# ICAO CIRCULAR

CIRCULAR 31-AN/26

1953

# AIRCRAFT ACCIDENT DIGEST
# NO. 3

*Prepared in the Air Navigation Bureau*
*and published by authority of the Secretary General*

INTERNATIONAL
CIVIL AVIATION
ORGANIZATION
MONTREAL • CANADA

This Publication is issued in English, French and Spanish.

Published in Montreal, Canada, by the
International Civil Aviation Organization.
Correspondence concerning publications
should be addressed to the Secretary General
of ICAO, International Aviation Building,
1080 University Street, Montreal, Canada.

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## FOREWORD

The Accident Investigation Division of the Air Navigation Commission 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 and extremely useful 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 and this is the third issue 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, accident investigation presenting one of the knottiest problems of standardization in international civil aviation for this very reason. 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 salutary effects which the vital intelligence it imparts has had in informing everyone concerned before they have all individually experienced the disastrous possibilities inherent in the various situations explored within its covers, 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 is 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, the intelligence required in order to be useful must 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.

Highlights of this issue are the reports of the three serious accidents which occurred at Elizabeth, N.J., U.S.A. while the aircraft were approaching or taking off from Newark Airport. Although the accidents were unrelated and constituted an unusual coincidence in occurring during so short a period in the same area, the seriousness of this type of accident and the implications arising therefrom cannot be lightly overlooked. In this respect, the President of the United States of America instituted a temporary Airport Commission to look into the problem of airport location and use. An extract from the report of this Commission is included in Part III, Section 1, Page 152. Part III, Section 2, page 166, also contains an article dealing with this series of accidents and includes an examination of the fire aspects.

# PART I

## SUMMARIES OF AIRCRAFT ACCIDENT REPORTS

### No. 1

### Latecoere - 531 F-WANU aircraft, crashed off Cape Ferret, on 28 March 1950.

#### Circumstances

**The aircraft, engaged on a test flight on 28 March 1950 between Point de Grave and Mimizan and carrying 12 crew and observers, crashed into the sea 3 miles off the Atlantic coast when control was lost after the port aileron was torn off. All twelve members lost their lives.**

#### Investigation and Evidence

The test flight was both an acceptance test by the S.E.M.A.F. and a continuation of surface strain measurements on propellers 1 and 4 by the C.E.M.H. At 1730 (local time) the aircraft was flying normally at high altitude in a NNW-SSE direction approximately 3 miles off shore. For no apparent reason, a large, heavy mass became detached from the port wing, the aircraft began to dive and then rapidly went into a spin. The aircraft turned several times in the spin, levelled off but on its back, went into a spin again and crashed into the sea.

A large proportion of the aircraft was recovered and the accident report gives details of its examination. The outer port aileron which was found by chance in the net of a trawler, had characteristic failures which were very carefully examined. All wing connections were broken. The control rod connection with the aileron was intact, but the ball bearing which forms part of the end of the control rod was found on the aileron attachment held by its shaft. This would imply that the end of the control rod broke in the diametrical plane of the ball bearing.

The universal joint connecting the outer and inner ailerons was torn from the inner aileron by shear and bending failure of the joint ring following piercing of the outer spar fitting.

The shear and bending failure of the universal joint ring would appear to indicate that the end of the outer aileron had been pulled backwards and downwards in relation to the inner aileron.

The mobile mounting of the aileron had a shear failure with slight backward bending near the upper surface.

The linkage between the trailing edge spar of the tab of this aileron and the trailing edge spar of the tab of the inner aileron had been folded over backwards and the bracing wire fitting on the trailing edge spar of the tab of the inner aileron had been torn off.

Four ribs of the aileron overhang were broken at the lower surface and a tear in the upper surface skin covering the end rib continued this rib failure.

The failure of the rib flanges did not cause any tear in the fabric.

The condition of the aileron and the fact that it was found a mile to the North of the point where the main wreckage was found indicates that it became separated from the aircraft in flight and its impact with the water was reduced by its "falling leaf" descent since it bore no signs of such impact.

The inquiry considered a number of theories including the possibility of a malicious act involving sabotage, the possibility of a caused or accidental explosion and abnormal vibration causing fatigue. These were fully examined and tests were conducted.

## Probable Cause

The inquiry came to the conclusion that the probable cause of the accident was fatigue failure of the aileron control couplings resulting from the simultaneous occurrence of several vibratory phenomena:

The cruising speed of the propeller with a 7/16 reducing gear in resonance with the critical vibratory frequencies of the wing and the aileron (excitation amplified by the propeller cuffs);

The occurrence of extreme aileron flutter, aerodynamically induced as a result of failure of the linkage between the aileron and the slat.

It was impossible for the crew to detect these phenomena before their results became irreparable.

ICAO Ref: AR/217

## No. 2

## Bristol - 170 F-BENF aircraft, crashed at Tanezrouft Sahara, on 29 July 1950

### Circumstances

The aircraft whilst on a flight from Algiers to Gao crashed at Tanezrouft (Sahara) on 29 July 1950, killing all thirty-two persons on board.

### Investigation and Evidence

The aircraft left Aoulef for Gao at 0242 hours and at 0248 reported its take-off to Aoulef adding "visibility good, climbing to cruising altitude, maintaining watch and keeping contact with Gao and Tessalit". At 0255 the aircraft again called Aoulef reporting that it would call that station again at 0400 hours. No further message was received from the aircraft. It was estimated by stopped watches on victims that the crash occurred at 0410 hours.

The crash was located 50 km to the west of the imperial route linking Adrar to Bidon V, on flat, hard, stony ground suitable for landing even at night with landing lights. This area, known as the Tanezrouft (land of thirst), is complete desert without water holes or any human, animal or vegetable life, with temperatures unbearably high making the task of the rescue unit and investigators particularly difficult.

Parts of the aircraft were scattered over a wide area indicating failure of the aircraft during flight. Three parts were clearly separated from the rest of the wreckage; the main starboard fuel tank, the booster pump and its attachment to the fuel tank.

The centre section of the wing structure lay right side up. It was broken off at the starboard side at the spar fitting connecting the outer wing structure with the central portion. A section of this spar fitting was examined by the Service technique de l'aéronautique and by the manufacturer. No trace of fatigue was discovered, however, they were clear failures. The centre section of the wing was broken off on the starboard side, along the plane of the rib connecting it with the outer wing section.

The centre section of the wing was broken off on the port side in an entirely different manner. The flanges of the front spar remained attached to the central portion of the wing, but the web had disappeared, the rivets which held it to the flange having loosened.

The rear spar, on the other hand, lacked its flanges, but part of the web remained. This type of failure shows that the port wing was subjected to very strong vibrations before its component parts fell off, one after another. The main port fuel tank was in place. Part of the upper surface was dismantled in order to gain access to the booster pump which was found to be intact. The following parts were still attached to the central portion of the wing: the complete left-hand landing gear, the fuselage bulkhead, and the radio equipment.

Outer portions of the wing

The port wing was in two sections. The starboard wing was in one piece. In both cases the ailerons were torn off and were found respectively -

starboard aileron - 100 metres from the starboard wing port aileron - 200 metres from the left part of the wing.

The tail plane

The units of the tail plane were all found together. However, part of the starboard horizontal stabilizer and one unit that could not be accurately identified were found 700 metres from the main parts of the tail plane.

The tail wheel landing gear, the stern post and part of the rear section of the fuselage remained attached to the tail plane assembly.

The right side of the stabilizer bore scratches and tears, probably caused by some part of the wing flying off in flight.

Tail Control Surfaces

The elevator was still attached to the horizontal stabilizer but was almost completely crushed by the impact.

The rudder trim tabs, spring tabs or manually controlled tabs were found either on the control surfaces themselves or nearby.

It was impossible to determine their position at the moment of impact, since they could have been moved by the impact itself and by the failures of the control lines.

The wing flaps were set in the landing position (approximately 15°).

The starboard flap was separated from the larger wing units but had still attached to it several of the plates of the trailing edge of the wing.

The port flap remained attached to the centre section.

Fuselage

Only the flooring, which forms the strongest part of the fuselage, was found more or less intact. The sides of the fuselage came apart, so that the sheeting was scattered about and blown around by the sandstorms which occurred after the accident.

The forward fuselage doors were found 200 metres from the floor. They were bolted at the time of the impact. The upper door of the radio operator's station was found 300 metres from the cockpit. It was also bolted at the time of the crash.

The cockpit was upside down and was crushed by the impact.

Landing Gear

The tail-wheel gear was intact and attached to the tail plane assembly.

The left main landing gear leg was still attached to the centre section of the wing.

The right main landing gear leg was separated from the wing structure and was found 40 metres from the centre section.

None of the three tires had been punctured and they were not much damaged by the impact. There was no sign of abnormal wear to indicate that the aircraft had dragged along the ground.

Power Units

The two power units were found lying about 100 metres from the centre section of the wing.

1) Starboard Power Unit -

Except for one propeller blade which broke off at the impact, all the various parts of this unit were grouped together.

The propeller was in the feathered position. Only one of the two remaining blades was bent, as the engine stopped at the impact.

2) Port Power Unit -

The various units, mounting, engine and propeller were separated.

The propeller pitch was close to the feathered position. The propeller was still windmilling at the time of the impact, which explains the twisting of the blades and their being torn from the shaft. The engine showed signs of a localized fire of which there was no trace on the centre section of the wing.

The engines and propellers could be examined only superficially. The oil and fuel filters were clean. From what could be seen of the cylinders and pistons these showed no indication of seizing nor of any faulty operation.

Controls

As the cockpit was crushed it was impossible to determine with any accuracy the condition of the various controls.

It was impossible to determine whether the automatic pilot was on or off.

The various control levers were found in the following positions:

Contacts: cut
Throttle: cruising position
Fuel supply valves: -
Main starboard tank: closed
Main port tank: open
Change-over: on
Trim tab controls: -
Rudder: +3
Elevator: +1
Aileron: +1 on right side

The two landing lights were extended into the landing position, the starboard light being somewhat more extended than the port light.

The position of the three parts of the wreckage much farther south (500 metres) than the remainder indicated that the damage that had caused the accident occurred near the main starboard tank.

The four fuel tanks (two main and two auxiliary) are located in the compartments formed by the upper surface, the lower surface, the front and rear spars and two ribs. They rest on the lower surface over wooden felt-covered supports and are held in place by steel webbing which is also protected by felt. The handling straps are of braided cotton.

The compartment in which each tank is located has a few small diameter holes in the lower surface to permit release of fuel arising from faulty filling or from leakage from the tank itself. The compartment has no ventilation, however. The electrical circuits which are installed in the compartments (junction box, fuel gage potentiometer, wires) provide a risk of explosion: gaseous mixture formed by gasoline vapour and possibility of spark from the electrical circuits (poor contact, broken wire, etc.).

It was stated that if explosion of a gaseous mixture were to occur between the tank and the sheeting which covers it on the outside, the removable panel for gaining access to the tank, which forms the upper surface, would normally be the first to give. It will be noted that this panel was actually torn off the centre section of the aircraft whereas the other panels suffered relatively little damage.

Without waiting the results of the investigation, the Secrétariat Général à l'Aviation Civile et Commerciale requested the manufacturer to study and make the modifications required to remedy this defect. The modification was made by September 1950.

The manufacturer also sent appropriate technical instructions to other users of this type of aircraft.

Two theories were advanced on the sequence of events leading to the final crash.

Theory I

First phase of the accident

a) Explosion occured in the main starboard tank compartment.

(Such an explosion was possible, as already indicated, owing to the lack of ventilation in the compartment and the presence therein of electric circuits.

Inadequate sealing due to cracking of the fuel tanks had been reported on many occasions. Moreover, during the night refuelling at Aoulef, where the lighting is poor, fuel may have filtered into the compartment and not have completely drained out through the holes in the lower surface of the wing.

Circumstances could therefore have favoured such an explosion).

b) The tank access panel on the upper surface of the wing was partly torn off and, owing to the shock wave, followed by aerodynamic depression, the tank flew out of its position.

(The tank, the booster pump and the cover of the latter were found within a circle 80 metres in diameter located approximately 500 metres from the outer section of the starboard wing.

The manufacturers design office stated that, in the event of an explosion, the upper surface would be the first to give.

The booster pump gear case was crushed by inertia of the liquid at the moment the tank hit the ground.

Note.- No carbon deposit indicating partial combustion was found on the tank or in the compartment.)

c) The aircraft failed to maintain its heading and began a turn to the right. The pilot then took the following action:

i) tried to keep the aircraft on course by operating the tabs, particularly the rudder tab;

ii) cut the starboard engine which was receiving no fuel and feathered its propeller;

iii) closed the valve of the fuel line from the starboard tank to the engine and, possibly not realizing the cause of the damage, switched to cross-feed,

Realizing that it was impossible to continue the flight, the pilot took the action required to make a forced landing. For this purpose he -

i) extended the landing lights;

ii) set the flaps in the landing position.

(It should be noted that the lowering of the flaps might have occurred accidentally during the subsequent failure of the wing structure. However, evidence would seem to discount the possibility of the flaps having been lowered by accident.)

iii) cut the port engine and feathered its propeller.

d) When the main starboard tank flew out, it may have struck the starboard stabilizer which became detached from the tail plane a few moments after the explosion. One of the walls of the starboard tank also flew off.

Second phase of the accident

a) The aircraft lost more and more height and an involuntary turn to the right became sharper. The vibrations caused by the tears on the upper surface of the wing became more marked and were perhaps increased by the lowering of the wing flaps, followed by loss of speed and displacement of the centre of torsion towards the trailing edge.

The vibration caused the outer portion of the starboard wing to break since it had become weaker than the port wing as a result of the damage to the compartment. The failure occurred near the tank where the outer section and centre section of the wing join.

b) The aircraft had now lost the outer starboard section of the wing but was otherwise more or less intact.

The outer section of the port wing then began to disintegrate under the action of the violent vibrations. This part would appear to have fluttered violently before breaking, judging by the appearance of the failure of the centre section.

c) What remained of the aircraft disintegrated at low altitude as a result of the vibration and the excessive centrifugal stresses. The position in which the bodies were found shows that the floor of the fuselage hit the ground in a flat spin.

Theory II

The manufacturer suggested that the accident might have occurred as follows:

> The pilot noticed a smell of gasoline in the cockpit, which was strong enough to affect him. This leak was either from a broken lead or from bad sealing of a joint. As the cockpit was at lower pressure than the wing and the cabin, harmful vapours could penetrate into it. Being unable to stop the leak, the pilot prepared to land and started to operate the flap and landing light controls. Just at that moment, a spark possibly caused by starting an electric motor, caused the aircraft to explode.

This theory confirms that the accident occurred in two stages and explains, to some extent, the way in which the wreckage was scattered.

However, it does not permit any reconstruction of the path of the aircraft nor does it explain the reason why the main starboard tank and the accessories were found quite apart from the remainder of the wreckage.

## Result of the Investigation

The investigation showed that:

Neither the aircraft, the crew, nor the airline were contravening the regulations in force at the time.

The rule requiring radiotelephony contact every half hour was not observed between Aoulef and the scene of the accident.

The compartments in which the fuel tanks were contained were unventilated and they could have exploded owing to the fact that electric cables passed through them.

Probable Cause

The accident was probably caused by an explosion in the wing compartment containing the main starboard fuel tank. This explosion tore off part of the upper wing surface which started a vibration of the wing structure which then caused multiple failures in flight.

ICAO Ref: AR/218

## No. 3

## DC-4 F-BELB aircraft, crashed 15 km. south of Bangui, French Equatorial Africa, on 8 December 1950

### Circumstances

The aircraft en-route Paris - Tananarive and return with intermediate stops, crashed into high ground four minutes after take-off from Bangui aerodrome. Forty-three passengers were killed and seven were injured, three crew were killed and three injured. The aircraft and cargo were totally destroyed by the crash and fire.

### Investigation and Evidence

The aircraft landed at Bangui at 0518 hours on 8 December 1950. This was the first time the crew had used this aerodrome and they were not familiar with the local terrain. Owing to refuelling and other delays it was decided not to leave before 1930 hours, so as to arrive at Dar-es-Salam after day-break, Dar-es-Salam being closed during the night.

The flight plan indicated an eight to twelve hour flight to Dar-es-Salam at 11 500 ft. with Mombassa specified as the alternate. All up weight was 31 457 kg., which was 3 112 kg. below maximum licensed take-off weight.

The pilot was warned verbally by the civil aerodrome manager to "Watch out for the hills" when being briefed regarding the ground run and take-off. The military controller who was also present at the briefing added "Keep a straight course for a while". This was intended to be a warning to avoid the hills in the immediate vicinity of the aerodrome.

To the east of the aerodrome there is a hill with its crest parallel to the runway, while from the north, to the west and south west, the clearances are good. Two ridges of hills (altitude approximately 300 metres) border the Oubangui 10 km South-East of the aerodrome.

The Bangui aerodrome approach chart No. 1125, published on 1 January 1948 by the aeronautical information service of the S.G.A.C.C., provides only limited and incomplete information on the topography of the southern region. The double ridge of hills is not shown. There is only one contour line without elevation, to indicate any change in relief, but it is shifted by about 5 km to the East.

The chart published on 15 February 1950 under No. 1125A is identical as regards relief.

This approach chart was prepared on the basis of official charts of the region, consulted at the local French and Belgian administrative offices. These charts gave very limited information concerning the relief and contained the same omission.

Weather conditions at time of take-off were: horizontal visibility approximately 10 kilometres - no clouds - black, moonless night - calm.

According to statements of the three surviving crew members and witnesses, the flight which lasted about four minutes, may be reconstructed as follows:

Normal take-off after run of 1 200 metres - engines 2 700 rpm - boost 47 inches - flaps at 5° (15° is normally prescribed for take-off). At the end of the runway, or 1 750 metres from the starting point, the aircraft was at an altitude of 30 metres.

Immediately after the retraction of the landing gear, the engines were reduced to 2 550 rpm and boost to 40 inches, which follows the correct procedure. About one minute later the engine speed was further reduced to 2 250 and 35 inches boost, although the correct procedure is to wait until a height above aerodrome level of 600 ft. has been gained. The climb indicator showed a 200 ft. a minute climb at 140 mph indicated air speed. Both the co-pilot and flight engineer noted that this was a low rate of climb for the indicated air speed.

Although the initial intention of the crew was to head towards Libengué (heading 165°) and from that point to turn on a heading for Dar-es-Salam, the pilot-in-command decided to turn and take the heading (120°) without waiting. The altitude at that moment was 500 ft. Two minutes later the aircraft struck some bushes on a hill and crashed catching fire.

The accident occurred some twelve kilometres from the Bangui aerodrome and about 10 degrees to the left of the direction of take-off at an elevation of approximately 280 metres above the runway level.

The inquiry in its study of the theoretical performance of the DC-4 in the configuration of the accident revealed that at the end of 4 minutes flying, the height above aerodrome elevation should have been 1 100 ft. instead of 800 ft.

The inquiry assumed that the pilot, expecting a long night flight over inhospitable terrain wanted to reduce the strain on the engines, and in view of the temperature (surface 24°), had adopted a lower rate of climb than that prescribed in the instructions for the handling of DC-4s.

It is obvious that the moment the pilot decided to make a left turn in order to head for Dar-es-Salam, he was sure that he had cleared all obstructions.

The charts depicting the area contained omissions regarding the relief of the left bank of the Oubangui river. The hills on which the accident took place were not indicated on the aerodrome approach charts, and the crew had therefore no knowledge of their presence.

## Probable Cause

The probable cause of the accident was indicated as ignorance by the crew of the topography of the surrounding area; the adoption of an excessively low rate of climb following a take-off at night in a little known region; and premature change of heading.

ICAO Ref: AR/219

## No. 4

**Northwest Airlines Inc., Martin 202 aircraft N-93054 crashed near Reardan, Washington, 16 January 1951. CAB Accident Investigation Report No. 1-0004. Released 12 March 1952.**

### Circumstances

The flight departed Geiger Field, Spokane for Seattle at 1204 on 16 January 1951 with 7 passengers and a crew of three. At 1208, the flight reported having reached cruising level of 6 000 feet. At 1212 a report that the weather at Wenatchee being below minima was passed to the aircraft. The flight immediately asked clearance to Yakima. At about 1213 while Spokane radio operator was requesting clearance, the flight broadcast an emergency message. There was no further radio contact. At or about 1214 the aircraft crashed about 3 miles west of Reardan, Washington, approximately 20 miles from Geiger Field. All aboard were killed and the aircraft was demolished.

### Investigation and Evidence

The aircraft struck the ground at an altitude of 2 310 feet MSL while on a heading of about 245 degrees true in a nose-down attitude of about 45 degrees and with right wing low. The speed of the aircraft at impact was high as evidenced by the explosive-like violence of the general disintegration and the fact that one air-speed indicator showed about 340 miles per hour. Instrument conditions prevailed during the short flight with low variable ceilings, restricted visibility due to snow, no ice and little turbulence.

A tape recording of the distress message from the aircraft, shortly after a routine message, was subjected to an analysis by the Bell Telephone Laboratories Inc. A graphical method was employed and the middle sentence, which had been interpreted three different ways, was confirmed as being "the wheel has gone nuts."

This phrase suggested that the emergency became known to the crew suddenly and manifested itself in unusual movements of the aileron or elevator controls in the cockpit.

Investigation disclosed that at the time of impact both propellers were in forward pitch position, the left at 29° and the right at 36°. Investigation did not reveal any malfunctioning of either propeller, of either powerplant, of the aircraft's electrical system, or of its hydraulic system.

There was no consistent fire pattern apparent in any of the aircraft's structure, indicating that there was no fire prior to the crash.

The aileron trim tabs were found approximately in the neutral position. The control wheel mechanism was found jammed in a position corresponding to approximately 30-45 degrees to the left of neutral; the rudder trim tab was set eight degrees to the right; however, evidence indicates that the rudder had been deflected between 8-1/2 and 19 degrees to the left. The elevator trim tab was found in approximately the neutral position (formal for cruising); however, the elevator position at the moment of impact could not be ascertained. Gust locks were off, and it was determined that the landing gear and wing flaps were up.

Despite the intensity of effort, nothing was found in any of the wreckage to allow a determination of the initial trouble, which resulted in loss of control and rapid descent to the ground. Many possibilities were thoroughly investigated, however, they were all later discounted. The following portion of this report deals in some detail with these possibilities.*

At the time of the initial failure or malfunction the flight was operating under instrument conditions in snow. However, there was no indication of icing, and there was little or no turbulence. For this reason the Board feels that the state of weather was not a contributing factor to the initial failure or malfunctioning but may conceivably have affected any subsequent recovery of the aircraft from any unusual attitude.

From Geiger Field to the site of the crash there is approximately 20 miles. However, the aircraft flew farther than this as computed from its climbing and cruising speed, the existing wind and the elapsed flight time of about 10 minutes. It should have progressed a distance of approximately two miles beyond the impact site when the initial difficulty developed. It then turned, or was turned, eastward toward Spokane, and from available evidence, crashed within 30 to 90 seconds after the initial trouble manifested itself. The reversal of flight direction is substantiated by persons who heard the aircraft just before it struck. The path of the airplane to the ground cannot be determined positively; it seems likely that the initial trouble was immediately followed by a sudden sharp descent coupled with a reversal of direction accounting for the final high speed and for the build-up in noise.

The circumstances under which the accident occurred, as determined by investigation, dictated the nature of the structural investigation and established certain facts which must necessarily be consistent with any determination of the initial difficulty. The emergency became known to the crew suddenly, as evidenced by a distress call shortly after a routine radio message, and was of such an extreme nature as to result in the aircraft striking the ground at a very high speed within 30 to 90 seconds after the distress call. The phrase in this radio transmission - "the wheel has gone nuts" - suggests that the trouble originated with or manifested itself in unusual movement of the aileron or elevator controls in the cockpit. The fact that the flight was under instrument conditions undoubtedly made it more difficult to maintain or regain control once the trouble had begun. That the aircraft had reached cruising altitude and

*<u>Note</u>.-This portion has been included in detail in this Digest because of its technical interest.

was flying a straight course with little or no turbulence precludes a number of possibilities that might have occurred had the aircraft been climbing, descending, or manoeuvring.

In the belief that it would be of assistance in the search for the cause of the accident, an effort was made early in the investigation to determine the attitude of the aircraft at the moment of contact with the ground. The direction of the accordion pleating of the right outer wing considered in conjunction with the impact gouge and the wreckage distribution at the scene of the accident, indicates that the right wing tip struck the ground first with the aircraft yawed to the left, right wing low and nose down. From the above it was established also that during the disintegration of the right wing on impact with the ground the aircraft pivoted slightly to the right until the nose of the fuselage struck the ground. Almost simultaneously with the break-up of the right wing, much of the right wing fuel ignited with explosive force scattering pieces of the right wing in all directions from the point of impact.

During the investigation at Spokane and later at the Martin factory, the wreckage was carefully examined for evidence of failures or malfunctions that could explain the facts as listed in the previous paragraphs. Many possible causes were considered and checked through by detailed wreckage examination, laboratory tests, etc.

It should be pointed out here that elimination of some of the possibilities as probable causes is restricted to an evaluation of the physical evidence available in the wreckage and does not preclude the possibility of the substantiating evidence either being obliterated or undetectable due to the severely damaged condition of the wreckage.

Possibilities:

A) Fire in Flight

During the early stages of the investigation it was thought that the numerous indications of burning on many of the parts, especially those in the fuselage belly and in the right wing, pointed to the possibility of in-flight fire. This suspicion resulted in building a mock-up of these areas. Careful examination of all pertinent parts of the mock-up, such as wiring bundles, flooring, tubing, structure, etc., failed to disclose any consistent space relationship of burned and unburned parts as would result if there were an extensive fire prior to disintegration. The cabin heater and anti-icing heaters were sectioned, but showed no evidence of burn through. The control cables on the right side of the fuselage showed indications of having been exposed to intense heat but the affected areas formed no consistent pattern and did not match or correspond with other burned areas on adjacent wiring bundles, flooring and structure. In addition, it was established that the amount of burning on the cables was not sufficient to affect the strength of the cable appreciable or to prevent the cable from transmitting pilot forces to the surfaces. The right nacelle showed no evidence of in-flight fire, indicating that the burned condition of the right landing gear, wheels and tires occurred after the landing gear was detached from its supporting structure. Wherever a positive check could be made, the mating of burned pieces of wreckage with adjacent unburned pieces of wreckage proved that the burning occurred after disintegration.

The track of small, light-weight, metal parts discovered along a general heading of 345° from the impact point and a considerable distance away were, at first, believed to indicate a fire in flight inasmuch as most of them were burned. However, in view of the facts that many of these fragments were later identified as coming from areas where adjacent pieces were found to be unburned and that there was a high wind shortly after the accident which would tend to blow light parts from the impact area to the path on which they were found, it is probable that these bits of wreckage were picked up from some of the more intense fires which occurred after the accident by gusts which carried them considerable distances.

Numerous specimens of burned parts were submitted to the Bureau of Standards early in the investigation for chemical analysis to determine sources of combustion. Preliminary examination disclosed no significant evidence, but in the event that any new evidence throws light on the problem, a supplementary analysis with respect to fire in flight will be made.

B) Explosion in Flight

The general absence of recovered and identified material from the right wing lower surface and the fuselage belly area gave rise to the thought that an in-flight explosion might have occurred in either of these areas; resulting in loss of control and ultimately in the accident itself. This possibility was another reason for the reconstruction of these areas for more detailed study.

Although only approximately 20% of the right wing lower skin blanket fragments from Station 187 to the tip were identified, the coverage of the lower surface was fairly uniform. Nothing to indicate that an explosion had occurred was found from a detailed examination of the structure that was pieced together.

The fuselage belly structure was so severely damaged that only a small portion of the structure forward of the wing was identified. Portions of all belly doors were identified, however. Examination of the belly structure identified, and the other items located in the fuselage mock-up, revealed no evidence of an explosion.

If an explosion had occurred in flight, parts or debris from the area involved would have in all probability become separated from the aircraft and would have been found during the extensive search of the surrounding locality. However, no pieces of wreckage other than the track of small, light fragments were found outside the general perimeter of the wreckage at the crash site, further indicating the probability of an explosion in flight.

C) Structural Failure in Flight

No component parts of the airplane, such as the wings, tail, flaps, ailerons, doors, fuselage, etc., were found away from the main wreckage. Places of minimum calculated stress analysis margins of safety in the wing structure were examined carefully for evidence of failure, but in all cases these points were intact while adjacent structure was broken up. The fact that the points of minimum margin of safety in the wing were intact indicates that the wing was not subjected to excessive loads in flight. This same general approach was used on the stabilizer and elevator but these surfaces were so severely damaged, including the points of minimum margin of safety that nothing conclusive could be drawn from the examination. However, it should be pointed out that the stabilizer is overstrength in bending because following the basic design steel straps were added to the chords to increase the rigidity of the surface, thus increasing the strength over the basic requirements. All of the wing spar splices, the inner to outer wing cover splices, the stabilizer to fuselage attachments, and the fin to fuselage attachments, were either intact or showed evidence of impact type of failure. The aft fuselage mock-up was constructed to examine for evidence of wrinkling in the aft fuselage side skin due to high loads on the vertical surface in conjunction with an unsymmetrical loading on the horizontal tail. This condition was critical for the aft fuselage and had wrinkling been found, it would have indicated high vertical tail loadings, but no wrinkling was found.

All of the control surfaces, including the flaps, were examined carefully for evidence of structural failure in flight, but no evidence was found. The tail ramp and all of the fuselage doors were accounted for and the condition of the ramp locks indicated that the ramp was in the closed position at impact. During the investigation it was brought out that Martin had conducted flight tests with the ramp open and no unusual flight characteristics were evident.

Aside from the points enumerated above, it is believed that had structural failure occurred in flight, it is quite probable that the failed portion or some adjacent structure would have become separated from the aircraft before impact and would have been found some distance from the scene. However, as mentioned before, search of the area around the accident scene failed to produce any such portion.

The possibility that one of the tail surfaces, ailerons, or flaps had failed structurally but had hung on to the airplane up to impact was considered, but examination of the structure adjacent to these surfaces revealed no evidence of parts beating against each other as would be the case if this type of failure had occurred.

No fatigue was evident in any of the many fractures. All critical areas in which a fatigue failure would have been catastrophic were covered in the examination.

D) Control System Failure or Malfunction

The crew's message with regard to the wheel and the violent nature of the accident suggested a failure or malfunction in the control system. For this reason intensive studies of all parts of the primary control system and the tab control systems were made. All cable breaks, bracket fractures, rod failures, etc. were examined in detail for evidence of any unusual condition. Various possible causes were considered and the wreckage was carefully examined to verify or discard the theory. No evidence of in-flight failure or malfunction was found.

It was further brought out that since the airplane was in a cruising configuration had any ordinary failure in the system occurred it would not result in such a violent reaction. Even if a cable had parted (no cable fraying was found), the surface would trail. It was established that had the elevator cartridge been sheared from its attachment to the torque tube, the pilot could still fly the airplane by means of the trim tab. If the elevator spring cartridge had failed, the pilot would be able to control the airplane through motion of the spring tab, although in this case the control forces would be greatly reduced. These and many other exploratory considerations were investigated without positive result. Nothing was found in the control system to explain the crew's emergency message. The possibility of control system jamming cannot be discounted entirely even though no evidence of such a condition was found. There must remain the possibility of jamming with the evidence thereof being destroyed.

The possibility of failure of the fabric or binding tape on the rudder (the ailerons and elevators on the Martin 202 are metal covered) of the subject aircraft was considered. Examination of the rudder disclosed that the major portion of the fabric covering had burned following impact; however, small pieces of fabric were found still adhering to structural members and around portions of the trailing edge former of the rudder, the appearance of which indicated that the fabric covering and tape was intact at impact.

E) Flutter

One of the earliest considerations was the possibility of wing or control surface flutter but all checks, including detailed examination of the wreckage for evidence of vibratory loads, proved negative. The hinge bearings of all surfaces were examined for signs of large load reversals but in all cases the bearings were either undamaged or showed only evidence of impact loading. One of the outboard elevator balance weights was not recovered and this suggested the possibility of flutter originating with the elevator. Aside from the fact that the physical evidence showed no evidence of failure due to flutter, a binary flutter analysis made for the condition of both outboard balance weights missing, which is more critical than the condition for a single weight missing, disclosed that the elevator was free from flutter. When the elevator spring tab cartridge was found separated from its attachments, it was thought that this could set up a flutter condition. Checks indicated, however, that with the elevator cartridge completely disconnected there was no tendency for the elevator to flutter.

F) Auto-Pilot

An intensive investigation of the auto-pilot installation was made to determine whether or not malfunctioning of the auto-pilot could be the initiating cause of the accident. The auto-pilot had malfunctioned en route from New York, to Minneapolis on the previous day and was placarded inoperative prior to departure from Minneapolis on the subject flight. At the time of the accident it was placarded inoperative. Since it was not disconnected or otherwise rendered inoperative, consideration was given the possibility that the crew might have engaged it intentionally or unintentionally. It is still possible for the pilot to overpower the servos and maintain control of the aircraft or to turn off the auto-pilot by use of either of two electrical switches, or by disengaging the mechanical clutch. Although it cannot be used as conclusive evidence, the portion of the disengaging controls (mechanical clutch) recovered indicated that the auto-pilot was disengaged at impact. The auto-pilot servo generator unit was opened and no evidence of rotation at impact was found. Further, the forces introduced by the servos into the surfaces are so selected in the design that they will not exceed the design strength or airplane loading. Malfunctioning of the aileron, elevator and rudder controls were all considered and it was found that, of these, only a malfunction in the aileron portion of the auto-pilot could produce a condition consistent with the time interval involved. Even then, a malfunction in the aileron auto-pilot control could only result in a dangerous condition if the pilot did not attempt to regain control or could not achieve control because of inadequate time. No evidence was found that this occurred.

G) Miscellaneous

In addition to the items discussed in previous sections, many other possible causes were considered and probed by intensive study of the wreckage. There had been reports of marginal or inadequate lateral stability of the model aircraft, and this point was explored in some detail. The chief complaint here was associated with aileron ineffectiveness due to ice build-up on the wings. However, the problem only became apparent at the slow speeds of take-off or landing approach. As a result, it appears that this difficulty could not be involved in this accident. In addition, the Martin Company had conducted an elaborate series of flight tests which demonstrated that even with large accumulations of ice on the wings and ailerons or with spoilers placed on the wing in front of the aileron, lateral control could still be maintained in all flight configurations and over a wide range of operating speeds.

Sabotage was considered but nothing was found during the investigation to give credence to this possibility.

The condition of the pilot and co-pilot seat tracks and safety belts indicated that both seats were occupied at the time of impact and that they were in the proper range of positions for effective use of the flight controls by the crew.

The possibility that the crew was incapacitated by an excessive concentration of carbon dioxide could not be checked positively from the condition of $CO_2$ bottles, since all but one were damaged sufficiently by impact forces to be discharged. However, the single bottle with the head still intact was found to be charged, indicating the probability that at least one of the two banks of bottles was not discharged by the crew. Since no evidence of in-flight fire was found by examination of the wreckage there is no reason to believe that either bank was discharged by the crew. The coherence of the crew's last radio transmission tends further to disprove the possibility of incapacitation by carbon dioxide.

Various possible causes of buffeting, such as the loss of an engine cowl, the opening of an access door, etc., were considered. However, fragments of all pieces of the engine cowls were found at the crash site indicating the improbability of buffeting due to the loss of one or more segments. Although it could not be proven that an access door was not open in flight, they are so positioned as to be an unlikely cause of severe tail buffeting if open.

The position of the rudder trim tab screw which was found to correspond to an 8° right tab setting could not be satisfactorily explained. It was felt that this position indicated an effort of the crew to raise the right wing or compensate for an unusual turning moment such as might be produced by an excessive drag on the right wing, but nothing was found despite intensive investigation to disclose any abnormality that would produce wing heaviness or drag.

No evidence was found to substantiate or give credence to any of the many theories with regard to the source of the initial trouble that were considered during the course of the investigation. No evidence of in-flight structural failure, fire, explosion, electrical or hydraulic systems failure or malfunction was found. The facts disclosed by investigation indicate that the initial difficulty, source undetermined, resulted in a loss of control while the airplane was in a cruising configuration. This resulted in a rapid descent at high speed and in the disintegration of the aircraft upon contact with the ground.

## Probable Cause

The probable cause of this accident was a sudden loss of control for reasons unknown, resulting in rapid descent to the ground.

ICAO Ref: AR/182

## No. 5

## DC-4 BBDO aircraft, crashed at Mount-Cameroon (Nigeria), on 3 February 1951

(Note:- The accident, which occurred in British territory, was investigated by France with a British observer present. This procedure is in accordance with Annex 13 of the Convention on International Civil Aviation.)

### Circumstances

The aircraft, en-route from Douala to Niamey with twenty-three passengers and six crew members aboard, crashed into the Cameroon Mountain in the British Cameroons, 12 kilometres north of Bouea and approximately 60 kilometres from Douala. The crash occurred approximately 8,500 feet above sea level. All the passengers and crew were killed and the aircraft totally destroyed.

### Investigation and Evidence

The DC-4 aircraft landed at Douala at 1200 hours and after refuelling, etc., took off at 1408 hours. The route forecast at the time was favourable for the whole route - no disturbances - over high ground the sky cloudy to slightly cloudy with stratocumulus or cumulus with cloud base at medium altitudes. In the Cameroon Mountain area the cloud was more extensive with 3/8 to 5/8 cumulus up to 3,800 metres and cloud base between 300 and 600 metres. Winds S.W. 6-8 knots up to approximately 1 000 metres - ENE, 5 to 10 knots at 2 000 metres and East 10 to 15 knots above 3 000 metres.

There are two departure routes specified for leaving Douala:

Route 1: The northern one, to Kano, leaves Douala and follows a track of 360° (magnetic);

Route 2: The southern route passes along the straits between Cameroon Mountain and Fernando Po Island - 225° (magnetic) - for a distance of 54 km. then turns at right angles taking a 305° (magnetic) heading towards Port Harcourt.

These two routes, particularly the latter one, ensure flight safety by avoiding the higher terrain.

The flight plan indicates that the pilot intended to take Route 2 and planned on a four-hour flight to Niamey at an altitude of 8 500 ft. Witnesses in a following aircraft stated that the DC-4 after take-off proceeded for three or four minutes on the 220° heading and then made a sharp climbing turn to NNW and disappeared into cloud at about 1 000 metres. This heading corresponds roughly to the direct route to Niamey. A witness at Ekona in the British Cameroons, approximately 45 km. from Douala and bearing 300°, saw the DC-4 pass over, still climbing, and clear of clouds, heading straight towards the first edge of the Cameroon range, which was all that could be seen of the range. He followed the flight for approximately 5 minutes and after the aircraft crossed the line of summits, the sound of the engines stopped. The aircraft after crossing, at right angles, a first ridge approximately 2 500 metres in height, found itself facing the mountain, the summit of which rises to more than 3 000 metres directly above the scene of the accident. Marks on the ground indicate that at the time of first impact the aircraft was turning sharply to the left with a bank angle of 45 degrees. It was not possible to determine with certainty what reasons led the pilot to depart from the established procedure and immediately take the en-route heading. It was noted, however, that by taking this new route it was possible to shorten the flight and also avoid a more cloudy area to the south of the mountains.

Estimation of Drift

With zero wind, it is possible, with the heading selected, to fly round the Cameroon range to the North. The wind indicated in the route forecast, although from the SW at ground level, was NE above approximately 1 200 metres and increased to 15 knots above 2 000 metres. Allowing for the fact that winds increase in velocity near mountains, it can be estimated that the wind in that area exceeded 20 knots and that the drift between 2 000 and 3 000 metres would have been about 10° to port. In this area in the prevailing conditions, changes in wind direction of about 180° between different altitudes could be encountered and, unless special care is taken, can cause considerable drift.

Visual Error in Judging the Mountain Area

Since the crew were able to see the mountains it is probable that they did not bother to check their navigation carefully and allowed the aircraft to drift to port, i.e., towards the higher elevations, under the influence of the NE wind.

To a pilot facing the sun, Cameroon Mountain, seen through the mist, is only faintly and partially visible. Furthermore, the clouds which form on the mountain may distort its appearance and hide certain ridges. Seen by an observer approaching from Douala, the Cameroon mountain mass has roughly the appearance of an irregular cone, the left-hand side of which slopes at an angle of 45 degrees, whereas the right-hand slope, which is less steep, extends the crest line towards the North-East. The pilot may have believed he had crossed the first ridge, which was perfectly visible, at a point which left a reasonable margin of altitude, but, being misled by the drift, he may have actually approached at another and higher point further to the West.

Clearing this first obstacle by about 150 metres, thanks to the assistance of a slight air current rising above the mountain, he suddenly saw a second and higher ridge appear before him out of the mist.

It then became obvious to the crew that, not having an adequate rate of climb,,they would not be able to clear this new obstacle. In order to avoid it, the pilot tried a sharp turn to the left where he saw a gap. The aircraft, caught in a downward air current, and not having sufficient room to make a complete 180° turn, was unable to avoid hitting the steeply rising ground with its port wing.

It is probable, moreover, that, by the time the pilot saw the second crest, no diversionary action was possible either to avoid a crash or to limit its effect.

Results of Investigation

The radio aids were functioning and there was a sufficient number of them to ensure accurate navigation. No unfavourable report concerning the quality of their operation was received. The wind was SW up to 1 200 metres, but turned right round to the opposite direction to reach NE 20 knots in the neighbourhood of Cameroon Mountain. The weather was generally favourable with some cloud over the mountains and visibility was reduced by the mist when facing the sun.

The instructions laid down by the airline for its aircraft at Douala covered arrival only. No instructions were laid down for departure.

After having selected the Southern route, the pilot changed his plans and took a route parallel to the Northern exit.

An error was made in judging visually the height of the mountains in the path of the aircraft. This error was due to the weather conditions and to a position error due to an unchecked drift.

The crash occurred when the aircraft was making a sharp turn to the left.

The navigation was not sufficiently accurate although it cannot be stated whether or not the crew did attempt to use the aircraft's radio compass nor whether the information obtained from it was correct.

## Probable Cause

On their own initiative, the crew abandonned the current procedure and followed a different and inaccurate procedure.

The navigation was not sufficiently accurate and the draft was not checked.

Error of judgment and over-confidence when flying over a mountain mass.

ICAO Ref: AR/220

No. 6

United Air Lines, Inc., DC-6 aircraft, N-37543, crashed en route 18 miles W-SW Fort Collins, Colorado on 30 June 1951. CAB Accident Investigation Report No. 1-0050. Released 12 December 1951

Circumstances

The aircraft was en route from Salt Lake City to Fort Collins, Colorado carrying 45 passengers (including 1 infant) and a crew of 5. The approved flight clearance indicated an IFR flight to Denver at 15 000 feet. The flight proceeded in a routine manner and at 0104 reported over Rock Springs, Wyoming, at 15,000 feet, with E.T.A. Cheyenne, Wyoming, 0147 and Denver 0207. At 0147 the flight reported having passed the Silver Crown fan marker (located 12 miles west of Cheyenne) and requested a lower altitude. A new clearance was immediately issued - "ARTC clears United ..... to DuPont intersection, descend to 8 500 feet immediately after passing Cheyenne, maintain 8 500 feet, no delay expected, contact approach control over Dacono" (fan marker located 15 miles N of the DuPont intersection). This clearance was acknowledged and the flight reported that it was over Cheyenne at 0147, at 15,000 feet and was starting to descend. The Denver altimeter setting was then given the flight as being 30.19 inches. Nine minutes later, at 0156 the flight reported reaching its assigned altitude of 8,500 feet.

No further communication was received from the aircraft. At 0200, the Denver Control Tower requested the company radio operator to advise the flight to call approach control. Repeated calls were made without response. It was later determined that the aircraft had crashed on a mountain 18 miles W-SW of Fort Collins, Colorado. All the occupants were killed and the aircraft was demolished.

Investigation and Evidence

Investigation disclosed, from the direction of the swath cut through the trees, that the aircraft struck the side of Crystal Mountain while flying left wing low on an approximate, magnetic heading of 210 degrees. The altitude at the point of impact was 8,540 feet MSL. After initial contact with the trees the aircraft continued to travel approximately sixty feet, at which point it struck the ground. From there it travelled in a straight line 225 feet, bounced and came to rest 465 feet further on. The aircraft was demolished and aircraft parts assemblies were strewn over a 1,400 foot area. Localized fires occurred after impact.

An examination of the wreckage revealed that at the time of impact the landing gear and flaps were retracted. Nothing was found to indicate any structural failure of the aircraft or its components prior to impact. The damaged engines and propellers were examined and these indicated that all 4 engines were developing considerable power when the impact occurred. All engine instruments were so severely damaged that their readings were of no value. A study of the aircraft's maintenance records indicated that the aircraft was airworthy at the commencement of flight. It was also established that the gross weight of the aircraft was within approved limits, and the load was properly distributed with respect to the center of gravity.

