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FOREWORD

Accident investigation is recognized today as one of the fundamental elements of improved safety and accident prevention. Nearly every accident contains evidence which, if correctly identified and assessed, will allow the cause to be ascertained so that corrective action can be undertaken to prevent further accidents from similar causes. Thus, the ultimate object of accident investigation and reporting, which is to permit the comparison of many accident reports and to observe what cause factors tend to recur, can be accomplished. These factors can then be clearly identified and brought to the attention of the responsible authorities.

The Accident Investigation Division of the Air Navigation Committee of PICAO* 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 PICAO in order that the Secretariat might appraise the information gained and disseminate the knowledge to Contracting States.

The world-wide collection by ICAO of accident reports and aeronautical publications and documents relating to research and development work in the field of aircraft accident investigation, and publication of the material in condensed form, assists States and aeronautical organizations in research work in this field. By stimulating and maintaining continuity of interest in this problem the dissemination to individuals actively engaged in aviation of information on the actual circumstances leading up to the accidents and of recommendations for accident prevention also contributes to the reduction of accidents.

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

The first Digest was issued in 1951 under the present title and with the new method of presentation. Since then, the usefulness of the series has continued to elicit favourable comment from the aeronautical world.

However, late in 1964, the Secretariat carried out a study of the problems associated with the publication of the Digest and considered various methods which, it was thought, would lead to a more rapid dissemination of accident reports forwarded to ICAO for release in summarized form in the Digest. These studies also consider amending the presentation of the summaries with a view to producing them in a more

* Provisional International Civil Aviation Organization.

standardized manner. Accordingly, the Secretariat prepared a uniform plan using fixed subject headings, in an agreed order and with standard paragraph numbering, to enable readers to extract pertinent information more readily, according to their particular interests. This plan was submitted to the Third Session of the Accident Investigation Division - Montreal, 19 January - 11 February 1965 - for its consideration and development. The meeting accepted the concept of a uniform plan but modified the details. Commencing with this issue, Digests are being prepared in accordance with the final version of the uniform plan, as approved by the Council. This plan for the "Summary of Accident Report" appears in Appendix 3 of Annex 13 - Aircraft Accident Inquiry - (Second Edition).

It is hoped that States will co-operate to the fullest extent permitted by their national laws in submitting material for the Digests in accordance with the provisions of paragraphs 6.3 and 6.4 of Annex 13. It is recognized that investigations take a diversity of forms under the variety of constitutional and juridical systems that exist throughout the Contracting States of ICAO and that, for this reason, accident investigation presents one of the most difficult problems of standardization in international civil aviation. At the same time it is a most fruitful source of material for the attainment of the objectives of the Chicago Convention.

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

Restriction upon reproduction in the Digest seriously impairs, of course, the usefulness of any reports, 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. Names of persons involved may, however, be omitted without detracting from the value of the report.

Follow-up action and other supplementary information or comments on an accident report by the State of Registry or State of Occurence provide useful material for inclusion in the Digest.

Whenever possible, photos and diagrams have been obtained for illustration purposes in order to give a clearer overall picture of the crash area, an idea of the probable flight paths of aircraft, the location of witnesses to the crash, and in general to make the reports more interesting to the reader.

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

Digests are now published twice yearly at approximately six monthly intervals. The first volume contains summaries and air safety articles. The second volume, in addition to containing further summaries, provides other accident data such as classification tables, statistics, lists of laws pertaining to accident investigation and air safety articles.

PART I

SUMMARIES OF AIRCRAFT ACCIDENT REPORTS

No. 1

West Coast Airlines, Inc., Fairchild F-27, N 2703, crashed into Great Salt Lake, Utah, on 17 January 1963. Civil Aeronautics Board (U.S.A.) Aircraft Accident Report, File No. 1-0005, released 10 September 1963.

1. Investigation

1.1 History of the flight

The aircraft had flown from Seattle, Washington, to Salt Lake City Municipal Airport arriving there on 17 January at 1431 hours*. When servicing of the aircraft had been completed, it took off at 1510 hours on Pilot Training Flight No. 703, which was to be a local flight of 1 hour and 30 minutes duration in visual meteorological conditions. The purpose of the flight was a type rating check of a pilot on the Fairchild F-27. At take-off he was in the left-hand seat. Others aboard the aircraft were a company check pilot in the right-hand seat and an FAA (Federal Aviation Agency) operations inspector in the jump seat. The aircraft made a practice landing at 1517 hours then took off again five minutes later. Several persons observed the aircraft on the subject flight. At 1531 hours it was seen with its left propeller feathered. Several minutes later the ground controller in the Salt Lake City control tower saw it flying level about 8 000 ft above the ground, and he noticed nothing unusual about the flight at that time. At approximately 1550 hours the aircraft was flying west of Salt Lake City Airport on a northwesterly heading, about 3 000 ft above the ground and descending. Data provided by the flight recorder tape established that 127 seconds prior to impact Flight 703 started to descend from 7 498 ft msl. It continued to descend to the lake's surface, which is 4 180 ft msl, and the average rate of descent was 1 566 ft/min. The airspeed varied between 102 and 113 kt, with an average of 107.8 kt. The magnetic heading varied between 268° and 278°. The vertical acceleration was almost constant at .95 g with some variations between 1.1 g and .80 g. The tape showed no evidence of an attempted flare out just before impact which occurred at 1553 hours.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	3		
Non-Fatal	0		
None	0		

1.3 Damage to aircraft

The aircraft was destroyed by impact.

* mountain standard time.

1.4 Other damage

No damage was sustained by objects other than the aircraft.

1.5 Crew information

The check pilot, age 42, had 15 509 hours of flying experience. This total included 578 hours on F-27 aircraft of which 457 had been as instructor. On 25 July 1962 he had passed his six-months proficiency check on the F-27 with above average grades, and he was properly certificated and rated.

The trainee pilot, age 46, had flown a total of 14 460 hours including 10 hours on the F-27 aircraft while training for a type rating. He held an airline transport pilot's licence with a rating for DC-3 aircraft.

The FAA inspector, age 45, had flown 8 795 hours including 62 hours on F-27 aircraft. He had attended the F-27 factory school at Hagerstown, Maryland and had taken refresher training on that aircraft.

