil aircraft flying to or from London, Northolt or Bovingdon Airports should, at all times, file IFR flight plans irrespective of weather conditions and remain in communication with ATC while in the London Control Area and London Control Zone. The additional load which such procedures might place on the ATC system and the communications channels cannot be calculated with accuracy and it is therefore proposed to introduce them for a trial period commencing in September 1953 and ending 15 December 1953 or earlier if necessary. Results of the trial will be reviewed at the end of November 1953. In order to assess this additional load it will be necessary that pilots do not cancel their IFR flight plan while within the London Control Area and London Control Zone but ATC may, at their discretion or on request from the pilot, permit VFR flight for a specified portion of the route.

6. It should be noted that these procedures will apply only in the London Control Area and London Control Zone during this trial period and will not affect the right of a pilot to operate under VFR elsewhere in the United Kingdom.

7. Details of the trials will be promulgated by NOTAM.

(United Kingdom NOTAM)

- END -

ICAO TECHNICAL PUBLICATIONS

The following summary gives the status, and also describes in general terms the contents of the various series of technical publications issued by the International Civil Aviation Organization. It does not include specialized publications that do not fall specifically within one of the series, such as the ICAO Aeronautical Chart Catalogue *or the* Combined Meteorological Tables for International Air Navigation.

INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES are adopted by the Council in accordance with Articles 54, 37 and 90 of the Convention on International Civil Aviation and are designated, for convenience, as Annexes to the Convention. The uniform application by Contracting States of the specifications comprised in the International Standards is recognized as necessary for the safety or regularity of international air navigation while the uniform application of the specifications in the Recommended Practices is regarded as desirable in the interest of safety, regularity or efficiency of international air navigation. Knowledge of any differences between the national regulations or practices of a State and those established by an International Standard is essential to the safety or regularity of international air navigation. In the event of non-compliance with an International Standard, a State has, in fact, an obligation, under Article 38 of the Convention, to notify the Council of any differences. Knowledge of differences from Recommended Practices may also be important for the safety of air navigation and, although the Convention does not impose any obligation with regard thereto, the Council has invited Contracting States to notify such differences in addition to those relating to International Standards.

PROCEDURES FOR AIR NAVIGATION SERVICES (PANS) are approved by the Council for world-wide application. They comprise, for the most part, operating procedures regarded as not yet having attained a sufficient degree of maturity for adoption as International Standards and Recommended Practices, as well as material of a more permanent character which is considered too detailed for incorporation in an Annex, or is susceptible to frequent amendment, for which the processes of the Convention would be too cumbersome. As in the case of Recommended Practices, the Council has invited Contracting States to notify any differences between their national practices and the PANS when the knowledge of such differences is important for the safety of air navigation.

REGIONAL SUPPLEMENTARY PROCEDURES (SUPPS) have a status similar to that of PANS in that they are approved by the Council, but only for application in the respective regions. They are prepared in consolidated form, since certain of the procedures apply to overlapping regions or are common to two or more regions.

The following publications are prepared by authority of the Secretary General in accordance with the principles and policies approved by the Council.

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