Much of the radio navigational equipment and some of the flight instruments were recovered and removed for study and analysis. The resulting investigation indicated that prior to the crash no fire existed in any of the electronic or electrical equipment and that all of the aircraft's communications and navigational equipment was apparently functioning in a normal manner. Conditions of propagation during the times involved were conducive to good radio reception. All ground radio stations in the area were functioning normally, as evidenced by subsequent flight checks and a study of each station's records. The aircraft was heading 210 degrees magnetic, plus or minus a few degrees, at the time of impact.

This last fact was further substantiated by the condition of the directional instruments when recovered. In the cockpit were four heading indication instruments. There were two magnetic or master direction indicators operated by a flux gate compass system, one each for the pilot and co-pilot, these were both jammed at a reading of about 210 degrees. The magnetic compass and the directional gyro were also found to be reading approximately 210 degrees. Furthermore, as a part of the radio navigational equipment there were two ADF (automatic direction finding) receivers. The dual indicator azimuth scale of the co-pilot's ADF must be rotated manually and when used to determine a bearing it is set to agree with the magnetic heading of the aircraft. This instrument was found jammed at a reading of approximately 202 degrees.

On each side of the control pedestal of the DC-6 are panels containing six audio selector toggle switches*. The two switches nearest the captain actuate the voice and range control positions of that pilot's ADF, the two middle switches actuate the same controls on the VHF navigation receiver,

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* As a result of this accident United Air Lines has effected a change in the audio selector panels which contain the six selector switches on all their DC-6 aircraft. This was accomplished by lengthening the middle two toggle switches which select the VAR and other VHF radio navigational receivers, and was done to help avoid any possible mistake by the crew in switch selection.

and the two furthermost from the captain actuate identical controls on the co-pilot's ADF. These switches are so located that they cannot be easily seen by either pilot and when using them at night without the use of lights it is customary to feel for them. All switches are of uniform size and are equally spaced on the panel. Although cockpit lights and a small flashlight are available to the captain, it is normal practice to use a minimum of cockpit lighting to avoid glare.

The magnetic course to Denver from Cheyenne is 168 degrees. The audio signals of the Denver low frequency range for this course are heard as an "A" on the left side and an "N" on the right side. At Denver there is another range, namely a VAR (Visual Aural Range), the north course of which nearly parallels the north course of the low frequency range. The audio signals of this course when flying toward Denver are heard as an "N" on the left or east side, and as "A" on the right or west side. The similarity of the tone of the signals emitted by both ranges makes it difficult to differentiate between them. The identification signal "DEN" is identical for both stations*. The Denver VAR range commissioned on 1 January 1946, has operated for five years in close proximity to the Denver low frequency range and although both ranges have always utilized the same "DEN" identification signal, there have been no known recorded complaints from airmen that difficulty or confusion resulted.

Recorded radio contact disclosed that between Salt Lake City and Cheyenne the flight was flown in accordance with the flight clearance. An exploratory flight was made in a similar type aircraft to determine the credibility of the probable flight path of the subject aircraft between Cheyenne and the scene of the crash. The test flight crossed the Cheyenne range station from the NW at 15 000 feet, and a shallow descending right turn was started toward a heading of 210 degrees magnetic. Two minutes were required to arrive at this heading. Continuing on this heading, a descent of 700 to 1 000 feet per minute was maintained at an indicated air speed of 245 mph. Descent from 15 000 to 8 500 feet MSL required 7 minutes. 4 minutes later the flight arrived over the scene of the accident after climbing slightly to clear the ridge. This time, added to the time the aircraft reported crossing Cheyenne, closely approximates the assumed time of the crash.

On the night of 29/30 June a weak upslope flow of air existed on the east slope of the Rocky Mountains in southeastern Wyoming and northeastern Colorado. This resulted in cloud layers ranging generally from 8 000 to 17 000 feet, with scattered light showers in southeastern Wyoming. No thunderstorms existed nearer than the eastern border of Colorado. There was a solid

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* In the interests of safety and to avoid any possibility of error in identifying these ranges, the CAA has placed the code letter "V" before the "DEN" identification signal of the VAR range.

layer of clouds south of Cheyenne with base 8 000 and top 12 000. No turbulence or icing of significance was indicated for that area. For this area winds aloft between 8 000 and 10 000 feet were northerly and under 10 mph. This was substantially as forecast.

Up to and including 30 June 1951 the Captain had flown 29 hours as first officer and 61 hours as captain of DC-6 aircraft (excluding 9 990 flying hours in DC-3 equipment). The records also indicated that he had made 11 one-way trips in and out of Denver as captain in this type of aircraft. The First Officer had accumulated 5 848 flying hours, of which 1 526 were on DC-6 aircraft and 917 on DC-4's. Both pilots were well acquainted with the terrain which lies to the right of the route between Cheyenne and Denver.

Numerous theories were explored in an effort to determine why the pilot, after crossing Cheyenne, possibly assumed a heading of 210 degrees magnetic and then held this heading until the aircraft crashed into the mountain. One plausible theory is that after the aircraft passed over the Cheyenne range station the Denver low frequency range was tuned for aural directional guidance to Denver. At the same time the Denver VAR range was tuned in for the purpose of identifying the DuPont intersection, the point to which the flight was cleared. This intersection is the point where the west course of the Denver VAR range crosses the north course of the Denver low frequency range. In order to isolate the low frequency range receiver to aid in its aural reception, the captain may have meant to eliminate the aural signals of the VAR range receiver by depressing the toggle switches (voice and range) which are mounted on the audio selector control panel located near the captain's right knee. As previously stated, in a darkened cockpit the lights must be turned up in order to see these switches and read their positions; however, instead of doing this it is often the practice to feel for them.

It is therefore possible that the captain may have inadvertently depressed the wrong switches, the second and third switches from the left, thinking he had depressed the third and fourth (or middle two) switches. This would silence the range signals of the captain's low frequency receiver and also silence the voice feature of the VAR receiver, but would permit the VAR range signals to be audible. As previously stated, the identification signals and tonal qualities of both are identical. After passing over the Cheyenne range station, the normal procedure would be the execution of a standard rate right turn to a heading of approximately 210 degrees, which would intercept the north course of the Denver low frequency range. With the above-mentioned configuration of radio tuning, the "A" signal is on the left (east) side of the north course of the Denver low frequency range. Also, the signal "A" is on the right (west) side of the north course of the Denver VAR range. It can be seen that on approach to Denver from the North, a right turn to attempt to fly the "on course" of the low frequency range while listening to the "A" (right) side of the VAR range would take the aircraft deeper into the "A" quadrant of the VAR range and thus an "on course" signal would never be heard. However, no logical explanation can be found for the length of time the aircraft was held on a heading which the crew should have known would lead to the mountains west of the airway.

Another possible theory was considered which was subsequently established by a flight conducted by the CAA. After passing Cheyenne, the CAA pilot tuned his ADF to the Denver low frequency range and tuned that receiver's selector switch to the compass position. In tuning the Denver frequency of 379 kilocycles he purposely detuned the receiver on the high side. This detuning allowed the receiver to be affected by the range signal of Fort Bridger, Wyoming (located approximately 304 miles WNW of Denver) the frequency of which is 382 kilocycles. As a result the ADF compass needle indicated an average bearing of 225 degrees on the azimuth scale but with the needle "hunting" plus and minus 20 degrees. With the ADF switch in the compass position and with fine tuning it was possible to receive a faint "A" signal and a "DEN" identification. However it should be noted that when the Denver low frequency range was properly tuned the signals were clear and distinct. Therefore if the captain had inadvertently detuned his ADF, as described above, and was following such a heading thinking his needle indicated the direction of the Denver range station he would have been flying towards the mountains.

The afore-mentioned theories are based on the premise that the pilot tuned to the Denver ranges after passing Cheyenne. However, the Cheyenne low frequency range provides and excellent airway course to the south, meeting the north course of the Denver low frequency range. Had the Cheyenne low frequency audio facility been utilized to a point approximately halfway to Denver and had the Denver range then been properly tuned, no difficulty would have been experienced in receiving correct ADF indications and clear aural range signals.

## Probable Cause

The probable cause of this accident is that after passing Cheyenne, the flight for reasons undetermined failed to follow the prescribed route to Denver and continued beyond the boundary of the airway on a course which resulted in the aircraft striking mountainous terrain.

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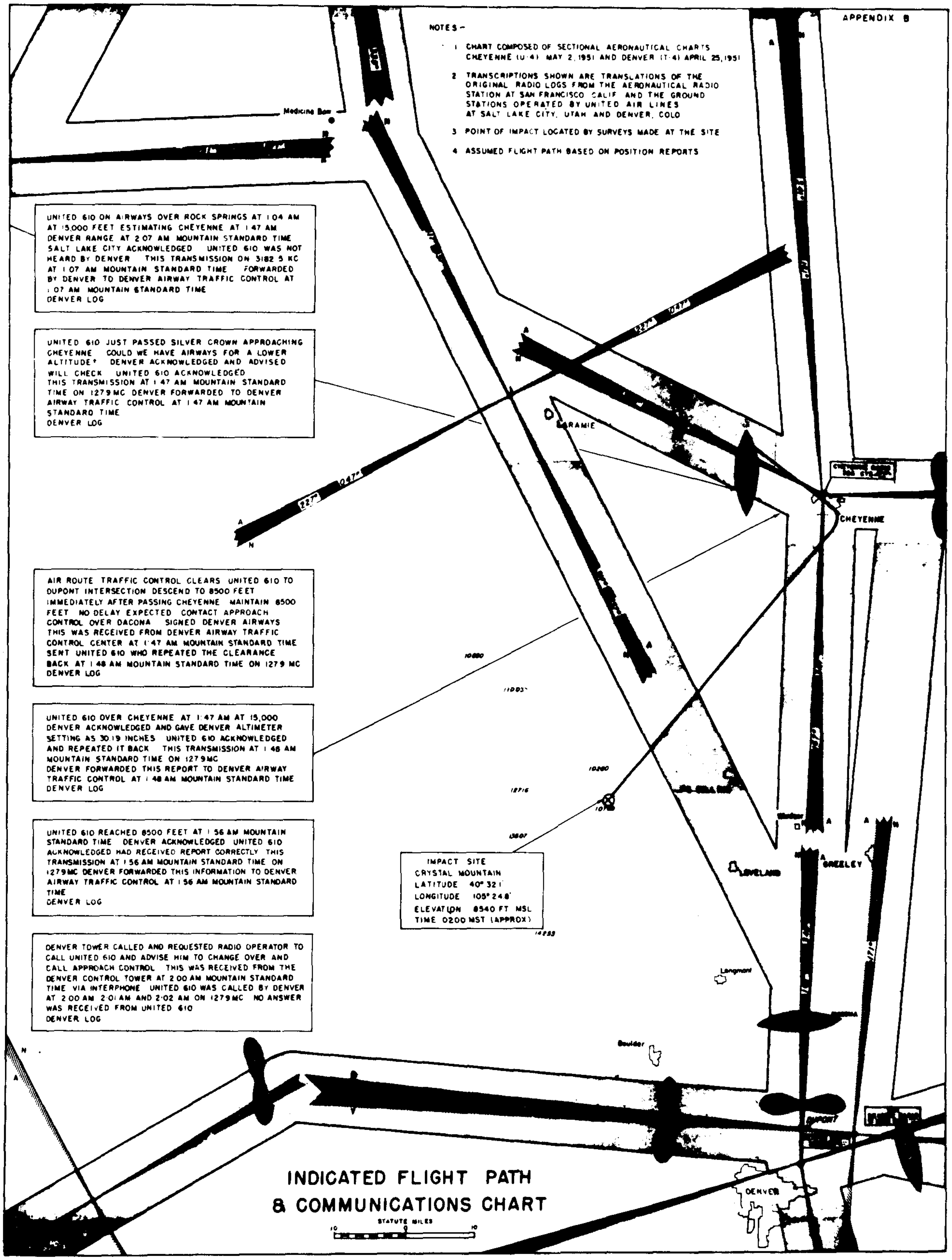
Note.- Subsequent to the investigation and public hearing relative to this accident, the Civil Aeronautics Board has been informed by United Air Lines that it has reviewed its entire flight operations administration. This review indicates, among other things, that greater importance should be placed upon indoctrination and training of flight personnel, with particular emphasis on maintenance of route and equipment qualification. It is understood that the program is at this time in the process of development and that United Air Lines will make it a continuous effort.

ICAO Ref: AR/165

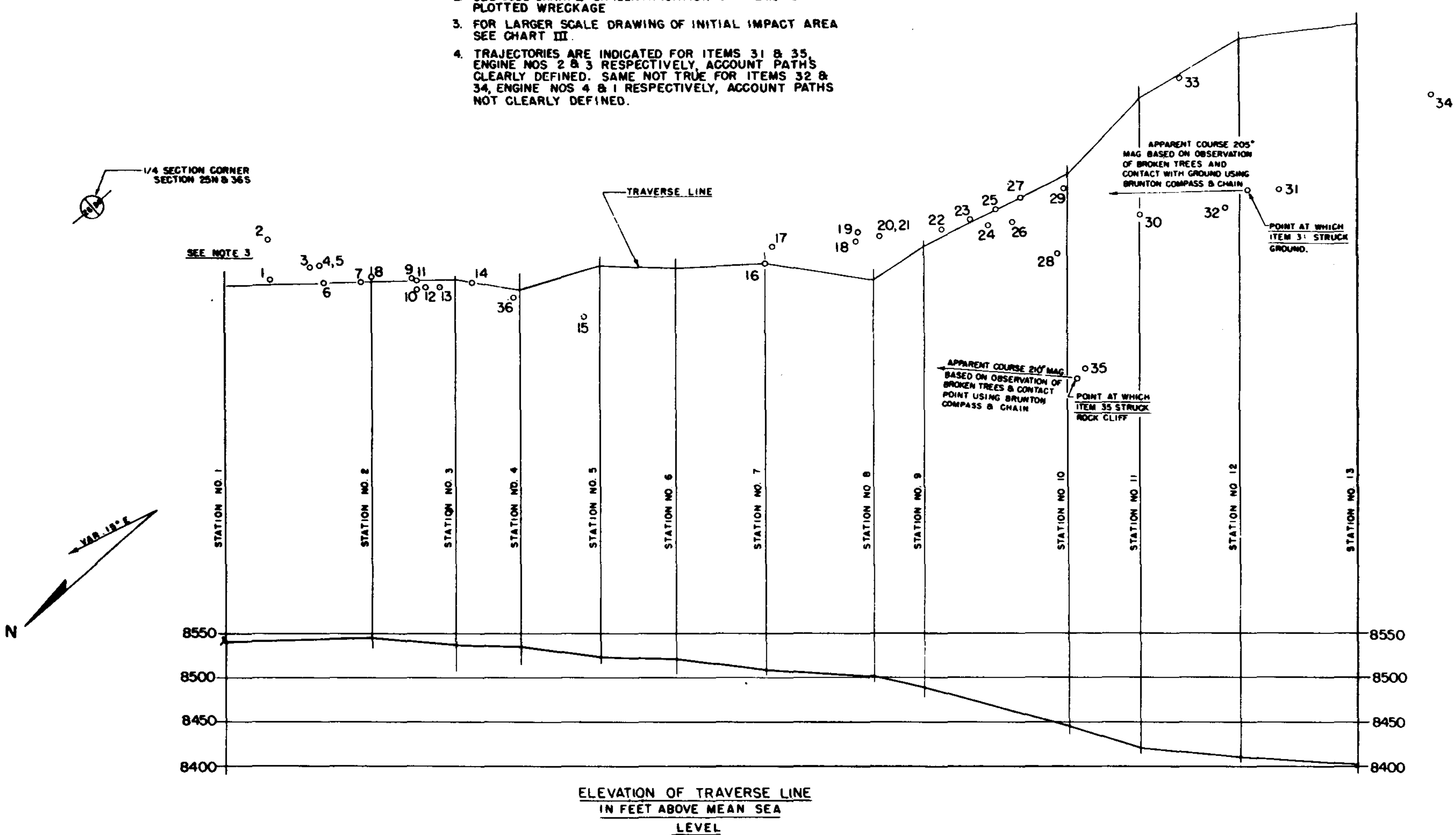


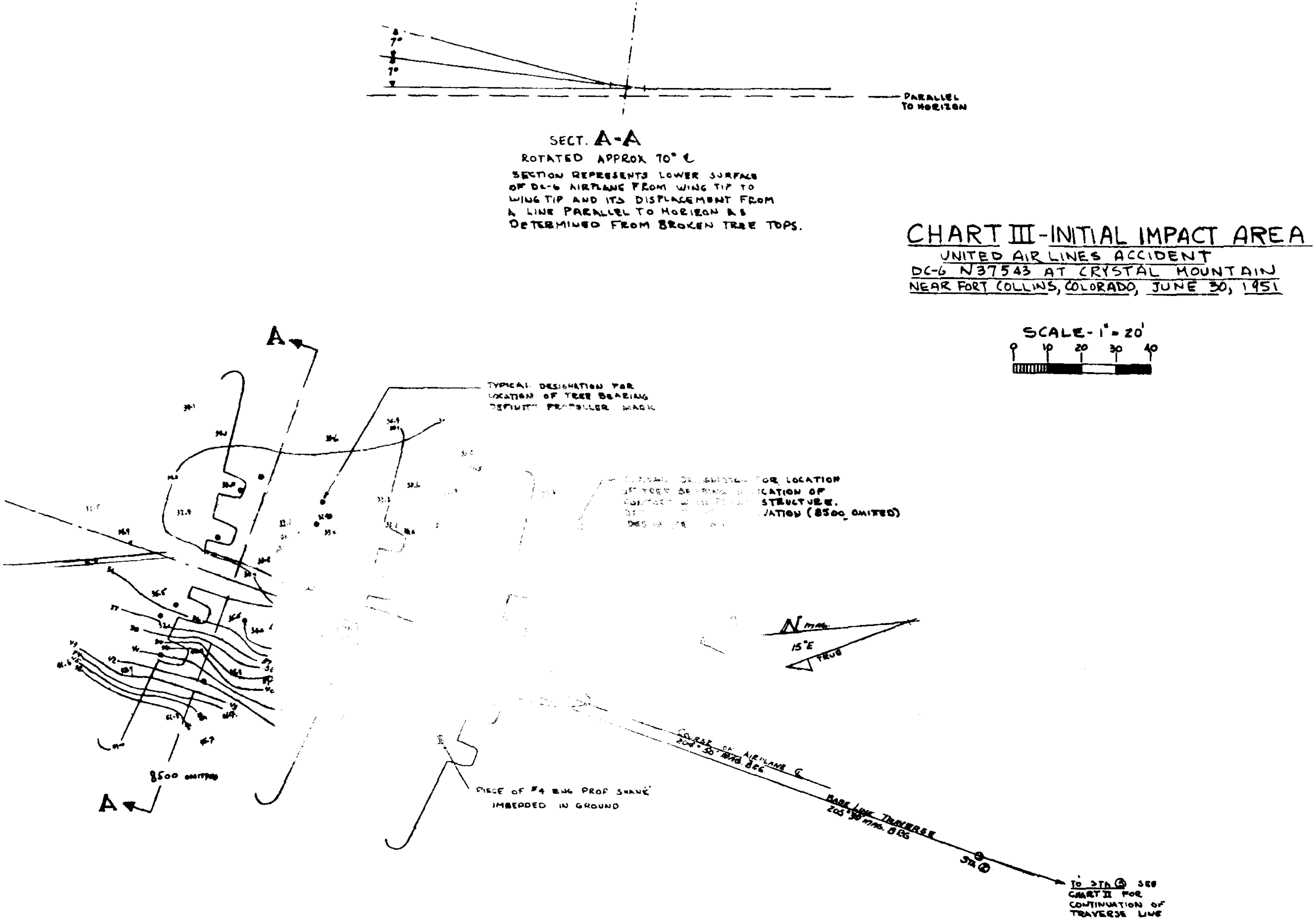

INDICATED FLIGHT PATH & COMMUNICATIONS CHART

## CHART II - DISTRIBUTION OF WRECKAGE
## UNITED AIR LINES ACCIDENT
### DC-6 N37543 AT CRYSTAL MOUNTAIN
### NEAR FORT COLLINS, COLORADO, JUNE 30, 1951

**NOTES:**

1. SCALE 1" = 40'
2. SEE CODE CHART II FOR IDENTIFICATION OF ITEMS OF PLOTTED WRECKAGE
3. FOR LARGER SCALE DRAWING OF INITIAL IMPACT AREA SEE CHART III.
4. TRAJECTORIES ARE INDICATED FOR ITEMS 31 & 35, ENGINE NOS 2 & 3 RESPECTIVELY, ACCOUNT PATHS CLEARLY DEFINED. SAME NOT TRUE FOR ITEMS 32 & 34, ENGINE NOS 4 & 1 RESPECTIVELY, ACCOUNT PATHS NOT CLEARLY DEFINED.




7°
7°
PARALLEL TO HORIZON
SECT. A-A
ROTATED APPROX 70° ℄
SECTION REPRESENTS LOWER SURFACE OF DC-6 AIRPLANE FROM WING TIP TO WING TIP AND ITS DISPLACEMENT FROM A LINE PARALLEL TO HORIZON AS DETERMINED FROM BROKEN TREE TOPS.
CHART III - INITIAL IMPACT AREA
UNITED AIR LINES ACCIDENT
DC-6 N37543 AT CRYSTAL MOUNTAIN
NEAR FORT COLLINS, COLORADO, JUNE 30, 1951
SCALE - 1" = 20'
0 10 20 30 40
A
TYPICAL DESIGNATION FOR LOCATION OF TREE BEARING DEFINITE PROPELLER MARK
15°E
8500 OMITTED
A
PIECE OF #4 ENG PROP SHANK IMBEDDED IN GROUND
COURSE OF AIRPLANE ℄ 204° 50' MAG. BRG
BASE LINE TRAVERSE 205° 30' MAG. BRG
STA ②
TO STA ② SEE CHART II FOR CONTINUATION OF TRAVERSE LINE

## No. 7

**Beech 35 Aircraft CF-FYD, ditched following take-off from Toronto Island Airport on 1 July 1951. Dept. of Transport, Air Services Branch, Civil Aviation Division, Report No. 51-25.**

### Circumstances

The aircraft took off from Toronto Island Airport, Ontario for a flight to Malton Airport, Toronto, Ontario, carrying two passengers and the pilot. Following take-off, and at about 500 feet, a progressive loss of R.P.M. was noticed together with a loss of manifold pressure. Corrective action had no effect and whilst attempting to return to the airport the engine stopped. A successful ditching was made in the Toronto Harbour. The passengers and pilot were uninjured and were soon rescued by a boat, although the aircraft was substantially damaged and sank within three or four minutes.

### Investigation and Evidence

The aircraft was salvaged and examination of the engine showed that three pistons had seized and metal had adhered to the cylinder walls. Connecting rod bearings, and crankshaft bearings had melted. It was determined that the cowling gills were closed during the run-up, contrary to the cockpit drill. The pilot held a valid Commercial Pilot Licence and had acquired one and one-half hours flying time in this type of aircraft.

### Probable Cause

The probable cause of this accident was power plant failure due to overheating as a consequence of misuse of the power plant controls by the pilot.

ICAO Ref: AR/173

## No. 8

**Piper J3, CF-EGC aircraft crashed near Sturgis, Sask., on 4 July 1951. Dept. of Transport, Air Services Branch, Civil Aviation Division. Serial No. 51-22.**

### Circumstances

At approximately 2030 hours CST on 4 July 1951, the aircraft, flown by a commercial pilot took off for the purpose of crop spraying. Two runs were carried out, however, during the turn into the third run, the aircraft stalled, did one turn of a spin, and struck the ground at a 75° angle from the horizontal. The pilot was instantly killed.

### Investigation and Evidence

The pilot had 150 hours flying time. The weather was clear, temperature - 66°F., visibility - 15 miles.

No evidence of malfunctioning was found. The aircraft was overloaded by 63 lbs. at take-off, but this was not, however, considered a contributory factor to the accident because both fuel and crop spraying solution were used during two runs prior to the accident which would bring the weight of the aircraft down to that permissible.

Recently, a Continental C90-8F engine had been installed. The carburettor heat system was not modified as required. However, this was not considered to be a contributing factor either, in view of the air temperature at the time and also because power was being developed at the moment of impact.

### Probable Cause

For undetermined reasons the pilot failed to maintain adequate flying speed and the aircraft stalled in a turn and commenced to spin at too low an altitude for recovery to be made.

ICAO Ref: AR/190

No. 9

Lockheed 18-08, CF-ETC aircraft made an emergency landing at Montreal, P.Q., on 11 July 1951. Dept. of Transport, Air Services Branch, Civil Aviation Division. Serial No. 51-24.

## Circumstances

The aircraft took off from St. Johns Municipal Airport, St. Johns, P.Q. on a ferry flight to Toronto, Ontario, via Montreal. Near St. Anne de Bellevue it was noticed that the propellers were not synchronized, Shortly after the port engine lost power and there was indication of fluctuating fuel pressure. On checking the port engine cylinder head temperature, the instrument read "full hot." Power was reduced and the ATC at Montreal cleared the aircraft for landing. Approximately 2 miles west of the airport, at 1 000 feet flames were seen coming out of the cowling behind the firewall of the port engine. An attempt to feather the engine was made and the ignition was turned off. The fire extinguisher lever was pulled with no result. Clearance was obtained for emergency landing on Runway 10 and a normal flaps-up landing was made.

The brakes were inoperative during the landing roll and the aircraft was steered onto the grass area of the runway. The fuel shut-off valves were not turned off when the pilot and co-pilot abandoned the aircraft. The aircraft was destroyed by the fire.

## Investigation and Evidence

The aircraft had just been overhauled to renew its airworthiness certificate. No evidence existed of malfunctioning. Tests failed to reveal the cause of fire and its exact location in the port engine. The fire's greatest intensity was reached near the auxiliary fuel pump. Weather was not a factor in the accident.

## Probable Cause

Exact cause of the fire has not been determined. The aircraft was destroyed on the ground by a fire which started in flight in the port engine.

ICAO Ref: AR/191

## No. 10

**Cessna 195, seaplane N-3470V, disintegrated in the air near Dunnville, Ontario, on 12 July 1951. Dept. of Transport, Air Services Branch, Civil Aviation Division, Report No.51-F3.**

### Circumstances

At 1210 the aircraft departed from Highland Seaplane Base, Pittsburgh for Toronto, Ontario, carrying two passengers and the pilot. At about 1415 hours it was heard either in or above cloud near Dunnville, Ontario. A few minutes later it was observed to dive out of the cloud base which was estimated to be some 200 feet above the ground. About three or four seconds later the aircraft started to disintegrate, and the wings and sections of the empennage fell into a wooded area, while the fuselage and floats continued forward for about 800 feet and dived into a pasture field. The three occupants were killed and the aircraft was destroyed.

### Investigation and Evidence

Examination of the wreckage failed to disclose any evidence of malfunctioning of the engine or controls. However, the manner in which the aircraft disintegrated, together with the distance the fuselage travelled without the support of the wings, would appear to indicate that the airspeed attained in the dive and pull-out was beyond the maximum safe speed given in the Cessna 195 Operations Manual.

No flight plan had been received by the Toronto Air Traffic Control Centre but notification of the ETA Toronto and arrangements for customs clearance had been made by telephone. The pilot was properly certificated and had acquired 50 hours on this type of aircraft. There was ample fuel on board the aircraft for the flight.

It is believed that the pilot delayed his departure in the hope that the weather at Toronto would improve. After a final weather check which indicated no improvement, the pilot decided to attempt the flight. Weather reports indicated that very low ceilings and poor visibility with intermittent rain and fog existed along the route from the south shore of Lake Erie to Toronto. At the time and place of the accident, the cloud base was estimated to be 200 feet, broken, with visibility restricted by drifting patches of fog.

## Probable Cause

The probable cause of this accident would appear to be continuation of VFR flight into deteriorating weather conditions, exceeding the operating limitation (airspeed) of the aircraft in the dive out of cloud and subjecting the airframe to loads greater than those for which it was designed when pulling out from the dive.

ICAO Ref: AR/177

## No. 11

**Eastern Air Lines, Inc., Lockheed Constellation Aircraft N-119A. Emergency Landing near Richmond, Virginia, on 19 July 1951. CAB Accident Investigation Report No. 1-0057. Released 4 January 1952.**

### Circumstances

The aircraft was cleared to proceed IFR from Newark to Miami at 18 000 feet. The total aircraft weight at take-off was 92 533 pounds (maximum allowable gross-weight 100 355 pounds), and the disposable load was properly distributed with relation to the centre of gravity of the aircraft. Prior to departure the pilot and co-pilot were briefed on the prevailing weather situation. Two frontal systems were in existence on 19 July; a cold front extended southwest through Buffalo and a weak warm front extended east-southeast from near Buffalo. The forecast indicated scattered thunderstorms along the route to North Carolina, with turbulence at all levels. A thunderstorm with squall line characteristics had already moved southeastward across the route between Wilmington, North Carolina and New York. Since it was not expected that a second squall line would form, no stress was laid on this possibility in the briefing.

The aircraft departed Newark at 1415 and gave ETA Philadelphia 1446, later modifying it to 1443. It was in the storm area, continuing the climb from 15 000 feet to the assigned cruising altitude of 18 000 feet as it passed Philadelphia. Cruising altitude was reached at approximately 1452 and for the next 25 to 30 minutes violent turbulence accompanied by intermittent periods of hail was encountered. During this period the captain noted severe buffeting of the aircraft. The flight continued past Philadelphia for a few minutes towards Dover, Delaware, then turned west in an attempt to avoid as much of the storm area as possible. By taking such action the pilots felt they would traverse the storm line at 90 degrees. Updrafts in the storm were so severe that the aircraft was carried to 23 500 feet and for a short time it was impossible to maintain the assigned altitude. Speed was reduced in the turbulence.

The flight broke out in a clear area at about 1517 some 30-40 miles northwest of Washington D.C. At 1521 ARTC was advised that the flight was proceeding southwest VFR and estimated Lynchburg, Virginia in a few minutes. The flight descended VFR to 8 000 feet. At 1540 an aircraft in the vicinity of Richmond was contacted by the subject aircraft for information regarding weather further on the route on Airways Green 6 and Amber 7. This aircraft advised that the weather was clear to the east and, therefore, a turn was made to an easterly heading.

A second squall was encountered in the vicinity of Lynchburg at 1550. The aircraft was slowed to 185 miles per hour indicated air speed; light turbulence and buffeting were experienced. After breaking out of the storm at 1554, the buffeting became so severe that the crew believed the aircraft would disintegrate. Air speed was further reduced, but the buffeting continued. At 1556, the captain radioed that an emergency landing was being made.

In the descent, speeds ranging from 205 to 140 m.p.h. were tried without success, to reduce the buffeting. Shortly after breaking out of the second disturbance the captain recognized Curles Neck Farm, selected the largest field and landed straight ahead with flaps up, propellers in high pitch and landing gear retracted. During the last few moments of flight, as the nose of the aircraft touched high corn in a field, the co-pilot and flight engineer cut all switches. The landing resulted in major damage to the aircraft. No injuries were sustained by any of the passengers or crew.

## Investigation and Evidence

A study of the weather which existed on 19 July showed that a line of scattered storms noted on radar at 1410 in New York was actually the forerunner of a squall line. The storms joined very rapidly, forming a solid or nearly solid squall line between 1410 and 1443. This development differed substantially from the weather briefing given to the captain. It was further revealed that at the time the aircraft departed Newark, a line of convergence and instability extended southwest from near New York City to north of Philadelphia and Baltimore, then swung westward to near Warrenton and Harrisonburg, Virginia, moving southeast at 25 to 30 miles per hour. A contPinous squall line did not extend throughout the length of this line, but rather a broken line of storms containing squall line characteristics, which would explain why the subject aircraft encountered severe storm conditions while other airline flights experienced no difficulty.

By the time the flight arrived near Philadelphia such a portion of squall line was well-developed between Philadelphia and Baltimore. It was in the forward edge of the storm, in the area south and southwest of Philadelphia that the worst conditions were encountered - hail, severe turbulence, aircraft icing and strong updrafts. By turning to the west, the aircraft took a course which nearly paralleled the storm line. Traversing this line, it broke out to the rear but re-entered the storm line a little later. Analysis showed that had the turn west not been made the flight would have broken out of the storm near Dover, and would have had good weather thereafter. As it was the flight was in the clear area to the west and rear of the first squall line, thus it had again to cross the line of convergence as it continued to Norfolk and Miami. A scattered thunderstorm condition had become a nearly solid squall line from Quantico to Gordonsville and near Lynchburg at about 1500.

The landing was made on a course of approximately 120 degrees magnetic. The captain stated that he felt it inadvisable when landing to make any turn, lower the flaps or otherwise change the flight configuration, since the cause of the severe buffeting was unknown. The leading edge of the right wing just outboard of number 4 engine struck a power line pole. The fuel tank in that area was ruptured and fire occurred behind the No. 4 nacelle, but was extinguished by rain and a local fire truck which arrived promptly. The wing was burned approximately one-third through at that point and collapsed just outboard of the nacelle. The No. 2 engine and nacelle were detached from the wing and No. 3 engine was partially detached as the aircraft skidded through the fields. The fuselage remained practically intact.

The engine nacelles, leading edge areas of the wing centre section, leading edges of rear stabilizing surfaces and the nose section all showed that heavy hail had been encountered. Exposed cylinder barrel fins were flattened by the impact of hailstones. Some peeling and lifting of skin on the central vertical fin and fin-stabilizer fillet was noted, however, whether this was caused by the storm, buffeting of the empennage, or the crash landing was not established.

The hydraulic reservoir access door 9 inches wide by 15 inches long on the top side of the left wing-to-fuselage fillet forward of the front spar was found fully open. One spring was detached on each of two of the four Hartwell-make Messerschmidt type spring loaded (two small coil springs per fastener) fasteners which furnish a flush enclosure with the aircraft surface, and are actuated simply by a moderate pressure of finger and thumb. A slight upward bend was noted on the outer edge of the door frame corresponding with the position occupied by one of the fasteners with the door closed, indicating the possibility that the door was sprung open while this one fastener was in the locked position.

Investigations disclosed that two previous in-flight openings of this door on Eastern Air Lines Constellations had been reported, and that in each instance, the manner in which the door latches had released could not be ascertained. Immediately following the first reported incident a series of tests were made using the same aircraft. It was found that the buffeting caused by the door being open in flight could be eliminated by extension of flaps. Eastern Airlines took limited action to acquaint personnel with the consequences of an open hydraulic reservoir access door, however those primarily concerned with such a possibility - the pilots - were not informed of the circumstances under which the buffeting would occur, or of changes which could be made in the in-flight configuration to eliminate it.

As part of the investigation a test flight was conducted in an identical Constellation employing the crew concerned in the accident. Suitable means were provided for selective release of the fasteners in flight. With all four latches released the trailing edge of the door rose and oscillated in the air stream. The open door created turbulence in the wing-to-fuselage fillet area which in turn caused the entire empennage to buffet. The induced buffeting was so severe that it was not allowed to continue for more than 30 seconds at a time. The crew concurred in the opinion that buffeting experienced on the test flight was of the same order as that they had experienced previously with the subject aircraft. It was found that buffeting could be eliminated entirely by the use of 60 per cent flaps which changed the air flow over the wing, causing the critical air speed for buffeting to be reduced, or by increasing No. 2 engine.

The mechanic who serviced the aircraft at Newark and the flight engineer both stated that they were positive all fasteners were secured prior to the take-off. Examination of the latches and coil springs on the fasteners from the subject aircraft revealed that due to weakened coils springs very little pressure was required to open them. The Hartwell representative advised that his company was aware of in-flight openings resulting from use of that model fastener on other aircraft types, and that as a consequence they had redesigned the fastener with a torsion spring in place of the coil springs. The new design requires considerably more pressure to actuate and is interchangeable with the former design.

Maintenance records reflected that the aircraft was properly certificated and airworthy on departure from Newark. Company records reflected that the pilots and flight engineer were competent and properly certificated. No evidence of malfunctioning of the aircraft control system was found during the investigation.

## Probable Cause

The probable cause of this accident was the in-flight opening of the hydraulic access door, which caused extreme buffeting of the aircraft, and resulted in the captain's decision to make an emergency landing.

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Note.- 1) Following the accident, corrective action was taken on all Eastern Constellations by adding a Dzus fastener at the rear of the door. This fastener was installed as a positive lock should external forces cause the Hartwell fasteners to release. Although the earlier Hartwell fastener was considered reliable, it is now being replaced with the improved design.

2) Following the accident, the Lockheed Aircraft Corporation made certain design changes in the access door, incorporating improvements in the method of closure. All Constellation operators were advised of the conditions which could be encountered with the door open, and changes which might be made in-flight configuration to overcome the buffeting.

ICAO Ref: AR/172

## No. 12

**Canadian Pacific Air Lines Limited, Douglas C-54A-DC, CF-CPC aircraft, missing between Vancouver, B.C. and Anchorage, Alaska en route from Vancouver, B.C. to Tokyo, Japan on 21 July 1951. Dept. of Transport, Air Services Branch, Civil Aviation Division Serial No. 51-35**

### Circumstances

At 1853 hours on 21 July the aircraft took off from Vancouver, B.C., on a scheduled flight with a crew of six and thirty-one passengers. The aircraft proceeded on schedule, the last position report being given at Cape Spencer intersection, B.C. The last position report gave the ETA Yakutat, Alaska as 2400 hours. No further communication was received. At 0044 hour an emergency warning was issued. When the aircraft became overdue a search was undertaken by the U.S.A.F. assisted by the R.C.A.F. which lasted until 31 October, 1951. No trace of the aircraft or its occupants has been found.

### Investigation and Evidence

Records show the aircraft to have been serviceable for flight. No written confirmation could be obtained to certify its airworthiness as the log books containing this certification were on board the aircraft. Sufficient fuel was on board for the flight and the aircraft was loaded in conformity with the Certificate of Airworthiness.

The pilot-in-command and two other crew members were given a MET briefing for the route Vancouver, B.C. - Elmendorf Field, Alaska. Nothing unusual in the weather was expected. The main feature was a depression in the Western Gulf of Alaska with an occlusion moving Northeast at 25 mph to about 150-200 miles offshore from Cape Spencer - Yakataga. Freezing level was forecast at 9000 ft. for the segment of the route between Cape Spencer and Yakataga. Severe icing was not expected.

The flight was normal to Sitka. The captain was unable to contact Sitka and so he gave the position report through Yakutat. According to a report from another pilot, who was flying in the area, radio conditions were poor and the Yakutat beam was swinging considerably at the time of the disappearance. A check of this beam later showed that it was in its normal position.

### Probable Cause

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

ICAO Ref: AR/192

## No. 13

## United Air Lines, Inc., Douglas DC-6B aircraft, N-37550, crashed on approach to landing at Oakland, California, Municipal Airport on 24 August 1951. CAB Accident Investigation Report No. 1-0058. Released 12 March 1952

### Circumstances

The aircraft departed Chicago for Oakland, California, carrying forty-four passengers (including two infants) and a crew of six. While approaching the Oakland Municipal Airport for landing, it crashed near the top of a hill. All passengers and crew were killed instantly and the aircraft was demolished.

### Investigation and Evidence

The flight was cleared by Approach Control to the Newark fan marker on the Oakland radio range to maintain at least 500 feet above the tops of the clouds. At 0425 the flight was cleared for a straight-in approach on the southeast course of the Oakland radio range from Newark. At 0427 the flight reported leaving Newark inbound to Oakland. The aircraft struck the rising mountainous terrain at approximately 0428.

An eye witness reported that it was on a straight course, but descending just before impact. The descent was verified by the fact that the next hill to the south, over which the flight passed is higher than the one struck. Wreckage was distributed over an area approximately 1 640 feet in length and 900 feet in width. A gasoline and grass fire flared upon impact. There was no evidence found of fire prior to impact.

The main landing gear was extended at the time of impact and reasonable proof exists that the nose wheel was retracted, or nearly retracted. Wing flaps were between the full retracted and 30 degrees extended position. All four engines were producing substantial power at the time of impact. Examination of propeller blade cuts in the earth and blade index settings showed that the blades were in the forward thrust range. Evidence indicated that ground speed was between 225 and 240 miles per hour upon impact.

Examination of the two ADF (Automatic Direction Finder) radio receivers revealed that the captain's was tuned to the Newark compass locator, with volume control approximately one-third ON, function switch on the ADF position, and the pointer position at 253 degrees relative to the heading of the aircraft. The first officer's receiver was tuned to the Hayward compass locator, the function switch was on the ADF position, pointer position at 28 degrees relative to the aircraft's final heading, and the volume control was in the OFF position. With these two low-frequency receivers in use, there was no other apparatus available to receive the Oakland radio range. Although it was not possible to determine the setting of the VHF, the switch was in the ON position with the volume turned to between one-third and one-half of full value. Parts of both altimeters were found, the captain's indicating 930 feet (the crash site was at 983 feet MSL). The setting of the first officer's altimeter was 29.90 inches, which closely approximated the Oakland altimeter setting of 29.88 inches as transmitted to, and acknowledged by the flight.

The dial and head of one Master Direction Indicator was locked at a magnetic heading of about 300 degrees. The card of the magnetic compass showed that the heading at impact was between 305 and 310 degrees. Detailed examination of structural, electrical, radio, and powerplant components revealed no evidence of failure or malfunctioning which might have caused or contributed to the accident.

The weather in the San Francisco Bay area was generally of the type characteristic of this area during summer. All reports gave ceilings between 1 000 and 1 500 feet with visibility beneath the clouds of six miles or better. Winds were light, less than 10 knots, and there was little or no turbulence. As the flight broke out under the stratus at about 1 500 feet, downward visibility was possible, but ground objects and contours were probably difficult to recognize and identify. For this reason, it is believed that weather conditions were closer to Instrument Flight Rules (IFR) than VFR at the time of the accident. Instrument approach procedures for the Newark area require an aircraft on an IFR flight plan to maintain an altitude of not less than 3 500 feet until it has left Newark inbound to Oakland on the southeast course of the Oakland radio range. Should the aircraft be holding at Newark on the standard race-track holding pattern to the southeast of the radio facility, the minimum IFR altitude would be 4 500 feet. The manoeuvring of the flight in the Newark area was probably at some altitude between 1 500 and 2 000 feet throughout the known pattern. Since the flight did not cancel its IFR clearance and advise Approach Control that it was contact, nor had it received instructions to hold, the minimum altitude permissible until leaving Newark inbound to Oakland would therefore have been 3 500 feet. Had the flight been conducted in accordance with the prescribed instrument procedures, this accident would not have occurred.

All pertinent maintenance records for the aircraft were reviewed but no items were found which would be significant or would show that the aircraft was in any way unairworthy.

Company records reflected that Captain Hedden and First Officer Jewett, who both held air transport ratings, had extensive flight experience in the Oakland-San Francisco area. Captain Hedden had logged over 400 hours in DC-6s and Mr. Jewett over 2 800. Both had satisfactorily completed transitional training for the DC-6B, which has nearly the same flight characteristics and cockpit arrangement as the DC-6.

## Probable Cause

The Board determined that the probable cause of this accident was the failure of the captain to adhere to instrument procedures in the Newark area during an approach to the Oakland Municipal Airport.