1.6 Aircraft information

The aircraft had flown a total of 11 708 hours. All checks and maintenance were current. There were no carry-over discrepancies entered in the aircraft's flight log which was recovered following the accident.

At take-off from Salt Lake City Municipal Airport the aircraft's gross weight was 28 310 lb, which was approximately 7 000 lb less than the maximum allowable. The centre of gravity was within the prescribed limits.

The aircraft carried 3 500 lb of Aero Shell Turbine Fuel 640.

Following the accident the left and right fuel quantity indicators read 1 400 lb and 1 290 lb respectively.

1.7 Meteorological information

On the day of the accident the official U.S. Weather Bureau observation at Salt Lake City Municipal Airport for 1555 hours was:

> ceiling estimated 12 000 ft broken, high overcast, visibility 12 miles, temperature 34°F, dew point 23°F, wind from the south-southwest at 5 kt, altimeter setting 30.05, smoky, snow showers of unknown intensity east.

The light southerly wind would have been conducive to a near calm water surface, which could have been deceptive if used to gauge altitude. Also, the aircraft was flying towards a low afternoon sun and consequent glare could have made altitude reference from the water more difficult.

1.8 Aids to navigation

They are not significant in this accident.

1.9 Communications

The last radio contact with the aircraft was at 1522 hours when the tower cleared it for the second take-off.

1.10 Aerodrome and ground facilities

No information in this respect is contained in the report.

1.11 Flight recorders

The flight recorder and its tape were recovered undamaged from the wreckage. Based on information derived from the readout of the tape, the Board was able to reconstruct the final portion of the flight. (See paragraph 1.1, History of the flight)

1.12 Wreckage

The wreckage of the aircraft was located about 15 miles west of the Salt Lake City Municipal Airport, 6 miles offshore, where the water was 25 ft deep. It was strewn on the bottom of the lake over an area about 450 ft long and 250 ft wide. Approximately 97% of the wreckage was recovered.

1.13 Fire

There was no fire subsequent to the accident.

1.14 Survival aspects

At 1700 hours the Salt Lake City Air Route Traffic Control Centre requested the Salt Lake City Flight Service Station to call Flight 703 on all available frequencies. Flight 703 did not reply and at 1758 hours it was reported to be overdue.

The following morning one victim and aircraft debris were seen floating on the lake, and the other two victims were sighted the day after. All three victims were recovered.

A Navy search aircraft found the wreckage six days later.

1.15 Tests and research

Complete autopsies, including toxicological and histological examinations were performed on all three victims. Abrasions and contusions probably caused by seat belts were found in the iliac (lap) region, but were not the cause of the deaths, which were attributed to exposure and drowning. Nothing was found which could have contributed to the accident.

Fuel samples taken at Boise, Idaho, the aircraft's last refuelling stop, were analysed following the accident and conformed to the specification requirements for Aero Shell Turbine Fuel 640.

Tests of the cabin heater assembly for combustion chamber leakage showed a major leak at a crack where the crossover passage was welded to the combustion

chamber. The heater was tested following replacement of the igniters. Air samples taken at this time showed no evidence of carbon monoxide in the ventilating airstream.

Flight tests were conducted in another F-27 aircraft with landing gear and wing flaps down, with a gross weight about the same as that of N 2703 at the time of the accident. Two descents were made at an airspeed of 109 kt and a rate of descent of 1 580/min. To maintain this rate of descent and airspeed, 30 psi torque pressure on each engine was required. This power setting resulted in approximately 10 500 rpm on each engine, and a deck angle of 9° nose-down.

2. Analysis and conclusions

2.1 Analysis

The wreckage indicated that at impact the aircraft's attitude was 11° nose-down, the landing gear was down, and the wing flaps were fully extended. Both engines were at low rotational speeds with correspondingly low shaft horsepower. The left altimeter was set at 30.04." However, the right altimeter (the check pilot's) was set at 30.22", which was about 180 ft too high.

According to the Company's training manual, when the trainee is told to make a simulated emergency descent he passes control of the aircraft to the check pilot who reduces power to idle and lowers the landing gears and flaps. The trainee puts on his oxygen mask, turns on 100% oxygen, unplugs his hand microphone, plugs in his oxygen mask microphone and establishes communication. He then resumes control of the aircraft and establishes an airspeed of 129 kt and a rate of descent of about 2 700 ft/min. The manoeuvre is terminated by the check pilot as soon as practicable after a satisfactory rate of descent has been established. The training manual does not specify an entering or a terminating altitude for this manoeuvre.

Based on witnesses' statements, the Board concluded that a simulated emergency descent was being carried out at the time of the accident. This appeared to be confirmed by the fact that the instrument flight shield was found fastened on the left windshield, the left oxygen mask was missing from its normally stowed position whereas the right oxygen mask was in its normally stowed position, and the left microphone was unplugged but still hanging on its hook. The flight recorder traces also confirmed this and showed that the trainee, who should have been primarily concerned with increasing his airspeed and rate of descent, was continually correcting the aircraft's heading to 270°. It appears that the check pilot allowed the trainee to continue the descent hoping that he would momentarily establish the required higher airspeed and greater rate of descent. The process may have been carried so far that it was not possible to recover, considering the probable deceptiveness of the water's surface. This theory presumes, of course, that the check pilot was either not watching his altimeter or knowingly went so low that he struck the water while his altimeter, inadvertently set to read 180 ft high, still showed a positive altitude above the lake's surface.

2.2 Conclusions

Findings

Complete autopsies performed on the three victims revealed no evidence of incapacitation or anything which could have contributed to the accident.

There was no evidence of engine or propeller failure, airframe failure, jamming of the control systems, in-flight fire, collision, internal explosion or decompression.

There was no evidence of fuel exhaustion or fuel contamination.

No reason was found for the difference between the altimeter settings.

Cause or
Probable cause(s)

The probable cause of the accident was the crew's lack of vigilance, for undetermined reasons, in not checking a simulated emergency descent before striking the water.