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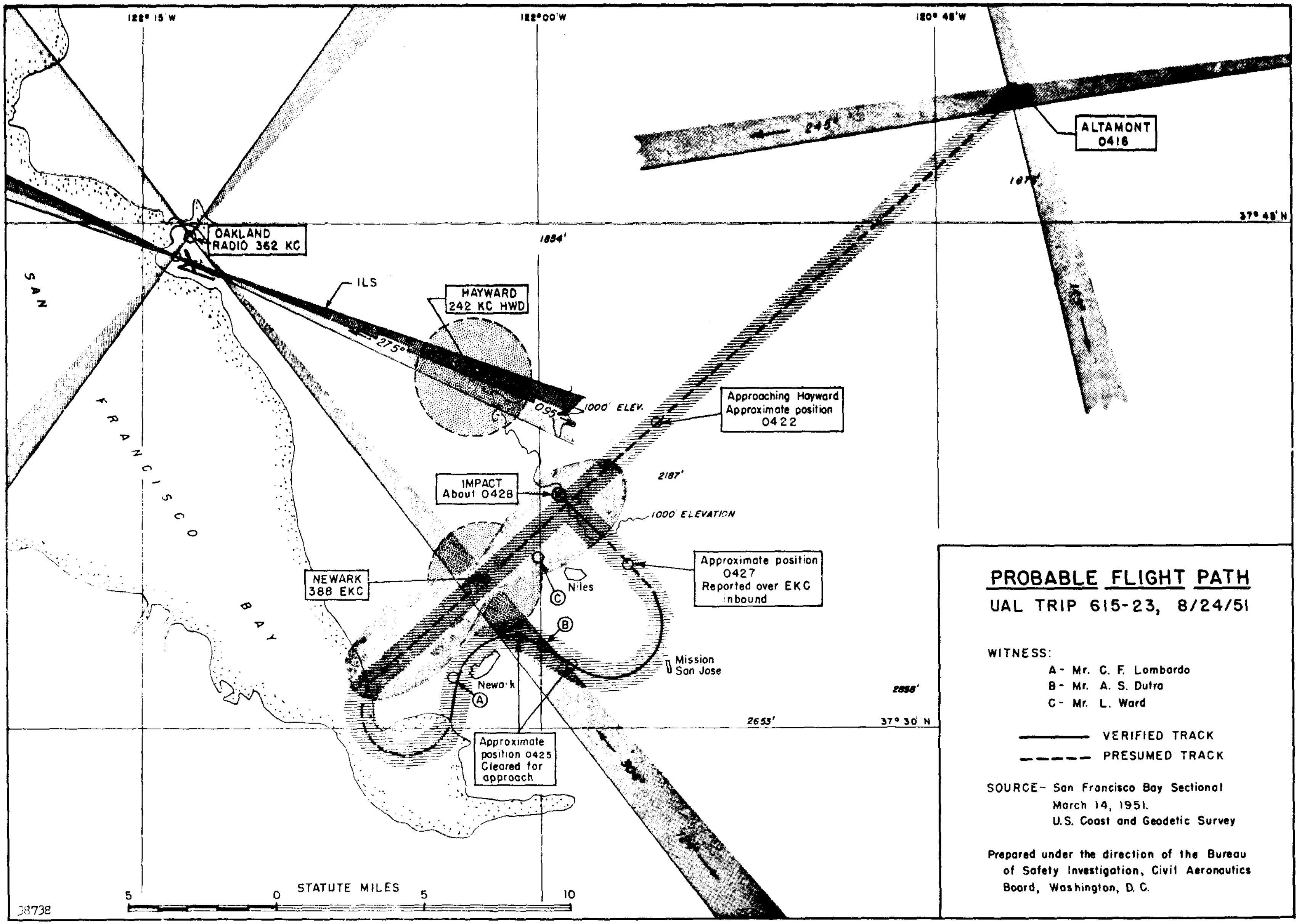
Note.- Shortly after this accident, United Air Lines made certain revisions in their Flight Operations Manual to prevent, in so far as possible, the recurrence of this type of accident. All pilots were instructed that United Air Lines' flights over the top of an overcast must be conducted in accordance with IFR and must be flown not lower than the CAA approved minimum IFR flight levels. The Manual revision further instructed them that IFR en-route minimum altitudes shown in radio procedure charts must be strictly adhered to, even though the flight be operating on a clearance of at least 500 feet on top. Thus, adherence to minimum en-route altitudes would always be equal to or greater than an on-top clearance, should the cloud tops be lower than 500 feet below the minimum en-route altitude. This includes altitudes prescribed for procedure turns and those between fixes or markers. Pilots were also directed to make full use of the aural range signals during ADF or holding procedures whenever aural signals are available.

ICAO Ref: AR/183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122°00' W
120° 45' W
37° 45' N
37° 30' N
ALTAMONT
0416
245°
OAKLAND
RADIO 362 KC
ILS
275°
095°
HAYWARD
242 KC HWD
1854'
1000' ELEV.
Approaching Hayward
Approximate position
0422
2187'
1000' ELEVATION
IMPACT
About 0428
SAN FRANCISCO BAY
NEWARK
388 EKC
Niles
Approximate position
0427
Reported over EKC
inbound
Mission
San Jose
Newark
2858'
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position 0425
Cleared for
approach
STATUTE MILES
5
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38738
PROBABLE FLIGHT PATH
UAL TRIP 615-23, 8/24/51
WITNESS:
A - Mr. C. F. Lombardo
B - Mr. A. S. Dutra
C - Mr. L. Ward
VERIFIED TRACK
PRESUMED TRACK
SOURCE - San Francisco Bay Sectional
March 14, 1951.
U.S. Coast and Geodetic Survey
Prepared under the direction of the Bureau
of Safety Investigation, Civil Aeronautics
Board, Washington, D. C.

No. 14

Pan American World Airways, Inc., Convair 240 Aircraft N-90662 crashed on approach to landing at Kingston, Jamaica, on 2 September 1951. CAB Accident Investigation Report No. 1-0074. Released 14 March 1952

Circumstances

The aircraft departed from Camaguey, Cuba, for Kingston, Jamaica, carrying 29 passengers (including one infant) and a crew of four. The flight was uneventful between Camaguey and Kingston; however, during the approach to land, a steeply banked turn was made at a low altitude in an effort to align the aircraft with the runway, and in so doing the right wing tip contacted the water. The aircraft crashed in the water about 800 feet short of the approach end of Runway 14, the point of intended landing. The passengers and crew all escaped serious injury. The aircraft was demolished by impact and salvage operations.

Investigation and Evidence

It was established that at 1003 the aircraft reported its position to Palisadoes Airport Tower, Kingston, as 20 miles north and a little later was cleared into the traffic pattern for Runway 14. The flight acknowledged this clearance and shortly thereafter reported that the field was in sight. Palisadoes Tower then advised the flight of the presence of a local squall between Kingston and the approach end of Runway 14, with heavy rain at the airport, and suggested a low approach. When the aircraft first came into view, it was just emerging from the heavy part of the squall. At this time the flight requested and received permission to circle the airport to the right. The aircraft flew parallel to the runway, and at approximately the runway intersection, turned right and continued around the airport to a point north west of the approach end of Runway 14 and over Kingston Harbour; here it was observed to descend into the water about 800 feet short of the runway. A motor launch from a nearby salvage vessel arrived in a matter of minutes and took the survivors ashore. The wreckage floated for a short time, then sank, leaving only a part of the tail group and one wing visible.

Initial contact with the water resulted in the right wing being torn from the fuselage at the wing root, and the nose section and cockpit structure breaking off at the front entrance door frame located on the right side of the fuselage. This nose section went to the bottom in 20-odd feet of water, however the captain and co-pilot were able to extricate themselves. Before the fuselage became fully submerged, all passengers either made their way forward into the water through the opening created by the missing nose section, or back and out through the emergency rear door. The wrecked aircraft sank in about 24 feet of water with the outboard half of the left wing, the left stabilizer and elevator, the rudder, and the upper portion of the vertical stabilizer remaining above the surface of the water.

Salvage operations eventually recovered the major portion of the wreckage. Those parts not recovered consisted of the right engine, much of the right nacelle, approximately two-thirds of the right wing including a section between the fuselage and the nacelle, approximately one-half of the right flap, and approximately one-half of the right aileron. Among the items of immediate interest recovered were two of the four right flap tracks and carriages (Nos. 1 and 3) and the right engine nose section with the propeller attached. These indicated, respectively, that the right flap was extended to the 33° position and the right propeller was in low pitch at the moment of impact. It was also determined that the left flap was extended to the 33° position and the left propeller was in low pitch. A thorough examination of all parts recovered failed to reveal any evidence whatever of malfunctioning of the aircraft or any of its components.

From the testimony of the captain and co-pilot, it would appear that the flight never entered the squall area on initial approach to the airport. Several passengers, however, stated that the aircraft passed through heavy rain on this initial approach. Furthermore, the air traffic controller on duty at the time stated that at 1005 he requested the flight's position and was advised that it was just coming over the ridge and had the city in sight. The controller further stated that a few minutes later when he had the aircraft in sight it was then approximately one-half mile away and was just breaking through the heavy part of the squall which was over the end of Runway 14.

The testimony of the captain disagreed on several very important points with that of the co-pilot, as to what occurred between the time the aircraft rolled out on to final and the impact with the water, furthermore their version of the last phase of the flight is in general conflict with the testimony of all ground witnesses interviewed and with statements submitted by several passengers. The following is quoted from the co-pilot's statement. "The final then entered, co-pilot stopped turning and called for full flap. Runway was ahead and at a fairly steep angle. Power was then reduced to approximately 28 ins. mercury. Co-pilot checked airspeed at 120 knots and altitude at 400 feet. He then looked across to the captain's side of the aircraft and checked the power. Upon checking the runway again, the co-pilot noticed that the aircraft had entered a right spiral descent. Attempt was made to right the aircraft with ailerons and elevator. No abnormal control pressures were felt by the co-pilot. The captain noticing the co-pilot's difficulty, attempted to help right the aircraft. The aircraft continued to descend and entered the water right wing first."

When asked the approximate angle of right bank at the moment of impact with the water the co-pilot stated "45 to 50 degrees". When asked how far from the approach end of Runway 14 did he make his turn on to final, he replied "1 500 feet". The co-pilot further stated that no attempt was made to reduce power, which at the time was 2 600 RPM and 28 ins. of mercury, before striking the water. The aircraft was closely aligned with the centerline of Runway 14 extended and a survey showed that when it sank, the nearest part of the aircraft was 798 feet from the end of the runway.

When the captain was asked if he concurred with the co-pilot as to the attitude of the aircraft just before striking the water, he replied, "Well, I don't concur with his attitude there. I assumed it was in a more level position -- just before contact when I eventually got on the controls, as I say, the aileron had been at full travel -- full travel had been accomplished -- and there was no bringing the right wing up, and the only other recourse was to flatten it, which we accomplished with the remaining back pressure". When asked how far from the approach end of Runway 14, the turn-on to final was started, he replied "in the neighbourhood of 3 000 feet, possibly more, because we were travelling at the rate of 125 knots there, and we ended up, I believe at 800 feet".

Both the captain and the co-pilot were in substantial agreement that: the altitude when turning on to final was between 400 and 500 feet and the air speed was 120 knots; light rain was encountered, and the wind-shield wipers were turned on; visibility was not restricted between the flight and the airport; and no turbulence was encountered during any portion of the landing approach.

Assuming the situation after turning on to final to be as described by the co-pilot -- airspeed 120 knots, altitude 400 feet, 1 500 feet from the approach end of the runway -- a descent of approximately 7 000 feet per minute would have been required to put the aircraft into the water 800 feet short of the runway. If we take the captain's description of the situation -- air speed 120 knots, altitude 400 feet, 3 000 feet from the approach end of the runway -- a descent in excess of 2 200 feet per minute would have been required to put the aircraft into the water at the point of impact. These estimates are based on a constant airspeed of 120 knots, however, both the captain and the co-pilot stated that there was no reduction of power during the descent; therefore, if their description of the situation is accepted, the speed during such a descent would have been considerably in excess of 120 knots. It is difficult to reconcile the relatively light impact forces sustained by the aircraft and the comparatively minor results of the accident with either of these rates of descent.

Seven of the ground witnesses were part of the crew of a salvage vessel operating approximately 1 500 feet from the scene of the accident. By the nature of their occupation, these men are well qualified to judge distances, speeds, and angles. Their testimony was in general agreement that the aircraft was in an almost continuous descending turn from the downwind leg until impact with the water, and that the bank was steepened during the final portion of the turn to line up with the runway. Altitude estimates for the approximate point where this increased bank began range from a minimum of 60 feet to a maximum of 200 feet.

One of the witnesses, a former naval aviation metalsmith who was standing in the motor launch that later picked up the survivors, stated, "I saw the plane approach from the SW and as the plane passed the end of the runway she started almost a 40-45° bank to right descending slowly at the same time. When the plane was off the end of the runway and still in a turn she seemed to slip right wing down toward the water. When the right wing hit the water the bank was less than 40° almost 10° bank. The right wing hit first, then the landing gear hit after she had skipped a little bit, then the nose hit the water". This estimate of the aircraft's attitude at impact coincides with the captain's testimony that he believed the aircraft at impact was much closer to level than was estimated by the co-pilot. Several of the passengers stated they thought a landing had been made on the airport until they saw water coming into the aircraft.

## Probable Cause

The probable cause of this accident was the serious error in judgement and piloting technique on the part of the co-pilot and the failure of the captain to recognize the error and take over the controls in sufficient time to take corrective action.

ICAO Ref: AR/180

## No. 15

**United Air Lines, Inc., Boeing Model 377, N-31230 aircraft, crashed on 12 September 1951 near Redwood City, California. CAB Accident Investigation Report No. 1-0089. Released 17 June 1952**

### Circumstances

The flight departed San Francisco at 0942 operating as "United Trainer 7030". Clearance was issued for local flight under VFR confined to a 100-mile radius from San Francisco and under 10 000 feet. The flight proceeded to Oakland where Oakland tower approved a simulated Instrument Landing System approach; this and a missed approach procedure were performed. The flight was advised of a delay due to traffic and the pilot decided to return to San Francisco. At 1039 the flight was cleared for an ILS approach to the San Francisco Airport but did not acknowledge. The controller heard the aircraft make an unreadable call on 121.9 megacycles, and instructed the flight to listen on 119.1. The flight was further instructed to hold VFR and stand by. The frequency change was accomplished and the pilot again requested permission to make a simulated ILS approach. This request was granted, with instructions to report upon leaving the ILS outer marker inbound. This message was not acknowledged. No emergency call was received from the aircraft. At approximately 1046 the aircraft abruptly dived from low altitude and crashed just offshore in San Francisco Bay, near Redwood City, California. The three occupants - two pilots and a flight engineer - were killed, and the aircraft was demolished upon impact.

### Investigation and Evidence

Witnesses estimated visibility from 2-1/2 to 3 miles, with haze and smog. Their attention was attracted to the aircraft by the "popping" of an engine, and the fact that the aircraft was flying lower and slower than usual.

Several flight tests were made to investigate theories of aircraft or engine malfunctions which could have caused or contributed to the accident. It was found that in addition to the usual method of increasing power through throttle advance a power surge could be induced without advancing throttles by closing the master electrical power switch and overspeeding the propellers through use of the propeller controllers.

Since nearly one-quarter of the wreckage could not be recovered, conclusive examination for mechanical or electrical failure could not be made. Examination of recovered material, which included the pertinent parts of the major components of the aircraft, including the control system, revealed no indication of mechanical failure or malfunctioning, fire, malfunctioning of the fuel or electrical systems, or air collision with any object. There were no indications of fatigue failure of any blade, and evidence indicated that all propeller blades were secure in the hub barrels upon impact.

The altimeter was set at 29.91 inches; the last setting given to the flight (but unacknowledged) was 29.78 inches. The directional gyroscope read 255 degrees.

Weather conditions at time of the accident were: ceiling unlimited with only residual stratus clouds at about 1 000 feet in some sections of the Bay area, visibility - 2 to 3 miles, haze and smoke.

The company, crew and aircraft were properly certificated. There was no evidence to indicate the aircraft was not airworthy at take-off.

The flight path during and following the turn near Redwood City, shows that control was normal, since there were no erratic manoeuvres prior to the dive. However, the stall could have resulted from a failure or malfunction in one of the control systems. An analysis of the simulated flight path shows that there was not sufficient altitude for the aircraft to have made an abrupt turn, thus placing it on the 250-degree heading along which the wreckage was strewn.

The fact that No. 4 propeller was found feathered, with no indication of malfunctioning in No. 4 or other engines gives good cause to believe that this configuration was the result of a simulated emergency given as part of the flight test.

It is evident that the aircraft struck at a sharp angle since the wreckage was confined to a very small area.

Engines Nos. 1, 2 and 3 were developing power at the time of impact. The landing gear was extended and wing flaps were down 10 degrees at time of impact.

The Boeing Model 377 was certificated with spoilers installed on the inboard leading edges of the wing between the inboard engines and the fuselage, in order to meet stall requirements for certification. The addition of spoilers results in certain problems in flying technique during take-off and landing, but the aircraft gives adequate stall warning and its stall characteristics are normal. The spoilers present a problem in angle of attack: if unduly increased (as during flare-out prior to landing), the aircraft might stall at this critical altitude, or if kept too high during the take-off run, maximum effective lift would not be obtained.

Concurrent with the several phases of investigation, a group of United Air Lines' engineers and safety specialists was organized to study the problem under the direction of the General Manager of Engineering. The primary question concerned the reason for the flight's descent from 1 700 feet, or above, to the approximately 300 feet reported by the witnesses, and subsequently, the crash.

Numerous hypotheses were advanced as to the reasons for voluntary and involuntary descent of the aircraft. However, no hypothesis was accepted.

The aircraft was in approach configuration and air speed would have been relatively low. The flight path pattern and observations of witnesses definitely indicate that the stall was the cause of the accident. However, the evidence available does not permit a definite determination of the cause of the stall.

## Probable Cause

The probable cause of this accident was an inadvertent stall at a low altitude from which recovery was not effected.

ICAO Ref: AR/202

No. 16

DC-4 F-BBDD Aircraft, made a forced landing
at Casablanca (Morocco) on 12 September 1951.

Circumstances

The aircraft, en route Casablanca-Dakar, crash landed in an open field 6 km. SSW of Casablanca - Cazes aerodrome. There were no serious injuries to passengers or crew although the aircraft was seriously damaged.

Investigation and Evidence

The DC-4 took off from Casablanca Cazes airfield at 1458 hours. The take-off was normal. The aircraft was in the climb configuration with $V_i$ = 150 mph and at an altitude of 3 700 feet when suddenly the intake pressure of No. 3 engine rose from 34 to 40 inches with the revs remaining at 2 250. An attempt to operate the throttle was ineffective and the pilot decided to return to Casablanca meanwhile instructing the engineer to feather the engine. In spite of several attempts, during which the propeller overspeeded, the propeller of No. 3 engine would not feather. As the aircraft was rapidly loosing height the pilot instructed the engineer to apply maximum continuous power (METO) to engines 1, 2 and 4. No. 4 engine did not respond and continued to show 2 250 RPM with intake pressure of 40 inches. The speed of the aircraft dropped to 130 mph and the rate of descent increased to 400 to 500 feet per minute. Fuel was jettisoned and the flaps lowered to 15°, but the aircraft was unable to reach the aerodrome. The pilot crash landed the aircraft (landing gear retracted) in a field 6 kilometres from the runway.

Examination of the engine controls established that the turnbuckle gearbox of the upper cable of the throttle was no longer in its proper place, and that therefore the throttle plate which was held in the "fully open" position by a release spring, could not be operated from the cockpit. No trace of the brass locking wire was found in the couplings, but it was noted that the first three threads of the two control cable couplings showed signs of having been stripped.

Subsequent examination of the feathering controls and the various accessories relative to the feathering mechanism showed no malfunctioning. Therefore, the cause of the overspeed and the reason for the inability to feather No. 3 engine propeller were not determined.

Examination and test of No. 4 engine showed no faults. A flight check in similar conditions to that experienced by the crashed aircraft was undertaken with the following results:-

The difference in rate of climb when No. 3 propeller is feathered and when it is windmilling at $V_1$ = 150 is approximately 250 feet per minute (engines 1, 2 and 4 being at maximum continuous power (M.E.T.O.))

The difference in rate of climb between "off" and "on" when No. 3 propeller is windmilling, is negligible (engines 1, 2 and 4 at (M.E.T.O.))

With No. 3 engine windmilling and No. 4 engine at 2 250 r.p.m. (1 and 2 being at M.E.T.O.), the aircraft retains a slight positive rate of climb.

For an aircraft speed $V_1$ = 150 m.p.h., the rotational speed of the windmilling propeller is 2 250 r.p.m.

The rate of descent and the piloting conditions with engines 3 and 4 reduced, follow very closely the pattern noted on the F-BBDD.

In short, the second flight has shown that the characteristics of the four power-units at the moment when No. 3 engine was switched off (altitude between 3 700 and 3 000 feet), were as follows:

Engines 1 and 2: METO power
Engines 3 and 4: propellers windmilling

The foregoing test shows beyond doubt that No. 4 engine had been windmilling probably from the moment No. 3 engine was switched off.

The crew was preoccupied with the No. 3 engine propeller and thought that the power given by No. 4 engine was somewhere between "climb" and "METO", as was shown on the engine speed indicator (2 250 r.p.m.) and the intake pressure gauge (about 40 inches) which in fact only showed the engine rate resulting from the windmilling of the propeller, and the intake pressure given by the compressor.

The engines were not equipped with a couple measuring device which would have immediately shown the absence of power.

It appears that the failure of No. 4 engine was probably caused by the simultaneous switching off of engines 3 and 4; the proximity of the two switches may have lead to their being operated simultaneously in a critical moment.

In short, the necessity for the pilot to land the aircraft in a field was due to a lack of power on No. 4 engine, resulting from a probable error in manipulation by the engineer.

Initial cause (ascertained)

Ineffectiveness of the throttle control of No. 3 engine, due to the fact that the cable operating the throttle pilot became disconnected.

Contributory Cause

Overspeed on No. 3 engine and inability to feather the propeller for undetermined reasons.

Lack of power on No. 4 engine due probably to a manipulating error (switches disconnected on engines 3 and 4 simultaneously).

Aggravating Cause (ascertained)

Forced landing caused by the absence of power on engines 3 and 4, and by the drag resulting from the windmilling of the corresponding propellers, which produced a sinking speed of 400 to 500 feet per minute.

ICAO Ref: AR/221

## No. 17

**Eastern Air Lines Inc., Douglas DC-4, N-75415, damaged when landing at Miami, Florida on 14 September 1951. CAB Accident Investigation Report No. 1-0081. Released 22 April 1952.**

### Circumstances

The flight originated in Boston, Mass., on 13 September 1951, its destination being Miami, Florida. Stops were scheduled at New York, Washington, D.C., and Jacksonville, with routine aircraft and crew change at New York. On leaving Jacksonville the gross take-off weight was 54 671 pounds (within allowable weight limit - 65 705). The flight was routine until landing.

When approximately 200 feet past the approach end of the runway, a normal landing was made on the main landing gear wheels. The aircraft then travelled a considerable distance during which the landing gear was observed to retract causing the aircraft to settle on its fuselage and slide to a stop. A flash fire in No. 3 engine nacelle was soon extinguished. No injuries were sustained.

### Investigation and Evidence

Although the crew stated that the landing gear control lever was placed in the fully down position and was not moved again, it is probable that after landing this lever was inadvertently moved upward instead of the flap control lever. This must have occurred when wing lift was still present and there was insufficient weight on the landing gear strut to actuate the landing gear control lever safety latch. This is substantiated by the manner in which the actuating cylinder rods were partially retracted.

Tests made subsequent to the accident showed that the landing gear mechanism and hydraulic system were capable of functioning in a normal manner.

The crew stated during approach they observed the green warning lights to be on and since the landing gear functioned properly after the accident it can be assumed that at that time the gear was down and locked.

The aircraft's maintenance records were reviewed and these indicated that normal inspections and maintenance had been performed. All airworthiness directives had been complied with.

All switches were in the OFF position. The carburetor mixture controls were at idle cutoff position and the carburetor air controls were in the cold position. The main auxiliary fuel and the fuel cross-feed valves were off; and the hydraulic fluid by-pass and hand pump valves were closed. The emergency brake pressure gauge registered a normal 1 000 psi and the hydraulic system pressure gauge registered a normal 1 200 psi - cowl flaps closed, propeller controls full forward, flap indicator and flap lever full down, landing gear lever down and the landing gear lever solenoid safety pin the safe lock position, and the landing gear warning light switch at the bright position.

## Probable Cause

The inadvertent moving of the landing gear control lever upward during the landing roll, caused the landing gear to retract.

ICAO Ref: AR/185

## No. 18

## Rocky Mountain Air Shows, Inc., Timm aircraft, Model N 2T-1, N-56308 (Experimental) crashed attempting slow-roll at Flagler Airport, Colorado on 15 September 1951. CAB Accident Investigation Report No. 4-1497. Released 3 January 1952

### Circumstances

The community of Flagler, Colorado, engaged Rocky Mountain Air Shows, Inc., to stage an air show. An "Application for Certificate of Waiver" was submitted to the CAA Aviation Safety Agent via the manager of Flagler Airport. A waiver was issued by the CAA who incorporated in the certificate the following special provisions applicable to the conduct of the air show:

1) No aircraft engaged in operations under the terms of this certificate of waiver shall be flown toward, over or within 500 feet horizontally of the spectators.

2) Flight visibility must be at least three miles during acrobatic flights.

3) No acrobatic flights shall be conducted at less than 500 feet vertically and 2 000 feet horizontally from any cloud formation.

4) A standard closed field signal (large white X) shall be prominently displayed on the landing area at all times when the air meet is in progress. This signal shall be of sufficient size to be readily seen and read from an altitude of 3 000 feet above the landing area.

5) Adequate provisions shall be made for the parking of automobiles and visiting aircraft within definite prescribed areas, so located as to preclude any aircraft operation, under the terms of this certificate of waiver, toward, over, or within 500 feet horizontally of such areas.

6) Adequate provisions shall be made for the proper control of spectators to insure that they will remain within the prescribed areas at all times when the air meet is in progress.

7) A physical barrier shall be provided to define the boundaries of the spectator areas and to assist policing personnel to confine spectators within such areas.

8) A suitable signal shall be provided to inform all participants (both in the air and on the ground) that the air show has been halted, in case such action should become necessary.

9) The air show shall be immediately halted if unauthorized persons enter the operations area, or if for any other reason such action is necessary in the interest of safety.

10) A representative authorized to act for the air meet management shall be immediately available at operations headquarters at all times while the air meet is in progress.

11) A deadline, readily visible to the participants, shall be provided to insure the minimum spacing between spectators and participating aircraft as shown in special provision Number 1, above. (NOTE: Runways or other clearly defined lines of demarcation if suitable (suitably) located, may be utilized for (for) this purpose).

12) Prior to the beginning of the air meet all pilots participating shall be thoroughly briefed on all special field rules, manner and order of events, and all provisions of this certificate of waiver.

13) All acrobatic manoeuvres shall be completed 500 or more feet above the surface of the ground.

14) All programmed flights shall be parallel to and/or at least 500 feet horizontally from the spectator area.

The day of the air show the CAA representative flew to Flagler and ascertained that the provisions of the waiver relative to ground safety measures had been met. At 1440 approximately the subject aircraft arrived south of the field at approximately 500 feet and flew north toward the south-north runway, laying a smoke trail as it approached at an estimated altitude of 150 feet. At a point opposite the south end of the hangar, and while directly over the south-north runway, the aircraft started a slow roll to the right. Its horizontal distance from the spectators' roped-off area was about 100 feet. Upon reaching the inverted position, the nose of the aircraft dropped and the line of flight was altered to the right approximately 30 degrees towards parked automobiles and spectators. The pilot was completing his roll when the left wing struck the ground and the aircraft crashed into spectators and automobiles. The accident resulted in the death of the pilot and 19 persons on the ground, and serious injuries to 10 others. A number of vehicles were extensively damaged, and the aircraft was demolished.

Investigation and Evidence

The incompleted slow roll that resulted in this accident was started at an altitude variously estimated at about 150 feet, and was improperly executed inasmuch as the aircraft lost altitude while inverted and slipped into the ground when the roll was nearly completed. Well qualified witnesses, including two CAA agents confirm this information.

Examination of the aircraft wreckage indicated that immediately after the left wing tip struck the ground, the nose of the aircraft struck a number of automobiles, parked three deep, and continued along the two outer rows for about 125 feet. The aircraft disintegrated and its parts were strewn along the 125 feet over a width of about 40 feet. The engine and its attached propeller had been carried away with the engine mount and front bulkhead of the fuselage. Propeller blade distortion indicated that power was being developed at the time of impact; the propeller was in low pitch. The pilot was wearing a parachute and had his safety belt fastened. The safety belt had pulled both of its anchors from the fuselage structure.

Investigation disclosed no evidence of any failure of the aircraft's structure, controls, or powerplant prior to impact. The rudder trim tab was set about 10 degrees to the left. The right elevator trim tab was found in the 30 degree "up" position. The glue bonds connecting the rear bulkhead of the fuselage to the longerons and fuselage skin were examined minutely. Although some deterioration of the glue bonds was noted in this area, there was no indication that this condition had resulted in any malfunctioning of the aircraft prior to the accident.

The subject aircraft was a two-place open land monoplane built in 1942. In June 1950 it was overturned on the ground during a windstorm with resulting damage to the propeller, vertical stabilizer and rudder. Following repairs the owner had a 300 horsepower Lycoming engine installed in place of the original 225 horsepower Continental. The Lycoming engine was not carburetted for inverted flight. Two days prior to the accident it was certificated in the experimental category for "Exhibition Flights," and was test flown by the aircraft and engine mechanic (and pilot) who had supervised the installation of the Lycoming engine. He pronounced the flight characteristics as satisfactory, adding that it was necessary to carry a slight amount of "up" elevator trim to offset nose heaviness, however, no acrobatics were performed during this test flight.

The day prior to the accident the subject pilot flew the aircraft in question. Ground witnesses saw him do a number of manoeuvres, not including slow rolls, and also saw him "fall out of a loop" as if the loop had been performed improperly. Later the same day the aircraft was again flown by a third pilot who went through a number of manoeuvres including slow rolls; he stated that the aircraft's performance was satisfactory.

The subject pilot was a lieutenant in the USAF and records showed his recent military flying had been in bombers; there appears to be no record of his having flown small aircraft acrobatically for a considerable time. His total piloting time was 2 500 hours in various types of military and civil aircraft. He held a commercial pilot certificate, currently effective on the day of the accident, with several ratings, including the appropriate one for the Timm aircraft. Although this certificate authorized him to fly civil aircraft, United States Air Force Regulations require a military pilot to obtain permission from his Commanding Officer to fly other than military aircraft. The pilot had not obtained this permission.

Evidence indicates that the pilot's only experience with the subject aircraft, prior to the flight from Denver to Flagler, was some 30 minutes on the day before the accident. Evidence also indicates that he had intended to practice acrobatics while en route from Denver to Flagler, but there is no evidence whether he did so or not. Investigation disclosed that the aircraft experienced mechanical difficulties (oil leak) accounting for its late departure for Flagler where it was due prior to 1300 so that the pilot could have a final briefing.

The show promoter testified that he admonished the pilot about adhering to the 500 foot minimum altitude for the conclusion of all acrobatics and the 500 foot minimum horizontal distance from the spectator area as well as the necessity of landing at Flagler, for briefing, prior to the start of the show. The pilot of a sailplane, also participating in the show, however, contradicted the show promoter's testimony by asserting that he had been instructed by same that in the event of arriving late at Flagler he was to go into his act immediately, which he did. The pilot of the subject aircraft likewise started acrobatics immediately on arrival at Flagler.

## Probable Cause

The probable cause of this accident was the pilot's loss of control of the aircraft during an attempted slow roll closer horizontally to the spectators and at an altitude lower than that specified in the waiver in utter disregard of the safety of persons and property on the ground.

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Note.— Subsequent to the accident the CAA announced a new policy under which certificates of waiver of the air traffic rules will be issued for air races, air meets and similar aeronautical demonstrations only when it is shown that such activities will contribute directly to the advancement of, and public confidence in, aviation. Under the new policy, certificates of waiver will not be issued for such events as acrobatics not under direct radio control provided by the certificate holder, delayed parachute jumping, dog fighting, crazy flying, intentional aircraft crashes, and similar unusual and hazardous types of aircraft operation.

ICAO Ref: AR/166

## No. 19

## Peninsular Air Transport, Curtiss A-C-46D, Aircraft N-74689 crash landed after take-off from Midway Airport, Chicago, on 16 September 1951. CAB Accident Investigation Report No. 1-0069. Released 29 February 1952.

### Circumstances

The aircraft carrying 49 passengers and a crew of 4 proceeded to take off from Midway Airport. It became airborne at about 100 or 105 m.p.h., but simultaneously it experienced a complete loss of power from the left engine. The landing gear was immediately retracted, and since corrective action proved of no avail the left engine was switched off and its propeller feathered. The aircraft started a slight turn to the left and began to lose altitude, therefore a crash landing was made in a stretch of open land near the airport. 36 of the 49 passengers and the 4 crew members were injured in varying degrees. The aircraft was extensively damaged.

### Investigation and Evidence

It was ascertained that following take-off the left engine started misfiring, then commenced backfiring. The Captain placed the left mixture control in the full-rich position, without effect so he then turned off the left engine's right magneto. The engine continued to fire erratically, the Captain put the magneto switch back on both magnetos, the engine then lost all its power, and its propeller was feathered. In the meantime the co-pilot informed the Chicago tower that the flight had an engine "out" and was returning to the airport, in reply to which the aircraft was cleared to land on any runway.

Evidence indicates that the aircraft climbed slowly on its right engine to an altitude of about 150 to 200 feet. The Captain stated that at this point he believed that the right engine was losing power. The aircraft continued to turn gradually to the left, with airspeed never more than 110 m.p.h. and sometimes as low as 100 m.p.h. The direction of flight was now at about 90 degrees to the left of the take-off direction and altitude was being lost. Over the edge of a sizeable stretch of open land at an altitude of about 75 feet, the Captain decided to crash land. He cut the power on the right engine, nosed the aircraft down, quickly flared it out, and landed exceptionally hard with landing gear and flaps retracted. The severity of contact broke both engines completely free of their mounts. The aircraft rode over both engines, bounced several times and slid to a stop.

Damage to the aircraft consisted of the tearing free of both engines, the crushing in of the bottom of the fuselage from impact and sliding over the ground, and the tearing of the undersides of both wings from riding over their respective engines. There was no indication of any failure of the aircraft's structure or any malfunctioning of its controls prior to the crash landing. Within the cabin there was no extensive damage. A few safety belts were broken and a few seats had failed at their attachments. The left propeller was found to be in the feathered position. There was evidence of a small ground fire at a broken oil line of the right engine, which appeared to have been self-extinguished.

It was established that the day prior to the accident following take-off from Covington en route for Midway Airport, Chicago, malfunctioning of the left engine had been experienced. This trouble manifested itself by intermittent misfiring, and was corrected by the use of full-rich mixture. On arrival at Chicago the aircraft was taxied to a repair station where the following morning it was discovered that the rear spark plug of No. 12 cylinder was gone and its lead wire burned. The spark plug, with its threads badly burned was found in the engine cowling. The threads of the plug bushing had been partially burned away. A top was run into the bushing to clean the threads. A new spark plug was then installed and screwed in place more firmly than usual. A new lead to the spark plug was also installed, and a small leak in the hydraulic system was repaired. The engine was run up several times with power settings of 30 inches of manifold pressure and 2 000 RPM. It performed to the satisfaction of maintenance personnel and the aircraft's captain whereupon the service manager, a certificated mechanic, approved the work.

Investigation centered on, first, the mechanical condition of the powerplants, particularly in regard to their ignition systems, especially that of the left engine, and second, the actual take-off weight of the aircraft. Spark plugs of the left engine were removed and examined. Apart from some impact damage all appeared to be normal, with the exception of both plugs from No. 12 cylinder. The front spark plug gave indication of having run hotter than normal. The rear spark plug (the new one installed on the day of the accident) was burned away for three-eighths of an inch of the circumference of its shell and the burning extended, decreasingly, for seven-sixteenths of an inch from the inner end. Eight threads of this spark plug were partially filled with material from the bushing; it had fused to the plug. Of the four shell electrodes, one had melted and another had fused to the center electrode; all four had been subjected to extreme heat. This spark plug was damaged in the same manner, but to a lesser degree, as the spark plug that came out during the flight to Chicago.

Cylinders of the left engine were removed and examined. All appeared to be normal, with the exception of No. 12. Its intake valve showed signs of abnormally high temperature, and its piston evidenced high operating temperatures in the portion adjacent to the rear spark plug. The interior of No. 12 intake pipe showed conclusive evidence of backfiring and torching into the induction system. The cylinder itself showed burning of three cooling fins adjacent to the rear spark plug, and the inner threads of the rear spark plug bushing were burned away with only traces of the root areas of the threads remaining unburned.

It is probable that the spark plug failed during the higher power settings with their higher pressure and temperature, induced when the engines were run up to full take-off conditions (approx. 52 inches and 2 700 RPM), during the take-off itself. As a considerable portion of the thread of the plug was burned away, and as the great majority of the mating surface of the spark plug's bushing had been burned away, it is apparent that there had been insufficient metallic contact between the spark plug and its bushing to allow the spark plug to cool sufficiently. Such a condition would readily result in the overheating of the spark plug to such an extent that two of its four shell electrodes melted, one fusing to the center electrode. The physical and thermal effects of this condition could cause the spark plug to act as a point of heat concentration sufficiently hot to fire incoming fuel simultaneously with the opening of the intake valve. The condition of the interior of the cylinder, the intake valve, and the intake pipe attest to this having happened.

Both magnetos of the left engine were examined. On the right magneto it was found that about one half of the center high tension rotor contact was missing, and the remainder was badly burned. This condition could not have contributed to or augmented the failure of No. 12 rear spark plug, inasmuch as this magneto fires the front plugs. However, the fact that the magneto was defective could well have caused some power loss entirely apart from the failure of the rear spark plug. The mating high tension contact in the magneto cover was about 60 per cent eroded and shaped to a point. The left magneto displayed no abnormality that could have caused it to malfunction. No significant irregularities were found in any of the other accessories of the left engine.

With regard to the right engine, all spark plugs appeared to be normal and nothing significant was found in any of the other engine accessories, except in this engine's right magneto. Its center high tension rotor contact was broken and lying in the bottom of the rotor cup and bore evidence of abnormal heat as result of arcing. The mating high tension contact in the magneto cover was completely eroded. It is possible that the condition of the right magneto of this engine could have been instrumental in causing a certain small loss of power.

According to the Weight and Balance Manifest, the aircraft was loaded within the maximum allowable gross weight of 45 000 pounds and the center of gravity was within specified limits. However, the amount of fuel shown to be aboard was 670 gallons, and this figure was in error. The aircraft left Miami the previous day with 1 000 gallons of fuel and 337 gallons were added at Covington. Based on flight time and on normal fuel consumption, the flight should have used 1 062 gallons between Miami and Chicago. The difference between 1 337 and 1 062 is 275. As 722 gallons were added at Chicago, the total fuel at time of take-off was 997 gallons. The manifest showed 670 gallons. The difference is 327 gallons which would weigh about 1 962 pounds. If 100 pounds of fuel are discounted to cover run-up and taxiing time at Chicago, plus increased fuel consumption due to running the left engine in auto-rich mixture between Covington and Chicago, it will be apparent that the take-off weight was approximately 1 860 pounds more than the maximum allowable of 45 000 pounds.

## Probable Cause

The probable cause of this accident was the poor technique used by the pilot in taking off at too low an airspeed to maintain single engine flight, followed by a critical loss of power from the left engine, and subsequently a partial loss of power from the right engine, conditions which were aggravated by the effects of the overload.

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Note.- As a result of this accident, the Administrator of Civil Aeronautics filed the following charges of violations of the Civil Air Regulations against the aircraft's captain:

a) That the aircraft was operated at a gross weight in excess of that authorized in its airworthiness certificate and the prescribed operations limitations contained therein, and at a weight in excess of the maximum take-off weight for said aircraft for the elevation of Chicago Midway Airport.

b) Operating the subject aircraft in a careless and reckless manner so as to endanger the lives and property of others.

The CAA also brought charges against the service manager of the repair station for violating those Civil Air Regulations relative to repairs affecting airworthiness.

ICAO Ref: AR/179

## No. 20

## Queen Charlotte Airlines Limited, Consolidated PBY-5A aircraft, CF-FOQ, crashed into Mount Benson, Vancouver Island, B.C. whilst on a non-scheduled flight on 17 October 1951. Dept. of Transport, Air Services Branch, Civil Aviation Division, Report No. 51-38

### Circumstances

The aircraft left Kildala, B.C. at 1532 bound for Vancouver carrying twenty passengers and a crew of three. At 1733 the aircraft reported over Sullivan Bay and gave its ETA Vancouver as 1840. At 1825 the ETA Vancouver was revised to 1903 on account of strong south-east winds. The next and last radio transmission received was at 1848 when the aircraft reported it was 20 miles west of Vancouver at 2 000 feet and requested clearance to the Tower frequency. At approximately 1855 hours the aircraft crashed into Mount Benson. All occupants were killed and the aircraft was destroyed.

### Investigation and Evidence

Immediately prior to the accident, the aircraft was seen in the vicinity of Wellington, B.C. by a number of witnesses (almost simultaneously) who stated that the aircraft was flying at approximately 500 feet above the ground in rain and in the base of or immediately below cloud, and heading toward Mount Benson, which rises to 3 366 feet and is situated 4-1/2 miles west of Nanaimo. At approximately 1855 hours, the aircraft was heard by witnesses to strike the mountain and, although their vision was obscured by cloud, the glow from the resulting fire was seen.

Mount Benson rises steeply to a peak 3 366 feet high and the actual point of impact of the aircraft was 1 600 feet ASL. The flight path of the aircraft just prior to the accident was 225° T., determined by broken snags about 60 to 70 feet in height. One large snag about 16 inches in diameter and approximately 200 feet from the final crash was broken off and the right wing, crumpled, was found nearby. The aircraft struck a rock wall which was almost vertical and then fell back onto a narrow ledge approximately 15 feet below. Examination of the wreckage indicated that the aircraft struck the face of the mountain in an inverted position.

Examination failed to disclose any evidence of malfunctioning of the airframe, engines or controls, though the latter were so badly burned as to offer no reliable information. The aircraft log books were not found and are presumed to have been destroyed. It was determined that the aircraft had adequate fuel on board for the flight and that it had been loaded in conformity with the requirements of the Certificate of Airworthiness. The crew were properly certificated.

The forecast issued by the Vancouver District Aviation Forecast office, valid from 1400-0200 hours indicated that a general lowering of cloud base was expected with frequent ceilings of 800 feet in the area of Vancouver Island. It was established that the latest Meteorological Information was not obtained by the captain before taking off on the south bound trip. At the time of the accident eye-witnesses stated that in that vicinity the cloud base was 400 to 500 feet, one witness who was about 300 feet further up the mountain stated that there was fog down into the trees. Heavy rain was also reported. It is to be noted furthermore that the accident occurred at 1855 hours which is one hour and six minutes after official night.

Recapitulation of the flight showed that when the aircraft's position was reported as 20 miles west of Vancouver at 2 000 feet, it must actually have been in the vicinity of 18 miles west to northwest of Nanaimo. This is confirmed by the aircraft's having been seen over the southern part of Nanaimo at 1855 just before the crash. It would appear therefore that through a navigation error the lights of Nanaimo were mistaken by the crew for those of Vancouver and that the aircraft turned to the right to avoid passing over what they believed to be Vancouver.

## Probable Cause

The probable cause of this accident was the continuance of the flight VFR at night under conditions of restricted visibility. Whilst it cannot be determined conclusively, it is probable that through a navigation error the pilot mistook Nanaimo for Vancouver. This may have been precipitated by inadequate pre-flight preparation in that the latest Meteorological Information was not obtained by the pilot before taking off on the south bound flight.

ICAO Ref: AR/175

## No. 21

**Noorduyn Norseman VI, CF-BTH aircraft, crashed while landing at Red Lake, Ontario, on 22 October 1951. Dept. of Transport, Air Services Branch, Civil Aviation Division. Serial No. 51-39**

### Circumstances

In the late afternoon, 22 October 1951, a Public Transport pilot took off from Red Lake, Ontario for McDowell Lake, Ontario. This flight was normal. However, on the return trip, on its final approach-to-land, the navigation lights of the aircraft were seen and reduction in power was heard. Then an unusual noise followed by a burst of power was heard, which in turn was followed by the power being turned off and the thud, as the aircraft crashed into the water and rocks in a semi-inverted nose-down position. The pilot was killed and the aircraft destroyed.

### Investigation and Evidence

The aircraft had a Certificate of Airworthiness for day flying only. Night flying facilities are not provided at Red Lake, Ontario. "Night" as defined in the Air Regulations commenced at Red Lake at 1742 hours CST and the accident occurred between 1840-1850 hours CST.

An approach-to-land had been made over the highest ground in the vicinity and the aircraft had collided with tall trees before impact.

### Probable Cause

Due to the continuation of a day VFR flight into the hours of darkness the pilot had to try a night landing without proper facilities and in so doing hit tall trees which caused the aircraft to crash into the water.

ICAO Ref: AR/193

## No. 22

## Bell 47D1 Helicopter, CF-GUD, crash landing near Burk's Falls, Ontario, on 30 October 1951. Dept. of Transport, Air Services Branch, Civil Aviation Division, Report No. 51-40.

### Circumstances

The aircraft was en route from Muskoka Airport to North Bay, Ontario, carrying one passenger and the pilot. In the vicinity of Burk's Falls, Ontario, the aircraft lost directional control and corrective action being of no avail, an immediate forced landing was attempted through trees. The passenger received fatal injuries, the pilot minor injuries and the aircraft substantial damage.

### Investigation and Evidence

It was ascertained that when about 2-1/2 miles south of Burk's Falls, the aircraft commenced a gradual turn to the right, of its own accord, which full left rudder failed to stop. During the turn height was lost and it was noted that the indicated engine and rotor speeds were less than normal for level flight. On opening the throttle the engine speed reading increased and then began to decrease again. The aircraft was then put into power-off auto-rotation for a forced landing. Directional control was regained immediately and a forced landing attempted through the trees. A flare-out was made just above the trees and an attempt made to hold the tail down to absorb the shock of the first impact and thus protect the occupants. The aircraft was found in an inverted position about five minutes after the crash with the pilot still strapped in his seat. The passenger's seat belt was unfastened and he was found about 4 feet from the wreckage.