3. Recommendations

As a result of this accident the Civil Aeronautics Board, on 17 July 1963, recommended to the Administrator of the Federal Aviation Agency that FAA Training Manuals of air carriers prescribe terminating altitudes for simulated emergency descents to provide safeguards against the hazardous prolongation of such descents.

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ICAO Ref: AR/770

Training
En route
Collision - water
Pilot - improper flight supervision

No. 2

British United (C.I.) Airways Ltd., Dakota C-47, G-AMJU, accident at Blackpool (Squires Gate) Airport, England, on 25 January 1963. Report, dated July 1963, released by the Ministry of Aviation, United Kingdom (C.A.P. 196).

1. Investigation

1.1 History of the flight

The aircraft was on the last sector of a scheduled service from Düsseldorf to Amsterdam, Newcastle and Blackpool. It departed Newcastle at 1937 hours GMT for an instrument flight to Blackpool, flying at flight level 60. Aboard were 3 crew and 6 passengers. The aircraft was cleared at 2000 hours by the Northern Air Traffic Control Centre to start its descent to Blackpool. It completed the descent over the sea and arrived over the aerodrome at 1 500 ft where a circuit was made. All lights were visible although the 1950-hour report for Blackpool gave the visibility as 80 yd in thick freezing fog. Two more circuits were made at 1 200 ft and 1 000 ft. Based on his observation of the aerodrome lights, the pilot-in-command decided that the visibility on the first half of the runway and the visual reference available were sufficient to make an approach and landing. He inadvertently used the term "dummy approach" in his next communication with the air traffic controller instead of requesting a clearance to approach and land. The approach was made with half flap and at a speed 5 kt higher than that recommended, in order to facilitate an eventual overshoot. At 700 ft and 2 miles from the threshold of runway 10 all runway lights were visible. At 400 ft the lights were visible for about half the runway length. The aircraft passed over the threshold lights and entered shallow fog. According to the co-pilot and pilot-in-command, the visible runway lights were reduced in number to 4 or 6 on each side. The aircraft was flared for landing but went farther than expected. The landing lights were switched on and their reflection in the fog dazzled both pilots, who lost their visual reference. The aircraft touched down, then swung off the runway and continued to roll on rough terrain. The throttles were opened briefly in an attempt to lift the aircraft but were closed again when the run became rougher. The outer portion of the port wing broke off when it struck a small brick building 3 320 ft from the beginning of the runway and 575 ft to the left of it. The aircraft came to rest 325 ft further on, facing the direction from which it had come. The accident occurred at 2019 hours.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal			
Non-Fatal			
None	3	6	

1.3 Damage to aircraft

Damage to the aircraft was confined to the severing of the port outer wing and aileron.

1.4 Other damage

No indication of other damage is contained in the report.

1.5 Crew information

The pilot-in-command, age 39 years, held a valid airline transport pilot's licence endorsed for Dakota aircraft. He had flown a total of 7 833 hours including 3 240 as pilot-in-command on Dakotas of which 612 hours were flown at night. During the six months prior to the accident he had flown 187 hours as pilot-in-command on Dakotas, 38 of which were at night. His most recent checks were as follows:

annual night flying check:	14 March 1962
route check to Düsseldorf:	30 March 1962
type competency check:	11 November 1962.

The co-pilot, age 32, held a valid commercial pilot's licence endorsed for Dakota aircraft. He also had a valid instrument rating and a flying instructor's rating. His total flying experience amounted to 1 584 hours which included 64 hours as pilot-in-command and 288 hours as co-pilot on Dakotas. During the six months before the accident his night flying experience amounted to 5-1/2 hours as pilot-in-command and 37 hours as co-pilot. His last competency check was satisfactorily completed on 5 December 1962.

The third crew member, a cabin attendant, was qualified and adequately experienced.

1.6 Aircraft information

The aircraft had flown a total of 12 124 hours. Its Certificate of Airworthiness was renewed on 3 May 1962 and was valid at the time of the accident. A Certificate of Maintenance, valid for 31 days or 100 hours' flying, had been issued for the aircraft on 2 January 1963. Since that time the aircraft had flown 70 hours.

The all-up-weight of the aircraft and its centre of gravity were within the prescribed limits.

The aircraft carried sufficient fuel for the subject flight. The type of fuel being used was not stated in the report.

1.7 Meteorological information

At Amsterdam there were aerodrome forecasts available for Newcastle, Manchester and Liverpool but not for Blackpool.

Prior to take-off from Newcastle at 1937 hours, the pilot obtained the 1850-hour report from Blackpool which indicated fine weather and visibility 880 yd. Just before take-off the pilot-in-command received word that visibility at Blackpool had deteriorated to 80 yd. When en route he was provided with the 1950-hour report for Blackpool which also showed visibility at 80 yd in thick freezing fog. (At 1915 hours the air traffic controller at Blackpool had observed that the fog was about 30 ft deep.)

A special report issued at 2027 hours, i.e. 8 minutes after the accident, was as follows: "wind calm, visibility 30 yd in dense fog, precipitating rime. Sky clear."

Runway visual range is not measured at Blackpool.

1.8 Aids to navigation

Aids available at Blackpool were VDF/Decca.

1.9 Communications

The pilot-in-command was in normal contact with the air traffic controller at Blackpool during the approach.

1.10 Aerodrome and ground facilities

The operations manual did not include any specific minima for landing on runway 10 at Blackpool. It was assumed that in their absence circling minima would apply (1 500/500 within 1-1/2 NM, 1 500/800 within 4 NM). Paragraph 8.2.4 defines "circling minima" as follows:

> "Circling minima consists of a minimum circling altitude and a minimum meteorological visibility to be applied where a break-cloud procedure is to be followed by a visual circuit within a fixed radius of the aerodrome."

According to this paragraph, circling minima apply a visibility limitation only in the case of a break-cloud procedure. Therefore, they do not appear to apply in this case. However, the instructions on circling minima in paragraph 8.6.3 of the manual were complied with. Paragraph 8.6.3 reads as follows:

> "Landing - circling minima
>
> Whenever a visual approach is to follow a descent on an approach aid or where the aid is not aligned with the runway, the captain shall discontinue the approach at the circling minima if at that height he has not visual reference with the ground sufficient to clearly fix his position continuously and accurately in relation to the field. If the aid is located outside the defined circling area, descent below the critical height for the aid is not permitted until the aircraft is over that area and its position can be determined by visual reference. An aircraft may not descend below the minimum circling altitude until it is aligned with the runway on its final approach."