The aircraft had been certified as airworthy and there was no evidence of malfunctioning of the airframe or controls. The investigation disclosed that the tail rotor gear box pinion shaft had failed as a result of fatigue during flight thus causing the loss of directional control and making a forced landing necessary. The pilot was properly certificated.

### Probable Cause

The probable cause of this accident was the failure, due to fatigue, of the tail rotor gear box pinion shaft during flight.

ICAO Ref: AR/176

## No. 23

## S.O. - 30 F-OAIY Aircraft, runway accident at Orly on 30 October 1951.

### Circumstances

The right main undercarriage leg retracted suddenly while the aircraft was on a take-off run at Paris/Orly airport. The right wing struck the ground and slewed the aircraft round in the opposite direction. Fire broke out in the cargo hold but all passengers and crew were safely evacuated. The aircraft and cargo were about 80% destroyed.

### Investigation and Evidence

After clearance was given to the aircraft for take-off, the aircraft was lined upon Runway 21 with its nose wheel set on the take-off line. The throttles were opened gradually and the aircraft began its normal take-off along the centre line of the runway. In the pilot's words, "the aircraft covered approximately 150 metres, engines were at 2 700 r.p.m; manifold pressure 42 inches; airspeed not more than 75 miles per hour. Just as the flight engineer was synchronizing the propellers a very loud explosion was heard and just about the same time the starboard wing listed heavily towards the ground. A bumping was felt on the right side and the aircraft swerved to the right".

The aircraft left the runway and came to a standstill facing in the opposite direction. Although the throttles were closed, engine switches and the master switch switched off and the fuel valves closed, the engines continued to operate at full throttle and only heavy spraying with $CO_2$ succeeded in stopping them.

Evacuation of the passengers, which began immediately the aircraft had come to a stop, was carried out rapidly in spite of the fact that it was impossible to fully open the rear entrance door which remained stuck 1/3 open. Shortly after the aircraft stopped, fire broke out in the lower hold but was rapidly brought under control by the airport fire brigade.

Examination of the damaged aircraft showed that the right landing gear leg had retracted. Statements by the crew confirmed that all three green indicating lights were on when seen just before the aircraft began to swerve to the right. Examination of the actuating equipment of the right leg indicated the following:

a) Electrical controls were operative and there was no evidence of any sudden switching of the electrical current to the right leg electro valve which could have caused sudden retraction.

b) The device for preventing retracting on the ground was in the proper operating position.

c) Extensive testing failed to indicate any failure in the hydraulic system.

It was established that the cause of the continued operation of the engines after the accident was the cutting of a number of circuits, controls and conduits by flying fragments of the propeller blades thereby rendering ineffective any action by the pilot or flight mechanic to stop the engines.

The reason for the rear exit door jamming in the 1/3 open position was the offsetting of the hinge system of the rear door caused by distortion of the fuselage consequent upon the accident.

The cause of the fire in the hold was the burning of the fuselage sheeting by the exhaust of the right engine, the exhaust acting as a blow-torch, igniting clothes and goods in the hold and hydraulic liquid spilled from broken lines.

## Probable Cause

The cause of the sudden retraction of the right leg of the main landing gear could not be determined.

ICAO Ref: AR/222

## No. 24

**United Air Lines, Inc., DC-3A aircraft N-17109, crashed on training flight northeast of Stapleton Air Field, Denver, Colorado, 4 December 1951. CAB Accident Investigation Report. No. 1-0096. Released 16 May 1952.**

### Circumstances

The aircraft departed Stapleton Air Field on a training flight at 0655, on 4 December 1951, carrying a crew of three. The 0628 weather conditions were ceiling - 15 000 feet, visibility 25 miles, wind - northeast 14 knots. No radio contacts were made by the aircraft after departure time. It was cleared for a training flight of four hours' duration within a 25-mile radius of Denver. Upon departure, the aircraft load, in addition to the crew, was 820 gallons of gasoline, full oil tanks, 650 pounds of sand ballast tied down in the rear baggage pit. The load was properly distributed with relation to the aircraft's center of gravity and the 22 910-pound gross weight at take-off was within allowable limits. Witnesses reported that at between 0720 and 0725 the aircraft was seen to stall, enter a spin, and strike the ground in a diving attitude before recovery was effected. The three occupants were killed and the aircraft was demolished.

### Investigation and Evidence

The flight was made for the purpose of a general review of terms taught at the Denver Training Center. When first observed the aircraft was flying in a northwesterly direction. One or more bursts of power were heard, accompanied by a black puff of smoke from each engine. The aircraft then stalled, entered a spin making two or more revolutions before diving into the ground. One witness stated that the aircraft struck the ground while diving at an angle approximately 60° below the horizontal with the wings almost level. United Air Lines conducted tests in order to estimate the altitude at which the aircraft entered the spin. Results showed that the aircraft was approximately 8 200 feet above MSL or 3 200 feet above the terrain. Prior to entering the spin considerable altitude, perhaps even 800 feet, was lost after power had been applied. During the test flight full power application at 2 700 rpm was necessary to simulate the sound heard by the witnesses.

Wreckage indicated that the aircraft struck the ground in a steep dive. The fuselage forward of a point four feet behind the main cabin door was demolished. Aft of this point, it was severely distorted and crushed. At impact the landing gear was extended and flaps were one-half down. All control systems were thoroughly checked but there was no evidence of malfunction or failure prior to impact.

Positions of controls could not be considered indicative of their positions prior to impact due to severity of impact and complete destruction of the cockpit.

Radio equipment was severely damaged. The high frequency transceiver was set on Channel 8, 3 322.5 milocycles; the VHF transceiver was set on Channel 8, or 126.7 megacycles. A barograph was installed but no information could be obtained from the film which was exposed when the unit was broken by impact. There was no evidence of overheating or fire.

The left and right propellers were set at a position five degrees above the low pitch stops. No evidence was found of excessive heat or internal part failure in either engine and both were developing power at impact. The aircraft was properly certificated and requirements of all applicable CAA airworthiness directives had been accomplished. Company and crew were also certificated.

Prior to the accident ground instruction was not given to trainees in spin recovery on DC-3 type aircraft and no flight instruction in spins can be given in the DC-3 type aircraft, since it is placarded against intentional spins. Subsequent to the accident, students at the Center have received ground instruction on the spin characteristics and spin recovery techniques applicable to the DC-3 aircraft.

During the investigation and public hearing, information was developed relative to the stall and spin characteristics of the DC-3.

Testimony of eyewitnesses indicates conclusively that the aircraft entered a spin at approximately 3 200 feet above the terrain. The Denver Training Center curriculum prohibits spins although it includes practice in approaches to a stalled condition except that aircraft are not brought to a full stall and all manoeuvres of this nature are to be performed between 8 000 feet and 9 000 feet MSL. Since no evidence was found of failure or malfunctioning of the aircraft it must be concluded that this spin was entered inadvertently. The fact that partial recovery was effected before impact is further substantiation that there was no failure or malfunctioning of the aircraft.

From the results of spin studies made by the NACA on this type of aircraft, which indicate that an altitude loss of approximately 3 000 feet will occur before full recovery can be effected, it is apparent that the spin in this instance was entered at an altitude too low to permit recovery from the dive, although rotation was stopped.

## Probable Cause

The probable cause of this accident was an inadvertent spin at an altitude too low for recovery.

ICAO Ref: AR/198

No. 25

Swissair, DC-4, HB-ILO crashed due to a failed overshoot operation on 14 December 1951 at Schiphol Airport, Amsterdam, The Netherlands. (Special Aircraft Accident Bulletin, Series 1952; No. 2, NFPA).

## Circumstances

This aircraft, a DC-4, HB-ILO operated by Swissair was making an ILS approach in dense fog at Schiphol Airport, Amsterdam, on 14 December 1951. The crash occurred at 1757 (GMT) due to a failed overshoot operation. All twenty occupants of the aircraft escaped.

## Investigation and Evidence

The crash landing occurred in ploughed clay ground and the aircraft touched ground some 650 feet outside the boundary of the airport. At the time of initial impact both the left and right wings were severed and the hull came to rest in a ditch some 328 feet from the point of first impact. The high speed impact (140 mph) separated the wing structures from the fuselage, the latter skidding some 328 feet beyond the point of first impact. Thus the greatest percentage of the 1,200 gallons of gasoline aboard burned at a distance from the occupied portion although the fuselage was gutted due to the entry of flames through the wing root.

Fire was instantaneous with the impact and entered the fuselage through the wing roots although the major spill and fire was, by virtue of the wing severence, some distance from the hull. A trail of fire connected the separate sections; some 1,200 U.S. gallons of gasoline were aboard. Eighteen persons escaped unaided and unhurt, one (a stewardess) suffering major burns when she fell into the ditch where fuel was burning. All passengers were able to evacuate through the normal (rear) exit door although some of the crew escaped through the navigation dome and cockpit windows.

Crash trucks at the airport had been on an alert status because of bad visibility conditions and were immediately dispatched by the Air Traffic Center. Three crash trucks and two ambulances responded. The exact accident site could not be seen by the tower but the correct location was radioed to responding equipment enroute. Arrival near the scene was therefore delayed (8 minutes total time), although this was of no consequence as far as rescue was concerned as the passengers and crew had already escaped. The crash trucks could not approach the wreckage closely because of a trench running parallel with the ditch in which the fuselage came to rest. On arrival both the fuselage and wing sections were burning and extinguishment could not be secured for 1 hour and 15 minutes.

Both premixed and "pick-up" foam solutions were employed. The crash trucks carried a total of about 1 900 gallons of water and an additional 1 800 gallons was supplied from an airport hydrant about 3 000 feet distant. The report secured from the local fire authorities indicates that a total of 140 000 litres of air foam was used and that "in view of the circumstances, we are of the opinion that this fire was extinguished in the best possible way". A total of 11 fire fighters were available.

## Probable Cause

The crash occurred due to a failed overshoot operation.

ICAO Ref: AR/214

## No. 26

**Miami Airline Inc., C-46F aircraft, N-1678l4, an irregular air carrier crashed shortly after take-off from Newark, N.J. Airport on 16 December 1951. CAB Accident Investigation Report No. 1-0100. Released 13 April 1952.**

### Circumstances

The aircraft arrived at Newark following a non-stop flight from Fort Smith, Arkansas on 15 December. During this 5-1/4 hour flight there was no reported malfunctioning of the aircraft or its powerplants except for both cabin heaters being inoperative. A CAA approved repair station at Newark was instructed to repair the heaters. Next morning one was believed repaired but the aircraft was not test flown to prove it.

The aircraft was serviced on the morning of the 16th. The left engine required five gallons of oil and the right engine, ten gallons to bring the individual tank totals to 34 gallons each. 767 gallons of fuel were also added. The aircraft's centre of gravity was within prescribed limits. Take-off weight was 117 pounds over the prescribed maximum of 48 000 pounds. A flight plan signed by pilot and co-pilot specified VFR (Visual Flight Rules) direct flight at a cruising altitude of 4 000 feet to Tampa, Florida.

After loading, both engines were run up. The right engine was run up longer than the left and smoke was seen continuously coming from that engine. This smoke was described as "white", "grey", and "light" in colour. At 1502 the flight was cleared for take-off, leaving the ground at 1503. The landing gear was retracted. At this point tower personnel saw a trail of white smoke coming from the right side of the aircraft and the supervisor fearing a fire, pressed the airport crash alarm button. The tower advised the flight to land in anyway possible, and cleared it back to the field. This was not acknowledged, The aircraft continued for approximately 4 miles slowly gaining altitude to approximately 800-1 000 feet. Black smoke and flame were seen coming from the underside of the right nacelle as the landing gear was lowered. The aircraft started a gradual left turn banked at approximately 10 degrees. At a point 2-1/4 miles from Runway 6 and at 200 feet altitude the left wing dropped downward vertically, with the right wing coming vertically upward and the aircraft fell with little forward speed, striking a roof, a brick building and plunged a few feet ahead to the bank of the Elizabeth River. The wreckage was in an inverted position, partially submerged in shallow water. A severe gasoline fire developed but was soon extinguished. All 56 occupants were killed and the aircraft was destroyed by impact and fire.

Investigation and Evidence

Impact with the ground was with the nose and left side of the aircraft and at a steep angle of descent. Layouts and reconstructions were conducted at Newark Airport and the Pacific Airmotive Corporation at Linden, New Jersey Airport.

The fire damage was then carefully studied. It was of two types:

1) fire in flight;

2) fire after impact.

Fire in flight was confined to the right nacelle whereas fire after impact was widespread. In-flight fire under apparent heavy draft burned its way through the closed doors of the right-hand wheel well, burned an area some eight inches in diameter on the outer surface of the right-hand tire and continued backward destroying numerous pieces of secondary structure. The relatively small burned area, on the tire tread is accounted for by the fact that the right wheel was well below the path of flame after the wheels were extended. However, the extension of the gear allowed the fire freer entry to the wheel well which damaged the numerous fuel, oil and hydraulic lines, all of which were behind the firewall shutoff valves. Fire left the structure in the vicinity of the nacelle tail cone at the rear spar. This in-flight fire left a tell-tale trail of small burned and molten metallic objects on the ground more or less under the flight path for a distance of 4 miles back from the impact site. With the exception of two pieces of cowl flap structure, these recovered objects came from aft of the firewall, showing that a fire also existed aft of the firewall in flight. Examination of the wreckage disclosed that the right wing did not separate from the aircraft prior to impact since it was found with the main wreckage. There was no in-flight buckling. No evidence was found indicating deformation or twisting of the right wing.

Four cylinders of the left engine were removed and power sections checked for mechanical failure. None was found. No discrepancies were noted in the oil screens. This engine was severely damaged externally by impact and ground fire but there was no evidence of in-flight fire. The propeller shaft and propeller barrel assembly were not recovered.

The right propeller was found at a pitch setting of 57 degrees, an angle within the feathering range. No. 10 cylinder and all but about 1-1/2 inches of the crank end of the No. 10 articulating rod were missing and have not been recovered. The stub end of the rod was attached to the master rod. No. 10 piston was found. The fifteen hold-down studs of this cylinder had failed. All of the studs on the centre case and three studs on the front case had failed as a result of fatigue fractures. One hold-down stud of No. 14 cylinder had failed as a result of a fatigue fracture. The studs that failed from fatigue do not show any deformation. Three of the broken studs showed rubbing of the threaded portion which would normally be covered by the hold-down nut. There was no evidence in these studs of metallurgical defects. The No. 10 cylinder crankcase pad bore evidence of galling, fretting and/or polishing with a pronounced ridge around the approximate front half of its circumference suggesting that the cylinder had been somewhat loose on its pad and that the stud failure had been progressive. The 4 sections comprising the crankcase were matched, each having the same serial number. The engine's front main bearing and the front master rod bearing had failed. Metal chips were found in the main oil screen and in all oil pumps which were moderately scored. Damage to the engine adjacent to the base of No. 10 cylinder occurred as the engine continued to operate for an appreciable period of time after the separation of that cylinder. Evidence showed that a severe fire originated at or near the base of No. 10 cylinder of the right engine. Genesis of the fire is not definite. Many factors contributed to developing the fire:

1) high draft through the nacelle;

2) a continuous egress from No. 10 cylinder hole of liquid and atmoized lubricating oil;

3) a flailing broken connecting rod;

4) opened exhaust and inlet ducts to that cylinder.

Although no trouble with No. 10 cylinder had been logged or discovered before take-off, the failure was probably initiated prior to take-off. The possibility of hydraulicing has been considered and eliminated as a contributing factor. Rubbing of stud threads which are normally covered by the hold-down nut indicates that loosening and backing of the hold-down nuts preceded the failure of the studs. These nuts had been improperly installed. The failure due to a fatigue fracture of one hold-down stud of No. 14 cylinder whose position precludes hydraulicing is further evidence that some factor other than hydraulicing existed. The failure was progressive. The high manifold pressure of about 52 inches of mercury normally used on take-off augmented the initial failure and precipitated complete separation of the cylinder.

The condition of the major rotating parts of the right engine indicated that considerable power was being developed during the take-off and climb.

The oil consumption of the right engine was twice that of the left engine during its last flight, inasmuch as the subject engine had approximately 103 hours of running time since overhaul and the left engine had approximately 275 hours since overhaul, it is reasonable to assume that there was oil seepage somewhere in the structure of the right engine which could account for the increased oil consumption. The fact that No. 10 cylinder crankcase pad was galled, fretted and/or polished shows that movement of the cylinder occurred which indicated that it was improperly secured. Seepage could have occurred at that point.

The presence of fresh oil on the right engine's cowl flaps should have been noted during pre-flight inspection and a thorough inspection should have followed.

It may be surmised that the propeller was not fully feathered due to the in-flight fire's having destroyed an electrical line or an oil lead, either of which would cause feathering to be discontinued, or that full feathering was interrupted by impact.

The exact manoeuvre that the aircraft underwent before its final plunge has been a subject of conflicting testimony, however, analysis indicates the manoeuvre was a stall with the then low left wing dropping abruptly. It is clear from evidence that the flight was attempting to return to Newark Airport and probably Runway 6.

The lack of adequate training in emergency procedures could have had a bearing on what appears to have been a delayed application of the emergency procedures for an engine fire by the crew.

Investigation of this accident has revealed that Miami Airline did not conform to requirements set forth in CAR in that the weight and balance manifest did not reflect the total load aboard and the flight plan did not include the total number of crew.

A reconstruction of the events leading up to the accident shows:

1) failure of No. 10 cylinder of right engine;

2) dense fire and smoke;

3) lowering of landing gear;

4) windmilling propeller due to partial feathering;

5) effect of maximum gross load;

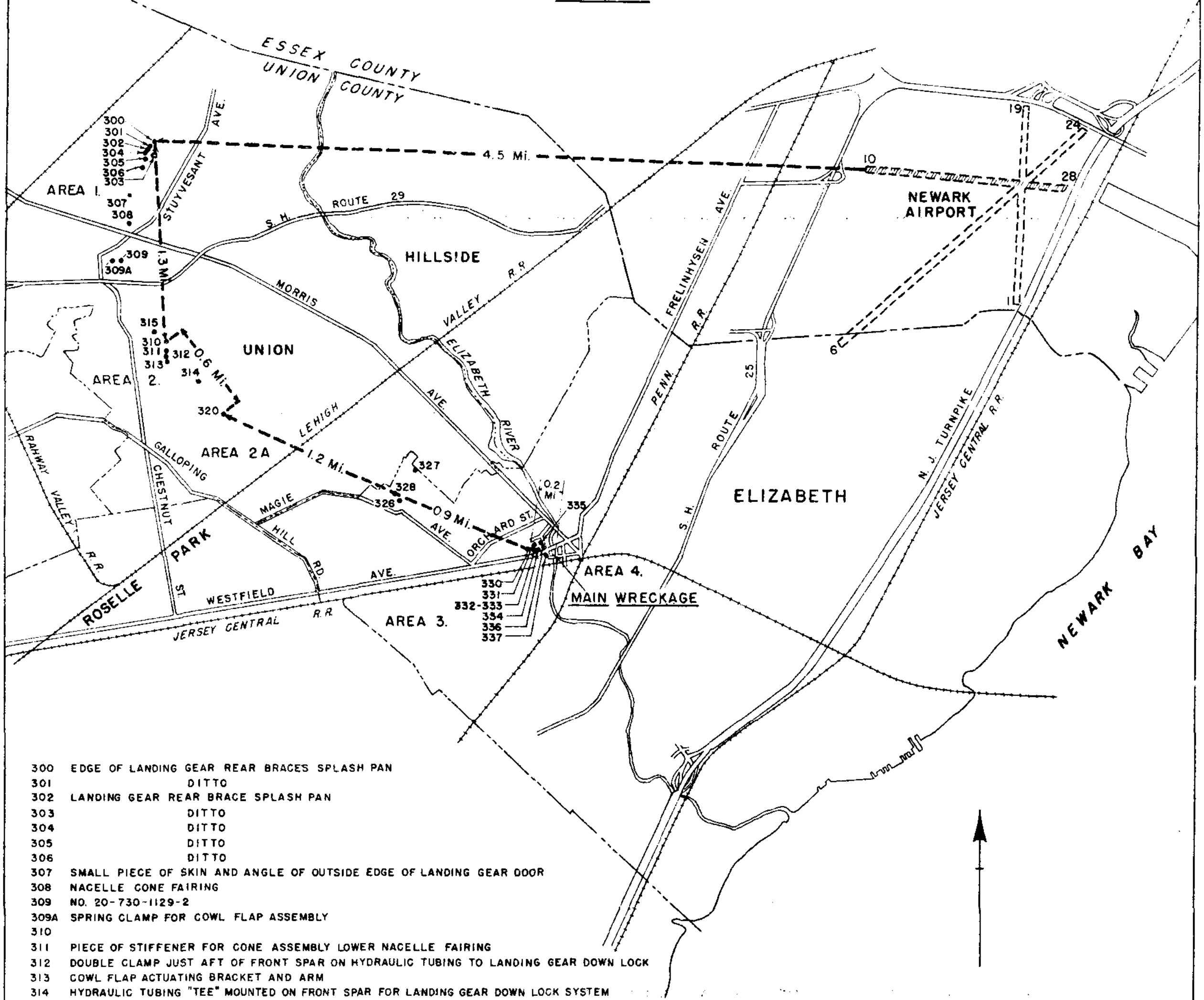
6) result - stall and loss of control.

## Probable Cause

The Board determines that the probable cause of this accident was a stall with the landing gear extended following a serious loss of power from the right engine. This power loss was caused by the failure of the hold-down studs of the No. 10 cylinder, precipitating a fire in flight which became uncontrollable.

ICAO Ref: AR/184

EXHIBIT 41a




300 EDGE OF LANDING GEAR REAR BRACES SPLASH PAN
301 DITTO
302 LANDING GEAR REAR BRACE SPLASH PAN
303 DITTO
304 DITTO
305 DITTO
306 DITTO
307 SMALL PIECE OF SKIN AND ANGLE OF OUTSIDE EDGE OF LANDING GEAR DOOR
308 NACELLE CONE FAIRING
309 NO. 20-730-1129-2
309A SPRING CLAMP FOR COWL FLAP ASSEMBLY
310
311 PIECE OF STIFFENER FOR CONE ASSEMBLY LOWER NACELLE FAIRING
312 DOUBLE CLAMP JUST AFT OF FRONT SPAR ON HYDRAULIC TUBING TO LANDING GEAR DOWN LOCK
313 COWL FLAP ACTUATING BRACKET AND ARM
314 HYDRAULIC TUBING "TEE" MOUNTED ON FRONT SPAR FOR LANDING GEAR DOWN LOCK SYSTEM
315 PIECE OF STIFFENER FOR CONE ASSEMBLY LOWER NACELLE FAIRING

320 REAR LEFT SIDE OF RIGHT NACELLE SKIN AT CORNER OF WHEEL DOOR

325 OIL TANK CHAFING STRAP INBOARD PART OF CRADLE
OIL TANK CHAFING STRAP SUPPORT
326 PIECE OF OIL TANK CRADLE AREA

330 20-720-1065-16R
20-201001-2
FRONT SPAR WEB BULB "TEE" SECTION STIFFENER
331 PIECE OF OIL TANK CHAFING STRAP
BOTTOM SKIN OF CENTER SECTION NACELLE AREA REAR
332 LANDING GEAR DRAG STRUT REAR SPAR ATTACHMENT FITTING INSPECTION COVER
333 1. $CO_2$ LINE FOR FUEL SELECTOR AREA IN NACELLE CONE 2. LAND GEAR DOWN LOCK CABLE
3. $CO_2$ CABLE PULL PULLEY 4. OIL TANK CANNON PLUG 5. OVERHEAD CABLE TUNNEL COVER FASTENER
334 1. PULLEY FOR FIREWALL SHUTOFF FOR 3 VALVES 2. AIR LINE FOR DE-ICER BOOT
335
336 C-4 FUEL STRAINER
337
332 1. FRONT SPAR WEB BULB "TEE" SECTION STIFFENER 2. TWO FOOT SECTION OF SELECTOR CROSS-FEED LINE ON RIGHT HAND SIDE OF NACELLE AT FRONT SPAR
333 FRONT SPAR WEB BULB "TEE" SECTION STIFFENER

## WRECKAGE DISTRIBUTION
## ELIZABETH, NEW JERSEY
## CURTISS C-46 N1678M
## DECEMBER 16, 1951

JOHN W. MEIXELL JR. COUNTY ENGINEER

JANUARY 1952

10000 0 1000 2 3 4 5000 6 7 8 9 10000

SCALE OF FEET

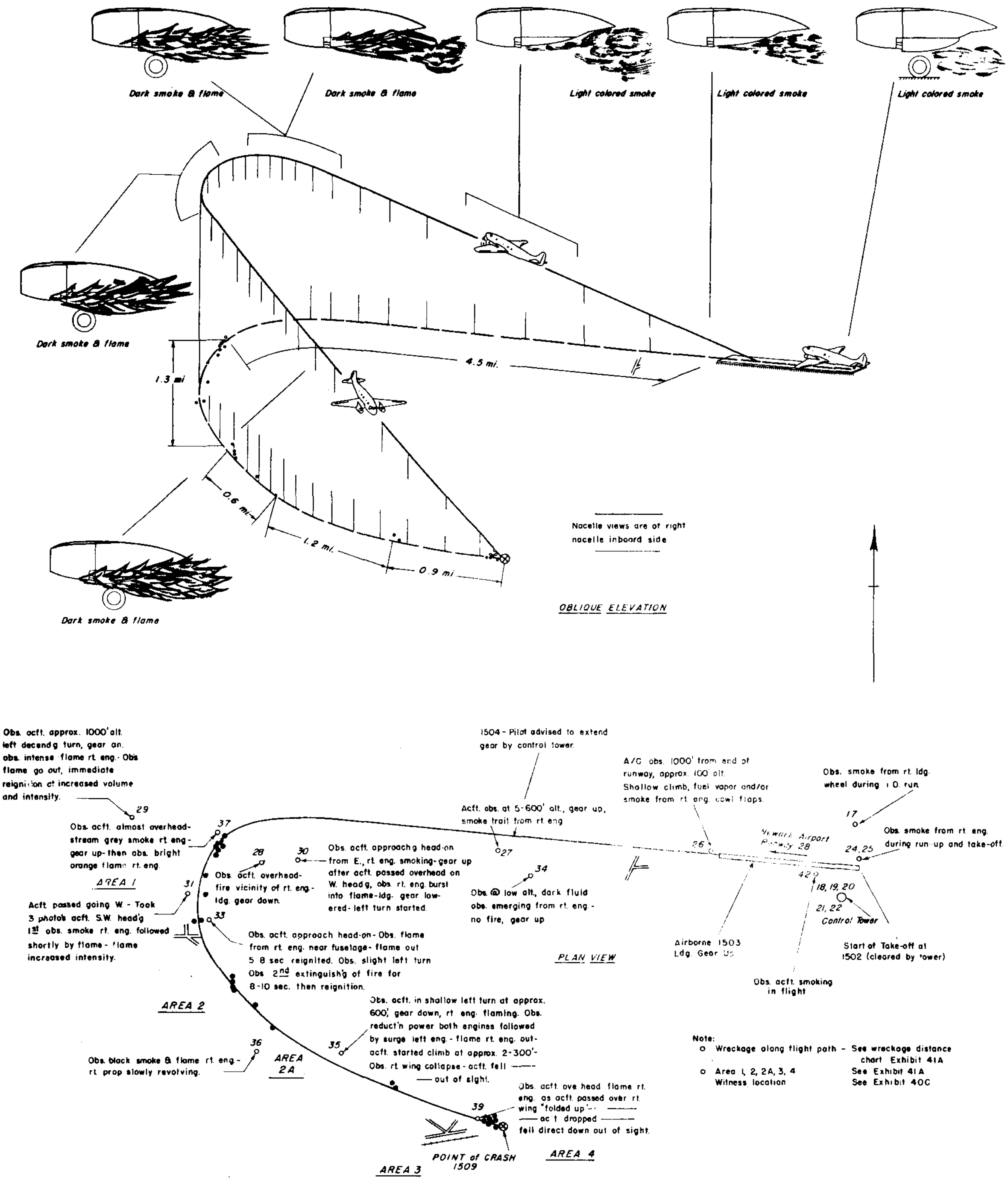
EXHIBIT 401

# AIRCRAFT ACCIDENT-ELIZABETH, N. J., 12-16-51

## MIAMI AIRLINE, INC. - C46-F N1678M

### FIRE PROPAGATION (RIGHT ENGINE)

### PROBABLE FLIGHT PATH BASED ON DISTRIBUTION OF WRECKAGE AND OBSERVATIONS OF WITNESSES



## No. 27

### Curtiss C-46E aircraft N-59487, forced landed near Cobourg, Ontario on 20 December 1951, whilst engaged on a charter flight. Dept. of Transport, Air Services Branch, Civil Aviation Division, Report No. 51-F4

#### Circumstances

The aircraft, cleared to proceed IFR at 9 000 feet, departed from Chicago Airport en route to Newark, N.J. carrying 44 passengers (2 infants) and a crew of three. After passing Toledo the aircraft encountered heavy snow, icing conditions and severe precipitation static. Radio reception deteriorated rapidly and the Captain, unable to determine his position, although several headings were flown in an attempt to do so, was obliged, by the shortage of fuel remaining, to descend in an attempt to obtain visual reference. The aircraft broke cloud over Lake Ontario and almost immediately afterwards the port engine stopped through fuel starvation. The aircraft was headed towards the shore and as it flew over Cobourg the starboard engine ran out of fuel and stopped. An immediate wheels up landing was made. There were no injuries to passengers or crew. As the field was covered with snow, damage to the aircraft was restricted to the propellers, oil coolers, bottom of the engine nacelles, and the under surface of the fuselage.

#### Investigation and Evidence

According to the evidence submitted by the Captain they climbed to the assigned altitude and reported their position over South Bend, Goshen, and Toledo, but were unable to make a positive radio fix on Cleveland the next reporting point. The First Officer stated that the South Bend fix was positive, Toledo and Cleveland were not. The radio appeared to become progressively worse and they were unable to contact any ground station and could not receive even the weather broadcasts. A minute or so after breaking cloud, Rochester came in loud and clear and the Captain requested a radar fix. Rochester advised that the aircraft was over Lake Ontario and gave a preliminary course for Rochester Airport. At that time the port engine stopped and almost simultaneously the Captain saw the shore line and headed towards it, advising Rochester of the shortage of fuel on board. As it flew over Cobourg the starboard engine stopped and an immediate wheels up landing was necessary.

The crew were properly certificated, and the Captain had logged some 3 500 hours on the type of aircraft involved. The certificate of Airworthiness was valid, and according to the evidence, the aircraft was loaded in conformity with the C. of A.

## Probable Cause

The probable cause of the accident was the complete loss of both engines as a consequence of running out of fuel. A major contributing factor was the inability of the crew to determine their position for a considerable period of time preceding the accident.

ICAO Ref: AR/178

No. 28

Robin Airlines, Inc., C-46 aircraft, N-59487, made a forced landing at Cobourg, Ontario, Canada on 20 December 1951. CAB Accident Investigation Report No. 1-0105. Released 16 July 1952.

Circumstances

The aircraft, owned by International Airports, Inc., was leased to and operated by Robin Airlines, Inc., Burbank, California, who at the time of the accident were doing business as North Continent Airlines.

The flight departed Burbank on an IFR flight plan at 0329, 19 December 1951 for Albuquerque, New Mexico with Las Vegas, New Mexico as alternate. The ultimate destination was Newark, N.J. with additional intermediate stops. At 0401 when over Palmdale, California, the captain advised Palmdale radio that the aircraft cabin heaters were not operating. Flight landed at Palmdale at 0439 where the necessary repairs were made. At 1353 the aircraft departed Palmdale on a DVFR for Albuquerque and Kansas City and landed at Kansas City at 2108 after refueling at Albuquerque. A routine crew change was made and the aircraft took off for Chicago where it landed at 0100 on 20 December. The aircraft departed at 0354 after being held at end of runway with engines running for nearly an hour. Shortly after passing Toledo a severe snowstorm was encountered. At this time the aircraft's ADF (Automatic Direction Finder) radio receiver failed to indicate properly and that soon thereafter static conditions made it impossible to obtain a readable signal for navigation purposes with either the range receiver, ADF receiver or manual DF receiver.

CAA communications stations along and adjacent to the aircraft's planned route were asked to contact the aircraft and numerous calls were made without response.

Since a shortage of fuel was bringing about a critical condition the captain decided to descend from the 9 000 foot cruising altitude in an attempt to determine his position. The final message receiver by Rochester radio was at 0738, which said "Sighted small town, both engines out, landing wheels up." At approximately 0740, the aircraft made a wheels-up landing in a farm field near Cobourg, Ontario. No one was injured.

## Investigation and Evidence

Damage was confined to the propellers, nacelles, and the bottom of the fuselage. Two blades of the left propeller and all three blades of the right propeller were moderately bent. It was determined that, at the time of impact, the propeller of the left engine was feathered, and the propeller of the right engine was windmilling.

Examination of the aircraft's records indicated that it should have been airworthy when it departed Burbank on 19 December 1951. A review of the Flight Plan and Log record, which was prepared by the crew for the segments of the flight between Burbank and Kansas City indicated a properly planned flight. However, for the remainder of the flight this was not the case. This document was practically devoid of all flight data such as estimated times of arrival, estimated fuel consumptions, radio frequencies available etc. Most of the other records pertaining to the flight were improperly and inaccurately prepared. As prescribed by the company's operations manual, duplicate copies of the flight records were to be mailed to the principal office of the company prior to departure from any point where a change in load etc. was effected.

Although the Captain stated that he was briefed by the Weather Bureau forecaster on duty at Chicago, this was denied by the forecaster and it is doubtful that the captain had adequate weather information with which to plan a safe instrument flight. However, at Kansas City, about six hours prior to take-off from Chicago the crew apparently did obtain some weather information for the remainder of the route to Newark. It would appear therefore that this was the only weather information upon which the crew relied, and that no crew member went to the Chicago Weather Bureau office.

From an analysis of the flight's records, the estimated and actual times over required reporting points, and the general conduct of the flight from Chicago to the forced landing, it is evident that the crew was either indifferent to, or ignorant of, proper flight planning.

The Flight Plan and Log record also showed that only 345 gallons of fuel would be consumed to Newark with 430 gallons of fuel remaining on arrival. This indicates an average fuel consumption of 99 gallons per hour, whereas normal fuel consumption for a C-46 is approximately 150 gallons per hour.

In short,

1) The crew and the aircraft were certificated for the operation involved;

2) The captain of this flight was the company's chief pilot and had never been flight checked by the company;

3) The company did not effectively check crew competency or provide proper flight training for its crews;

4) The crew did not conduct the flight in accordance with the company's operations manual;

5) Prior to departing Chicago, the crew did not check the en-route and forecast weather;

6) Instrument flight conditions were forecast prior to the flight's departure from Chicago, to prevail until reaching Cleveland, with intermittent visual contact weather from this point to the destination and further indicated that weather conditions would be worse north of the intended course;

7) The crew did not prepare, at Chicago, or maintain while in flight, an adequate Flight Plan and Log for a safe instrument flight; they attempted to prepare this at Cobourg;

8) The Weight and Balance Manifests, Passenger Manifests, and other flight forms, were improperly and inaccurately prepared; the crew attempted to correct this also at Cobourg;

9) A CAA instrument flight plan was filed, Chicago - Newark with La Guardia as the alternate airport;

10) Prior to take-off at Chicago, the aircraft remained near the end of the take-off runway with the engines running for a period of 58 minutes without being refuelled, and the flight did not have sufficient fuel to proceed to its destination;

11) After passing Toledo, radio navigational signals were unreadable; the crew became lost and did not maintain appropriate dead reckoning headings;

12) Because of fuel exhaustion the captain made a wheels-up forced landing near Cobourg, approximately 200 miles north of the flight's intended course and at a point still 300 miles from its destination.

## Probable Cause

The probable cause of this accident was the crew's incompetence in flight planning and navigation, fostered by failure of the company to check crew competency and provide proper flight training, which resulted in the crew becoming lost and making an off-course landing due to fuel exhaustion.

ICAO Ref: AR/203

No. 29

Continental Charters, Inc., C-46A Aircraft N-3944C, crashed en route 5 miles SW of Little Valley, New York on 29 December 1951. CAB Accident Investigation Report No. 1-0101. Released 13 March 1952.

## Circumstances

The aircraft en route from Pittsburgh, Pennsylvania to Buffalo, New York carrying 36 passengers and a crew of 4, crashed about 5 miles southwest of Little Valley, New York. Twenty-six of the 40 persons on board lost their lives and the remaining 14 sustained injuries varying from minor to serious. The aircraft was demolished but there was no fire.

## Investigation and Evidence

It was established that the flight departed Pittsburgh for Buffalo at 2147 on a VFR flight plan. The take-off weight was 40 263 pounds which was 4 737 pounds less than the aircraft's certificated gross of 45 000 pounds and the disposable load was properly distributed with respect to the center of gravity. At 2152 the flight called Pittsburgh Tower and reported that its time off was 2147; this was the last radio contact. When the flight failed to arrive at Buffalo within a reasonable time after its ETA (2247) a search was initiated. On 31 December at 1433, the aircraft wreckage was located in a heavily wooded area near Little Valley, New York. A survivor, who had made his way from the wreckage to a farmhouse to obtain help, reported that the crash occurred at 2225 December 29, approximately 38 minutes after the flight departed Pittsburgh.

Investigation at the scene indicated that the accident occurred about 100 feet below the crest of a hill, at an altitude of 2375 feet MSL, while the aircraft was in level flight and on a true heading of approximately 18 degrees. Indications were that first contact was with small branches of a tree 60 feet above the ground. From this point on, as forward travel continued, disintegration of the aircraft progressed along a path 933 feet beyond the point of initial impact. All major components were accounted for along this path. Disintegration of the aircraft was complete with the exception of the aft part of the passenger compartment which came to rest at the most distant end of the line of travel. It was in this section that all those who survived had been seated. Detailed examination of the wreckage disclosed no evidence of structural failure or mechanical malfunctioning of any part of the aircraft or its components. Both engines were developing appreciable power at impact, and both propellers were found in approximately the 30° setting, which is within the cruising range.

It was determined that when the flight departed from Miami to Pittsburgh (previous segment of schedule) it had 1 100 gallons or 7 hours 20 minutes of fuel aboard, as indicated on the weight and balance manifest and flight plan. The uneventful flight of 5 hours 35 minutes from Miami to Pittsburgh consumed an estimated 838 gallons of the 1 100 gallons of fuel aboard. There was no evidence that a fuel measurement was made prior to departing Pittsburgh, as required by the company's operations manual, and it was definitely established that no fuel was added. It must therefore be assumed that the flight departed Pittsburgh with a fuel load of 262 gallons or 1 hour 45 minutes of fuel on board. These calculations are based on an hourly consumption of 150 gallons which the company requires for flight planning purposes. No explanation can be found for the discrepancy between this figure and the fuel load shown on the flight plan and weight and balance manifest out of Pittsburg which in themselves were at variance with each other.

The VFR flight plan out of Pittsburgh indicated three hours (or 450 gallons) of fuel aboard. However, the weight and balance manifest out of Pittsburgh indicated fuel aboard in gallons as 400, after taxying and engine run-up, and as 2 hours 20 minutes (or 350 gallons) in hours of cruising. This manifest further indicated IFR flight and other discrepancies, including designation of an airway that does not exist in that area and an incorrect reflection of the number of seats occupied.

Investigation disclosed that the crew had made no attempt to obtain weather briefing from Flight Advisory Weather Service for the route Pittsburgh to Buffalo. It was known by the weather briefer at this time that VFR conditions did not exist over the direct route and that weather was considerably worse over the higher ridges to the east. At 2124, when a member of the crew was filing a VFR flight plan, by telephone, the CAA Communicator on his own initiative gave the latest weather for Pittsburgh, Brookville and Buffalo and stated that it did not appear suitable for VFR flight. The 2128 weather reports, available to the crew before departure from Pittsburgh, gave the ceiling, visibility and wind at Pittsburgh and Brookville as 2 400 feet, 10 miles, south 10 mph, and 1 900 feet 5 miles, south-southwest 9 mph, respectively, with very light rain; and at Buffalo as 2 000 feet, 7 miles, south-southwest 21 mph. The aircraft departed on a VFR flight plan, apparently with no more information on the latest weather developments than that given by the CAA Communicator. At Bradford, Pennsylvania and Jamestown, New York, the nearest weather reporting stations along the Pittsburgh-Buffalo route ceilings had been reported as below 500 feet when official weather reporting was discontinued for the day at approximately 1902. The observer at Bradford later stated that no appreciable weather change took place there prior to the time he left the airport at 2245.

The direct course from Pittsburgh to Buffalo is 18° true. In its Flight Information Manual, the CAA classifies this area as mountainous terrain, requiring a VFR night flight to maintain an altitude of not less than

2 000 feet above the highest point within a horizontal distance of 5 miles either side of the center of a direct course. In non-mountainous terrain, an altitude of not less than 1 000 feet above the highest point is required for VFR night flight. Continental Charters' operations over this area were being conducted on the premise that the terrain is not considered mountainous; further the company had been so advised by the CAA Aviation Safety District Office, Miami, and the agent assigned to supervise Continental Charters' operations so testified at the public hearing on this accident.

Reports of ground observers and testimony of surviving passengers indicated that the flight was conducted at a low altitude all the way from Pittsburgh to the accident scene. It is difficult to understand why a VFR flight plan was filed direct to Buffalo, under known en-route instrument weather conditions, while IFR flight was indicated on the weight and balance manifest. The only logical explanation appears to have been an effort to save time, the aircraft being already 5 hours 40 minutes late when it arrived at Pittsburgh.

## Probable Cause

The probable cause of this accident was the captain's poor judgement in attempting a flight by visual reference during instrument weather conditions.