As stated, runway visual range is not measured at Blackpool. The visibility passed to the aircraft by air traffic control (80 yd) was far lower than the runway visual range prescribed in the manual for other runways at Blackpool (300 yd, 600 yd, 1 000 yd).

1.11 Flight recorders

Flight recorders are not mentioned in the report.

1.12 Wreckage

See paragraph 1.3.

1.13 Fire

There was no fire.

1.14 Survival aspects

The crew followed the appropriate emergency drills, and the passengers left the aircraft through the main door.

The use of the term "dummy approach" in communications between the pilot-in-command and the air traffic controller at the time of the approach led to some confusion. As a result, for a short time, air traffic control did not know what had happened to the aircraft. It was some time before it was known that an accident had occurred. This fact, and the difficulty of locating the aircraft in fog, delayed the arrival of the fire and rescue vehicles on the scene of the accident.

1.15 Tests and research

Following the accident, a taxying test of the brakes showed there were no defects. The engines also functioned normally.

2. Analysis and conclusions

2.1 Analysis

Visibility in shallow fog is least restricted in the vertical plane and most restricted in the horizontal. Based on statements of the crew, it was concluded that at the time when the final approach was begun, the visibility was about 3 or 3-1/4 miles; at 400 ft it was 1-1/2 miles, and 40 to 50 ft above the runway threshold it was 400 to 600 yd. Considering the visibility (80 yd) passed to the aircraft, the pilot should have anticipated the serious reduction in visibility which occurred when the aircraft was flared for landing. He should also have realized that the switching on of the landing lights, when he did, would result in dazzle which would cause a complete loss of visual reference.

2.2 Conclusions

Findings

The crew was properly licensed.

The documentation of the aircraft was in order.

The aircraft was properly maintained in accordance with an approved maintenance schedule.

The weather information passed to the aircraft by the air traffic control officer clearly indicated the existence of very low visibility near the ground.

The pilot-in-command switched on the aircraft's landing lights at a stage of the approach inappropriate in the prevailing circumstances and deprived both pilots of visual reference.

Cause or
Probable cause(s)

The accident was the result of an unintentional change of direction after both pilots lost visual reference when the pilot-in-command switched the landing lights on during a landing in fog.

3. Recommendations

It is recommended that steps be taken

a) to ensure that when circling minima are included in operations manuals, provision is made for the conditions associated with radiation fog; and

b) to encourage the measurement of runway visual range by operators of aerodromes at which air transport operations take place in conditions of low visibility.

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ICAO Ref: AR/780

No. 3

Slick Airways, Inc., Lockheed Constellation 1049H, N 9740Z, accident at San Francisco International Airport, San Francisco, California, on 3 February 1963. Civil Aeronautics Board (U.S.A.) Aircraft Accident Report, File No. 1-0003, released 11 October 1963.

1. Investigation

1.1 History of the flight

The aircraft departed the Naval Air Station at Norfolk, Virginia, on 1 February on a cargo flight to the Naval Air Facility, China Lake, California via Dallas, Texas. It left Dallas at 2257 hours* with a crew of 3. Following departure the flight engineer noted the alternating current (AC) voltmeter pegged at the maximum reading of 150 volts, and shortly thereafter the co-pilot informed the engineer that he had lost all of his radio navigation instruments. A check revealed that all AC radio fuses had been blown and that the AC voltmeter read 150 volts in all positions of the voltmeter selector switch. Unsuccessful attempts were made to restore power, and the aircraft landed at Albuquerque at 0105 hours** (2 February) in order to have the navigation equipment repaired.

During the ground check, all four inverters of the AC electrical system were found to be in satisfactory condition, and the reason for the electrical malfunctions was not determined. When the equipment could not be put back into service, the pilot-in-command arranged through the Company offices in San Francisco for a repairman to be sent to Albuquerque. The repairman reached Albuquerque at 2200 hours and subsequently determined the reasons for the malfunctioning. When he failed to correct the malfunctions, the No. 2 VOR power supply unit and the complete No. 2 automatic direction finder unit were replaced with units from another aircraft which was dispatched to take on the cargo of the subject flight. Because of space limitations on the assisting aircraft, 3 750 lb of revenue cargo, consisting of two missile motors, were reloaded back onto the original aircraft.

Following completion of the radio repair and trouble-shooting*** procedures, the weather situation was checked, and the aircraft took off from Albuquerque at 0823 hours (3 February) on a visual flight rules flight plan. The trip to San Francisco was expected to last 4 hours and 15 minutes. Aboard were a crew of 3 and 5 non-revenue passengers. No radio contacts were made by the flight until 1038 hours**** when it

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* central standard time.

** mountain standard time.

*** Note by ICAO Secretariat:
A term used by mechanics to designate the act of locating and diagnosing the trouble in a malfunctioning engine, mechanism, system, or unit.

**** All times in the remainder of the summary are Pacific standard unless otherwise indicated.

called the Flight Service Station at Paso Robles, California, for the weather conditions at San Francisco, Alameda, and Oakland. At 1053 the flight reported over the Mount Hamilton Intersection, closed out its VFR flight plan and was provided on its request with the San Francisco 1200 - 1600 terminal forecast.

At 1056 the flight reported descending VFR and requested an IFR clearance into San Francisco. Visibility at San Francisco at this time was 1/16 of a mile in fog and smoke but was expected to improve to one mile in a half hour. The flight advised it would hold in the San José area and maintain VFR. An altimeter setting of 30.11 was passed.

The aircraft continued to hold and received the weather reports for 1122, 1140 and 1151 hours. The last two showed the weather to be at and slightly above the landing minima of 200 ft ceiling and 1/2 mile visibility, although the RVR (runway visual range) readings for runway 28R were less than 2 000 ft.

At 1152 hours the flight reported its position and requested an approach to the San Francisco International Airport. The aircraft was in radar contact and was subsequently vectored to the ILS final approach course. At no time did the crew advise the air traffic control personnel at San Francisco that the aircraft's ILS glide slope receiver was inoperative.

At 1155 the flight was advised that the visibility had improved to 3/4 of a mile in ground fog and smoke and that runway 28R visual range was still less than 2 000 ft. The crew advised that they would "like radar advisories on localizer approach". The flight was vectored in a wide circle up until 1201 when the aircraft was 9 miles from the outer marker and cleared for an ILS approach. The RVR on runway 28R had increased to 2 800 ft.

The flight began its final approach to runway 28R at 1204 hours. Radar monitoring of the ILS approach was provided as requested by the San Francisco Precision Approach Radar Controller. During the approach to the middle marker the aircraft was initially high on the glide slope and to the right of the localizer course. The flight was advised of a fog bank on the approach end of runway 28 or 28L extending up to a point where runway 1R crossed. The last advisory given to the flight placed it 100 ft left of course passing the middle marker and 25 ft above the glide path.

The aircraft continued its descent, went below the glide slope and about 11 seconds after passing the middle marker it entered a fog bank. It then struck approach lights 1 170 ft before the runway threshold, climbed to about 200 ft in a slight left turn and crashed hitting the ground with the left wing tip 1 900 ft beyond the runway threshold. It slid an additional 800 ft and came to rest on the left edge of runway 28L. The accident occurred at 1207:30 hours.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	2	2	
Non-Fatal	1	3	
None			

The flight engineer was the only member of the flight crew who survived the accident.

1.3 Damage to aircraft

The aircraft was destroyed.

1.4 Other damage

The main and nose landing gears of the aircraft struck approach lights No. 11 through 5, and heavy damage resulted. The entire lighting system went out.

1.5 Crew information

The crew consisted of a pilot-in-command, a co-pilot and a flight engineer.

The pilot-in-command, age 42, held an airline transport pilot's certificate with ratings for C-46, DC-3, DC-4, DC-6/7 and Constellation aircraft. His last L-1049H check and last instrument check were on 4 July 1962 and 10 January 1963, respectively. He completed 20 hours of recurrent ground school training on the L-1049H on 21 December 1962 and had the following flying experience:

total time	18 000 hours
night time	6 800 "
on instruments	368 "
as pilot-in-command on L-1049H aircraft	882 "

During the 90 days prior to the accident he had flown 212 hours, which included 131 night hours, 6 instrument hours and 154 hours on the L-1049H aircraft.

The co-pilot, age 48, also held an airline transport pilot's certificate with ratings for C-46, DC-4, DC-6/7 and Constellation aircraft. He was rated as captain on Lockheed L-749 aircraft on 11 April 1961 and was given a 24-hour conversion course from L-749 to L-1049H aircraft on 31 October 1962. On 2 November 1962 he was given a company L-1049H flight check which was followed on 30 November 1962 by a company line check on L-1049H aircraft. His flying experience was as follows:

total time	18 600 hours	
night time	8 365 "	
on instruments	200 "	(as of 1949)
on the L-1049H aircraft	232 "	

Within the 90 days prior to the accident, he had flown 232 hours on the L-1049H aircraft and at least 60 hours of night time.

The flight engineer, age 41, was rated as a flight engineer on 16 August 1957 and qualified on L-1049H aircraft on 23 April 1962. He held a valid flight engineer's certificate. He received his company line check on 26 April 1962 and recurrent ground school check on the L-1049H aircraft on 8 January 1963. He had a total experience of 4 000 hours as flight engineer of which 700 hours were in the L-1049H. In the 90 days prior to the accident he flew 142 hours of which 113 were in the L-1049H.

1.6 Aircraft information

Total air time prior to the accident was approximately 4 258 hours. The aircraft was operated by Slick Airways under their Part 42 certificate for a total of 683 hours.

Compliance with all applicable directives on the airplane engines and components was current.

At the time of departure from Albuquerque the aircraft's gross weight and centre of gravity were within the prescribed limits.

The type of fuel used on the subject flight was not mentioned in the report.

1.7 Meteorological information

While at Albuquerque, the crew checked the current and forecast weather conditions for the route and for the San Francisco terminal. The last check was made just prior to departure at 0823 hours.* While en route, the flight requested and received from the Flight Service Station, Paso Robles, California, the weather reports for San Francisco (1025 hour Special), Alameda (1000 hours) and Oakland (1000 hours). At 1053 the flight was given the following San Francisco 1200-1600 terminal forecast: "3 000 ft scattered clouds; ceiling 10 000 ft overcast; visibility 3 miles in ground fog". Further reports on the San Francisco weather conditions were provided to the flight at 1122, 1140 and 1151 hours. At 1155 the San Francisco cloud cover had not changed - 5 000 ft scattered, 15 000 ft overcast. Visibility had improved to 3/4 mile in ground fog and smoke, and runway 28R visual range was less than 2 000 ft. Within the next 6 minutes RVR increased to 2 800 ft on runway 28R. As stated, the final approach was begun at 1204 hours. The aircraft was warned of the fog bank on the approach end of the runway and was kept informed of the RVR. Other than by pilot reports, there was no way to determine the visibility within the fog bank extending out over the approach lighting system for runway 28R. No pilot reports were given during the 15-minute period preceding the accident:

1.8 Aids to navigation

The ILS at San Francisco was checked by the FAA following the accident on 3 February 1963 and was found to be operating satisfactorily.

PAR (precision approach radar) scopes were in use at San Francisco at the time of the accident. The safety zone lines on the scopes terminated at the ILS middle marker.

The aircraft was equipped with the following aids:

(2) VOR navigation receivers,

(2) ADF receivers,

ILS glide slope receiver,

marker beacon receiver (not involved in the electrical malfunction

While en route from Dallas, Texas to China Lake, California, the aircraft's radio navigation equipment malfunctioned. At Albuquerque it was determined that the power

* mountain standard time.

supply units for both VOR navigation receivers and the power transformers for both ADF receivers were burned out, and the ILS glide slope receiver had burned out tubes and filter condensers. Following repairs, one VOR receiver and one ADF receiver were functioning, however, the glide slope receiver was still inoperative.

There were no failures of the radio navigation equipment during the flight from Albuquerque to San Francisco.