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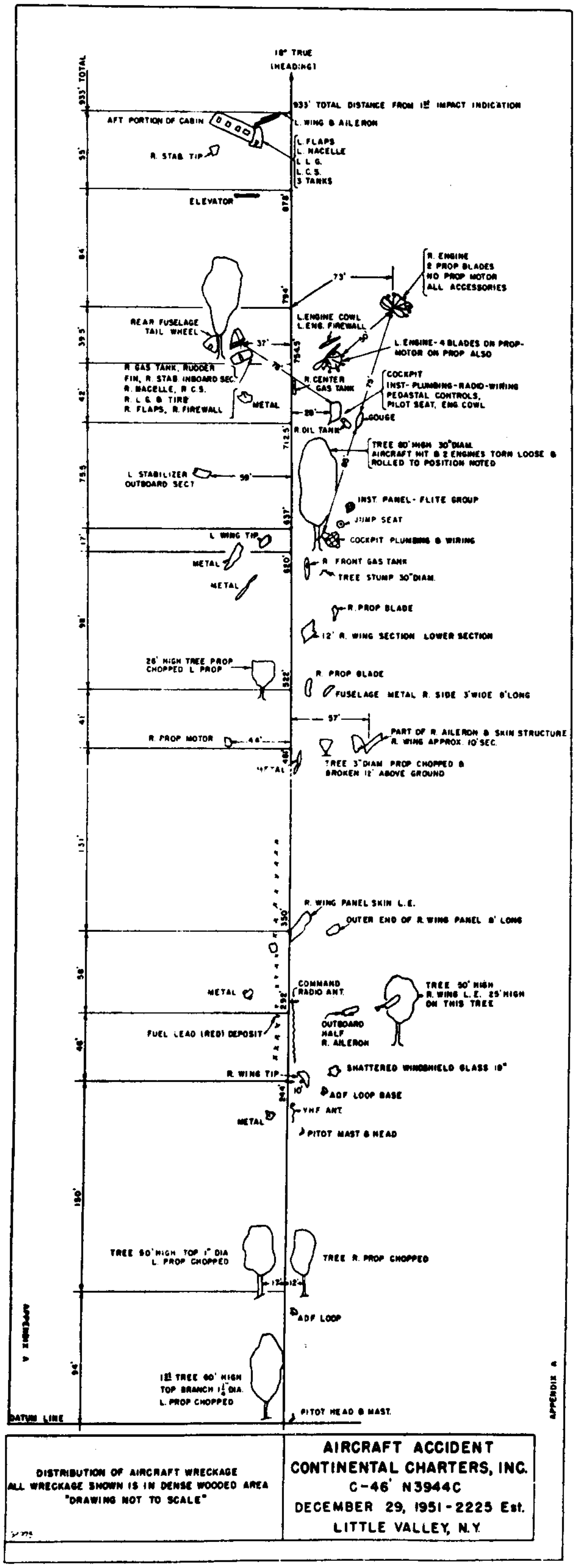
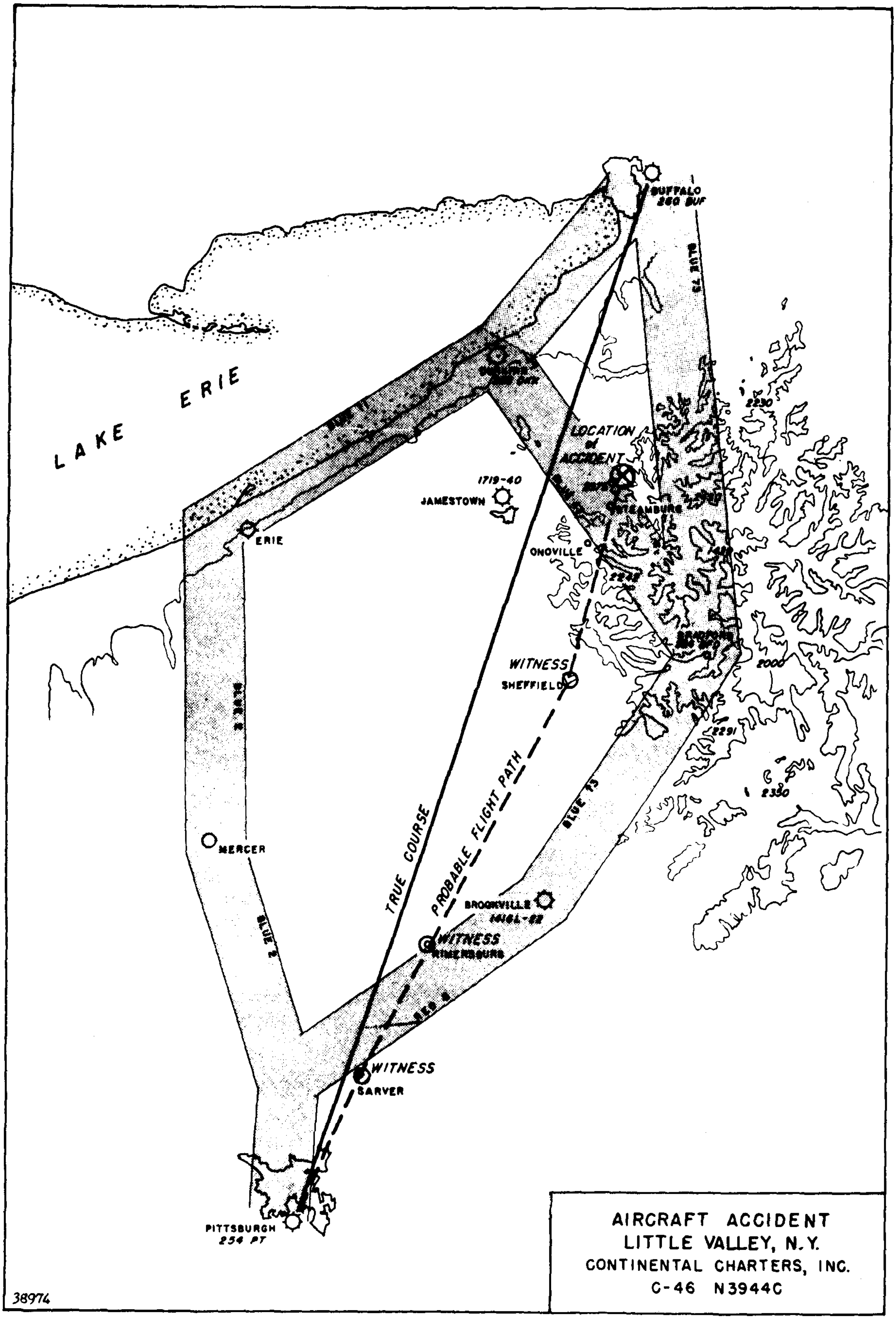
Notes.-

1) Following this accident, Continental Charters' adopted a company policy that all of their night operations would be conducted in accordance with instrument flight rules. In addition instructions were issued to flight crews prohibiting use of the automatic pilot at an altitude of less than 3 000 feet above the local terrain. Soon afterwards further instructions were issued prohibiting use of the automatic pilot during instrument weather and while climbing and descending.

2) As a result of information gained from this investigation, the Board had caused to be issued Civil Air Regulations Draft Release No. 52-8, dated March 10, 1952, proposing, among other things, an amendment to Section 42.58 of the Civil Air Regulations so as to require that night VFR passenger operations in large aircraft be conducted only over civil airways and at airports equipped with radio ranges or equivalent facilities (unless otherwise specifically authorized by the Administrator).

ICAO Ref: AR/181


18° TRUE (HEADING)
933' TOTAL DISTANCE FROM 1ST IMPACT INDICATION
AFT PORTION OF CABIN
L. WING & AILERON
L. FLAPS
L. NACELLE
L. L. G.
L. C. S.
3 TANKS
R. STAB TIP
ELEVATOR
R. ENGINE
2 PROP BLADES
NO PROP MOTOR
ALL ACCESSORIES
REAR FUSELAGE
TAIL WHEEL
L. ENGINE COWL
L. ENG. FIREWALL
L. ENGINE - 4 BLADES ON PROP-MOTOR ON PROP ALSO
R GAS TANK, RUDDER
FIN, R. STAB INBOARD SEC.
R. NACELLE, R C.S.
R. L. G. & TIRE
R. FLAPS, R. FIREWALL
METAL
R. CENTER GAS TANK
COCKPIT
INST - PLUMBING - RADIO - WIRING
PEDASTAL CONTROLS,
PILOT SEAT, ENG COWL
GOUGE
R. OIL TANK
TREE 80' HIGH 30" DIAM.
AIRCRAFT HIT & 2 ENGINES TORN LOOSE & ROLLED TO POSITION NOTED
L. STABILIZER OUTBOARD SECT
INST. PANEL - FLITE GROUP
JUMP SEAT
COCKPIT PLUMBING & WIRING
L. WING TIP
METAL
R. FRONT GAS TANK
TREE STUMP 30" DIAM.
R. PROP BLADE
12' R. WING SECTION LOWER SECTION
26' HIGH TREE PROP CHOPPED L. PROP
R. PROP BLADE
FUSELAGE METAL R. SIDE 3' WIDE 8' LONG
PART OF R. AILERON & SKIN STRUCTURE
R. WING APPROX. 10' SEC.
R. PROP MOTOR
TREE 3" DIAM. PROP CHOPPED & BROKEN 12' ABOVE GROUND
R. WING PANEL SKIN L.E.
OUTER END OF R. WING PANEL 8' LONG
METAL
COMMAND RADIO ANT.
TREE 50' HIGH
R. WING L.E. 25' HIGH ON THIS TREE
OUTBOARD HALF R. AILERON
FUEL LEAD (RED) DEPOSIT
R. WING TIP
SHATTERED WINDSHIELD GLASS 18"
ADF LOOP BASE
VHF ANT.
METAL
PITOT MAST & HEAD
TREE 50' HIGH TOP 1" DIA L. PROP CHOPPED
TREE R. PROP CHOPPED
ADF LOOP
1ST TREE 60' HIGH TOP BRANCH 1½" DIA. L. PROP CHOPPED
PITOT HEAD & MAST
DATUM LINE
APPENDIX A
DISTRIBUTION OF AIRCRAFT WRECKAGE
ALL WRECKAGE SHOWN IS IN DENSE WOODED AREA
"DRAWING NOT TO SCALE"
AIRCRAFT ACCIDENT
CONTINENTAL CHARTERS, INC.
C-46' N3944C
DECEMBER 29, 1951 - 2225 Est.
LITTLE VALLEY, N.Y.




AIRCRAFT ACCIDENT
LITTLE VALLEY, N.Y.
CONTINENTAL CHARTERS, INC.
C-46 N3944C

No. 30

Transocean Air Lines, Curtiss 46F, N-68963, crashed near Fairbanks, Alaska on 30 December 1951. CAB Accident Investigation Report, No. 1-0116. Released 23 June 1952.

## Circumstances

The aircraft en route Point Barrow, Alaska to Fairbanks, Alaska, struck Chena Dome which is on a true bearing of 59° and 35 miles from Fairbanks radio range station. The accident occurred during an attempted orientation on the Fairbanks radio range, preparatory to landing at Ladd Field when the flight made an unauthorized left turn while outbound on the east leg of the Fairbanks Radio Range and subsequently struck a mountain northeast of the station whilst on a westerly heading. All occupants - two pilots and two passengers - were killed, and the aircraft was demolished upon impact.

## Investigation and Evidence

Distribution of wreckage indicated that the aircraft struck the snow-covered area in the immediate vicinity of Chena Dome at approximately 4 550 feet MSL and on a heading of approximately 240 degrees magnetic; it appeared to have been in a left turn at impact. Both engines and their propellers bore evidences indicating that power was being developed at the time of the accident. The ADF (Automatic Direction Finder) tuning dial indicated that the unit had been tuned to the Fairbanks radio range frequency. Post study of the weather indicated that the maximum wind velocity was 60 knots from the South West. There was considerable lowering of ceilings. The ceiling over Fairbanks at the time of the accident was 4 000 feet, with possibly a lower ceiling in the Chena Dome area.

At no time during the flight was the aircraft reported unairworthy. Shortly before the accident, the only ADF was reported "out". It is possible that the unit was not inoperative but the pilot rejected the indication of the needle as incorrect because he thought the flight was still west of the station. Had the ADF actually been inoperative, the loss of this receiver would not have precluded a successful orientation and approach at Fairbanks since the aircraft was equipped with two additional low frequency receivers. One of these receivers was a manually operated direction finding loop. In addition, a marker beacon receiver was installed in the aircraft.

The ground speed between Umiat and Bettles (1950 to 2053) was 170 miles per hour. After passing Bettles, the flight plan called for cruising altitude of 10 000 feet to Nenabank intersection, necessitating a climb of 6 000 feet. Following the report over Bettles, the next message from the flight gave its position as 25 miles northwest of Nenabank intersection (2144), IFR, and estimating the intersection at 2150. The ground speed over this segment of the flight, taking the climb into account, was in conformity with that made good since departure from Umiat. However, the estimate of 2150 over Nenabank intersection was an increase of 80 miles per hour over the previous 170 miles per hour made good.

According to the radar plots, at 2144 the flight was only 12 miles west of Fairbanks, or about 60 miles southeast of the 2144 estimated position. It is apparent that the pilot was estimating his position, when he reported at 2144, as 25 miles northwest of Nenabank intersection. At 2136, radar plotted the flight's position approximately 38 miles east of the 2144 reported position.

Flight 501 reported over Nenabank intersection at 2148 estimating Fairbanks at 2200. This position report (2148) further strengthens the theory that the pilot was estimating his progress very inaccurately since the ground speed of 375 miles per hour (25 miles in 4 minutes) is unrealistic. Furthermore, the radar plots indicated that at about 2148 the flight was over or very near the Fairbanks range station rather than over Nenabank intersection, and thereafter continued east of the station. It is difficult to understand why the pilots so confused their actual position with reported position, for determination of the Nenabank intersection and the Fairbanks station involve totally different interpretations and usage of receiving equipment.

Failure to contact the flight after 2209 indicates that the crash occurred very shortly before this time. The time of the crash is further confirmed by a wrist watch found on the scene of the accident which was stopped at 2207:7.

The almost complete lack of adherence to the flight plan following departure from Bettles, and the wide discrepancies between the position reports and radar plots indicate that this accident was the result of errors in navigation. Several theories have been advanced in an effort to verify the track made good, the cause of the pilot's confusion regarding his position, and suggested methods of utilization of the radio navigational equipment aboard the aircraft. No detailed discussion of these points is deemed feasible, since pure conjecture would become the dominant factor. It is apparent, however, that intelligent and proper use of the radio equipment was not accomplished after the flight's passage over Bettles, resulting in increasing confusion which culminated in the accident.

## Probable Cause

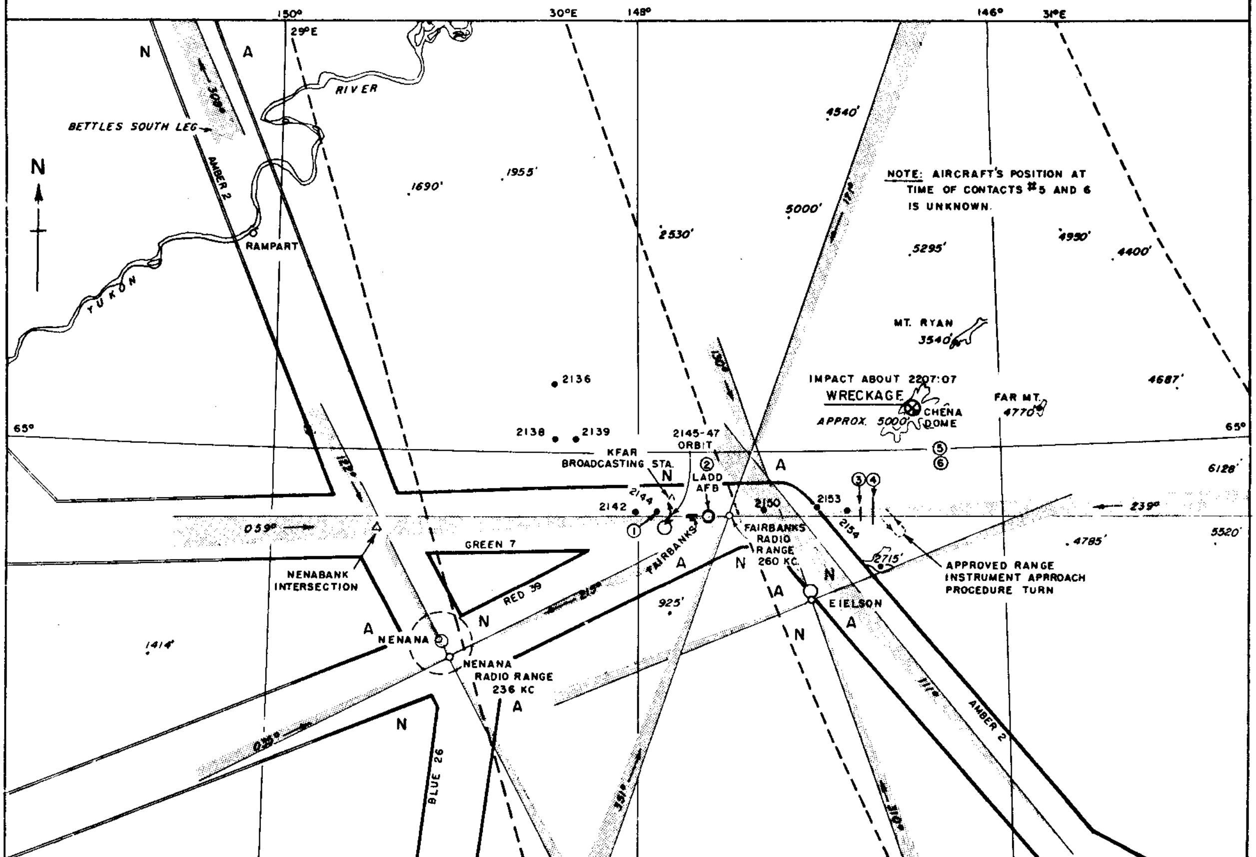
The Board determines that the probable cause of this accident was the failure of the pilot to follow procedures and utilize properly the radio facilities for approach and letdown at Fairbanks, with the result that the flight became lost.

ICAO Ref: AR/210

## ATTACHMENT I

## SHOWING AIRCRAFT RADIO CONTACTS AND RADAR PLOTS RELATIVE TO ACCIDENT

### TRANSOCEAN AIR LINES C-46F; N68963 NEAR FAIRBANKS, ALASKA - DEC. 30, 1951




## RADIO CONTACTS

TIME (All times in Alaska Standard)

① 2144 - At 8,000 feet, IFR, estimated time over Nenabank (Intersection) 2150. Request clearance.
[N-68963 cleared to Nenabank Intersection, cruise and maintain 8,000 feet, thence 5,000 feet to Fairbanks.]

② 2148 - Over Nenabank (Intersection), descending to 5,000 feet IFR, estimating Fairbanks at 2200.

③ 2155 - Reached cruising altitude 5,000 feet at 2155.

④ 2157 - [ARTC cleared N-68963 for standard range approach, to cross Fairbanks at 4,000 feet.]

⑤ 2205 - ADF out. Have missed cone. Proceeding out west leg. Will call when over station.

⑥ 2207 - [Flight requested to confirm proceeding out west leg.]
Confirming proceeding out west leg.
(Last contact with the flight.)

NOTE: Above contacts are not verbatim, but were obtained from abbreviated CAA flight contact records.

RADAR PLOTS

- • FIX
- ) ORBIT
- || FADE OUT

PREPARED UNDER THE SUPERVISION OF
FRED G. POWELL
Bureau of Safety Investigation, C.A.B.

SOURCE: World Aeronautical Chart #77

10 5 0 10 20 30 40 50
STATUTE MILES

No. 31

ZS-DFA aircraft made a forced landing near Rand Airport, Tvl., on 9 January 1952. Report No. 14/52, J.10/2/645.

## Circumstances

On 9 January 1952 at about 0700 hours, an airline transport pilot took off with 7 passengers on a scheduled flight in Dove ZS-DFA. After climbing to the cruising height of 8 000 feet A.M.S.L. engine revolutions and boost were reduced. When these adjustments were being made, the port engine cut abruptly. The pilot feathered the propeller and a successful forced landing was made at the original field of departure.

## Investigation and Evidence

Chips of a spin gear wheel and phosphor bronze were found in the engine oil filters. Strip examination revealed failure of the supercharger, first lay shaft bearings, due to a split pin throwing out from a clamping bolt with portions of the pin entering the bearings and causing failure. The pilot's total flying experience was 5 023 hours of which 741 were on Dove aircraft.

## No. 32

**General Airways, Inc., Douglas DC-3C, N-41748, crashed on Mt. Crillon, Alaska, 12 January 1952. CAB Accident Investigation Report No. 1-0003. Released 11 August 1952.**

### Circumstances

A Douglas DC-3C, carrying cargo on a non-scheduled flight, departed Portland, Oregon, at 0200 hours, 12 January 1952 destined for Merrill Field, Anchorage, Alaska. The flight landed at Annette, Alaska, at 0709 after an uneventful flight. The take-off gross weight after refuelling at Annette was 26 894 pounds. (The maximum certificated take-off gross weight for the aircraft was 26 900 pounds.) There was a two hour and twenty-two minute delay at Annette due to weather conditions at Anchorage. Both pilots (only occupants) were thoroughly briefed on weather conditions. A solid overcast was forecast over the Annette to Anchorage route with temperature at flight level lowering from -10°C at Annette to -12°C. between Sitka and Cape Spencer and -14°C. at Yakutat. Winds at the 10 000 foot level were forecast as approximately 230° and 45 knots to Sitka, and 200° and 65 knots north of Sitka. Light icing at flight level was forecast. The freezing drizzle changed to snow at about 0905, and the pilots made preparations to continue the flight.

A new flight plan was filed at Annette and the flight was authorized to proceed under IFR direct from Annette to Sitka and thence to Anchorage via Amber Airway No. 1, and to maintain at least 500 feet on top of clouds while in control area, join Amber 1 at Sitka at 9 000 feet and maintain this altitude. The flight departed Annette at 0931 and reported to Annette at 0940 that it estimated time of arrival over Sitka would be 1050. At 1111, the flight advised Sitka radio that it was meeting strong head winds and estimated arrival over Sitka in 5 or 10 minutes. At 1116, the pilot reported by Sitka at 1113, at 9 000 feet, and estimated arrival over Cape Spencer intersection at 1156. The flight reported by Cape Spencer intersection at 1147, at 9 000 feet, estimated arrival over Yakutat at 1245. This was the last radio contact with the aircraft.

### Investigation and Evidence

The wreckage was located 13 January, however, the crash site is not accessible to helicopter, conventional aircraft or land parties and therefore it was impossible to determine what radio equipment was in use, and the frequency or frequencies to which the receivers were tuned. It was evident that the flight was off course when the pilot reported "by" both Sitka and Cape Spencer intersection.

None of the communications stations along the route received any radio contacts from the flight in which the pilot asked for assistance in fixing position.

For some time prior to this accident, consideration of a probable hazardous situation between the Sitka and Yakutat radio ranges had been under study by the CAA, as there had been several accidents in the area over a period of years. At the time of the accident, the Sitka station transmitted on 323 kilocycles. On a northbound flight, once a pilot had established the proper heading to maintain course on the northwest leg of Sitka (N signal on right side of on-course signal), he might re-tune the range receiver to Gustavus in order to establish the position of Cape Spencer intersection, which lies about half-way between Sitka and Yakutat. Then, after passing the intersection and while changing frequency to receive Yakutat (A signal on right side of on-course signal), the pilot might inadvertently again tune in Sitka due to the small separation in frequencies (9 kilocycles) or the possibility of transposing the last two figures of the Sitka and Yakutat frequencies. Thus a pilot, failing to identify the range station, could get off course to the right while correcting for an N signal from Sitka, not an N from Yakutat. The terrain rises steeply north of Cape Spencer intersection and while the same error could be made on a southbound flight, the possibility of striking a mountain would be greater while northbound.

It appears that there was no malfunctioning of any component part of the aircraft or radio equipment, since no discrepancies were reported by the pilot between Annette and Cape Spencer intersection. Also, several radio contacts were made en route with the pilot reporting that the flight was at its assigned cruising altitude of 9 000 feet; the altitude at which it crashed.

It can be assumed that the flight in all probability experienced satisfactory radio reception.

The flight could have been off course to the right, due to wind effect from the left. The wind in the vicinity of Cape Spencer intersection was of higher velocity than forecast and had veered about 10 degrees from the forecast direction. Although weather must be considered a factor in this accident, the pilot could and should have established the proper heading to maintain course on the radio range between Sitka and Cape Spencer, and thence toward Yakutat. There was no radical change in wind direction or velocity between Cape Spencer intersection and Mt. Crillon. It was observed that the estimated times of arrival over Sitka and Cape Spencer intersection are at considerable variance with the actual times reported abeam those points.

It is noted that as a result of its studies, the CAA, subsequent to this accident, changed the transmitting frequency of Yakutat to 385 kilocycles and the identification of Sitka to "S.I.T." No change in the identification of Yakutat or the transmitting frequency of Sitka was necessary. These changes were made only coincidentally, and not as a result of the crash.

Whether the deviation from course was intentional or unintentional is a matter of pure conjecture. The Board must conclude, however, that the flight was not conducted in accordance with the flight plan, and improper navigation is strongly indicated. There is no reasonable explanation for the pilot's failure to have established the proper heading to follow the northwest on-course signal of Sitka, which would have placed the flight in a safe position, at sea, to continue on the southeast leg of Yakutat radio range.

## Probable Cause

The Board, upon consideration of all available evidence, determines that the probable cause of this accident was deviation from the planned route due to improper navigation of the flight.

ICAO Ref: AR/209

No. 33

Northwest Airlines, Douglas DC-4, N-45342 aircraft, crashed at Sandspit, B.C. on 19 January 1952. Dept. of Transport, Air Services Branch, Serial No. 52-F1 and CAB Accident Investigation Report No. 1-0017. Released 15 September 1952.

(Since the accident occurred in Canadian territory, the Canadian Government assumed primary investigative jurisdiction, and invited the Civil Aeronautics Board to send an official observer, who immediately proceeded to the scene of the accident. Subsequently, a Board of the United States of America Government conducted an investigation of this accident and the Canadian Government furnished the Board with a summary report of its own investigation. The following résumé, therefore, contains extracts from both reports.)

## Circumstances

The flight en route from Tokyo, Japan to McChord Air Force Base, Tacoma, Washington, via Shemya and Anchorage, Alaska, arrived at Elmendorf Air Force Base, Anchorage at 1830*, 18 January 1952. During the scheduled stop at Shemya, one magneto was changed on No. 1 engine. The balance of the trip to Anchorage was completed without incident. The flight departed Elmendorf Air Force Base, Anchorage at 2111, 18 January, carrying a crew of three and forty passengers for Tacoma, Washington, U.S.A. on an IFR Flight Plan. The flight was normal for the first three hours with the pilot-in-command giving the usual position reports until opposite Sitka, Alaska, at 0003 hours (19 January) a message was sent stating that No. 1 engine had been feathered and the aircraft was proceeding to Sandspit for a precautionary landing. At 0029 the pilot-in-command advised the company that the oil cooler in No. 1 engine was broken. The aircraft made a three-engined approach at Sandspit and touched down at 0138 hours, 1/3 of the way down the runway. Before the termination of the landing run, power was applied, the aircraft became airborne but the port wing struck the water causing the aircraft to crash 3/4 of a mile off shore. When help arrived there were only 7 survivors. The aircraft was destroyed.

## Investigation and Evidence

The only complete record of maintenance work contained in the log book was lost in the crash. However, after re-checking time records, an inadvertent error was found in the recording of time since overhaul of No. 1 engine. Consequently, the maximum time of 1500 hours between overhauls was exceeded by 225 hours, 16 minutes on some of the components of the engine at the time of the accident.

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* Pacific Standard Time used throughout - based on the 24-hour clock.

Shortly after departure from Anchorage, First Lieutenant Donald E. Baker, a U.S.A.F. navigator, and one of the survivors, was invited forward by the captain. He was therefore cognizant of the flight's position and operation of the aircraft until the start of final approach at Sandspit, at which time he returned to his seat in the cabin.

When near Sitka, the pilot noted a drop in oil pressure in No. 1 engine and a rapid loss of oil. Although the flight advised that the oil cooler in No. 1 engine was "broken", there was no positive means of ascertaining that this was the cause of the oil loss.

In accordance with company operating procedures the captain elected to land at the first available airport, which in this instance was Sandspit, rather than continue to destination on the three remaining engines. Annette Airport, although equipped with better facilities and slightly closer than Sandspit at the time the propeller was feathered, was not available for a precautionary landing due to poor weather conditions. The Sandspit airstrip is designated as an emergency airport for Northwest Airlines operations.

Shortly after the propeller was feathered a small amount of ice formed on the forward cockpit window. The aircraft climbed well on three engines and level flight was resumed at approximately 1,000 feet above the previously approved flight altitude of 8,000 feet. The change in altitude stopped further ice accretion. According to Lt. Baker, the aircraft flew well on three engines and the crew reported no difficulty in handling it.

Lt. Baker advised that the descent at Sandspit appeared to be normal. There was light turbulence. It seemed that the aircraft was coming in somewhat high, and before the flare-out was completed rough contact was made on the runway. Lt. Baker saw lights along the runway flash by, power was applied, and the aircraft took off. He heard the hydraulic pumps operating. Shortly after becoming airborne, Lt. Baker felt vibrations associated with an impending stall; they were not violent, and to him it seemed that the aircraft was settling but not in a fully stalled condition. At the first impact with the water, the wings seemed to be level or with the left wing slightly low. The aircraft bounced and seemed to slip to the left. All lights in the cabin went out at the time of the first impact. The second impact occurred with the left wing slightly down and the aircraft spun to the left as it came to rest. Deceleration was quite rapid, but not violent.

The passengers had been advised of the feathered propeller, but no verbal instructions were issued for them to don life jackets or otherwise to prepare for a precautionary landing. Investigation disclosed that in Northwest Airlines' flight operations three-engine operation is considered a potential, not an actual, emergency. A ditching was not anticipated, and therefore an emergency was not declared.

The local weather, was: overcast, ceiling estimated 2 500 feet, visibility 10 miles, temperature 34, dewpoint 30, wind south-southwest 10, altimeter setting 29.44, stratus overcast with breaks. There were snow showers in the area which reduced ceilings and visibilities.

Investigation disclosed that the aircraft carried one 15-man life raft stowed forward in the crew compartment, and two 20-man life rafts stowed near the main cabin door, with sufficient life vests for all aboard. Information on the use of this equipment was given to passengers in the form of tri-lingual pamphlets which the stewardess instructed passengers to read upon departure from Tokyo. The pamphlets described a collar-type life vest, while the type carried on the aircraft were the vest type. None of the life rafts was launched. So far as is known no effort was made to launch the two rafts in the cabin, nor was the emergency lighting in the passenger compartment turned on. The first officer and others made valiant attempts to get the 15-man life raft out through the astrodome opening, but without success.

All Northwest Airlines flight crews engaged in overwater flight are given training in ditching and survival. Pilots are also trained in two and three-engine operation. The Northwest Airlines operations manual states that three-engine take-off and initial climb are to be made with flaps extended 15 degrees. Company records showed that all crew members in this instance had completed all the required training in these matters.

The landing strip had been cleared with snow plows and had a thin coating of packed snow and ice, with braking action reported fair. The strip was lighted along its length with kerosene flare pots since snow had covered the electrically lighted system. The radio operator on duty at the airstrip was in communication with the flight during its let down and approach, and advised the flight of field conditions and local weather.

Search and Rescue facilities were not alerted until after the accident because no emergency had been declared and ditching had not appeared probable. The nearest rescue facilities were located at Annette, too far from the scene to be immediately effective. There are no rescue facilities at Sandspit, and rescue was necessarily delayed owing to the fact that the small boat had to be taken from winter storage and carried to a suitable launching point at the southeast end of the runway. Shoal water with many rocks made the rescue very difficult.

Inspection of the aircraft revealed that it had broken into two separate sections, with the break occurring at a station immediately forward of the main entrance door. Divers were unable to enter the cabin due to the strong current. They estimated by feel that the wing flaps were extended 40 degrees. The left wing panel was found to have sheared at a point approximately eight feet from the center wing to the outer wing attachment. The No. 1 power plant was missing from the firewall forward, as were propellers and nose sections from Nos. 3 and 4 engines. After a few days salvage attempts were abandoned.

Examination of maintenance records for this aircraft disclosed that certain component parts of the engine installed in the No. 1 position had at the time of the accident exceeded the required overhaul time period of 1 500 hours. Northwest Airlines at Seattle was advised by TWA that the time since overhaul on this engine was 790 hours and 50 minutes. The stock clerk at Seattle who received this message did not forward the information to the Northwest Airlines' St. Paul Routing Office, since he had not been required to do so in the past. (Normally TWA transmitted such information direct to St. Paul.) After 555 hours and 16 minutes of additional operation, this engine was installed in N-45342, where it had accumulated 379 hours and 10 minutes at the time of the accident, or 225 hours and 16 minutes in excess of the 1 500 hours allowed between overhauls. The oil cooler reported by the flight as "broken" was one of the accessories that had been in service only 934 hours and 25 minutes.

Although the captain's handling of the situation following feathering of the No. 1 propeller was in conformance with Civil Air Regulations and company operating procedures, it would appear that with one engine out on a sub-Arctic overwater flight, at night, and under IFR conditions, it would have been highly desirable for the captain to have prepared the aircraft and passengers for a possible ditching. Neither passengers nor crew were prepared for a crash landing or an unpremeditated ditching. Preparation for ditching would probably have resulted in less loss of life, particularly had the life rafts been readily available for launching and inflation. Under the circumstances, the rafts were nearly inaccessible, owing to the sunken fuselage and freezing water. Had it been possible to release and inflate them the survivors could probably have rowed to shore.

Use of life jackets might also have been instrumental in saving more lives. However, their effectiveness in this instance is questionable since immersion in freezing water for as short a time as ten to fifteen minutes usually results in unconsciousness.

Subsequent to this accident, Northwest Airlines began a study of improvements in procedures and the desirability of relocating or installing additional emergency equipment on aircraft operated on overwater flights. The ditching pamphlet has been supplemented by oral briefing of passengers on location of emergency exits and how to open them; location of life rafts, how to remove them, and instructions on inflation; and personal demonstration to groups of four passengers of the manner in which life vests are to be donned and inflated. The equipment study is still in progress.

After No. 1 propeller was feathered, it was demonstrated that the aircraft could not only maintain level flight, but that the power available from three engines was sufficient to enable the aircraft to climb in the clean configuration without difficulty. Thus it was demonstrated that there should have been adequate power available for the climb after take-off at Sandspit. Of course the possibility remains that the same amount of power developed in the previous three-engine climb was not being developed at this time, due to possible carburetor icing or other factors which would reduce horsepower output. Survivors reported no additional engine failure or malfunctioning. Since it was impossible to conduct a tear-down and examination of the engines, no concrete statement can be made regarding their condition.

Possible ice accretion could have lowered airfoil efficiency in the climb following take-off, since weather conditions at Sandspit were favourable to formation of light icing on the aircraft structure.

Testimony of Lt. Baker indicated that the aircraft was very near the stalling point. Further, he stated that deceleration was rapid but not violent. This would indicate that the speed for the aircraft was low. Since the wind was of low velocity, its effect on ground speed would have been negligible. Thus there is considerable evidence that since the aircraft was flown at low air speed after take-off, the wing was at a high angle of attack. During slow flight, a high angle of attack can result in decreased lift, increased drag, further loss of air speed, and loss of altitude. Air speed and angle of attack are interrelated; if air speed is maintained near the stall point, as in this case, the aircraft must inevitably settle.

In regard to the overtime of No. 1 engine; it is obvious as developed under Investigation that the engine was used beyond its maximum allowable overhaul period because of a clerical error of omission. A company official testified that since spare powerplants received from TWA were generally newly overhauled units, it was apparently assumed by the St. Paul Routing Office where such records are kept that a complete overhaul had been accomplished on this engine. It, therefore, appears that this overuse of the engine was without intent to exceed the overhaul limitations. The conditions that allowed this error to occur have been corrected by the carrier to the satisfaction of the CAA.

## Probable Cause

### United States Investigation

The Board determines that the probable cause of this accident was the high approach to the airstrip and the attempt to again become airborne at insufficient air speed, which resulted in the aircraft settling into the water.

### Canadian Investigation

The underlying causes were failure of No. 1 engine and pilot error.

ICAO Ref: AR/194 and AR/215

## No. 34

## American Airlines Inc., Convair 240-N-94229, crashed at Elizabeth, N.J. on 22 January 1952. CAB Accident Investigation Report. No. 1-0016. Released 28 April 1952.

### Circumstances

The flight was routine from Buffalo and was cleared to descend and make an ILS approach monitored by GCA, to the Newark Airport.

The last advisory given was "glide path is good 3-1/2 miles out and you're drifting to the right, you're 900 feet to the right of course and 1/2 mile from the Court House". Five seconds after this the aircraft vanished from both the azimuth and elevation screens of the ten-mile precision scope. At the same time the operator of the 3-mile precision scope saw no indication in either of its screens and transmitted that the aircraft was not in radar contact. The aircraft crashed and burned at about 2 100' to the right (SE) of the glide path and about 3-3/8 miles from the touchdown point on Runway No. 6. All 20 passengers and 3 crew members were killed. Impact and ensuing fire destroyed the aircraft. Considerable damage resulted to buildings and seven persons therein were fatally injured.

### Investigation and Evidence

No meteorological factors existed that should have been much more than routine in navigating and making an approach for landing during instrument and near minimum conditions.

Although it is impossible to determine accurately the exact path of the aircraft from the time it was last seen on the GCA screens until it crashed, the following reconstruction of its most probable path can be made. The accident undoubtedly had its inception just before the last screen observation, which was four or five seconds after the last advisory report. That report placed the aircraft 900 feet to the right of course, at the proper altitude (about 900 feet), and three and one-half miles from touchdown. Four or five seconds later, when the aircraft disappeared from the GCA screen, it must have been at least 500 feet lower because it could have been tracked to 400 feet altitude. This rate of descent (500 feet in 4-5 seconds) is abnormally high, approximately 6 000 feet per minute. The cause of such extreme rate of descent can most readily be attributed to an unsymmetrical power, and consequently thrust, condition.

Because the aircraft was last seen by ground witnesses headed in an easterly direction paralleling South Street, it must have turned approximately 40 degrees to the right from the point it was last seen on the GCA screen. This fact is supported by the testimony of O'Connell who thought from the sound of the engines that the aircraft was turning to its right. That the aircraft did turn to the right is substantiated by Mr. Michael Calabrese, the first ground witness who actually observed it directly overhead below the overcast.

The aircraft was seen to be flying level for about three city blocks, at an altitude of 100-150 feet before it struck. The "about three city blocks" is a most elastic distance, but it measured about 1 300 feet; therefore the point of the aircraft's emergence below the 100-150 foot overcast would be approximately 400 feet beyond the point where it vanished from the GCA screens.

Because the azimuth screen of the 10-mile precision scope could have tracked the aircraft from a considerable distance still farther to the right than where it was last seen, we must conclude that disappearance from both screens occurred when the aircraft went below the 400-foot level, below which it could not have been tracked because of the ground interference.

As stated, the times of GCA advisories are not recorded, and it is thus not possible to know the time interval from the last advisory to the crash time which was determined to be about 1544. However, the aircraft's last position report was at 1541, over Linden, approximately three miles back along the approach path from the crash site. Because times are recorded at the previous full minute, a precise time-distance computation cannot be made. (Three miles in three minutes is an impossibly low air speed for the aircraft involved.) But it appears probable that there could have been no manner for the aircraft to descend from some 900 feet to 100-150 feet except at an extremely high settling rate.

It has previously been stated that examination of the undestroyed portions of the wreckage revealed nothing that reflected upon the integrity of the aircraft's structure, its engines, or its propellers. Further, the weather, as far as can be learned from exhaustive study, was not of a degree of severity to cause such rapid descent because of downdrafts or to cause the aircraft to stall because of violent and abrupt wind changes. We must, therefore, because of the lack of physical evidence advance certain conjecture as to the cause of the aircraft's rapid descent.

The possibility of a bird strike was considered and rejected for several reasons. First, there was no evidence of bird remains on any of the recovered parts of the windshields or their frames. Although none of the left windshield was identifiable, the right one was nearly intact, indicating that any bird strike incapacitating the pilot on the left should not have affected the pilot on the right. Further, birds never fly in solid overcast conditions as far as is known.

One possible cause of the aircraft yawing sharply to the right and losing altitude quickly, would be unequal extension of the two wing flaps. However, examination of the fractures in the flap torque tubes indicated that they were intact until the aircraft disintegrated and that, as a result, the flaps were equally extended until disintegration at impact. Aside from this, any failure in the flap system would be likely only during the retracting or extending cycle which places much higher stresses in the torque tubes than do flight loads. It follows then that if unequal flap extension had resulted in loss of control the accident should have happened much farther back along the flight path near the point where the flaps are normally extended. These facts allow the exclusion of unequal flap extension as a reason for the aircraft's manoeuvre.

Another possibility is that of carburetor icing. It has been pointed out that ground witnesses, all laymen, reported hearing unusual and varied engine noises. If during the descent and at about the time the aircraft vanished from the screens one or both carburetors had been iced, and if at that time more power had been required of the engines, it is conceivable that there could have been a power surging, presumably of the right engine inasmuch as the aircraft went to the right during descent. This would cause unusual engine noise. If surging had occurred, it would have taken some time for the crew to effect corrective action, and during that time the speed of the aircraft may have decreased to a marginal value with a consequent high sinking rate. However, it is difficult to reconcile the possibility of icing with other facts. First, the carrier's operations manual sets forth explicitly that carburetor heat shall be used, to the extent of raising the air temperature to 40° C during periods of visible precipitation. It was raining at the time and place of the accident. Further, it appears most likely that a carburetor icing condition existed during the earlier part of the descent below the 4 000-foot level. If so, there is little doubt but what carburetor heat would have been used to avert icing starting at the 4 000-foot level. Most of the other flights landing at Newark during the general time period did use carburetor heat. The pilot of another Convair, operated by the same carrier, landed at Newark only five minutes before the accident; he testified that he had used carburetor heat as prescribed by his company's operation manual. The subject aircraft was equipped with an alcohol system as a second means of removing carburetor ice.

It may also be pointed out that the company's operations manual calls for a complete pre-landing check before the aircraft starts inbound from Linden. This covers a number of items including checking for the need of carburetor heat. In conclusion, all factors, the company's procedures, the pilot's training and experience, and the existing weather conditions point to the probability that the pilot did use carburetor heat. There is no single bit of evidence to suggest that he did not, except that of witnesses who heard varying engine noises including three loud blasts accompanied by yellow glare, suggestive of backfire and engine surging, that could have been caused by faulty carburetion due to carburetor ice. The characteristics of the subject engine in regard to icing of its carburetor preclude the possibility of any significant ice accretion during the three or four minutes following the time of the compulsory landing check. However, carburetor ice may have existed during cruise and descent prior to the time that the compulsory pre-landing check would have been made, due to non-use of, or inadequate carburetor heat. This may not have been indicated since power requirements were progressively reduced during the descent and weather conditions were conducive to carburetor icing below the 4 000-foot level accompanied by saturated air and rain. If there was still no indication of carburetor ice at the time of the pre-landing check and no additional carburetor heat was applied while power was still being reduced for the final approach, it is possible that ice accretion could have increased and at a more rapid rate.

GCA monitoring indicated that the aircraft was making a normal ILS approach, which was indicative that the power settings and rate of descent had been stabilized. Had more power been applied to compensate for deviations in azimuth and sharp turbulence, which existed during the final approach, and carburetor ice accretions were present, such increase of power probably would have precipitated backfiring and surging of either or both engines with attendant loss of power and altitude.

A continuous surging of large displacement engines, such as the type involved, would affect controllability and air speed adversely, particularly in view of the fact that the landing gear and wing flaps were extended, which would result in the loss of air speed to a marginal value. This condition, together with the effect of the near maximum gross weight (approximately 36 234 pounds) and high wing loading could have precipitated a high settling rate.

Witnesses heard and/or observed the aircraft in near level attitude during the final portion of the flight which indicates that the rapid rate of descent had been checked. With the 100 to 150-foot ceiling and poor visibility existing due to fog and rain, it is evident that forward visibility from the cockpit was greatly restricted, although some witnesses saw the aircraft during its final approximate 1 300 feet of flight. A number of these witnesses observed the impact. From their observations and the analysis of the physical evidence at the scene, including the damage to buildings, it is concluded that the aircraft struck in a very steep descent and crashed through the roofs. The damage to the aircraft and extreme localization of the wreckage distribution at impact indicates that the longitudinal axis of the aircraft was at a high positive angle of attack relative to the descent path. If the aircraft was in a level attitude, during the final 1 300 feet, as the witnesses described, it appears that there was not sufficient power being generated to avoid settling into the buildings.

The possibility of a propeller reversing its pitch has been studied. Normally, pitch is reversed for ground braking, and an electrical switch incorporated in the landing gear allows the propellers to be reversed after the hydraulic landing gear oleo strut has been compressed approximately one-half inch. This movement, resulting from the aircraft's weight on its wheels, closes the switch, which energizes a solenoid. This, in turn, unlocks the throttles reversing mechanism, thus permitting rearward movement of the throttles into the reverse propeller pitch position.

The throttle lock on the reversing mechanism can also be normally operated from within the cockpit. This is done by pulling out a "T" handle manual override control. This control is spring loaded, and normally stays in when the aircraft is in flight. It is connected mechanically to the solenoid plunger and its outward movement has the same effect on the throttle lock as does the energizing of the solenoid. The "T" handle is plainly placarded, "The manual override must not be used until the airplane is firmly on the ground". American Airlines' operating manual, as well as a mechanical check list mounted in the cockpit, both list checking the position of this manual override switch prior to landing. The object is to prevent unintentionally pulling the throttles back into the reverse pitch range during flight.

Propeller pitch reversal in flight on the subject aircraft would involve malfunctioning of the reversing system. Careful inspection of the propellers and their reversing systems failed to disclose any evidence of malfunctioning that would be indicative of a reversal in flight.

As stated, the blades of the left propeller were determined to have been at 33° pitch at the time of impact; those of the right propeller to have been at 41°. Both propeller governors were found set to allow their respective engines to run at about 2 270 RPM, considered within the normal range for approach. The pitch setting of the left propeller, 33°, was considered within the normal range for an approach; however, the pitch setting of the right propeller, 41°, was considered too high. A logical explanation of this high pitch setting is that the right engine surged. This would result in alternating decrease and increase of engine RPM of probable increasing magnitude. A power surge could result in a peak RPM higher than that for which the governor was set. The governor, sensing only RPM, would then increase the pitch to reduce the RPM to its setting. This governor reaction and resultant propeller blade change lags in relation to any appreciable change in RPM. At the moment of impact, the propeller blades could have been at this high blade angle, as found, due to the action of the governor to decrease RPM.

The possibility of crew incapacitation was considered unlikely. The last radio contact with the flight was at 1541 and since the accident occurred at 1544, there was no indication that either the captain or the co-pilot was incapacitated in any respect. Moreover, all contacts with the flight indicated a routine operation and at no time was an emergency declared. The crew had had adequate rest periods and both pilots held currently effective medical certificates..

Investigation of this accident determined that the carrier's operating procedures, in general, including its training for Convairs, were consistent with good and accepted practices.