1.9 Communications

The aircraft was equipped with VHF transmitters and receivers. Two were functioning after repair work was completed at Albuquerque.

The aircraft departed Albuquerque at 0823 hours (m.s.t.) and made no en-route radio contacts until 1038 hours (P.s.t.) when it contacted the Flight Service Station at Paso Robles, California. Thereafter it was in radio contact with the Flight Service Station at Oakland, Approach Control at San Francisco, and finally with the PAR controller at San Francisco up until the time it passed the middle marker at about 1206:36. The accident occurred at 1207:30.

1.10 Aerodrome and ground facilities

The threshold of runway 28R is at 13 ft msl.

The approach lighting system (ALS) was operating at the time of the accident. This is based on the statements of the crew members of three other flights that made approaches to runway 28R between 1140 and 1207 hours prior to the subject flight. Also the local controller in the San Francisco tower stated that the runway lights and the ALS light switches were on position No. 5 full up, and the sequence flashing lights' (SFL) switch was on. A failure of the ALS/SFL system is indicated by a buzzer which can be turned down to a point where no sound can be heard. The lights were found to be inoperative 3 hours and 20 minutes after the accident. No one in the tower recalled hearing the buzzer prior to, during or after the accident. None of the crews of the aforementioned flights could recall seeing the sequence flashing lights nor could they state that they were operating. The approach light structure projects outward along the centre line of runway 28R into the bay, a distance of about 3 000 ft. The lights are at 18 ft msl in groups or stations at 100 ft intervals, and they are numbered 1 through 30 out from the runway threshold.

All the weather observing equipment at San Francisco International Airport was operational at the time of the accident. Runway 28R is equipped with a system for measuring runway visual range (RVR).

The minima for a straight-in approach to runway 28R at San Francisco are 200 ft ceiling and 1/2 mile visibility provided all components of the ILS installation and related airborne equipment are operating satisfactorily.

Because of the low visibility, radar monitoring of the ILS approach was required. Air Traffic Control was aware that the crew of the subject flight wanted radar advisories during the approach. The procedures prescribe that a flight shall be advised of the distance from the touchdown each mile on final. Five advisories should have been given for this flight, one for each mile en route to the runway. Only two of the radar advisories provided included the distance from the touchdown point. Also, the procedures

state that if during an ILS approach, the pilot fails to report the runway approach lights or runway in sight, the PAR controller shall advise the pilot that radar advisories are being terminated when the aircraft reaches the point where the azimuth safety zone lines terminate or at the middle marker. The controller shall then continue to monitor the aircraft's position and so advise the pilot whenever a radar observation reveals a situation, which, in the judgement of the controller, is likely to affect the safety of the flight.

1.11 Flight recorders

Flight recorders are not mentioned in the report.

1.12 Wreckage

Not relevant.

1.13 Fire

Following impact an intense fire engulfed the aircraft and destroyed it.

1.14 Survival aspects

Three of the four survivors, one the flight engineer, left the aircraft through the right-hand crew entrance door which, because of incorrect emergency procedures, could not be raised more than 12 to 14 inches from the flight deck. The other survivor is believed to have left through the aft right-hand emergency window exit.

The passengers had not been briefed regarding emergency evacuation. Although a briefing was not required, it is believed that had all personnel aboard had adequate knowledge of emergency evacuation procedures, additional lives might have been saved, and the injuries sustained by the survivors would have been of a less serious nature.

1.15 Tests and research

The investigation revealed no evidence of failure in the propellers or engines. The flight engineer's testimony confirmed their normal operation prior to impact.

No malfunction was found in the alarm system of the ALS/SFL system following the accident. It was not until 3 hours 20 minutes after the accident that the tower personnel were notified by an FAA technician that the ALS/SFL system had been damaged and was inoperative.

Examination showed that the pilot-in-command, the co-pilot and two passengers died of thermal burns and smoke inhalation.

2. Analysis and conclusions

2.1 Analysis

The flight was carrying out an ILS approach to runway 28R at San Francisco Airport at the time of the accident. Radar monitoring of the approach was provided by the Precision Approach Radar Controller on localizer voice. Communications revealed

that the flight did not report having the approach lights or runway in sight, and the PAR controller failed to advise the flight that radar advisories were being terminated when the aircraft passed the middle marker. The flight continued descending after passing the middle marker and was following the approach lights as it entered a fog bank. Although the aircraft was aligned with the runway of intended landing, the crew did not have adequate visual reference during this phase of the approach and allowed the aircraft to descend into the approach lights. At initial impact the gears were extended and locked, and the flaps were at 66% (approach setting) with no indication of an asymmetrical condition. The nose gear assembly was forced rearward into the fuselage, the left main landing gear assembly separated from the aircraft, and the right main landing gear assembly collapsed rearward. The heavy damage inflicted by the main and nose landing gears corresponded to an aircraft bank angle of 3° right wing down at a nearly nose level attitude. Following the initial impact with the lights, which caused substantial damage to the control cables and hydraulic lines, the aircraft was no longer fully controllable.

2.2 Conclusions

Findings

The crew members were qualified and experienced.

Compliance with all applicable directives on the aircraft engines and components was current.

During the Dallas-China Lake portion of the trip the radio navigation instruments malfunctioned, and a landing was made at Albuquerque where efforts were made to repair the equipment. Not all of the malfunctions were corrected. On completion of the repair work, one of the components which was still inoperative was the ILS glide slope receiver. On reaching San Francisco, the crew did not notify air traffic control that this receiver was inoperative.

The advisory service provided at San Francisco was not in accordance with the procedures.

The crew were aware of the fog bank which existed on the approach end of runway 28R.

The high intensity lights of the approach lighting system were on at the time of the approach. However, it was possible that the sequence flashing lights were not on at that time.

When the aircraft hit the approach lights the whole system went out. This should have activated a warning buzzer. However, none of the tower controllers recalled hearing the buzzer immediately prior to, during, or subsequent to the time the aircraft was making its approach. Therefore, the Board believed that at that time the buzzer was turned down too low. It follows that a failure of the sequence flashing lights prior to the time of the accident would have been undetected for the same reason.