All evidence points to the fact that the aircraft was airworthy on departure from Syracuse, and that the crew was fully qualified in the aircraft and over the route involved. The captain, by virtue of his experience, undoubtedly was familiar with the terrain and the navigational facilities in the

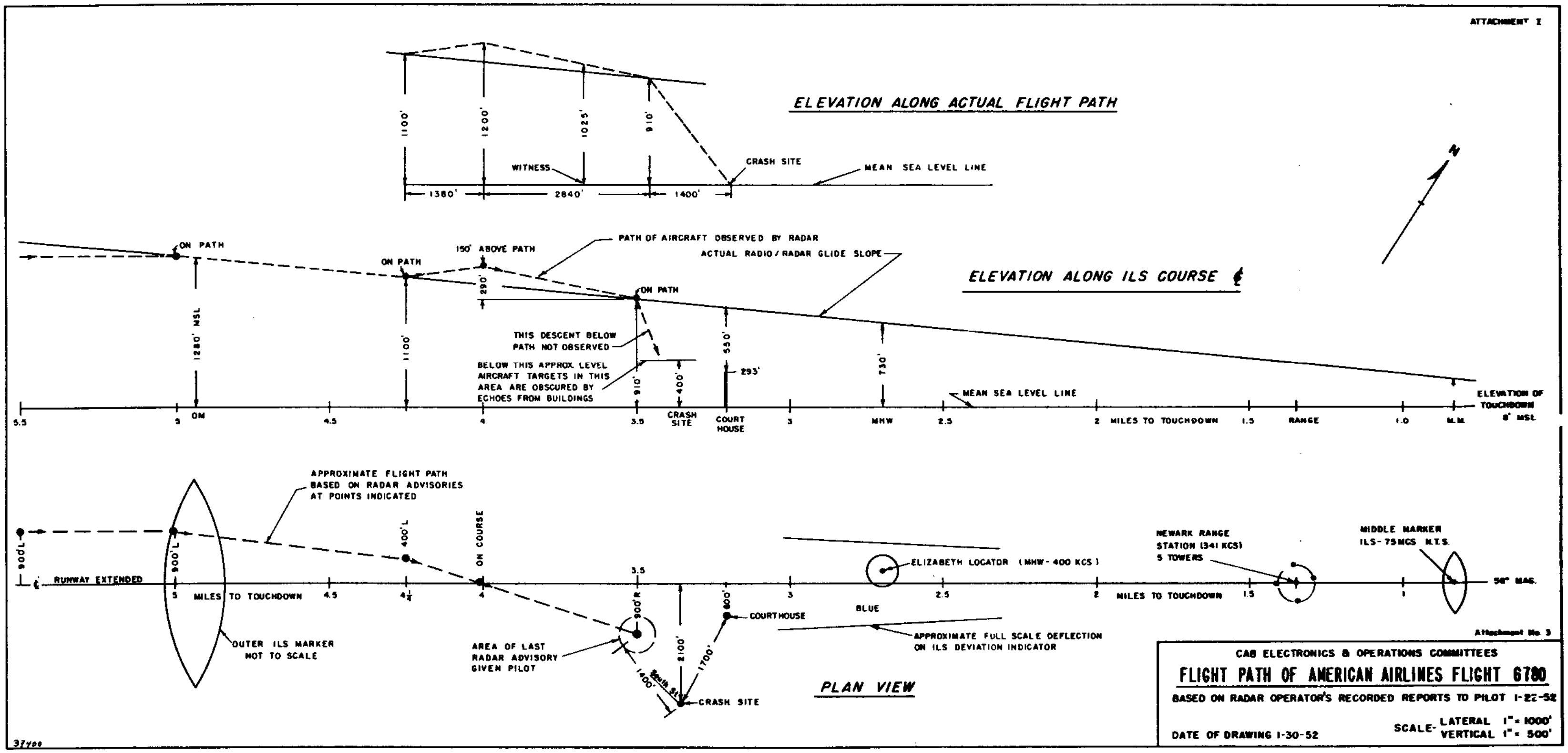
Newark area. In fact, the operation of the flight can be considered normal until after its last report at 1541, when GCA was advised that its signals were loud and clear. The aircraft's manoeuvres during the first portion of the glide path traversed were described as being normal; however, the Board, as previously stated, can only conjecture as to what might have caused the sharp descent and right turn. Whatever happened during the very short period of time before impact was of such nature that it was beyond the capabilities of both pilots to effect complete recovery.

Although the facts are inconclusive as to the probable cause of this accident, there is some evidence to indicate that carburetor icing, followed by severe surging, occurred.

## Probable Cause

The Board determines that there is insufficient evidence available at this time upon which to predicate a probable cause.

ICAO Ref: AR/197


ATTACHMENT I
ELEVATION ALONG ACTUAL FLIGHT PATH
1100'
1200'
1025'
910'
WITNESS
CRASH SITE
MEAN SEA LEVEL LINE
1380'
2840'
1400'
ELEVATION ALONG ILS COURSE ℄
ON PATH
ON PATH
150' ABOVE PATH
PATH OF AIRCRAFT OBSERVED BY RADAR
ACTUAL RADIO / RADAR GLIDE SLOPE
ON PATH
290'
1280' MSL
1100'
THIS DESCENT BELOW PATH NOT OBSERVED
BELOW THIS APPROX. LEVEL AIRCRAFT TARGETS IN THIS AREA ARE OBSCURED BY ECHOES FROM BUILDINGS
910'
400'
550'
293'
730'
MEAN SEA LEVEL LINE
ELEVATION OF TOUCHDOWN 8' MSL
5.5
5
OM
4.5
4
3.5
CRASH SITE
COURT HOUSE
3
MHW
2.5
2 MILES TO TOUCHDOWN
1.5
RANGE
1.0
M.M.
APPROXIMATE FLIGHT PATH BASED ON RADAR ADVISORIES AT POINTS INDICATED
900'L
900'L
400'L
ON COURSE
RUNWAY EXTENDED
5 MILES TO TOUCHDOWN
4.5
4¼
4
3.5
900'R
2100'
800'
COURTHOUSE
ELIZABETH LOCATOR (MHW - 400 KCS)
3
2.5
BLUE
2 MILES TO TOUCHDOWN
1.5
1
NEWARK RANGE STATION (341 KCS) 5 TOWERS
MIDDLE MARKER ILS - 75 MCS N.T.S.
58° MAG.
OUTER ILS MARKER NOT TO SCALE
AREA OF LAST RADAR ADVISORY GIVEN PILOT
1400'
1700'
CRASH SITE
APPROXIMATE FULL SCALE DEFLECTION ON ILS DEVIATION INDICATOR
PLAN VIEW
Attachment No. 3
CAB ELECTRONICS & OPERATIONS COMMITTEES
FLIGHT PATH OF AMERICAN AIRLINES FLIGHT 6780
BASED ON RADAR OPERATOR'S RECORDED REPORTS TO PILOT 1-22-52
DATE OF DRAWING 1-30-52
SCALE- LATERAL 1" = 1000'
VERTICAL 1" = 500'
N

No. 35

Private, Cessna 120, CF-EHC, crashed near Wabowden, Manitoba, Canada on 30 January 1952. Dept. of Transport, Air Services Branch, Civil Aviation Division, Serial No. 52-1

Circumstances

At about 0945 hours C.S.T. on 30 January 1952 the aircraft took off from Wabowden, Manitoba, for Stevenson Lake, Manitoba, to pick up a cargo of fish. A stop was made at Molson Lake to await an improvement in weather conditions. The aircraft then continued to Stevenson Lake. While the cargo was being prepared, a passenger was flown to Island Lake and back again. Having been refuelled and with about one hour of daylight remaining, the aircraft took-off from Stevenson Lake for Wabowden. No anxiety was felt for the aircraft until the afternoon of 31 January 1952 at which time an unsuccessful air search of the area was made. The search was resumed the following day and at about 1100 hours C.S.T. the aircraft was found. The pilot had suffered fatal injuries in the crash and the aircraft was destroyed.

Investigation and Evidence

Examination of the wreckage indicated that the aircraft had struck the ground with the starboard wing and ski, followed by the engine, causing it to cartwheel and come to rest facing the opposite direction. There were indications that the engine was developing power at the time of the impact and that there was fuel in the system. There was no evidence of malfunctioning of the aircraft, engine or controls.

It was estimated that at the time of the departure of the aircraft from Stevenson Lake, its all-up-weight exceeded the maximum permissible weight by 431 lbs.

There was evidence of ice on the leading edges of the wings and also on the windshield. At Wabowden another pilot reported ice accretion on the wings and windscreen of his aircraft during the afternoon of 30 January 1952 and a ceiling of 500 - 600 feet with visibility 2 - 3 miles.

The weather report for the Wabowden area showed that during the afternoon the sky was overcast, with Stratus, and the ceiling estimated as 800 feet with a visibility of 2 miles and fog. Temperature 18°F and dew-point 18°F. Later in the day the weather deteriorated to ceiling 400' visibility 1/2 mile and fog. Temperature 18°F. Dew-point 18°F.

The pilot held a valid Restricted Commercial Licence and had accumulated a total of about 1 440 hours of flying time.

## Probable Cause

Through the continuation of VFR flight into unfavourable weather conditions in an overloaded aircraft, control of the aircraft was lost at a low altitude causing it to cartwheel after striking the ground with the starboard wing and ski.

ICAO Ref: AR/211

No. 36

Private, Waco AQC-6, CF-DTB aircraft, crashed at Lesser Slave Lake, Alta., on 7 February 1952. Dept. of Transport, Air Services Branch, Civil Aviation Division, Serial No. 52-4

## Circumstances

At 1500 hours M.S.T. on 7 February 1952 the aircraft, carrying a pilot and one passenger, made a second attempt to take off from Lesser Slave Lake. The aircraft failed to clear some telephone and power wires, struck a tall tree top and crashed to the ground fatally injuring the occupants and destroying the aircraft.

## Investigation and Evidence

No evidence of malfunctioning was found. There was, however, need of an engine top overhaul. The aircraft weight limitation was exceeded by 289 lbs.

Although weather did not contribute to the accident, surface snow conditions were described as "sticky".

In the take-off, of the 2 640 feet available, about 2 350 feet were used before the aircraft became airborne 290 feet in front of the telephone wires.

## Probable Cause

The pilot did not discontinue the take-off when it should have been apparent that the take-off could not be completed successfully. As a result, the aircraft collided with power lines and crashed. Contributory factors were:

1) sticky snow conditions

2) aircraft was overloaded by 290 lbs.

ICAO Ref: AR/195

## No. 37

## Hiller - 360 F-BFPL aircraft, crashed on training flight, at Toussus-le-Noble, on 7 February 1952

### Circumstances

The aircraft, on a solo training flight in the vicinity of Toussus-le-Noble airfield, crashed 1 km north of the airfield killing the pilot instantly.

### Investigation and Evidence

The accident occurred while the aircraft, flown solo by a student pilot, was circling the aerodrome for the third time. The pilot had taken off into wind, climbed to approximately 150 metres and carried out a 90° right turn. Shortly after the turn, the attention of a number of witnesses was attracted by a sharp report similar to a "rifle shot". About 2 seconds after this noise, the helicopter, which had continued its flight at an altitude of 150 metres, began to turn, rolled to one side, and entered into a steep dive from which the aircraft did not recover. Witnesses estimated that the rotor turned only at half normal rotational speed during the aircraft's fall.

A thorough examination of the airframe showed no sign of any failure prior to striking the ground. Examination of the engine showed that the connecting rod of No. 2 cylinder was broken midway of its length. No. 2 piston, with part of the broken rod, was jammed at the top of the cylinder following expansion of the compression ring over the sleeve. The other part of the rod was still attached to the crank-pin, but the end was bent up against it, blocking it in that position. A breakdown inspection of No. 2 cylinder and of the big end of the connecting rod revealed that the failure of the rod was due to fatigue. Detailed examination disclosed that the failure was due to fatigue fracture, and that fissuration, originating from a metallurgical flaw, had begun a few hours after use. A close analysis of the point of origin of the fissure did not reveal the exact nature of the flaw which may have occurred during forging, straightening or annealing of the metal.

From the evidence it was established that the probable sequence of events was as follows:- The helicopter was performing normal level flight at an altitude of approximately 150 metres with a forward speed of 80 km.p.h. with a rotor speed of approximately 330 RPM. A connecting rod of the engine broke splitting the lower part of a cylinder; this was the sound heard by witnesses. The aircraft continued in forward level flight for a few seconds while the pilot endeavoured to maintain rotor speed, which was dropping, by opening the throttle. This manoeuvre was unsuccessful owing to engine failure and the rotor speed must have dropped to approximately 200 RPM. At such low speed the rotor was no longer efficient and stalling of the rotor blades resulted, the aircraft descending out of control.

The emergency manoeuvre which is required by the pilot in cases of engine failure was not carried out or was too late to be of any use. Very prompt action is called for, in fact, at the first signs of an engine failure (irregular noise or loss of RPM) the first action by the pilot is to go into autorotation (application of minimum pitch and reduction of power) in order to avoid stalling. The over-running clutch then automatically disengages the rotor and the aircraft settles vertically without power (autogyro). Although autorotation landings require a certain amount of training before proficiency is acquired, the manoeuvre itself, even if incorrectly performed, does not entail serious risks for the pilot. All students of the company involved were made to perform some ten autorotations before flying solo.

ICAO Ref: AR/223

## No. 38

## Nord 1203, Norecrin F-BEUB, crashed during take-off at Addis Ababa Airport, Ethiopia, 9 February 1952

### Circumstances

The aircraft stalled during the climb after take-off resulting in collision with the ground, the force of the impact killing the pilot and two passengers and destroying the aircraft.

### Investigation and Evidence

From all evidence it appears that the aircraft engine was functioning satisfactorily up to the moment of the crash. Whether the altitude control was used is not known. The aircraft took off from the extreme north east end of the runway into a headwind of 12 m.p.h. The estimated temperature was 26.5°C (80°F) and the density elevation of the airport 10 300 feet. The aircraft was fully loaded for sea-level take-off at standard temperature. The pilot was warned that it was advisable for fully loaded light aircraft to depart in the early morning. In the direction used the runway is up-grade for the first hundred feet and then has a down gradient of 1.8%.

The aircraft left the runway after covering a distance in excess of 2 000 feet (manufacturer's figures give take-off run at sea level as 820 feet). Unable to remain in the air the aircraft returned to the runway and again bounced into the air and the pilot immediately retracted the landing gear. The flight was continued at near stalling speed and sufficient height gained to clear the trees east of the Airport.

In this "near stall" condition the aircraft turned (or was turned) to the left which caused a complete stall from which the aircraft failed to recover.

The point at which the aircraft struck is approximately 50 metres lower in elevation than the airport runway making approximately 100 metres descent in the stall before striking the ground in an almost vertical attitude.

Although the pilot may have voluntarily turned the aircraft to return to the field on the near edge of which he crashed, any thought that he was gliding in must be discounted as the angle from the trees over which ha had passed to the point of contact was very steep, and the attitude at moment of impact could only have been due to a dive following a complete stall.

Recommendations:

1) That take-off limitations be more generally studied and applied and that the effect of altitude and temperature be emphasized to flight personnel.

2) That the values of density elevations in certain parts of the world be made widely known to flight personnel.

## Probable Cause

Error in judgment on part of the pilot in attempting to take off with an overloaded aircraft under adverse conditions of air density and temperature.

ICAO Ref: AR/201

## No. 39

## Dove ZS-DFA aircraft, made a forced landing near Vereeniging, on 11 February 1952. Aircraft Accident Report No. 7/52. - J.10/2/645.

### Circumstances

The aircraft with pilot and four passengers took off at 1515 on a scheduled flight and climbed to attain a height of 1 200 feet A.M.S.L. At 1 000 feet the port engine cut completely. The pilot tried to feather the port propeller but failed due to a jammed propeller pitch lever. However, the propeller feathered when the propeller pitch lever was pushed forward and then forced right back into the feathering position. A successful forced landing on one engine was made. No injuries were sustained.

### Investigation and Evidence

The engine had run 934 hours since new and 575 hours since overhaul. At 800 hours all cylinder heads were found to be cracked and all exhaust valves burned at the seats and were replaced.

### Probable Cause

Engine failure caused by fracture of No. 5 cylinder gudgeon pin. As a result, a bending moment was applied to the connecting rod causing the connecting rod to fail at the small end. After considerable internal damage, a further failure occurred at the big end.

ICAO Ref: AR/186

No. 40

National Airlines Inc., Douglas DC-6, N-90891, crashed and burned at Elizabeth, N.J. on 11 February 1952. CAB Accident Investigation Report No. 1-0015. Released 16 May 1952.

Circumstances

At 0013 Newark Control Tower gave the flight taxi clearance and the controller observed the aircraft taxi into take-off position and proceed down the runway in a normal manner, becoming airborne at 0018 after a roll of approximately 3 200 feet. The climb-out appeared normal until the aircraft passed the vicinity of the Newark Range Station. Here it lost altitude suddenly and veered slightly to the right. At 0019, the pilot radioed "I lost an engine and am returning to the field." During the last radio transmission the controller observed the aircraft continuing to veer to the right at a low altitude and then disappear from sight, crashing into an apartment building. There were 63 persons aboard the aircraft, including one infant and a crew of four. Twenty-six passengers, three crew members and four occupants of the apartment house were killed.

*Investigation and Evidence*

No evidence was found to indicate structural failure or malfunctioning prior to impact, either by visual observations or by functional tests where such tests were possible. No. 4 engine was stopped prior to impact with its propeller in the fully feathered position, which indicates that this condition had been accomplished through action by the flight crew. No. 3 was operating at impact and there was no evidence to indicate that it was not capable of continued operation. The testimony in general describes circumstances which would be expected to accompany a sudden reversal of a propeller under power in flight - sudden increase in noise level of short duration, accompanied simultaneously by abrupt settling and veering to the right of the aircraft. It is not unreasonable to assume that the comparative violent manoeuvre, which occurred at low altitude and low air speed, created an emergency with such attendant urgency in the cockpit that the crew did not have sufficient time to make a correct analysis of the difficulty. Under these conditions the feathering of No. 4 propeller with No. 3 propeller operating in reverse pitch at appreciable power would adversely affect performance resulting in a high rate of descent. Had the aircraft been equipped with reverse pitch indicating lights in the cockpit, the malfunctioning propeller could have been readily identified and the No. 4 propeller undoubtedly would not have been feathered.

Examination of the propeller of No. 3 engine indicated that the dowels and screws which retain the blade gear to the blade were sheared on all three blades by loads tending to turn the blades toward reverse pitch direction, indicating their being in reverse pitch at the time of impact.

Due to impact and fire, the propeller control system in its entirety could not be examined, however, certain facts were considered. The governor solenoid valve circuit, which extends from the cockpit to the governor on the nose of the engine and which is not isolated from other circuits, will cause reversal of the propeller if it should become energized. Should this occur, due to some fault in the electrical system, resulting in unwanted voltage to the governor solenoid valve circuit, reversal of the propeller would result without any action on the part of the crew and as long as the circuit remained energized, the propeller could not be taken out of the reverse pitch position.

On February 14, 1952, the Administrator of Civil Aeronautics sent to all CAA regional offices the following telegram:

> "... to preclude possibility of inadvertent propeller reversal of Hamilton Standard propellers on Douglas DC-6, DC-6A and DC-6B aircraft the wiring from the engine firewall to the governor solenoid valve is to be isolated from all other circuits to prevent inadvertent application of electric power to solenoid circuit. This is to be accomplished preferably by removing wire from any bundles in which it may run and placing it in separate isolated conduit. Isolation of this portion of circuit to be accomplished as soon as possible but not later than midnight February 18. Portion of circuit behind firewall and throughout remainder of aircraft to be inspected immediately. Inspection to include check of all terminal points to assure no hazard of contact with loose wires nearby and check of all points where chaffing or other damage may occur which could permit energized wires to contact solenoid circuit wire or terminals. Further instructions re isolation of portion of circuit behind firewall will be transmitted as soon as available. We do not recommend deactivation of reversing propellers on any aircraft while above program being accomplished."

National Airlines on 13 February began a program of rendering the propeller reversing feature inactive on all their DC-6 equipment.

## Probable Cause

The probable cause of this accident was the reversal in flight of No. 3 propeller with relatively high power and the subsequent feathering of No. 4 propeller resulting in a descent at an altitude too low to effect recovery.

ICAO Ref: AR/199

No. 41

Deccan Airways, Dakota VT-AXE, crashed on 19 February 1952 at Sonegaon Airport, Nagpur, India, Gov. of India, Ministry of Communications Accident Report.

## Circumstances

While on the final approach to land the aircraft was observed by the Aerodrome Operator on duty at the Control Tower. Both the aircraft landing lights were "on", but the operator noticed that the aeroplane was coming in unusually low and drew the attention of the Duty Officer to it. Subsequently, the aircraft assumed a steeply banked attitude with the port wing down and crashed at 0223 hours at a point 2000 feet from the end of runway 27 and directly in line with it. Fire broke out on impact. 12 passengers and 3 crew members required medical treatment but the pilot and one passenger could not be removed from the aircraft and the radio officer expired subsequently in hospital.

## Investigation and Evidence

The aircraft initially struck a Simul tree at a height of 58 feet above ground level. At impact the aircraft was substantially in level attitude laterally and longitudinally. Both the engines were under power and the aircraft was trimmed for approach to land. The undercarriage and flaps were down for the landing.

The radio antenna mounted at the bottom of the fuselage was torn free on the tree. The impact resulted in a drop in forward speed and the aircraft lost height rapidly maintaining its direction of flight with the port wing dropping. The port wing impacted 4 small palm trees 500 feet from the point of initial impact with the simul tree and the aircraft swung to the left and crashed in a nose-down attitude immediately afterwards into a deep nullah running at right angles to the direction of flight.

Both the ignition switches were on and the power setting denoted an engine assisted power approach. There was no evidence of malfunctioning of any aircraft or engine components prior to the crash.

The co-pilot survived the accident and reported that he had seen the obstacle before it was struck. On being questioned as to whether it was not his responsibility to warn the pilot when he knew that something was going wrong he replied that he dare not interfere with the captain's flying as he was only a co-pilot. (Total 771 hours - 280 Dakota at night as co-pilot.)

The aircraft carried 400 Imperial gallons of petrol and 42 gallons of oil at the time of take-off from Madras. This was more than adequate for the intended flight to Nagpur which was expected to take 3-1/2 hours.

It has been established that all the available facilities were working satisfactorily on the night of 18/19 February 1952.

The pilot approached the aerodrome from a southerly direction. When fairly close, he was twice warned by the Air Traffic Control to make a wide approach so as to enable the preceding aircraft to clear the runway in use. This manoeuvre probably put the aircraft at a longer distance away from the aerodrome when he turned in on the final approach that what the pilot would be accustomed to. When within the approach control zone of Nagpur aerodrome, the pilot should, according to the company's regulations, have set the sub-scale of his altimeter at the QFE reading passed to him by Air Traffic Control. Up to the time of entry into the approach control zone, the general procedures, to which Deccan Airways adhered, is to set the sub-scale to QNH of the destination aerodrome. The QNH reading for Nagpur at the time was 29.35 inches.

The sub-scale of the captain's altimeter was set at QNH, which prevented the captain from obtaining a direct reading of his height above aerodrome level.

The committee is unable to offer an explanation why the pilot failed to observe the obstruction ahead in sufficient time to take corrective action. It was noted during the investigation that the pilot had had a rest of 39 hours since he had completed two consecutive night flights between Madras and Delhi. This was not in accordance with the company's practice, which was to give two nights off after a pilot had flown two nights consecutively on the night airmail service.

The saving of the large number of lives was due to the prompt warning and efficient rescue work.

Recommendations

It is recommended that:-

1) there should be strict enforcement and checking of operating procedures as laid down in the Company's Operating Instructions and more effective supervision over the flying habits of aircrews;

2) in selecting the aircrew for the operation of the night airmail service, it should be ensured that not only the captain but also the co-pilots are of proved ability and possess long and mature experience of air transport flying;

3) the question of crew fatigue particularly on night services should be studied in consultation with experts on aeronautical medicine;

4) normally, for landing at night, the requirement to make a circuit or a partial circuit of the aerodrome should not be waived;

5) every effort be made to accelerate the provision of high intensity runway and approach lighting at Nagpur, regarding which the committee noted, action had already been initiated by the Civil Aviation Department.

## Probable Cause

The accident was due to errors of judgment by the pilot when attempting landing during night. He misjudged the approach, undershot and hit the top branches of a tree.

The setting of the pilot's altimeter to QNH, rather than the customary QFE during the final approach was a contributory factor.

ICAO Ref: AR/200

## No. 42

## Bonanza ZS-BXM aircraft, collided with ant heap on landing near Stollsberg on 21 February 1952. Aircraft Accident Report No. 8/52. J.10/2/646.

### Circumstances

The aircraft with a pilot and one passenger took off from Barberton at 0635 hours to fly to an asbestos mine near Stollsberg, the landing to be made on a strip of an unlicensed field. 15 minutes later, having made a dummy run over the strip the pilot touched down, applied brakes but due to a collision with an ant heap, nosed over. No injuries were sustained.

### Investigation and Evidence

The flight was non-scheduled. The pilot's total flying experience was 3 224 hours, 34 of which were on Bonanza Aircraft. The documentation of the aircraft was in order.

### Probable Cause

Due to striking an ant heap during landing on an unlicensed field the nosewheel leg broke. Major damage resulted.

ICAO Ref: AR/187

No. 43

Noorduyn Norseman IV, CF-DFU aircraft, crashed while landing at Comox, B.C. on 21 February 1952. Dept. of Transport, Air Services Branch, Civil Aviation Division. Serial No.52-8

Circumstances

At 1314 hours P.S.T. a Public Transport pilot took off from Vancouver, B.C. for Sultry Bay, B.C. The first part of the trip was uneventful. Six passengers boarded the aircraft at Sultry Bay. The aircraft took off from Sultry Bay at 1415 hours P.S.T. arriving at Comox where it crash landed at 1444 hours P.S.T. No injuries resulted although the aircraft was substantially damaged.

Investigation and Evidence

The aircraft was airworthy and there was no evidence of malfunctioning. The pilot intended to land behind the Comox spit in sheltered water but changed direction of landing when visibility was suddenly sharply decreased by the snow flurries which made it unsafe to land toward the spit in sheltered water. The aircraft landed in unsheltered water where there were heavy swells and the undercarriage struts and spreader bar collapsed.

Probable Cause

Due to poor visibility the landing direction was changed and the aircraft had to land in rough water, where the undercarriage collapsed. The pilot erred in continuing the landing when it was apparent that the surface was unsuitable. The flight should not have continued through the Comox control zone in weather conditions below the VFR limits for control zones.

## No. 44

## Piper Cruiser ZS-BPA, collided with a vulture and forced landed on 29 February 1952 at Hluhluwe Game Reserve, Zululand, South Africa. Accident Investigation Report No. 11/52.

### Circumstances

The aircraft, converted for aerial spraying, and being piloted by a commercial licensed pilot, was making a commercial flight with three other aircraft. While doing a South West to North East flight a vulture appeared out of the smoke spray of the preceding aircraft. Evasive action proved ineffective and the vulture hit the aircraft on the port side. Unable to maintain height, as a result of vibration, the pilot made a forced landing into the trees. The aircraft was demolished.

### Investigation and Evidence

One foot of the propeller was smashed and a hole 9 inches by 6 inches resulted in the windscreen. Airspeed at the time was 105 mph. and the excess speed was used in an attempt to gain height.

The pilot's total flying hours were 615, of which 110 were on Piper Cruisers.

### Probable Cause

A vulture struck the aircraft, fracturing the propeller and windscreen causing the pilot to make a forced landing.

ICAO Ref: AR/188

## No. 45

**Private, De Havilland DH 104, N-4964N, crashed at Goose, Newfoundland on 29 February 1952. Dept. of Transport, Air Services Branch, Civil Aviation Division. Serial No.52-F2.**

### Circumstances

At 1325 hours on 26 February 1952 the aircraft took off from Hatfield, England, bound for Toronto, Canada, on a ferry flight via Prestwick, Scotland; Keflavik, Iceland; Bluie West I, Greenland; Goose, Nfld; Montreal, Quebec. The flight proceeded without incident as far as Bluie West I where it arrived at 1935 hours on 27 February 1952 having landed and refuelled en route at Prestwick and Keflavik.

The aircraft departed Bluie West I at 1757 hours on 28 February 1952 for Goose with a signed flight clearance. After various exchanges of radio messages, the aircraft reported over the Goose radio range at 2252 hours 28 February 1952.

After refusing GCA, several instrument let-downs were attempted using the radio range and the aircraft crashed at about 0010 hours on 29 February 1952. Both the pilot and navigator were killed and the aircraft was destroyed.

### Investigation and Evidence

Examination of the aircraft failed to disclose any evidence of failure or malfunctioning of the airframe, engine or controls. In accordance with United Kingdom regulations, a Certificate of Safety had been issued for the aircraft prior to its departure from Hatfield. Evidence at the scene of the accident indicated that at the moment of impact the port engine was producing power and the starboard engine was not producing power.

Three of the four wing tanks were damaged in the crash and were found to be empty. The fourth wing tank was undamaged and contained about one gallon of fuel. The auxiliary wing tank was found to be intact and dry. Examination of the snow in the vicinity of the accident failed to show evidence of fuel having escaped from the damaged fuel tanks.

The pilot-in-command held an Airline Transport Rating that appeared to be medically expired. Details of his flying experience were not available.

It was not determined whether or not the navigator held a navigator's licence but a Commercial Airmen Medical Certificate which appeared to be out of date was found in the wreckage.

At Bluie West I the pilot-in-command was briefed on the weather for the route, destination (Goose), Stephenville, Gander and Mingan. Although Mingan has no airport facilities or radio aids, and is to be used for emergency only - it was chosen by the pilot as the Alternate, Gander and Stephenville being beyond the safe range of the aircraft. At this briefing the weather for Goose was given as - Ceiling 300 feet obscure; Visibility 3/8 miles; moderate snow, light blowing snow; wind 25 kts. gusting to 40 kts. A weather folder was prepared for the flight but was not picked up by the pilot. In view of the weather two other pilots attempted to dissuade the pilot-in-command from departing and the clearing officer refused to sign a flight clearance for the aircraft. Before leaving, the pilot checked the weather with the forecaster to determine when he would meet the bad weather and how bad the icing would be. He was told where he would first meet the bad weather and that it would deteriorate progressively as he approached Goose. Icing was forecast to be moderate with the possibility of clear icing in the vicinity of Goose.

The aircraft departed from Bluie West I at 1757 hours and reported over the radio range at Goose at 2252 hours having been in the air 4 hours and 55 minutes. A further hour and eighteen minutes before the accident, was spent in the vicinity of Goose attempting instrument let-downs, thus giving a total airborne time of 6 hours 13 minutes. On the basis of the fuel consumption for the flight to Bluie West I, the maximum endurance of the aircraft would not exceed 7 hours 30 minutes.

During the 1 hour and 13 minutes that instrument let-downs were being attempted the fuel consumption of the aircraft would have been high.

There is, therefore, a strong possibility that the aircraft ran out of fuel while attempting an instrument let-down.

## Probable Cause

The aircraft struck the ground at an angle of about 30°. It was not possible to determine conclusively whether or not the accident was precipitated by fuel exhaustion. It is considered that poor judgement was shown by the pilot-in-command in undertaking the flight in such adverse weather conditions.

ICAO Ref: AR/212

No. 46

Dragon Rapide ZS-BCP aircraft, made a forced landing at Meob Bay, South West Africa on 13 March 1952. Aircraft Accident Report No. 13/52. J.10/2/651

## Circumstances

At about 1725 hours on 13 March 1952, the aircraft, flown by a commercial pilot took off on a non-scheduled flight. The aircraft weight was 4 596 lbs. (1 154 lbs. below allowable limit). Shortly after take-off the starboard engine commenced to run roughly, then the oil pressure dropped to zero. The pilot throttled back and switched off the engine. The aircraft was then at 3 500 A.M.S.L. and the pilot was unable to maintain height until the engine seized and the propeller ceased wind milling at 2 200 feet A.M.S.L. A successful forced landing was made at the original place of departure.

## Investigation and Evidence

The exhaust valve of No. 5 cylinder had fractured followed by failure of No. 5 piston. Broken parts circulating in the oil system caused No. 2 and 5 connecting rods to jam against the crankcase resulting in two holes being made in the crankcase.

## Probable Cause

Engine failure was due to fracture of No. 5 cylinder exhaust valve during flight. The exhaust valve had a running life of 65 hours since new and the reason for the failure is being investigated.

## No. 47

**Robin Airlines, Inc., C-46 aircraft, N-8404C, crashed near Whittier, California on 18 April 1952. CAB Accident Investigation Report. No. 1-0027. Released 21 August 1952.**

### Circumstances

The aircraft departed New York, N.Y. at 1809, 16 April. After making a scheduled stop at Chicago, Illinois, it arrived at Kansas City, Missouri, at 0208, 17 April. Departure from Kansas City was delayed approximately eleven hours when it was found necessary to replace the right engine oil cooler which had developed a leak. The flight departed Kansas City on a VFR (Visual Flight Rules) flight plan at 1338. A precautionary landing was made at Wichita, Kansas, at 1500, to check oil consumption and the flight departed at 1534 on an IFR flight plan. The flight encountered a severe thunderstorm in the vicinity of Tucumcari, New Mexico whereupon the flight turned eastward and landed at Amarillo, Texas at 1814. At 2102 the flight again proceeded westward on an IFR flight plan to Phoenix, Arizona.

At 2235 the flight reported over Albuquerque, New Mexico, and at this point changed from an IFR to a DVFR (Defence Visual Flight Rules) flight plan estimating Phoenix at 0020. It arrived at Phoenix at 0030, 18 April, and departed there at 0143 on a DVFR flight plan to cruise at 8 000 feet, Green 5 airway, to Riverside, California, then direct to Burbank, California, the destination.

At 0313 the flight requested and was furnished the Burbank and Los Angeles 0228 weather, which was as follows:

> Burbank closed, visibility 1/8 mile and Los Angeles measured 700 overcast, visibility 2-1/4 with haze and smoke, temperature 57°, dew point 54, wind southeast 1, altimeter 29.91. At this time the flight advised that it would file an IFR flight plan later. At 0317 the flight reported over Riverside Range Station at 6 000 feet and requested an IFR approach to Los Angeles, estimating over Downey at 0336.

The Los Angeles low-frequency radio range was not in operation, which fact was known to the pilot. At 0323, ARTC (Air Route Traffic Control) gave the following clearance to the aircraft:

"From present position to Downey radio beacon cruise at least 500 on top - Descend VFR and cross Downey and maintain 3 000 - Contact Los Angeles Approach Control over La Habra - No delay expected." The pilot repeated this clearance.

The following information is from the report of the Los Angeles Airport Chief Controller:

"At 0333P, N-04C called Los Angeles Approach Control on 119.9 Mc (very loud and clear) advising he believed he was in the vicinity of La Habra and was having difficulty with his ADF equipment on account of static and that he would have to make some other type of approach. The Approach Controller asked N-04C if he had ILS equipment and whether he believed he could pick up the outer marker satisfactorily. The pilot answered in the affirmative and further stated that he could probably find the ILS Glide Path and proceed from there on in. N-04C was then cleared (0333P) for a straight-in ILS approach from the Los Angeles outer marker and was given the Los Angeles weather and also advised that the Los Angeles L.F. Range was inoperative on account of being shut-down for maintenance.

The Los Angeles Approach Controller then immediately began watching for N-04C's appearance within the next few minutes on the Surveillance Radar Scope on the normal setting of 20 mile range as the flight continued westbound toward the Los Angeles Outer Marker. When no target appeared on the Surveillance Scope by 0337P several radio calls were directed to N-04C by Los Angeles Approach Control. No response was received."

About 1000 on the morning of 18 April the wrecked aircraft was discovered about 2 miles east of Whittier and 22-1/2 miles east-northeast of the Los Angeles International Airport. All persons aboard - 26 passengers and three crew members - were killed in the crash.

## Investigation and Evidence

The accident occurred near the top of a grassy knoll at an altitude of 980 feet MSL while the aircraft was banked slightly to the left, probably level longitudinally, and on a heading of 260° magnetic. This site is approximately 2 600 feet north of the centre line of the ILS approach path to Los Angeles International Airport, slightly west of north of La Habra, and about 7-1/2 miles east of the Downey fan marker.

Evidence indicated that the power plants were operating normally and that both were developing appreciable power at initial impact. Following first ground contact, the aircraft continued airborne for a distance of 1 875 feet across a ravine, where it crashed and burned on the upslope of the opposite side.

Examination of the wreckage revealed that at initial impact with the ground the landing gear was in the extended position and the wing flaps were fully retracted. No evidence was found to indicate that any structural failure or malfunctioning of the aircraft and power plants, or of any of their components, had occurred prior to the accident. As far as could be determined from examination of the wreckage and a review of the maintenance records, the aircraft was well maintained and was in an airworthy condition when it crashed.

Damage to the cockpit section was so extensive that no reliable readings could be made of most of the instruments or control settings. The barometric scale of each of the altimeters was set at 29.89. Examination of the aircraft clock disclosed that although the hour hand was loose on the shaft, the minute hand was stuck at approximately 33:45 and the second hand at :45.

The latest weight and balance report obtainable was the one out of Kansas City, which indicated a gross weight of 44 952 pounds, including 1 315 gallons of fuel. This was within the allowable gross of 45 000 pounds. It was impossible to locate a manifest out of Phoenix, a copy of which should have been mailed to the company's headquarters in accordance with the Civil Air Regulations. At Amarillo, 606 gallons of fuel and 32 quarts of oil were added. Using the basic weights out of Kansas City and estimating 150 gallons per hour fuel consumption (normally used for C-46 flight planning purposes) with 17 gallons per stop allowed for taxying and warm-up, the aircraft is calculated to have departed Phoenix with a gross weight of 40 542 pounds, including 715 gallons of fuel. At the time of the accident, approximately 422 gallons of fuel remained.

Nearly all of the radio equipment was destroyed by the impact and subsequent fire. It was determined, however, that the ILS Control Head was positioned to Channel (Y), corresponding to the Los Angeles ILS frequencies, and that the ADF was tuned to approximately 260 kc. The Los Angeles outer marker operates on a frequency of 266 kc. According to company maintenance records, all radio equipment had been overhauled, establishing ZERO service time. It was then installed on this aircraft 25 March 1952. The ADF was suitably compensated 3 April 1952.

All radio contacts with the flight were normal, the last one at 0333 being reported as, "very loud and clear." The only irregularity mentioned by the flight crew was the difficulty with the ADF equipment because of static. The Airways Flight Inspection Branch of CAA, on 18 April, made a special check of the Los Angeles instrument landing system and the La Habra and Downey fan markers. The report on this check indicated that operation of these facilities was normal in all respects.

Information given the crew at Phoenix showed clear weather for the remainder of the flight, with the exception of the immediate vicinity of Los Angeles where Burbank was forecast to be zero-zero with fog, and the Los Angeles Airport 800 feet and 2 miles with fog and haze, at the time of the flight's anticipated arrival there.

During the last leg of the flight, Phoenix to Los Angeles, it appears that clear sky and excellent flying conditions existed as far as Pomona, California. At the time of the accident the weather at Los Angeles Airport was reported to have been ceiling 700 feet, overcast, visibility 2-1/4 miles with haze and smoke; and Burbank ceiling 100 feet, sky obscured, visibility 1/4 mile with fog. The stratus and fog had been spreading inland and at the time of the accident apparently included the cities of Whittier and Puente, and the adjacent hills. The top of the stratus ranged from about 1 200 to 1 500 feet and it is indicated that the west slopes of the Puente hills, including the tops of the ridges and site of the crash, were in the fog at the time of the accident; however, it was clear immediately to the east of these hills. Aircraft icing conditions did not exist and turbulence, if any, would have been negligible.

Captain Lewis Reed Powell had been actively engaged in aviation for a number of years and had accumulated 7 751 hours of flying time when he became physically incapacitated on 30 March 1951, by a coronary attack. This flight time included, as captain, 1 500 hours in DC-3's, 1 900 in DC-4's and 600 in C-46's.

On 14 November 1951, Captain Powell was issued a first-class medical certificate, dated 1 September 1951, with the limitation "Valid for Company Check Pilot Duties." When Captain Powell was examined on 14 March 1952, for renewal of his medical certificate, Dr. Herzog (the CAA designated medical examiner from whom he usually took his pilot physical examinations) found no physical irregularities but because of the pilot's heart history, issued a medical certificate with the same limitations as before.

Mrs. Powell, widow of Captain Powell, was unable to testify at the accident investigation hearing. However, her statement was taken later, at which time she stated that both she and Captain Powell were well aware of the limitation on Captain Powell's medical certificate, as was an official of another irregular carrier for whom Captain Powell made two trips in December 1951. She stated further that Captain Powell told her he was not discussing the limitation on his certificate with any of the other pilots, as he hoped to go to Washington and have the limitation removed.

All of the passenger-carrying flights made by Powell were contrary to the limited medical certificate which restricted him to company check pilot duties.

Company officials testified that prior to the accident they were not aware of any limitation on Captain Powell's medical certificate, although they had examined his pilot papers on more than one occasion.

The waiver clause in Part 29 of the Civil Air Regulations is designed for use where a pilot's experience, ability and judgment compensate for physical deficiency. However, no amount of experience, ability and judgment can compensate for an organic disease which may, at any time, completely incapacitate the pilot. Hence the finding required by Section 29.5 before a waiver is granted could not have been properly made in this case. The Administrator of Civil Aeronautics has been requested to take specific steps to prevent recurrence of such a situation as arose in the case of Captain Powell.

The autopsy surgeon reported he found definite evidence that Captain Powell had a badly damaged heart and that he had had a recent hemorrhage. While he could not determine whether or not death occurred before the crash, he did state that this hemorrhage had occurred within, "probably a matter of hours, at the outside. It could have been immediately before or it could have been a matter of several hours before."

Since examination of the wreckage and review of maintenance records did not reveal any evidence of failure or malfunctioning of the aircraft or power plants or of any of their components prior to the crash, and since no mechanical difficulty was reported in any of the radio contacts with the flight, it must be concluded that the cause of the accident was operational rather than mechanical.

Based on the known fuel aboard when the flight departed Kansas City and that taken aboard at Phoenix, it is evident that there was sufficient fuel for the flight to have remained in the air from two or three hours longer had the crew considered it necessary or advisable. It is also apparent that at initial impact with the ground the aircraft was in controlled flight with both engines operating at appreciable power.

From the time of departure from Phoenix until reporting over Riverside at 6 000 feet, the flight averaged approximately 200 mph. Had this average been maintained beyond Riverside the flight would have arrived in the vicinity of La Habra at approximately 0329, five minutes before the accident occurred. A very unlikely reduction in ground speed to 141 mph would have been required to bring the flight direct from Riverside to the scene of the accident in the 17-minute interval between reporting over Riverside and the time of the accident. It, therefore, appears more logical to believe that the flight arrived in the La Habra area about 0329 and spent the next few minutes manoeuvring in that area at a low altitude. This belief is further substantiated by statements of witnesses who saw and heard a low-flying aircraft in the area a few minutes before the crash occurred.

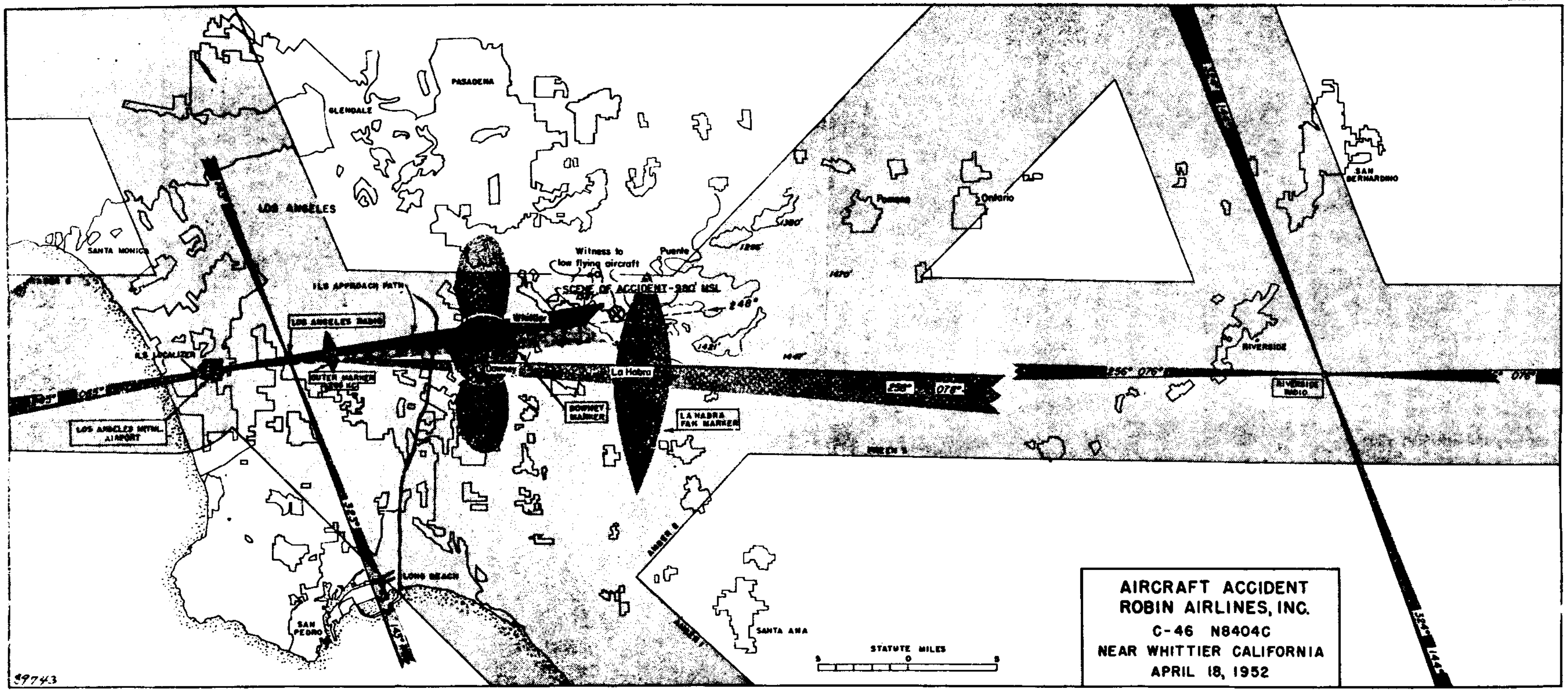
Since the flight had been instructed by ARTC to maintain 3 000 feet until passing Downey, its altitude in the vicinity of La Habra (east of Downey) should not have been less than 3 000 feet. It is difficult to explain the flight's being so low in this area, unless the pilot was attempting to make a visual approach beneath the overcast, which in the Board's opinion, is most likely to have happened. The layer of fog had moved inland to a point approximately five miles east of the scene of the accident; east of there, however, the weather was clear. Much of Captain Powell's flying experience had been acquired in the Los Angeles area and he was familiar with the terrain. Only one-half mile south of the scene of the accident, the terrain is considerably lower, and had the aircraft been in this area, a visual approach might have succeeded. There is no excuse for such an approach to have been attempted, however, in view of the presumed capabilities of the crew and the properly functioning flight and ground facilities available for the ILS approach for which the flight had been cleared.