Cause or
Probable cause(s)

The probable cause of this accident was the continuation of an instrument approach after adequate visual reference was lost below authorized minima. Inadequate monitoring of the instrument approach by the precision approach radar controller was a contributing factor.

3. Recommendations

No recommendations were made in the report.

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ICAO Ref: AR/784

No. 4

Zantop Air Transport, Inc., Curtiss C-46F, N 616Z, crashed at Thun Field, near Puyallup, Washington, on 16 February 1963. Civil Aeronautics Board (U.S.A.) Aircraft Accident Report, File No. 1-0004, released 8 November 1963.

1. Investigation

1.1 History of the flight

Logair (Logistic Air Support) Flight 60-16 originated at Hill Air Force Base (AFB), Utah and was to proceed to Portland International Airport, Oregon, McChord AFB, Washington and Malmstrom AFB, Montana, before returning to Hill AFB. Following a routine flight the aircraft arrived at McChord AFB at 1619 hours*, where a crew change was made. There were no passengers. The aircraft took off from McChord at 1813 hours on an instrument flight plan to Malmstrom. Seven minutes later when the aircraft was 13 miles east-northeast of McChord at 4 600 ft msl, climbing to 9 000 ft, the crew asked for clearance to return to McChord as they had feathered the left engine. The flight was provided with a vector to intercept the precision approach course for runway 16, and the crew advised that the aircraft would descend to and maintain 3 000 ft. The latest weather information was provided by the radar controller. At 1821 the crew reported a runway propeller. At his stage the aircraft was flying in visual meteorological conditions and was advised that it was 5 miles north of the runway at Thun Fied. At 1822 the crew requested that Thun Field flash its landing lights. The controller then instructed the flight to "turn left heading 150 for Thun Field". It was then 4 miles north of Thun Field. The controller gave the runway at Thun Field as 5 300 ft. The flight was further instructed to "turn right heading one five five" and was advised that it was 3 miles north of the airport. By 1824, N 616Z was one mile north of the field and a little left of the runway. The last partially garbled message from the flight was received at 1825 hours. It stated that the flight was high and would have to go around.

Several witnesses saw the aircraft descending toward Thun Field. One aeronautically qualified witness was standing midway down the west side of runway 17/35 at Thun Field. He saw a large aircraft on a long final approach, lined up with the runway and flying at an airspeed of about 110 - 120 kt. Its landing lights were on. The aircraft passed over the north end of the asphalt portion of the runway about 20 - 25 ft high, went a few hundred feet down the runway and made a steep climbing turn over the trees to the east of the runway. The witness estimated it climbed to about 75 to 100 ft over the tree tops. (These trees are about 100 ft high). The flight was "holding its own" until the propeller oversped again, and the aircraft made a descending turn toward the west. The witness heard it crash, and a fire followed. The accident occurred at 1826 hours.

* Pacific standard time.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal			
Non-Fatal	2		
None			

1.3 Damage to aircraft

The aircraft was destroyed by impact and the post-impact fire.

1.4 Other damage

No other damage resulted from the accident.

1.5 Crew information

The pilot-in-command, age 42, held a valid airline transport pilot's certificate with ratings in C-46 aircraft. He had flown a total of 7 003 hours, including 1 133 hours on C-46 aircraft. During the last 90 days he had flown 204 hours. His last proficiency check on a C-46 aircraft was on 20 August 1962.

The co-pilot, age 28, held a valid commercial pilot's certificate with no type rating. His licence was for single-engine land aircraft with an instrument rating. He had flown a total of 2 133 hours, including 300 hours on the C-46. In the 90 days prior to the accident he had flown 229 hours. His last proficiency check, given in a C-46, was dated 12 August 1962.

Both crew members held valid first-class medical certificates without waivers.

1.6 Aircraft information

A test flight performed on 17 January 1963 included full feathering of the engines. No discrepancies were reported. The mixture control arm on the left engine was replaced after 110:56 hours time since overhaul (TSO), and the right magneto of the left engine was replaced at 144:48 TSO. A No. 2 check was performed on the aircraft at 147:38 hours a No. 1 inspection was performed on the left engine. At this time the left throttle linkage was adjusted by an unlicensed mechanic. The aircraft flew approximately 66 hours after this maintenance without any reported engine difficulties. Following the accident, the investigators were not able to ascertain who inspected the adjustment on the throttle linkage. Maintenance personnel who carried out the work during the engine run-up and post run-up adjustments stated that on completion of their work there were no discrepancies on the engine.

The aircraft had flown a total of 17 683 hours. The last major overhaul inspection was performed at 5 076 hours, and the last pre-flight check of the aircraft was carried out on 16 February 1963, the day of the accident. The last recorded discrepancies were corrected before the aircraft left Hill Air Force Base. No mechanical difficulties were noted in the flight log regarding the flight to McChord Air Force Base, and no maintenance was performed at this Base.

The gross take-off weight (46 751 lb) and the centre of gravity (29.3% MAC) were within the permissible limits.

The aircraft carried 1 200 gallons of fuel. The type of fuel used is not stated in the report.

1.7 Meteorological information

The weather situation had no bearing on the accident.

1.8 Aids to navigation

Not pertinent to this accident.

1.9 Communications

The crew was in contact with the radar controller at McChord Air Force Base up until 1825 hours when the last message was partially garbled. The accident occurred one minute later.

1.10 Aerodrome and ground facilities

The aircraft was landing on runway 17 at Thun Field. The landing area was about 5 200 ft long and 3 420 ft of this area was a macadam-surfaced runway 40 ft wide. The remainder of the landing area, approximately 800 ft on the north end of the runway and 1 000 ft on the south end, was rough graded soil containing gravel, rocks, stones and sod. There were tall trees in the approach zone which reduced the useable length of the hard-surfaced runway to 2 667 ft.

The FAA Radar Approach Control (RAPCON) chief stated that the State of Washington Directory of Airports was used to compile the data regarding Thun Field. The Directory showed the runway's width as 150 ft and the elevation of the airfield as 520 ft. Also, it mentioned that 40 ft trees created an obstruction on a north approach.