## Probable Cause

The Board determines that the probable cause of this accident was the action of the pilot in voluntarily descending below the minimum altitude for which he was cleared, and attempting an approach at an altitude too low to clear the terrain.

ICAO Ref: AR/213

APPENDIX A


PASADENA
GLENDALE
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SANTA MONICA
Witness to
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LOS ANGELES RADIO
Whittier
ILS LOCALIZER
OUTER MARKER
Downey
La Habra
DOWNEY MARKER
LA HABRA FAN MARKER
LOS ANGELES INTNL. AIRPORT
LONG BEACH
SAN PEDRO
SANTA ANA
Pomona
Ontario
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248°
256° 076°
STATUTE MILES
AIRCRAFT ACCIDENT
ROBIN AIRLINES, INC.
C-46 N8404C
NEAR WHITTIER CALIFORNIA
APRIL 18, 1952
59743

No. 48

ZS-BCP aircraft, made forced landings twice at
Van Rhynsdorp, C.P., 21 April 1952. Report No. 19/52.
J.10/2/657

Circumstances

On 21 April 1952 a commercial licensed pilot was flying on a cross-country scheduled flight in a Dragon Rapide aircraft with 6 passengers, when engine vibration and fall-off of power occurred. He made a successful forced landing. It was discovered that the valve rocker bolt of No. 5 cylinder had fractured. The bolt was replaced and the flight resumed when the engine again gave trouble so the pilot force landed again. The cause of the second failure was fracture of the exhaust valve of No. 2 cylinder.

Investigation and Evidence

Investigation revealed that the rocker bolt had failed because the wrong length bolt had been fitted during overhaul. The bolt had been drilled for a split pin and the pin hole was well down inside the nut, resulting in about 3 threads of the bolt holding in the nut. The bolt had failed at the split pin hole and stripped the 3 threads. The valve failed in fatigue having run 180 hours since new. The pilot's total flying experience was 1 500 hours with a small number on Rapide aircraft.

Probable Cause

The probable causes of the engine failure were due to:

i) wrong length bolt fitted with possible over-tightening producing pre-stress. No torque spanners were used;

ii) incorrect valve fitted. Valves of Gypsy Queen and Gypsy Major engines had been mixed.

ICAO Ref: AR/207

## No. 49

### ZS-BCR aircraft, made a forced landing near Mossel Bay, C.P. on 4 May 1952. Report No. 20/52. J.10/2/658.

### Circumstances

On 4 May 1952 at about 1020 hours, the pilot was on a cross-country flight, when, forty minutes after take-off, both engines started vibrating and power fell off. He force-landed successfully.

### Investigation and Evidence

It was found that rocker bolt failures had occurred on both engines. Material was tested and found to meet specification requirements. The bolts failed 13 running hours after fitting. Previous to the failures, a change had been made in the method of locking the bolts from split pin locking to tab washer and lock plate locking. The lockplates and washers were locally made. No torque spanners for bolt tightening were used.

### Probable Cause

The probable cause of the rocker bolts failing or loosening was due to locking being inadequate, with possibly overtightening and so overstressing in the first instance.

ICAO Ref: AR/206

No. 50

ZS-DFP aircraft, destroyed during re-fuelling, at Grand Central Airfield, Transvaal, on 11 May 1952. Report No. 22/52, J.10/2/660.

Circumstances

On 11 May 1952 at about 1800 hours, a native who had been refuelling aircraft for the past 6 years without accident, was refuelling Fairchild UC-61K aircraft ZS-DFP after a flight. He was filling the port tank, which was already half full, when after putting in 12 gallons, he moved the funnel sideways to the left, tipped it on its side and immediately the funnel and outside of the fuel tank burst into flames.

Investigation and Evidence

No one was smoking near the aircraft at the time and the native stated he had used two earthing clips, attached to the hose, one clipped to the tank and the other to the funnel. The attachment of the earthing lead to the hose was a very loose fit but this was not considered serious. Five aircraft had been refuelled the same day from the same pump without incident. The pump and hose had been in use since 1946.

The hose was of the standard flexible type, was 22 feet long and had a spring loaded trigger nozzle. Hose and nozzle were tested for continuity and found satisfactory. The native stated he had not spilled petrol over the wing. The aircraft wings were timber spars and fabric covering, the fuselage metal tube and fabric covered. The tires were Goodrich Silvertown 650 x 10. The fuel being pumped was No. 91 octane. The aircraft had flown 23 hours since new and about 2 hours on the day of the accident. The bonding of the aircraft was in order. The weather was good, chilly with 15-20 mph surface wind.

Probable Cause

The probable cause of the accident was fire due to static electrical discharge. No defect was found in the refuelling equipment and the possibility of a spark being produced when the native moved the funnel can be discounted.

ICAO Ref: AR/205

## No. 51

## ZS-DFC, Dove DH-104 aircraft undercarriage collapsed on take-off at Welkom, O.F.S., on 23 May 1952. Report No.: 26/52, J.10/2/664.

### Circumstances

On 23 May 1952 at about 1355 hours, the pilot was taking off from a licensed airfield. The pilot states",... the normal cockpit checks before take-off were executed and I was satisfied everything was in order, the actual take-off was commenced at 1355 hours. Approximately 3 or 5 seconds after the full throttle position had been reached, I suddenly felt the starboard main wheel collapse. The right wing immediately sagged and the aircraft slowly started to turn towards the right. I was unable to keep the aircraft straight and realised that it would not be able to take off. Accordingly, I throttled back and managed to keep the wing off the ground for a few seconds longer. However, soon the wing touched the ground and the aircraft went off the runway onto the rough....the aircraft slithered to the right and then to the left violently, until it came to rest. Exit had to be made through the escape hatches, as the cabin door was jammed.

### Investigation and Evidence

The starboard undercarriage operating jack was found defective. The piston rod had broken away from the piston near the piston end, in tension. The material was found to be excessively porous throughout and crystal size was excessive and variable. The appearance of the fracture in certain areas was of an inter-crystalline nature. There was no evidence of fatigue failure and the fracture although considered to have taken place progressively was essentially instantaneous. It is considered that failure took place in tension and resulted from overloading of an area of small cross section weakened by excessive porosity, aided by embrittlement developing or resulting from this condition. The reason for overloading is still the subject of investigation.

The flight was of a regular scheduled nature. The pilot held an Airline Transport Licence. His total flying experience was 5 293 hours of which 1 018 were on Dove aircraft. The take-off was from a licensed airfield.

## Probable Cause

The probable cause of the accident was collapse of the starboard undercarriage caused by failure of the starboard undercarriage jack piston boss. The piston of the undercarriage jack parted from the piston rod. The air pressure in the jack forced the piston rod outwards, which broke the down lock and retracted the starboard undercarriage. Inspection of the undercarriage jack when dismantled, showed no evidence of the piston fouling the jack casing at either end of the stroke, or the seizure of the piston in the cylinder.

ICAO Ref: AR/204

## PART II

## List of Laws and Regulations of the Contracting States containing provisions relating to "Aircraft Accident Investigation"

### Amendments to the List of Laws and Regulations of the Contracting States appearing in ICAO Circular 24-AN/21 (Aircraft Accident Digest No. 2)

1. Law and Regulations relating to "Aircraft Accident Investigation" received since 27 December, 1951.

BURMA

1949 August - Notice to Airmen No. 5/1949 - Aircraft Accident and Incident Investigations.

JAPAN

1952 Civil Aeronautics Law No. 231, 1952: Chapter 9, Article 132. - Investigation of Accidents.

SAAR

1951 29 mai Arrêté relatif au contrôle de la navigation aérienne et à l'institution d'un Office de l'Air en Sarre:

Article 3.- Attributions de l'Office de l'Air:
- les enquêtes relatives aux accidents.

UNITED KINGDOM COLONY
GIBRALTAR

1952 Jan. 3 The Air Navigation (Investigation of Accidents) Regulations, 1952.

2. Modifications, repeals and corrigenda to be made to Circular 24-AN/21, 1952 - Part II - Legislation.

FRANCE The date shall read 21 avril 1937 instead of 28 avril 1937.

| | |
|---|---|
| HONG KONG | Hong Kong shall be omitted on pages 119 and 126. |
| IRELAND | Legislation appearing under Ireland shall read as follows: |
| 1928 | The Air Navigation (Investigation of Accidents) Regulations, S.R. & O. No. 21, as amended by Air Navigation (Amendment) Regulations, S.R. & O. 228 - 3 August 1943. |
| 1936 | Air Navigation and Transport Act, No. 40: Part VII - Section 60 - Investigation of Accidents. This Act has been amended by Amendment Acts No. 10, 1942; No. 23, 1946 and No. 4, 1950. |
| PHILIPPINES | For Commonwealth Act No. 168 - 22 November, 1936, the following shall be substituted: |
| 1952 June 20 | The Civil Aeronautics Act of the Philippines, No. 776: Chapter V.- Section 32. - Powers and Duties of the Administrator: (11) - Investigation of Accidents. |
| UNITED KINGDOM | Statutory Instrument number of the Civil Aviation (Investigation of Accidents) Regulations, 1951 shall read S.I. No. 1653 instead of S.I. No. 563. |
| UNITED KINGDOM COLONIES | Under United Kingdom Colonies shall be added the following: |
| 1949 Oct. 28 | The Colonial Air Navigation Orders, 1949 to 1951: |
| | Article 69. - Application of Accident regulations to aircraft belonging to or employed in the service of His Majesty. |
| UNITED STATES OF AMERICA | The word "accident" shall be inserted after the word "aircraft" under: Economic Regulations - Part 311 of 15 September 1950. |

# PART III

## Section 1

## PUBLICATIONS AND REPORTS

### The Airport and Its Neighbours

### (The Report of the President's Airport Commission)

Editorial Note.-The following extract from the report of the President's Airport Commission contains "Part I," only of the report and is reproduced in this Digest by kind permission of the Government of the United States of America. The report as a whole has not yet been approved by the Executive Branch of the Government and the recommendations contained therein are receiving further consideration by the appropriate agencies of the Executive Branch.

#### Summary

The task of the President's Airport Commission has been to consider means to safeguard the lives of people living in the vicinity of airports and to alleviate for them, as far as possible, the disturbance that arises from the operation of aircraft. As directed by the President, the Commission has studied these problems in the light of an urgent need for continued development of both civil and military aeronautics for the welfare and safety of this country.

Establishment of the Commission was an outgrowth of a sequence of tragic accidents in the New York-Northeastern New Jersey metropolitan area. The fact that these mishaps were confined, by coincidence, to a single community accentuated fears of many Americans that aircraft represent a serious hazard to ground-dwellers. They also served to increase awareness of nuisance aspects in the use of airports, particularly with regard to noise. As the result of a careful and detailed study of both hazard and nuisance factors, the Commission feels that a great deal is being done to protect the people, it also feels that more could and should be done.

Along with every other vehicle invented and used by modern man, aircraft suffer occasional accidents with resulting fatalities to their occupants. More rarely, people and property on the ground are also involved. Incidents of this sort are most likely to occur near airports because operations are somewhat more hazardous at terminals than en route. Current improvements in equipment and in operational procedures, however, offer the possibility that accidents of all kinds will be further reduced. Accidents involving aircraft on airways and at air terminals should eventually fall well below rates now considered normal for other forms of commercial transportation.

The same favourable trend cannot be forecast as confidently for the nuisance factors. Exhaust mufflers and slow-turning multi-blade propellers of large diameter have been applied successfully to quiet small airplanes. As aircraft become larger and faster, the power required to propel them and the resultant noise multiplies many fold. Some noise reduction can be achieved, even in these large aircraft, by reduced propeller tip speed and by removing more energy from exhaust gasses, but reducing their noise to comfortable proportions still presents a difficult problem.

In the future, with wider use of high speed turbine-driven propellers or high thrust jet-propulsion, there will be a tendency for the volume of noise to increase beyond levels now experienced and for the character of the noise to become more objectionable. Research is now under way in these areas, but the problems are technically difficult and no effective solutions are in sight.

Airport Growth

The growth of air transportation has put a severe strain on many major airports. Original facilities for handling airplanes in the air and on the ground and for taking care of passengers, mail, express and freight in terminal buildings have been outgrown. Many airports are approaching saturation. Some of them are badly out of balance due to a deficiency in one or another of their facilities. For example, some of our large municipal airports now have traffic control capabilities permitting a great many landings and take-offs per hour but their runways or their servicing facilities on the ground have not kept pace. In some cases runways which were once adequate in strength will not now support today's heaviest airplanes. Larger and faster airplanes making more landings and take-offs in worse weather will call for more adequate runways, larger clear approach areas and improved traffic control facilities and procedures.

Definite traffic patterns have been established by the Civil Aeronautics Administration at every major terminal airport in the country. These flight tracks have been designated after careful consideration of all flight safety factors. Serious efforts are being made to reduce ground hazard and noise. Eventually airports and their runways should be planned so that all approach and holding patterns minimize flights over thickly settled areas.

Tighter control of aircraft near airports must be achieved. To accomplish this, necessary equipment must be developed, procured and installed. Once adequate facilities are operational, positive traffic control at congested airports should be insisted upon at all times, even under what are now considered Visual

Flight Rule conditions. The ceiling and visibility limits for VFR flights in congested terminal areas and the minimum ceilings and visibilities under which aircraft are permitted to circle and manoeuvre after instrument approach should be raised.

Airport use becomes more complicated when there is joint use by civil aviation and the armed services. In the interest of economy it is common practice for air defense, military air transport or air reserve training units to be based on municipal airports. Combat airplanes are generally noisy and will probably become noisier with the advent of more powerful jet types. Because of the noise of military operations (especially on week ends) and because accidents have occurred, people living near such airports have complained. Joint military and civil use of major airports is undesirable. Separation should be effected whenever it is economically feasible. Military training operations over thickly settled regions should be prohibited.

In some cases, manufacturing plants are located on busy civil airports and both experimental and production aircraft are being flown from these airports. Recognizing the potential hazard involved, especially with the very fast jet types, some manufacturers have established test facilities on remote airports, and are making trial and shakedown flights away from congested areas. Whenever practicable this should be required. Flight delivery of production aircraft may be permitted under proper procedures and under conditions where nuisance and hazard to the surrounding community are reduced to the minimum.

<u>Community Encroachment</u>

Another aspect of the problem deals with the technical and economic forces which are pressing for airport expansion and which, in turn, are opposed by the encroachment of the surrounding community. Many communities are approaching an impasse arising from limitations to safe operation on existing airports combined with a physical inability to improve or extend them because homes or factories have been built close to the runway ends.

The pattern of development for major airports has been historically similar. Twenty years ago when airplanes were small in size and few in number, airport sites were selected at a distance beyond the city limits where ground was cheap and where few buildings obstructed the natural approaches to the field. Few then complained of the noise because it was infrequent and not very loud. As a matter of fact, this audible evidence of the arrival and departure of mail and passenger airplanes was often a source of local pride.

Normal growth, greatly augmented by the wartime movement of people to the cities, caused a spreading out toward the airport. Furthermore, the airport and its activities frequently acted as a magnet, drawing first the sightseer and then the businessman interested in concessions. Because desirable land was cheap, and a new and advantageous type of transportation was available, industries (sometimes aeronautical, sometimes not) settled near the airport.

Attached to all of these enterprises were people. People required homes within a short distance of their jobs. Speculators saw the opportunity to subdivide cheap land at a profit. Public utilities established primarily for the airport could be made available to the adjacent housing. Villages emerged, complete with shopping centers, schools, hospitals and recreation facilities. As a consequence, many municipal airports which were started less than two decades ago in the open country were progressively surrounded by residential and industrial areas.

The immediate problem is to find a way to protect present airports and the people residing near them by applying some means of control of ground use in approach zones. Local authorities should prevent further use of land for public and residential buildings near the ends of existing runways. If this is not done, new contingents of home owners will be added to the ranks of those who are now protesting against noise and hazard. In time public pressure may threaten the continued existence of the airport and large investments of public and private funds will be jeopardized.

Zoning

This Commission has two suggestions to make in this connection: (1) that certain extensions or over-run areas be incorporated in the airport itself, and (2) that larger areas beyond such extensions be zoned by proper authority, not only to prevent the erection of obstructions that might be harmful to aircraft, but also to control the erection of public and residential buildings as a protection from nuisance and hazard to people on the ground.

Many airports already maintain cleared areas beyond the ends of paved runways to reduce the danger from accidental over-runs on landings, or from aborted take-offs. The Commission feels that no new airport should be planned without clear and, if possible, level areas at least 1,000 feet wide and at least one-half mile long beyond each end of the dominant runways. These areas should be incorporated within the boundaries of the airport.

Beyond such extensions, the problem of control of the use of the land in approach zones becomes more difficult because of the large area involved. For reasons shown elsewhere in this report, it would be desirable to protect approaches to dominant runways for a distance of at least two miles beyond the runway extensions. Such protective zones should be fan-shaped with a width of at least 6,000 feet at the outer ends.

Outright ownership of sufficient land at each end of the dominant runways would provide the best solution. There is no legal question but that airports engaged in interstate commerce are a public utility for which public funds may be expended. Also, there is no legal question but that States, counties and municipalities may join together to condemn land (where enabling legislation exists) outside the boundary of any one municipality for airport purposes. The cost of acquisition of sufficient land, however, is frequently beyond the capabilities of a single community.

Where it is not economically feasible to purchase such tracts of land so that absolute control of their use could be maintained, reliance must be placed on zoning laws to protect both the aircraft using the airport from obstructions to flight and the people on the ground from hazard and noise.

Although there are legal means to zone approach areas to protect aircraft from collision with obstructions, no zoning laws have been enacted to the knowledge of this Commission to control land use generally in approach zones. Consideration of basic property rights raises the question in both cases as to whether or not such control of use constitutes a "taking" of the property, and as such should be compensable to the owners.

Traditionally the power to control the use of land rests with the States and may be delegated to counties and local communities. The Federal Government should, however, propose model airport protective legislation for enactment by the States, and should help where practicable toward reaching a satisfactory solution of this type of zoning problem.

It is recommended that the responsibility for zoning be left with the States and their political subdivisions, at least for the present, and until they have had a full opportunity to cope with the problem under adequate Federal guidance. It is further suggested that the Federal Government commit no funds for new airport construction unless the State, or other local authority gives reasonable assurance that the air approaches to the airport will be protected in accordance with the recommendations made herein. The land under the approaches should not be put to any use which might later serve as a basis for an effective argument that the space above should not be used by aircraft. Future residents should not be given any grounds for claims that aircraft approaching or departing from the airport, or which may be involved in accidents, create a nuisance which entitles them to an injunction, to recover damages or to demand that the airport be closed.

The suggestions made above apply particularly to new airports to be laid out in areas free from natural and artificial obstructions. Such ideal conditions are to be found in a very few localities desirably adjacent to sources of air traffic. For a long time to come, therefore, most airports must make the best of existing conditions even if they fall short of the ultimate airport specifications recommended here.

To promote the general welfare and to protect necessary systems of air transportation, it is essential that the major airports now engaged in interstate commerce, the postal service, or in defense activities be continued in operation. Furthermore, these airports must not be allowed to deteriorate. They must be continually improved to the greatest possible degree along the lines recommended. They should be made to approach the ideal airport as closely as local conditions permit. Local zoning authorities should employ their powers to prohibit further developments which will interfere with appropriate use of existing airports. Here also availability of Federal funds should be dependent upon such local action.

Federal Assistance

Federal aid for construction at airports was inaugurated in the early 1930's. The Federal Airport Act of 1946 set up a continuing program with an authorized maximum expenditure rate of $100 million per year. In general, the program called for financing airport projects on a "matching" basis, with the Federal Government providing grants-in-aid to the communities concerned. Unfortunately, this program has lagged because of inability to synchronize the availability of Federal and local funds. Such difficulties should be resolved at the earliest possible date. Priority of expenditure of Federal funds should be given to the lengthening of runways and to the acquisition of cleared extensions beyond the runways for incorporation in the airport.

Runway Design

A solution to many aspects of the airport problem is, in the opinion of the Commission, the early acceptance of the single or parallel runway design of airport with approaches over relatively clear areas. By this means, airport development could proceed along economical lines with minimum hazard and annoyance to neighbors. The single or parallel runway airport has one shortcoming - difficulty of operation in strong crosswinds - but this is being overcome through pilot training techniques, the use of tricycle gears and the further development of special cross-wind landing gears.

Too much emphasis has been placed on statistics of prevailing winds, including light and variable airs of little consequence in modern flying practice. As a result large sums still are being programmed unnecessarily for multiple intersecting runway airports, and too little consideration is being given to the hazard zones off the ends of these same runways. Simplified traffic control, economy of navigational aids, more effective use of radar, less airport acreage, room for expansion, protected runway extensions and smaller paved areas are favored by an oblong rather than a square airport. This is a principle that can be applied to new airport design and, in many cases, to present airports which are being hemmed in on some sides by residential areas. However, where high cross-winds are prevalent an additional but shorter runway, oriented at 90° to the dominant runway, will be needed for some years.

Runway Length

Some manufacturers suggest that future transport airplanes (derived from current long-range high speed bombers) could be designed to have a marked gain in performance and efficiency if airports with runways several miles long with clear, flat approaches of several additional miles at each end were available. Such configurations for a few new airport projects might prove economically feasible, but for existing municipal airports such extensions are impractical. There are very few sites available within reasonable distance of population centers where airports with extremely long runways could be built. A well balanced system of civil air transportation, adequate to meet the needs of national defense, air commerce and the postal service calls for a wide-spread network of airports of reasonable size with the future to determine the requirements for a few "super" airports at strategic points for very long-range routes.

Most municipal authorities consulted by this Commission wish to retain their present airports. They urge that current standards of runway length be "frozen" and remain in effect for a substantial period of time in order to protect their already large investment. They argue that airplane designers should apply the results of research and invention to the improvement of the safety, peformance and economy of their products within existing runway length limits.

Standard runway lengths for different categories of airports have been proposed. As many airports as possible should bring themselves up to these standards. It seems to this Commission that major air terminals should eventually provide principal runways, for the use of transcontinental or intercontinental airplanes, that are at least 8,400 feet long. A length of 10,000 feet should accommodate all types of practical transport airplanes now foreseen. Additional runway length would provide an additional safety factor but should not be required for normal operations.

A future change in the established standards for runway length should come only after compelling considerations. Its effect on the air transport industry would be world-wide. Few principal civil airports could undertake any substantial increase in runway length, and a new system of airports would have to be undertaken.

While runway length standards are desirable, it appears undesirable to specify a long term standard for strength of runway construction, or to attempt to limit airplane designers on airplane weight or wheel loads. Airports should be designed for the greatest wheel loads anticipated, and in the event that runways prove inadequate in strength for future airplanes, they can be reinforced or rebuilt.

Nuisance Factors

Some excuse may be found for failure to have foreseen the rapid rate of aeronautical progress in designing airports in the past, but it is to be regretted that more consideration was not given to the comfort and welfare of people living on the ground in the vicinity of airports. To be sure, many settled near an airport after it was in operation, with little realization of the potential nuisance and hazard. The public cannot be expected, however, to anticipate technical developments and it should be informed and protected by the responsible authorities.

The public deserves a clear explanation of necessary airport procedures, accompanied by valid assurances that everything possible is being done to alleviate both noise and hazard. For example, in low visibility, incoming aircraft sometimes must be "stacked" near an airport under precise traffic control to prevent collisions. The public will understand and accept this necessity if it is assured that, within the limit of safe operation, the holding areas are selected so that the stacks will not be a source of nuisance. Also where operators are making a sincere effort to reduce engine run-up noise by controlled ground procedure and by the provision of proper acoustical treatment, and are avoiding take-offs over inhabited areas, reasonable people can be persuaded to tolerate some noise as a part of the cost of living in this age of technology. Operators, pilots and airport controllers must be indoctrinated to consider the people on the ground and make every effort consistent with safe flying practice to reduce hazard and noise.

Aircraft designers and manufacturers must also assume a share of the noise alleviation task. So far, they have been concerned mainly with noise levels inside the airplane.* If the manufacturer is given a penalty for high noise or better yet a premium for low noise level, it will stimulate competition in the development of quieter aircraft.

## Standardization and Training

It is believed that through standardization and training, accidents due to pilot error can be reduced. There is, at the moment, a regrettable lack of uniformity of design and arrangement of transport aircraft cockpits. Not only is there variation between different types of aircraft, but also variations in the same type, depending on the ideas of individual airlines. A useful step in improving the training of pilots in emergency procedures would be the standardization and simplification of equipment in cockpits. Simplified emergency procedures naturally would follow. The pilot's job would be easier and safety would be increased.

More training in emergency procedures should be required. Simulated emergency drills, in airplanes without passengers, should be conducted periodically. Such training flights should, of course, be conducted over uninhabited areas. A method of training flight crews without hazard is through the use of flight simulators. These are complicated devices duplicating the cockpit and flight deck of the airplane. The equipment and instrumentation are operated by an instructor to simulate various emergency conditions. The crew then deals with the situation as it would in flight. Necessary practice is thus provided without risk. Since flight simulators are expensive and one is required for each type of aircraft, it may be necessary to purchase and use them on a cooperative basis.

## Airport Planning

Alleviation of presently undesirable conditions is not enough. Policies and plans for the future must take into account trends in the air transport system of the nation. This will require continuing study.

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*They should also strive to minimize noise outside the airplane.

It is to be expected that air transportation will continue to develop at a rapid rate. Municipalities should anticipate this expansion. They should plan for it and prepare to finance their share of it. Plans should include improvement of existing airports up to the point of balanced saturation and also the purchase of land required for additional airports some years before saturation is reached. If the latter is not done, the purchase cost will be much greater and the chance of obtaining and protecting a desirable site correspondingly reduced. Insofar as topography, present land use and economics will permit, the airport should be as close as possible to the center of the area from which air traffic originates. Comprehensive forward planning is essential to the establishment of efficient, economical, nuisance-free airports.

Such planning may require changes in the laws that govern the use of the navigable airspace, including the flight path to and from airports. Coordination and standardization in the development of airports used in interstate commerce are necessary. It is possible that the future will call for a system of airports for a metropolitan area with separate facilities for certain types of air traffic. This involves regional and city planning and particularly questions of interconnecting highway and air services and the integration of the air and ground traffic. It also implies successful development of short-haul aircraft, possibly of the helicopter type.

The inadequacy of our present road network, particularly in the vicinity of major cities and between city and airport, is one of the greatest deterrents to the further development of transport aviation.

Navigable Airspace

As a result of fear engendered by low flying aircraft, several communities have recently passed local ordinances prohibiting flight over them at altitudes less than 1 000 feet. Along airways such regulations would present no problem. They could, however, severely hamper approaches to certain airports. It is anticipated that the courts will shortly be called upon to decide this question.

This Commission believes that the Federal Government, through the Civil Aeronautics Board and the CAA, now has authority from Congress to regulate and determine approaches for airports used in interstate commerce. Accordingly, the CAA should determine what is the best approach pattern for a particular airport, and should then declare that the "safe altitude" in that area is in conformity with the airport approach pattern. Pursuant to the Civil Aeronautics Act of 1938, this should mean that there is a "public right of transit" in accordance with that airport approach pattern. If the pattern appears to depreciate property values of underlying landowners, the Federal Government might, if funds are made available by the Congress, exercise the power of eminent domain to acquire title to the land. If an easement through the airspace is involved, it appears that additional legislation would be required.

Airport Certification

It is clear that commercial airports are instrumentalities of interstate and foreign commerce. As such, they have a definite public character. Their continued efficient operation vitally affects interstate commerce, national defense, and the postal service. They are, however, at the present time subject to little Federal regulation. The Commission believes that such regulation should be kept to a minimum, but also believes that more authority over such airports is required than is now provided by Federal statutes.

The Civil Aeronautics Act authorizes the Administrator to inspect, classify and rate any air navigation facility (which includes airports) as to its suitability, and to issue certificates for any air navigation facility. But the Act does not require the issuance of a federal certificate to airports, nor does it make unlawful the operation of an airport without a certificate.

The Civil Aeronautics Act should be amended to require that certificates shall be issued for the operation of airports used in interstate commerce. Such certificates should define minimum standards for safe operation and proper maintenance and should be revoked if such standards are not met. The abandonment of such certificate or the closing of an airport for other reasons, however, should not be permitted except after notice and hearing and due finding that the proposed action is in the public interest.

## Recommendations

The Commission feels that definite arrangements should be made and specific governmental agencies designated to develop and to implement the following recommendations:

1. Support required airport development.

New airports will be needed and present airports must be improved. State, county and municipal governments should be prepared to assume their proper share of this expense.

2. Expand Federal-Aid Airport Program.

Authorization of matching funds for Federal aid to airports should be implemented by adequate appropriations. Highest priority in the application of Federal aid should be given to runways and their protective extensions incorporated into the airport, to bring major municipal airports up to standards recommended in this report.

3. Integrate municipal and airport planning.

Airports should be made a part of community master plans completely integrated with transportation requirements for passenger, express, freight and postal services. Particular attention should be paid to limited access highways and other transportation facilities to reduce time to the airport from sources of air transport business.

4. Incorporate cleared runway extension areas into airports.

The dominant runways of new airport projects should be protected by cleared extensions at each end at least one-half mile in length and 1 000 feet wide. This area should be completely free from housing or any other form of obstruction. Such extensions should be considered an integral part of the airport.

5. Establish effective zoning laws.

A fan-shaped zone, beyond the half-mile cleared extension described in Recommendation 4, at least two miles long and 6 000 feet wide at its outer limits should be established at new airports by zoning law, air easement or land purchase at each end of dominant runways. In this area, the height of buildings and also the use of the land should be controlled to eliminate the erection of places of public assembly, churches, hospitals, schools, etc., and to restrict residences to the more distant locations within the zone.

6. Improve existing airports.

Existing airports must continue to serve their communities. However, cities should go as far as is practical toward developing the cleared areas and zoned runway approaches recommended for new airports. No further building should be permitted on runway extensions and, wherever possible, objectionable structures should be removed. Operating procedures should be modified in line with Commission recommendations for minimizing hazard and nuisance to persons living in the vicinity of such airports.

7. Clarify laws and regulations governing use of airspace.

Authority of the Federal, State or municipal governments with respect to the regulation of the use of airspace should be clarified to avoid conflicting regulation and laws.

8. Define navigable airspace in approach zones.

The limits of the navigable airspace for glide path or take-off patterns at airports should be defined.

9. Extend Civil Aeronautics Act to certificate airports.

The Civil Aeronautics Act should be amended to require certification of airports necessary for interstate commerce and to specify the terms and conditions under which airports so certified shall be operated. Certificates should be revoked if minimum standards for safety are not maintained. Closing or abandonment of an airport should be ordered or allowed only if clearly in the public interest.

10. Maintain positive air traffic control.

Certain air traffic control zones in areas of high air traffic density should be made the subject of special regulations to insure that all aircraft within the zone are under positive air traffic control at all times regardless of weather.

11. Raise circling and manoeuvring minimums.

Present straight in instrument approach minimums are considered satisfactory but the minimum ceilings and visibilities under which aircraft are permitted to circle or manoeuvre under the overcast in congested terminal areas should be raised.

12. Accelerate installation of aids to air navigation.

Research and development programs and installation projects designed to improve aids to navigation and traffic control in the vicinity of airports, especially in congested areas, should be accelerated. Installation and adequate manning of radar traffic control systems should be given high priority.

13. Revise present cross-wind component limits.

Existing cross-wind component limitations should be reviewed to establish more liberal cross-wind landing and take-off specifications for each transport-type aircraft.

14. Develop and use cross-wind equipment.

Although modern transport aircraft can operate successfully in any but very strong cross-winds, the further development and use of special cross-wind landing gears should be accelerated.

15. Extend use of single runway system.

New airports should adopt a single or parallel runway design. This should be adequate except under strong wind conditions, in which case a shorter runway at 90° to the main one may be required. Present airports should plan to develop the dominant runway at the expense of those less used. Airport expansion should be achieved through additional parallel runways.

16. Meet standard requirements for runway length.

For each category of airport a standard runway length has been established consistent with its future planned use. Airports should bring their runways up to the standard. For intercontinental or transcontinental airports, the length of the dominant runways should be 8 400 feet with possibility of expansion to 10 000 feet if later required and with clear approaches as per Recommendations 4 and 5.

17. Accelerate ground noise reduction programs.

Engine run-up schedules and run-up locations should be adjusted to minimize noise near airports. Adequate acoustical treatment in run-up areas and at test stands should be provided.

18. Instruct flight personnel concerning nuisance factors.

A tight discipline with respect to airport approach and departure procedures to minimize noise nuisance to people on the ground (within the limits of safe operating procedures) should be maintained at all times.

19. Arrange flight patterns to reduce ground noise.

Airways and flight patterns near airports should be arranged to avoid unnecessary flight over thickly settled areas to minimize noise, but only within the limits of safe flight practice.

20. Minimize training flights at congested airports.

Flight crew training should be conducted, as far as practicable, away from thickly settled areas and with a minimum number of flights into and out of busy airports.

21. Minimize test flights near metropolitan areas.

Production flyaway from aircraft factories under proper conditions is acceptable but all flights of experimental aircraft and test flying of production models near built-up areas should be reduced as far as possible.

22. Avoid military training over congested areas.

Although the basing of reserve air units at airports near cities has been considered generally desirable, and the location of certain combat units there is sometimes necessary, training manoeuvres, particularly with armed military aircraft, should be conducted only over open spaces. Rapid shuttle service to an outlying military training field offers minimum interference with civil air operations and maximum safety and freedom from nuisance to people on the ground.

23. <u>Separate military and civil flying at congested airports</u>.

Military aircraft should not be based on congested civil airports except when it is not economically or otherwise feasible to provide separate facilities for them nor should commercial aircraft operate regularly from busy military airports.

24. <u>Provide more flight crew training</u>.

Every flight crew should be required to have frequent drills in instrument and emergency procedures. This can be accomplished in part in flight simulators. These flight simulators should be located at convenient points and should be available to all operators on a fair basis.

25. <u>Develop helicopters for civil use</u>.

Concurrent with military helicopter development, interested government agencies should encourage civil helicopter development for inter-airport shuttle services, and for short-haul use, emphasizing safety, reliability and public toleration factors.

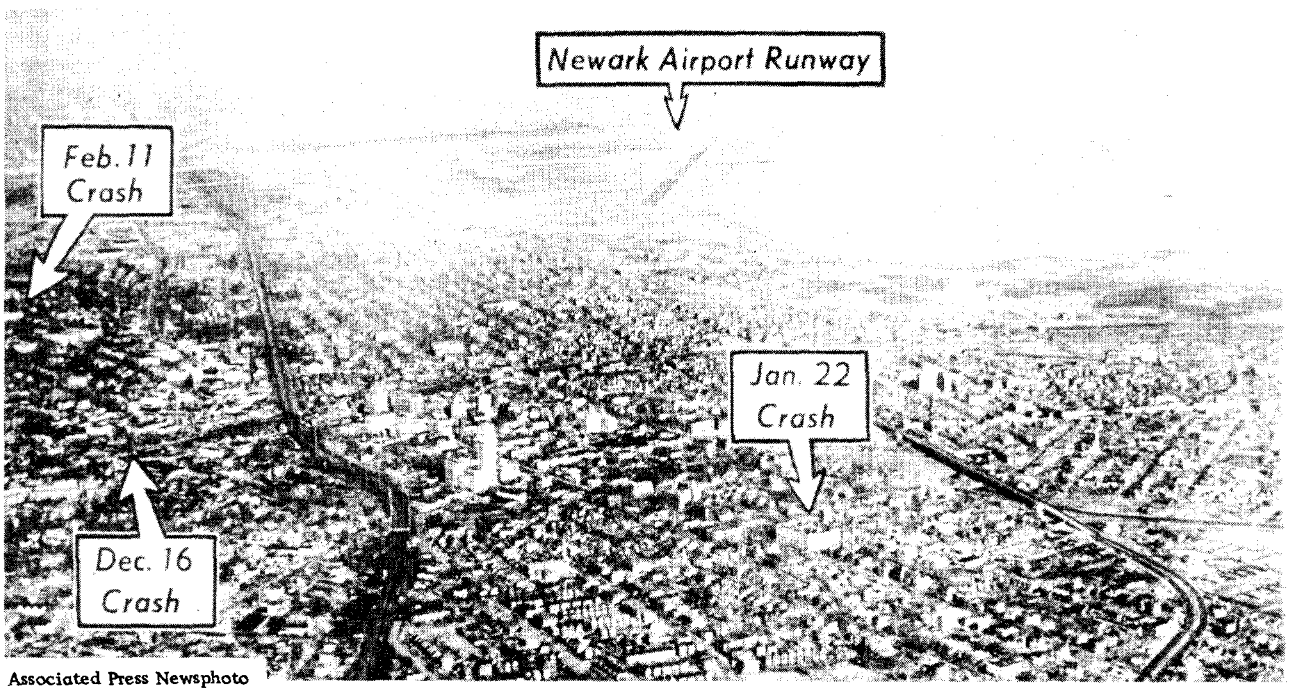
## Section 2

## Elizabeth, New Jersey - Incredible Coincidence!

(This article first appeared in the NFPA Quarterly for April 1952 and is reproduced here by kind permission of the National Fire Protection Association - International. It will be noted that there are slight discrepancies in the stated causes of the accidents in this article and those in the official accident investigation reports as the official findings were not available until sometime after this article was printed.)

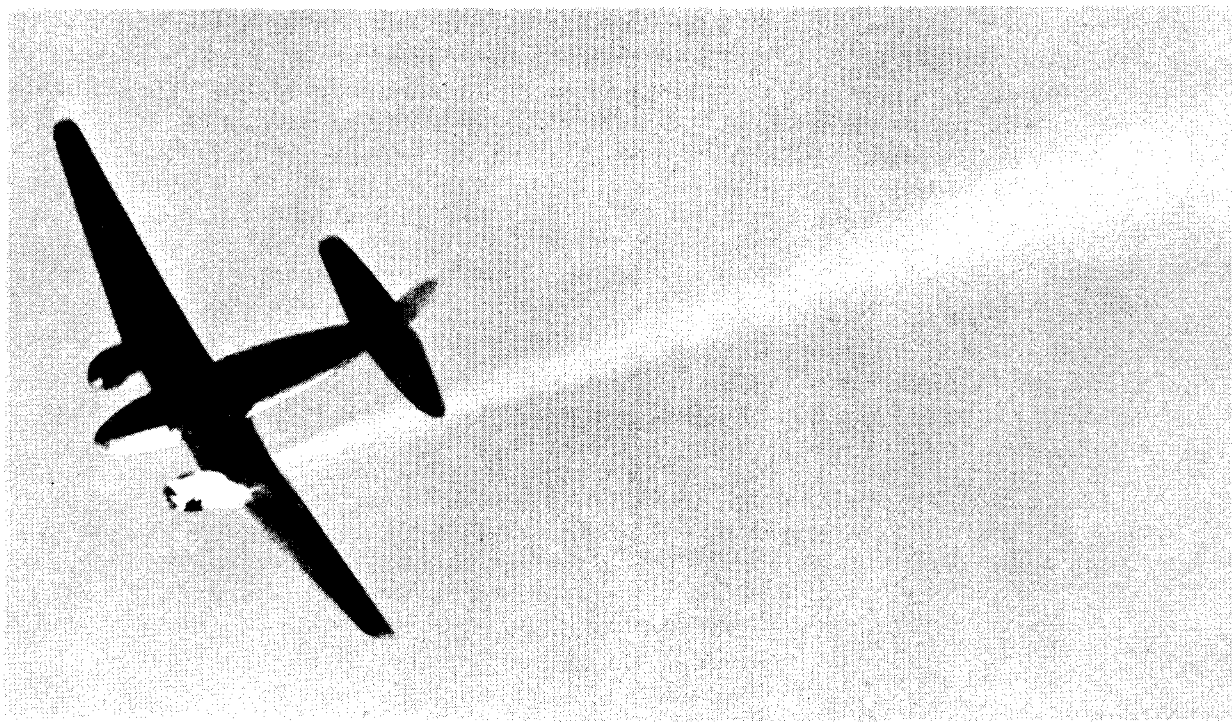
The laws of probability, according to one aviation safety engineer, would have ruled out what happened in Elizabeth except once in 36,000,000 years! The Elizabeth Fire Department only knows that in two months they had to fight three aircraft crash fires in an area a mile and a half long and a quarter of a mile wide. These three accidents caused 119 deaths and at least 51 were injured. Eleven of those killed were residents of the buildings struck. Property and aircraft losses and presently known life insurance claims indicate an aggregate monetary loss of about $3,500,000.

Particularly notable about the accidents was that the only common denominator linking the three was that each of the aircraft involved was attempting to enter or keep within the traffic pattern of the same runway at Newark Airport. Two had just taken off and, because of in-flight difficulties, were seeking to return for emergency landings. The third was attempting a normal instrument approach when it suddenly went out of control and crashed. As a result of these three accidents, Newark Airport was closed by the operator, the Port of New York Authority, until a full investigation could be made. At this writing, the Airport is still closed except "for limited use by the U.S. Air Force."




Associated Press Newsphoto

No. 1, 2 and 3 Crashes. Air view of Elizabeth showing Newark Airport in the background. For 23 years aircraft operated from this airport without an accident in Elizabeth until these three occurred within two months. The Jan. 22 accident was 1-1/2 miles from the site of the Feb. 11 crash.



Other cities also sustained "within-limits" crashes during the year - Chicago, Seattle, and Denver to mention only the most outstanding examples. In each of these situations, as in Elizabeth, the proximity of airport facilities to the built-up area were factors in the accidents. Not always have airports been located where they expose existing densely populated areas; in some notable cases, airports have attracted extensive housing and industrial developments to their environs on previously undeveloped land, particularly those airports which boast aircraft production or maintenance facilities within their confines. These zones might well be considered "accident-prone" under certain conditions (depending on flight patterns) but no city is immune to certain kinds of aircraft accidents where descent is uncontrolled. Small towns like Morningside, Maryland, and Temple City, California, had crashes during 1951 quite unrelated to airport proximity. But, it was Elizabeth, N.J., which has brought the matter into focus.

No. 1 Elizabeth Fire

The first accident occurred at 3:09 P.M., Dec. 16, when a twin-engine C-46, operated by Miami Airlines, crashed soon after take-off, following an uncontrolled engine fire in flight which, subsequently, caused wing structural failure. This was an uncontrolled descent. Weather was good and not a factor. All 56 occupants of the aircraft were killed.

## Fire Alarm for No. 1

Before the first crash, a Captain of Engine Co. No. 7 of the Elizabeth Fire Department noted the burning C-46 in flight and his Company responded when it was apparent that the aircraft would crash close to quarters. Four street alarm boxes were pulled by citizens in rapid succession and automatic multiple box alarm response brought 10 companies and 80 men from the Elizabeth Fire Department. Some 10 to 15 minutes after the crash a Port of New York Authority crash truck from Newark Airport reached the scene, almost 2 air miles from the airport.

## Crash Impact Conditions

The C-46 was out-of-control when it began its sharp descent, a wing having failed in flight. The aircraft struck a corner of an unoccupied frame building, demolished a two-story brick storehouse, overturned and landed on its back in two feet of water near the east bank of the Elizabeth River. (See Figure 1)

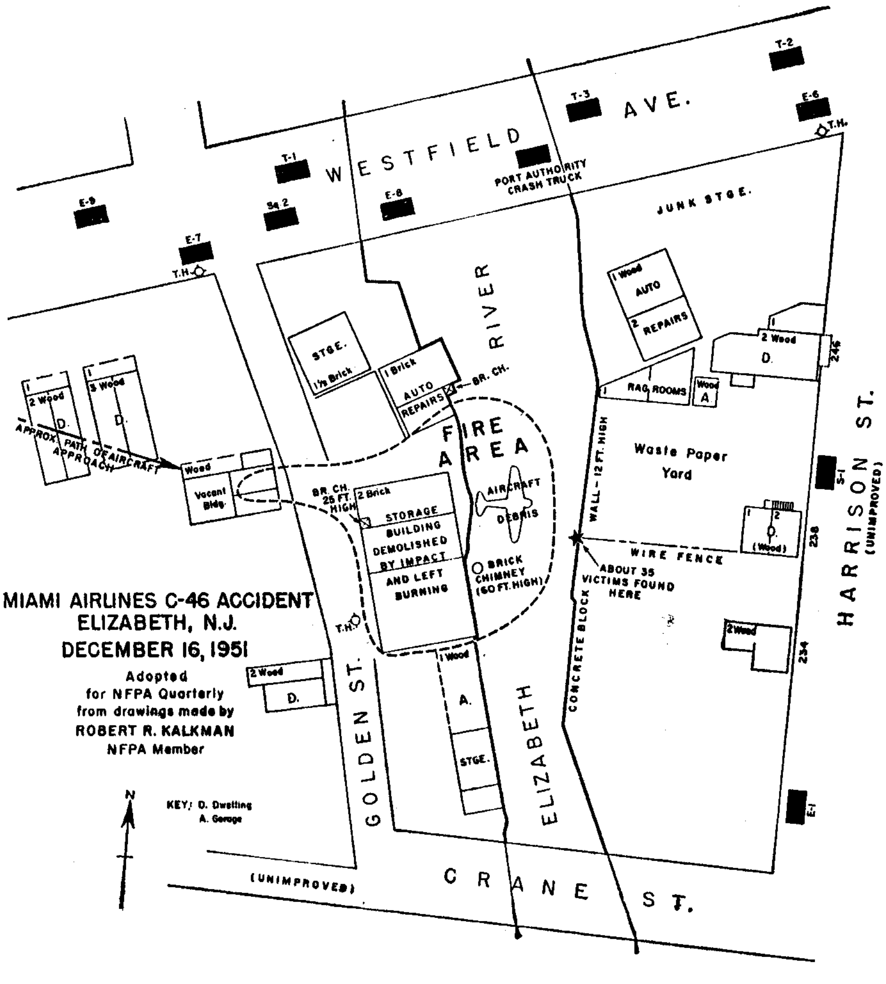



Figure 1

## Fire and Rescue Problems

Even when the first companies arrived at the site of the first crash, fire heavily involved the partly submerged C-46 as it rested in the shallow waters of the Elizabeth River. The two-story brick warehouse was badly wrecked and was also heavily involved in fire. It was quickly evident that all the occupants of the aircraft had been killed by the impact. Thirty-five of the 56 had been catapulted from the aircraft and were found in one mass on the east bank of the river. Two 30-foot ladders were lashed together, truss side up, and planks were placed over the rungs to serve as a bridge for litter bearers to transport the bodies from the east bank to waiting morgue vehicles. No victims were found in the aircraft after the fuselage was raised and overturned. Despite the pre-crash response of Engine Company 7, and immediate box alarms, rescue opportunities were not present.

## No. 1 Fire Fighting

At the first accident, because of the fear of floating unburned gasoline on the River, the Elizabeth Fire Department did not use foam on the aircraft and the waterborne gasoline spill fire. Hose streams were used to subdue the intense convective and radiated heat. Fog-foam and foam was used by the Port of New York Authority crash truck.

Acme Photo

No. 1 Crash. The C-46 crashed into this storehouse (a former Pumping Station) causing a severe fire and its almost total destruction. The fuselage main section came to rest a few feet beyond on the edge of the Elizabeth River.

Several 2-1/2-inch hose lines were stretched from Westfield Avenue to both sides of the River. Lines on the east side were used to wet down buildings seriously exposed to the radiated heat. Lines on the west bank were principally used on the burning brick storehouse. Two lines from a hydrant on Golden Street prevented fire spread to the frame garages communicating to the south. While the fires were practically extinguished within 60 minutes it took nearly 12 hours to remove all the victims. Fire Department services terminated at 3:30 A.M., 12 hours after the accident. This accident, unlike the other two, did not cause loss of life to anyone on the ground as the buildings struck were unoccupied.

Elizabeth Fire No. 2

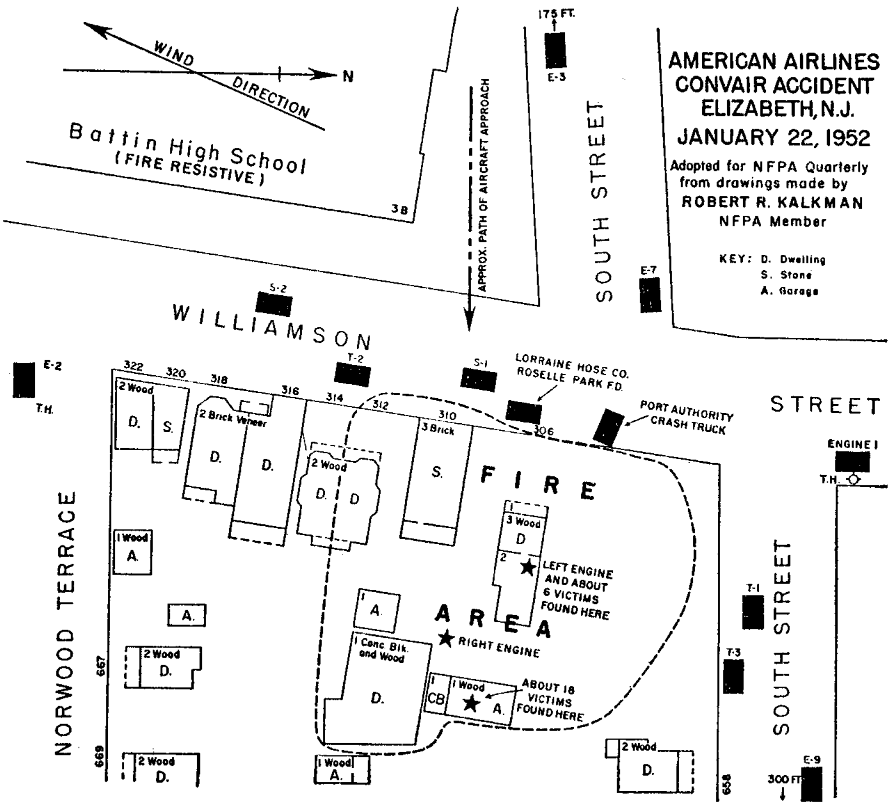


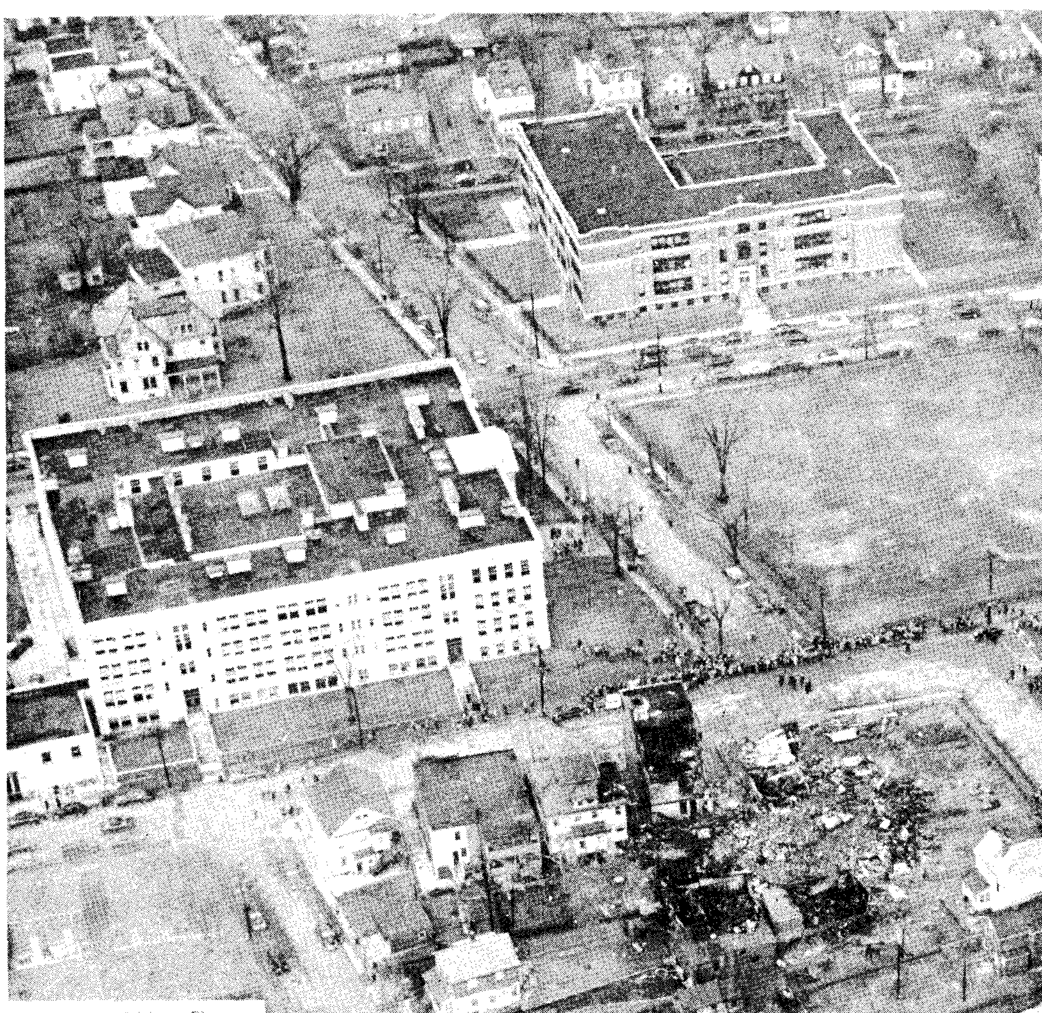

Figure 2

The second accident occurred at 3:44 P.M. Jan. 22 as an American Airlines "Convair" was making an instrument landing approach to Newark Airport. All 23 occupants of the aircraft and 7 on the ground were killed. The exact cause of this accident has not been officially revealed. Failure of a vital control surface might have been responsible as the change in the aircraft's attitude was sudden, the descent sharp and the pilot had no time to radio any difficulty. Weather was unfavorable; when the accident occurred there was a 400 ft. ceiling, intermittent rain, 1-1/2 mile visibility, and a 14 MPH wind.

Answering a succession of box alarms, 10 pieces of Elizabeth apparatus and 160 men responded to the Convair accident site. A "recall signal" brought Chief Officers to the scene and again the Port Authority dispatched its crash truck. Roselle Park Fire Department also saw action in this second accident.

No. 2 Crash Impact Conditions

It is assumed that the Convair was also out of control when it struck three dwellings, completely demolished one, and damaged beyond repair a three-story brick building housing a store. (See Figure 2) Telephone wires surrounding the crash site along the streets were not knocked down.



## No. 2 Fire and Rescue Problems

Fire companies responding to the second accident found the remains of the aircraft and the 2½-story wood dwelling burning fiercely. Another dwelling (a concrete block structure to the rear of the initial dwelling struck) and the three-story brick store were enveloped in smoke and flames as the result of a volume of gasoline that had penetrated the buildings following the impact. The 2½-story frame duplex dwelling at 312-314 Williamson Street was burning rapidly in the attic corner which was also struck by the aircraft.

It again appears that all 23 occupants of the aircraft were killed outright. Six occupants of the buildings struck were killed immediately and 1 died later in a local hospital. The fire department directed its first efforts to determining whether there was anyone alive in either the aircraft or the structures. Those occupants found dead were located in 306 and 310 Williamson Street.

## Fire Fighting

Following the second crash, the task was to confine the fires to the involved structures after determining no rescues could be accomplished. These fires gained their initial rapid spread by being started with sprayed gasoline from the rupture of the aircraft fuel tanks. The direction of the wind towards exposed dwellings prompted the use of a deluge set that was put in position opposite 310 Williamson Street. Hand lines were advanced after the fire had been subdued sufficiently in these two buildings.

Simultaneously, other fire crews attacked the fire in the crushed dwelling in which the bulk of the aircraft wreckage rested. The Port Authority crash truck used two foam lines on the burning aircraft, but most of the extinguishment was secured with 2½-in. hose lines (a total of 13 used). The effectiveness of the "stop" secured is made evident by the post-fire aerial photo which also shows how close the accident site was to two large schools which were fortunately missed. All fires were practically extinguished in 90 minutes, although mopping up and digging into the debris kept fire fighters at the scene until 1:30 A.M. when it appeared that all bodies had been recovered. (Two additional victims were found, however, on the following day.)

United Press-Acme Photo

No. 2 Crash. Close up of the main fire area shows how the brick store was gutted and the dwelling initially struck flattened. To the extreme right, it will be observed that this seriously exposed dwelling was protected from fire damage on the ground floor level. The attic floor to the rear was brushed by the aircraft and set afire but the Fire Department succeeded in preventing spread.

## No. 3 Elizabeth Fire

Number three occurred Feb. 11 at 12:20 A.M. when a four-engine National Airlines DC-6 crashed soon after take-off following power failure of No. 4 engine and the unexplained reversal of the propeller of No. 3 engine.

This was the only accident of the three where some of the occupants of the aircraft survived. Twenty-six of the occupants were killed outright, 3 died later as a result of injuries and 37 escaped. Four residents of Elizabeth were fatally injured. It is probable that survival was made possible in this accident since the deceleration was in stages and a twenty-foot long aft portion of the fuselage broke away from other parts of the aircraft and was not involved in fire.

### Fire Alarm

A radio car of the Hillside Police Department was cruising about a block from the accident site of the February 11 crash and gave the first alarm, to the Hillside Fire Dept., for the third accident. (Hillside and Elizabeth have common borders within a block of the site.) The Elizabeth Fire Dept. was

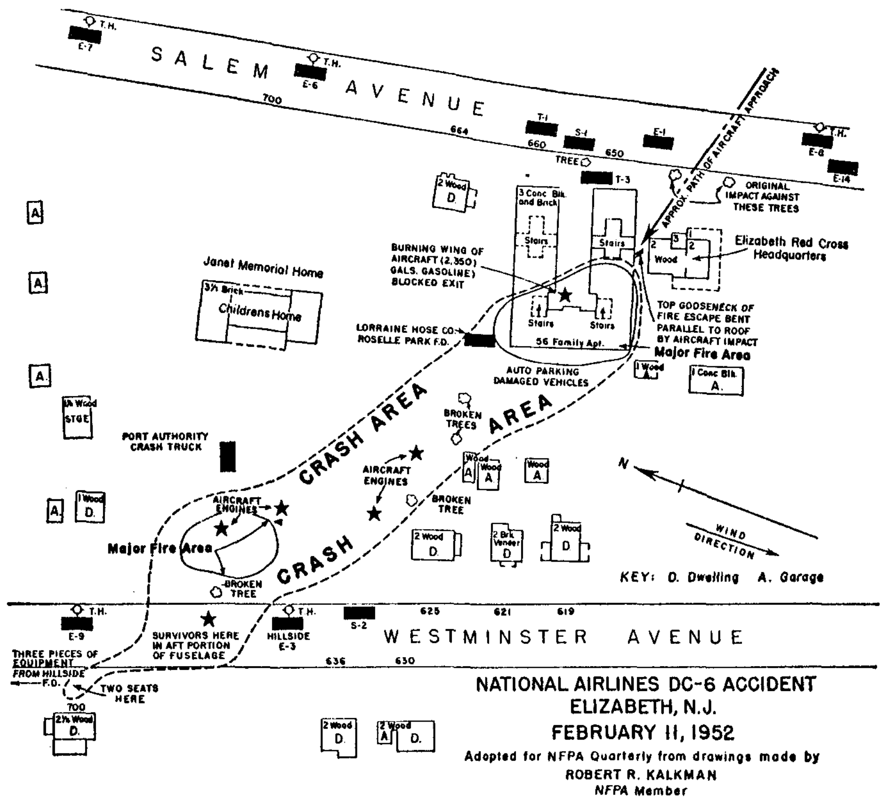



Figure 3

notified by a telephone alarm. Within 3 minutes, the complete first alarm companies were on the scene and a third alarm was sounded 6 minutes later. Elizabeth sent 10 companies and 145 officers and men; Hillside and Roselle Park responded with a total of 5 companies; the Port Authority again sent its crash truck.

## Crash Impact Conditions

The DC-6 first came in contact with the top of two trees in front of the Elizabeth Red Cross Headquarters, knocked down an antenna on the top of this building, and then struck the roof gooseneck of one of the fire escapes on the south side of the 56-family apartment building at 650-660 Salem Avenue.

A wing section dropped in the apartment courtyard when the aircraft struck and moved several inches the entire top story wall section at the northeast corner of the south stairway, skidded across the roof, demolishing an eight-inch cinder block, brick coped fire wall and tore down a section of the rear wall about five feet in depth and approximately eighty feet in length. This wall fell on automobiles parked in the rear of the building.

The impact with this building slowed the plane somewhat but in its further descent it snapped off several trees in the rear of the apartment, struck and skidded along the open ground behind the Janet Memorial Home, and, leaving engines and pieces of wing and tail behind, finally came to rest when a portion of the fuselage (about 20 ft. in length) uprooted a tree (three feet in diameter) and was inverted across the street from 700 Westminster Avenue. From Figure 3, it will be noted that apparently each object struck turned the aircraft slightly to the right and thus it passed dwellings it might well have otherwise demolished and this fact also probably saved the lives of those who survived the crash in the aft section of the fuselage.

United Press Photo

## No. 3 Fire and Rescue Problems

As firemen reached the scene of the third accident, a severe fire was in progress in the apartment house and its courtyard, involving building contents on the top floor, the cockloft and about 2,350 gallons of gasoline in the wing which fell into the yard. Other fires were in the open around the parts of wreckage as shown in Figure 3. Fortunately, the aft section of the fuselage, where survivors were found, was not involved in fire. Other, less fortunate, occupants of the DC-6, were found in an area of about 200 ft. by 850 ft., with indications that some had been catapulted as far as 650 ft. following the impact.

Associated Press Photo

No. 3 Crash. The unburned portion of the fuselage where the survivors were located. This section came to rest after breaking the trunk of a three-foot diameter tree. Those who escaped apparently had their seat belts attached.

The burning wing cut off normal egress from one stairway in the apartment. One of the 4 victims who occupied the building was apparently trapped in a hallway and burned to death. The others were seemingly killed by the falling walls; their bodies were badly burned before they could be reached.

Occupants of the aircraft who survived reported that after the initial impact with the apartment building, flames entered the fuselage and inflicted serious burns on passengers even before the aircraft came to rest.

## No. 3 Fire Fighting

Following the third crash, Elizabeth Fire Department personnel concentrated on the apartment building after size-up showed other fires were in the open and all survivors removed from hazardous areas. Hand lines were effectively used to prevent the spread of fire in the apartment to lower floors while an aerial was used as a water tower to knock down the bulk on the fire in the cockloft. An excellent "stop" was again made, only 6 apartments being severely damaged. Special attention had to be given to the burning wing section and the burning automobiles.

United Press Photo

No. 3 Crash. The burning apartment house which the DC-6 struck looks totally involved but actually only six apartments were severely damaged. The dropping of a wing in the apartment courtyard containing over 2 000 gallons of gasoline complicated fire fighting activity. Four occupants of the apartment lost their lives.

The Port Authority crash truck used fog foam on the outdoor major fire area involving aircraft parts. They were assisted by the Elizabeth Fire Department using foam and water fog. It is estimated that about 4 700 gallons of gasoline from the aircraft's fuel tanks fed these fires. Some of the aircraft's fuel had been dumped intentionally by the pilot before the aircraft actually crashed. Residents 3 blocks away reported a gasoline "shower" but no fires occurred.

Fire fighting in various sections of the crash area continued for about four hours. Fourteen 2-1/2-inch hose streams were used plus foam, fog-foam and turret streams. Again, the situation was favorable to the extent that the aircraft missed many dwellings it might have struck, but, most important, the Children's home.

## Summary of the Three Crashes

Three accidents within two months in Elizabeth, N.J. did constitute an incredible coincidence! Each accident involved a different type of aircraft!

Each accident involved airborne difficulties, each different in basic cause! Experienced pilots could not prevent disaster in any of the three!

While Elizabeth's proximity to Newark Airport can be cited as being the common denominator, these three accidents occurring in two months cannot be explained solely on this count against a background of over 23 years of operations at this airport which produced no such previous accident! While similar accidents might have occurred anywhere along the air routes, the fateful timing of the airborne difficulties were beyond human control at the time such difficulties occurred. These in-flight failures, coupled with the altitude of the aircraft involved combined to overcome pilot skills and aerodynamic lift.

The Elizabeth Fire Department and their cohorts did an admirable piece of work in each of the accidents. It was tragic that they did not have opportunity to perform rescue work, but this was through no lack of courage, determination or skill. The crash conditions simply made it impossible to save life in either of the first two accidents and, in the third, the survivors were either able to escape under their own power or were assisted by companions or local citizens.

The news of the disaster by press, radio, and television prompted the convergence of auto and pedestrian traffic to the scene, seriously interfering with the work of local police, fire, medical and Red Cross services. Well-meaning civil defense units from outside Elizabeth were among those who heard these flashes and rushed to the scene. Such disasters showed that as long as civil defense units are solely under municipal control, there is need for effective machinery to control intercity disaster work by civil defense personnel.

Not all aircraft accidents are like these three and local fire departments should not dismiss rescue operations, just because of these occurrences. NFPA pamphlets 402 and 403 are recommended for study on this subject as well as NFPA Aviation Bulletin No. 80 giving tentative recommendations on "Aircraft Rescue and Fire-Fighting Techniques for Municipal and Rural Fire Departments Using Conventional Fire Apparatus and Equipment" and the April 1952 and September 1951 issues of FIREMEN magazine.

## Other Aircraft Fires

There has been a total of 58 aircraft accidents involving fire reported to the NFPA during the period January 1, 1952 to April 14, 1952. These 58 accidents have been responsible for 379 deaths.

## Section 3

## Around the World

### Dangerous Goods

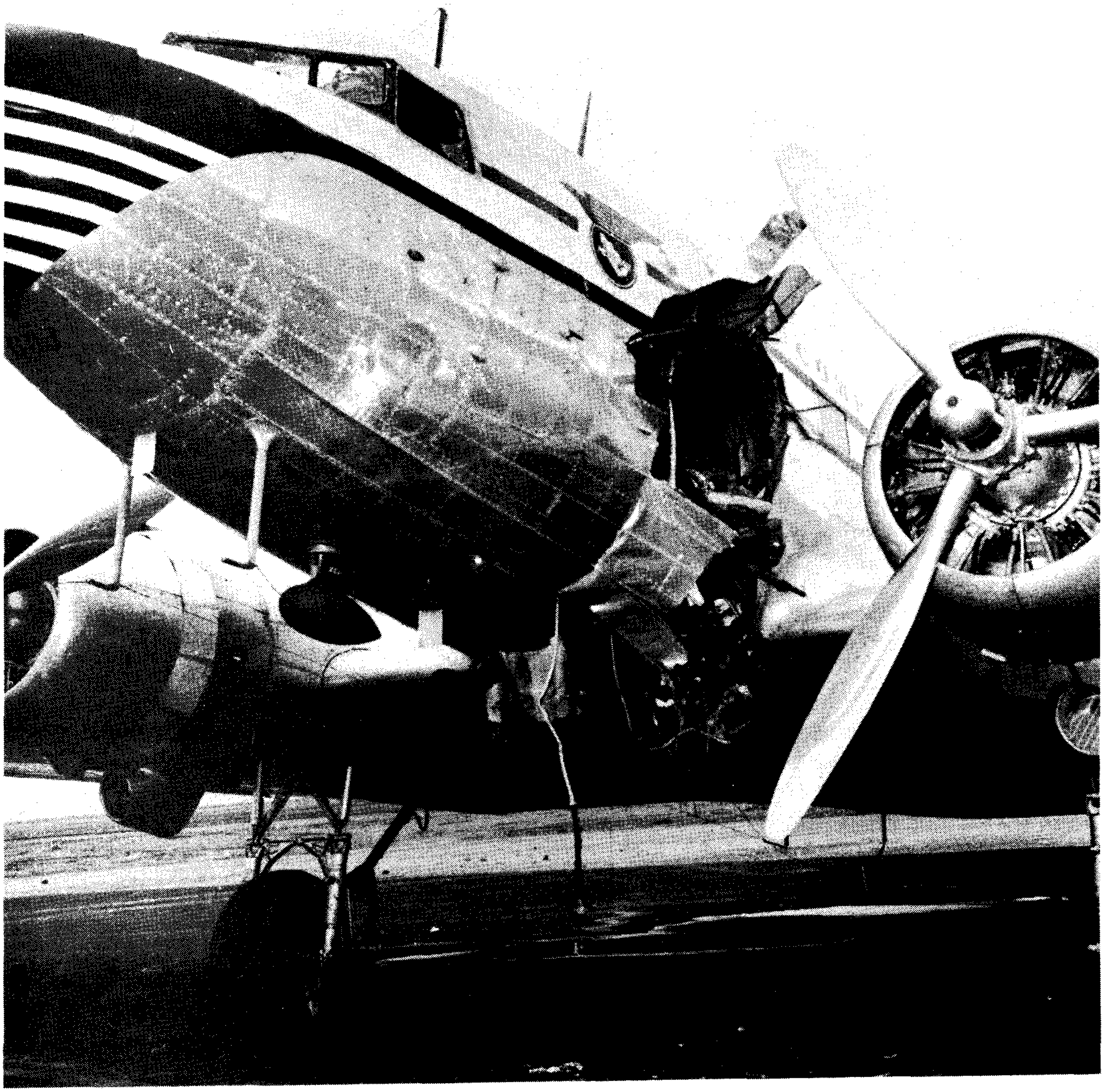
Johannesburg - A fantastic encounter between a plane pilot and his radio operator and a four-foot green mamba, the most deadly African snake, at the crucial moment of take-off from Dar-es-Salaam, East Africa, was described by the radio operator.

The aircraft, with passengers aboard, had just gained flying speed when the radio operator was horrified to see the mamba drape itself around the neck of the pilot.

He and the pilot managed to dislodge the snake, which flung and coiled itself around the top of the control column, from where it let fly at the radio operator, its fangs striking the double fold of his tunic collar. They struck at the snake again, flipping it onto the instrument panel, from where it fell to the floor and vanished.

Fearing it would strike at their legs, the airmen hastily returned to the airport. They eventually found the snake in a locker beneath their feet. It had probably come from there and had been loaded with the ballast. They killed it.

The New York Times, 13 May 1952.



Dangerous Practice

Mexico City: A DC-3 of Compañía Mexicana de Aviación, with seventeen passengers aboard, forced landed at a military aerodrome shortly after the explosion of a time-bomb in a suitcase placed in the forward luggage compartment of the aircraft. The pilot, luckily delayed fifteen minutes in take-off, was over the military field when the explosion occurred and was able to land the crippled ship safely. Note the damaged windshield in the pilot's compartment in the photograph.

Ditching Rules Proposed by CAB

New airline regulations designed to give passengers a better chance for survival after water landings are being proposed by CAB's Bureau of Safety Regulation. Briefing of passengers on ditching procedures and equipment is one of the requirements.

In a hurry to get the new rules into effect, CAB has set Sept. 29 as the deadline for industry comment. The push was supplied by safety investigators' reports that in this year's two airliner ditchings, 88 persons drowned largely because of inadequate briefing and remote location of lifesaving equipment.

The cases involved were NWA-operated DC-4 crash off Sandspit, in which 36 drowned and the PAA DC-4 water landing near San Juan, in which 52 passengers drowned.

Here are the four new CAB proposals for ditching and one for emergency evacuation in land accidents:

Rafts and lifevests. Rafts and vests must be CAA-approved and must be located in approved locations, suitable for surprise ditchings. Past regulations were not only loosely interpreted and enforced, but were written on the theory that ditchings would be with warning. But in the last several years, almost all have been sudden, Equipment has often been hard to reach in coat-closets. The 20-man rafts weighing well over 100 lb. have been located where the hostess could not lift them to the door or exit alone. Lifevests have been of varied design and sometimes inferior quality, CAB and CAA found.

Emergency lighting. Doors and exits must be spot-lighted; the lights must be fed from independent battery source. Door handles must be plainly marked in luminous paint. Lights must be designed to go on automatically on crash impact. Night ditching by Northwest Airlines at Sandspit, B.C., last Jan. 19 was a lights-out situation; so no rafts and few lifevests were found.

Passenger briefing. "In the case of extended overwater operations," airlines must brief passengers not only verbally but with actual demonstration of where to find the rafts and lifevests and how to put the vests on. Briefing must be held before the plane goes over water - before take-off if necessary. Passenger panic, reported in some past ditchings, is attributed to insufficient briefing on what to do and where to go.

Land exit. Ropes, chutes or other acceptable means of descent must be at all doors and exits (except those over the wing) more than six feet above ground when the plane is standing with its landing gear down.

Aviation Week, 15 Sept. 1952.

Explosion of Drum of Liquid Brewers Yeast

"On June 25 a drum of Liquid Brewers Yeast blew up in a cargo area at one of the major airports. The drum had been en route approximately 36 hours, having been off-loaded at another station on account of load.

"The liquid yeast was packed in a steel beer keg, 1/2 barrel size. This keg was inside a large fiber drum approximately 3 feet tall and the keg was surrounded by sawdust and water ice.

"When the explosion took place the bottom portion of the steel drum was torn away from the top portion and the top piece together with the fiber drum went straight up and hit the steel trusses in the hangar roof, glanced off and hit the concrete roof itself. The drum landed about 50 feet away from its starting position. Yeast and sawdust were scattered for about a 50 yard radius. No one was hurt.

"A representative of the shipper stated that liquid yeast has been moving by air freight for the past year and no trouble has been experienced.

"It was this representative's opinion that by the time liquid yeast is in transit 24 hours, fermentation has begun and gas pressure starts to build up. He agreed that since delays can take place at anytime, it is not safe to transport the product in air freight service.

"Another yeast company states that they ship only compressed and dry yeast and these items move in paper board cartons, under dry ice refrigeration."

Flight Safety Foundation Bulletin 52-20, 31 July 1952.

Cause of Near-crash

Cause of the recent near-crash of a United Air Lines DC-3 taking off from Mills Field, Calif., was improper loading of passengers and cargo too far aft in the plane.

The plane veered 90 deg. to the right after taking off. It circled the field one and one-half times before the pilot and copilot could straighten it out. They landed three minutes later, having gained no more than 300 ft. of altitude.

Cargo was 59 lb. overweight for the rear cargo pit and all 21 passengers sat aft in the 28-passenger DC-3. This caused loading at 30% from center of gravity. Company limit is 26% and maximum allowable for the aircraft is 28%.

Tail-heaviness caused the fuselage to blank out the air flow over the tail's control surfaces.

Aviation Week, 5 May 1952.

<u>Operating Techniques - Operators of DC-3's - Watch that C.G.</u>
(A dangerous yawing movement can be induced by a tail heavy take-off)

The flight had aboard 21 passengers, two of whom were children, and 1 209 pounds of cargo in the rear pit. The total take-off gross of the airplane as shown on the weight manifest was 24 299 pounds with the maximum allowable gross being 24 630 pounds. There was 59 pounds more cargo in the rear pit than was shown on the manifest. The flight was cleared to take off.

At about 55 to 60 mph, the Captain had to exert considerable forward pressure on the control column to bring the tail up. At this time, the airplane started veering to the left. The Captain applied right rudder followed by two intermittent right brake actions at the same time. He then checked on the power settings and the position of the left throttle, feeling that the throttle had crept back which might have been the cause of the yawing of the airplane. The power on both engines appeared normal and about that time the airplane was yawing considerably to the runway, whereupon the Captain pulled the airplane off the ground at about 80 to 85 mph and ordered the gear up as he felt that the landing gear would not stand the strain.

The airplane left the runway in a yawing condition to the left and apparently after leaving the runway the left wing dropped sharply in a tight turn. The Captain applied full right rudder and aileron and then reduced power on the right engine to about 0 thrust in order to try to pick up the left wing. At that time, the left engine was putting out approximately 50" of manifold pressure and the Captain ordered the right engine to be feathered. It then became apparent that the airplane would not stay in the air without some help from the right engine so before the engine had actually come to a stop, he ordered the engine unfeathered and carried about 20" of manifold pressure on this engine. In the configuration of gear and flaps up, full right aileron and hard right rudder, with all available power on the left engine and 20" of manifold pressure on the right engine, the airplane circled the field to the left, staying within the airport boundaries until on the last portion of the circle when the path was over the water in order to get lined up with the runway.

The airplane was in varying degrees of bank during this circle and at times appeared to be almost level in flight; however, it was in an apparent slip to the left. The airspeed during the circle was in the neighborhood of 100 to 105 mph indicated and the altitude varied from 150 to 300'. The Captain maneuvered the plane to line up on Runway .... and after gaining speed to 110 mph indicated, attempted to throttle back the left engine but was unable to do so account creating additional yawing to the left. The runway was contacted in a yawing attitude and the airplane ended up heading about 90° from the runway and on the turf. No passengers were injured nor was the ship damaged in any way.

The baggage in the rear pit was weighed and the total was 59 pounds over allowable limit of 1 150 pounds in the rear pit. The passengers were not seated in accordance with the cabin attendant's manual but were allowed to take any seats that they wished, which upon investigation was felt to be proper by both the cabin attendant and the Captain. If the airplane was loaded strictly in accordance with the loading charts, the percentage of MAC would have been 26.1%. The allowable is 28%. From the information gathered from the cabin attendant concerning the manner in which the passengers were seated, this airplane was loaded to approximately 29.8% of MAC.

Flight tests were then made with the airplane loaded in aft CG configuration similar to the flight in question. Three different pilots could get the airplane in somewhat the same configuration that prevailed when the field was circled, but it differed in that the trim tab was cranked full to the left before starting the maneuver. From the reports, we are reasonably certain that the trim tab on the flight in question was practically centered. To get into this position it was necessary to go through rather extreme maneuvers and upon conferring with the Douglas Company it was not deemed advisable to continue them due to the stress on the airplane.

A meeting was arranged with the Douglas Test Pilots and their Chief Aerodynamicist concerning the flight. They are of the opinion that any DC-3 could be placed in a similar position if it followed the flight path and plane attitudes as followed by this plane. They are of the opinion that when the first tight turn was made, the left wing tip either went into a primary or a secondary stall and the flow over the rest of the wing was relatively smooth due to the high power output of the left engine. The full right aileron position assisted in holding up the left wing as well as did the thrust from the left engine and the position of the rudder. They feel that although the aileron and rudder were in extreme positions, the control forces were in aerodynamic equilibrium so that the airplane was able to remain in the air during the circling of the field. Due to the attitude of the airplane and its direction of flight, and the fact that the rudder was positioned far to the right, the Douglas people believe that the rudder was in a position of over-balance.

The tail was very hard to raise due to the extreme tail heaviness and we know that the fuselage blankets out the rudder in a tail low attitude and that the extreme aft CG of the airplane tends to aggravate the yawing tendencies on take off. If the airplane started to yaw to the left in a tail low position, and the tail had been raised to a point so that there was very little pressure on the tail wheel, the rudder would not be very effective in straightening out the yawing. Due to the extreme aft CG, the tendency to yaw would become considerably more pronounced.

Instructions have been released to all personnel concerned outlining the circumstances surrounding this incident and stressing the importance of loading all aircraft within specified loading limits.

How Long does it Take to Feather Manually?

A frequency plot was made of the pilot time required to recognize an engine failure and to complete corrective action on the primary controls following an engine failure at speed $V_1$ during the take off run. The mode * of this curve falls between 1.75 and 2.5 seconds and the arithmetic mean time is 2.6 seconds. The time to recognize an engine failure and complete corrective action on the controls presented in this curve is not considered to be indicative of the actual case since in all take-offs the pilot was expecting an engine to be cut at $V_1$ speed. The data recorded, however, indicates that a minimum of 2.6 seconds of the pilot's time will be required in coping with an engine failure.

The elapsed time from the instant after the airplane is brought under control following an engine failure at speed $V_1$ until the pilot calls for the retraction of the landing gear varied with the technique used during the take off. If the nose gear is held on the runway until $V_2$, the gear cannot be retracted until after $V_2$ has been obtained, and a safe altitude for retraction is reached. It is interesting to note that in one or two cases the pilot forgot about the gear retraction until the co-pilot placed his hand on the retraction lever.

- Excerpted from page 11 "Comparison of Take-off and Climb Performance Obtained in Actual Operating Conditions for Douglas C-54A Airplane".

Note:- Pilot reaction time, expecting an engine to be cut at $V_1$ speed, varied from 1.3 to 7.3 seconds.

Flight Safety Foundation Bulletin 52-12, 8 May 1952.

Watch Those Specks

The captain of an executive B-23 was surprised to find that a new speck on his windshield was equipped with four power plants. The speck, a DC-6, was descending under VFR conditions at a speed estimated over 300 mph. **The B-23 pilot estimates that from the time he recognized that he and the DC-6 were on a collision course to the time that he passed about 50 feet under the wing of the DC-6 was less than six seconds. Of this, three seconds were spent in evaluating the situation, leaving about three seconds for evasive action.

* Statistics: Mode = Occurring most often, i.e. a "cluster" of statistical dots fell between 1.75 - 2.5 seconds; some far above, some below, bringing the average up to 2.6 seconds.

** The B-23 was flying straight and level at 240 mph.

He observes that at a distance of about a mile, the head-on appearance of a modern type airplane is very similar to a speck on the windshield.

There were three crew men in the cockpit of the DC-6; he and his copilot in the cockpit of the B-23. The copilot of the B-23 never did see the DC-6. None of the three crew men in the DC-6 saw the B-23 at any time!

Five crew men in the cockpits of these two planes; only one saw the imminence of collision!

Flight Safety Foundation Bulletin 52-13, 28 May 1952.

## An Effect of Lightning

"Recently, one of our DC-6 aircraft experienced a lightning strike. A careful inspection of the ship structure, its accessories and wiring disclosed everything normal. The flight proceeded and operated normally. After the aircraft had been on the ground approximately three hours, and while being prepared for another flight, it was found that all engine fuel and oil pressure indicators, supercharger oil pressure and all heater fuel pressure indicators were inoperative. Ground checking disclosed that the various transmitters of these units were electrically okay pin to pin but that their magnets had apparently become demagnetized. After replacement of the transmitter units, all operation was again normal. Although continuing our investigation of this incident, we are unable at this time to explain why the aircraft systems functioned normally before. It would be well for all pilots to be alert against a recurrence of this irregularity."

Flight Safety Foundation Bulletin 52-13, 28 May 1952.

## Reversing

"Reversing difficulties and engine stalling are sometimes encountered due to the decrease in electrical power when all engines and generators are slowed down during reversing procedures or when the battery is low or when lights, radio, etc., are on and sufficient electrical power is not available to pull back the secondary latches. Some crews have improved the situation by reversing the two inboard engines first allowing them to pick up speed to furnish a generator power and then reversing the two outboard engines. This procedure is authorized when and if the airplane battery is suspected to be low. Although this is an approved emergency procedure, caution should be used so that it does not become a regular habit so that when a situation arises where an accelerated stop is required that there is no delay in using all four engines in reverse."

Flight Safety Foundation Bulletin 52-24, 9 Sept. 1952.

Sensory Illusions - Collision

The following report from an airline shows that a sensory illusion as between aircraft in flight may create a mid-air collision hazard:-

"Recently we have had two or three reported ATC irregularities wherein potential mid-air collisions were involved. Each of these instances involved aircraft holding presumably at their assigned altitudes under IFR and at night. Each irregularity included one or the other, or both, of the two pilots involved visually sighting the other while in a turn and believing the other was at his altitude. In these instances evasive maneuvers were effected by one or the other aircraft and these maneuvers resulted in near collisions.

"Modern aircraft being operated at normal holding speeds have a relatively high angle of attack. This coupled with angle of bank of normal turning and normal pilot perspective provides all the elements of a perfect optical illusion. It is very easy under situations such as described to believe the other man is at a wrong altitude.

"Whenever you may experience such a situation, it is believed safer to consider the observation as an illusion; stick to your assigned altitude and stay on your gauges. Evasive maneuvers are almost certain to be in the wrong direction and very hazardous exposure can result."

Flight Safety Foundation Bulletin 52-14, 6 June 1952.

Aircraft Altimeter Settings

"A recent incident of a new First Officer mis-setting his altimeter and the flight holding at a wrong altitude focuses attention on the need for constant continuous altimeter setting monitoring by all crew members. Altimeter control procedure was born of much bitter experience."

It is best that we all profit from our mistakes. Mutual monitoring is one answer to a large segment of our safety problems.

Flight Safety Foundation Bulletin 52-14, 6 June 1952.

A Factor Named "Joe"

"One of the basic requirements of the whole approach and landing process was therefore found to be an inherent limitation in Joe himself - the amount of time which he requires to adjust his own processes from instrument to visual conditions once he has broken through the cloud base and to compute what he sees into a decision on landing, leading finally to the flare-out and landing. This was termed Joe's 'exposure time' and was reckoned to require a minimum of about 15 seconds.

"It was therefore inevitable that much of the Conference discussion should have revolved around an average airline pilot - 'Joe' - and that his performance as a unit of the approach and landing system should have been seriously examined.

"Joe's basic characteristics as an instrument were summed up by Wing Commander H.P. Ruffell Smith of the RAF in these terms:-

'Man is not as good as a black box for doing certain specific things. However, he is more flexible and reliable. He is easily maintained and can be manufactured by relatively unskilled labour'."

(From IATA press release on recent conference.)

Crew Gains Altitude

"By way of interest and to show that clear air turbulence seems to be real enough we have the report of the crew of a Dakota on April 17, 1951 which left Singapore for Saigon and was climbing smoothly and slowly 18 miles north of Singapore when it encountered violent turbulence in clear air. The plane fell from 4,800 feet to 3,000 feet in five seconds. The crew of three were pinned to the roof for a short time, and a sextant inside its case was badly dented and the case smashed. Stoppers on all the large vacuum flasks were ejected. There appeared to be no clouds in the vicinity and the underlying terrain was flat mangrove swamp. Convection was not the cause since the incident occurred about 2 hours before dawn when conditions would be relatively stable. Winds over the area were about 10 Kt. or less."

(Keep Belts Fastened.)

Flight Safety Foundation Bulletin 52-25,
22 Sept. 1952.

Turbulence Caused by Large Aircraft

A recent accident has focussed attention on the flight hazard caused by the propeller wash of large aircraft. A Rapide was making an approach behind a Stratocruiser when at about 300 feet it was rocked violently several times and lost height rapidly in a left wing low attitude. Although the Rapide was at least 1,000 yards and may have been more than 2 000 yards behind the Stratocruiser the turbulence left by its propeller wash was still violent enough to make it impossible for the pilot to regain control. At the time there was a slight cross-wind of 15 knots and the Rapide was approaching on the lee side of the approach path.

An American source reports no less than 200 incidents of this nature of which at least one was fatal. Even aircraft as large as Dakotas have been seriously affected. Experience indicates that the hazard remains longer when there is no wind and the temperature is low, but as the Rapide accident shows the danger is present even when a fair breeze is blowing. It also appears that the hazard is greatest behind aircraft taking off, which is probably explained by the fact that on these occasions maximum power is being developed. Experts also suggest that the turbulence produced by jet aircraft is considerably higher than that caused by piston engined aircraft.

Most instances have occurred at low heights. Because large airliners as a rule make long low approaches and light aircraft relatively steep approaches, the light aircraft does not normally fly into the wake of a large aircraft until near the ground, which adds to the danger.

In the light of these occurrences the following recommendations are made for the guidance of pilots to minimise the risk from the wake of other aircraft:-

(a) Never be hurried in taking off or landing behind another aircraft.

(b) When approaching in a cross-wind keep to the windward of the approach path, and land on the up-wind side of the runway.

(c) Maintain a little extra flying speed.

(d) Take extra care during calm cool days.

(e) If propeller wash turbulence is encountered open the throttle(s) and attempt to climb out of it as quickly as possible.

Ministry of Civil Aviation - United Kingdom
Information Circular No. 177/1952

- 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* 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 worldwide 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.

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*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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*TECHNICAL MANUALS* provide guidance and information in amplification of the International Standards, Recommended Practices and PANS, the implementation of which they are designed to facilitate.

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*ICAO CIRCULARS* make available specialized information of interest to Contracting States.

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