The runway lights consisted of two green lights on the runway edges, 660 ft down the runway from the approach end of runway 17 and 10 sets of white lights spaced 240 ft apart, along the runway. The parallel rows of lights were 49 ft apart. A number of these runway lights were missing or inoperative at the time of the accident. There was a rotating white beacon installed and operating at Thun Field. The remaining portion of the landing area was not lighted.

Approximately 1 000 ft east of and nearly parallel to the runway was a brightly lighted "drag strip" which was estimated to be 5 000 ft long and 90 ft wide. The drag strip looked very much like a lighted runway.

1.11 Flight recorders

Flight recorders were not mentioned in the report.

1.12 Wreckage

The accident site was in a pasture approximately one-half mile northeast of Thun Field.

The cockpit area was severely damaged, and the fuselage was broken just aft of the main cargo door. All major aircraft components were in the wreckage area. The left wing fuel tanks had separated from the wing and burned after impact.

The landing gear and flaps were found in the "up" position. The rudder trim tab was found set 2-3/4 inches to the right (nose left), and the right aileron tab was 1-3/4 inches up (right wing up). The elevator trim tab settings could not be determined.

Both engines, which had been torn from the aircraft, were relatively intact with the propellers attached. The propeller dome of the left propeller was removed, and the piston was found positioned at the low pitch (10°) stop. The carburettor from the engine showed the mixture in the full rich position with the control arm bent away from the carburettor. The throttle was in the full open position, and the throttle control rod that connects the throttle arm to the jack shaft was separated from the rod end at the carburettor control arm.

1.13 Fire

A fire broke out following impact.

1.14 Survival aspects

The pilot-in-command, who was flying the aircraft during the approach, was thrown from the aircraft still strapped in his seat. He received multiple fractures and burns. The co-pilot could not recall how he got out of the wreckage. He was found some distance from the aircraft, suffering from a broken leg, concussion and burns.

1.15 Tests and research

Regarding the left engine, the propeller governor was found in an abnormal condition. A bench check showed that the pressure cutout switch in the propeller governor was operating at 700 - 745 psi, i.e. about 100 psi higher than specified by the overhaul manual. The switch was then installed on another aircraft. Ground tests showed that it opened when the propeller was fully feathered. However, on two tests, the holding coil held the cockpit feathering switch "in" during the unfeathering cycle. A flight test revealed no discrepancies.

The feather pump and motor assembly could not be operated as a unit due to impact damage. The pump was bench-checked satisfactorily.

Ground tests showed that a throttle linkage disconnect, with the throttle near or forward of a climb power position, resulted in the throttle valve going to the full open position. The same tests made with the throttle aft of a climb power setting resulted in the throttle valve going to approximately 26 "Hg. Following the accident, the co-pilot stated that on the subject flight his attention was drawn to the manifold pressure gauge by the pilot-in-command and its reading was about 26 "Hg.

2. Analysis and Conclusions

2.1 Analysis

Because of a lack of maintenance inspection following adjustment of the throttle lingake, the jam nut which locks the throttle rod to the rod end at the throttle arm clevis

was not properly secured. The improper installation of this jam nut and marginal mating between the threads of the rod and the rod end caused extreme wear on the rod end. The throttle rod was worn to such a degree that the threads could no longer hold in the rod end, and the throttle linkage separated due to normal engine vibrations and throttle movements. Since there was no indication of an internal engine failure or engine fire, there was no immediate urgency to shut down the engine and feather the propeller, and the left engine should have been controllable, in part, by proper use of the propeller control. However, in view of the relatively short distance to McChord and the single-engine capabilities of the aircraft, the pilot-in-command decided to shut down the engine.

The feathering system was capable of feathering the propeller. However, the high pressure setting of the propeller governor pressure cutout switch could have adversely affected the proper sequence of events during the feathering cycle.

Based on the following evidence:

a) the mixture was found in the full rich position,

b) the propeller control piston was found against the low pitch (high rpm) stop, and

c) the firewall shut-off valve was not operated,

it was apparent that the feathering procedure as published in the Zantop Operations Manual was not properly executed. This, combined with the high pressure setting of the propeller governor pressure cutout switch, caused the propeller to go through a series of feather-unfeather cycles with consequent overspeeding.

Following the pilot's decision to land at Thun Field the RAPCON controller should have supplied him with certain essential facts in order that he might properly evaluate the airport's suitability for an emergency landing. The pilot was not informed of the partial runway lighting, the tall trees in the approach zone, the amount of useable hard-surfaced runway and the fact that the runway was unusually narrow. Also, the brightly lighted drag strip may have caused some confusion.

A witness estimated that the aircraft's airspeed on final approach was 110 - 120 kt. At the gross weight of this aircraft with a windmilling propeller on its left side, maximum power on the right engine and operating in ground effect, the aircraft would have little, if any, climb capability at a normal single-engine approach speed. It follows, therefore, that either the left engine was developing some power or the aircraft had a relatively high airspeed.

It was not possible to determine whether the left turn during the attempted go-around which followed was caused by excessive drag from a windmilling left propeller or was induced by the pilot. Based on the evidence available, it appeared that the turn was intentional and that some power was available from the left engine.

The go-around was successful until the left propeller oversped, causing an asymmetric drag condition which resulted in a loss of control and a crash landing.

2.2 Conclusions

Findings

The crew were properly certificated.

The aircraft records indicated that all maintenance was performed and signed off in accordance with company and FAA requirements.

The aircraft was loaded properly.

No evidence was found of pre-accident damage to the aircraft structure or malfunctioning of the right engine or the flight control systems.

Work carried out by an unlicensed mechanic on the throttle linkage had not been inspected. This led to a separation of the throttle linkage in flight.

The pilot did not correctly analyse the malfunction of the left engine, and did not carry out the prescribed procedure for feathering a propeller.

The improperly rigged pressure cutout switch caused the feathering button to stay depressed, held by the holding coil. This allowed the feathering pump motor to run until the propeller was driven to the low pitch stop, causing the propeller to overspeed.

RAPCON did not provide the flight with complete information regarding the runway at Thun Field. When the pilot did not find the situation to be as expected, he attempted to go around.

During the attempt to go around, the left propeller oversped. This caused a loss of control and the subsequent crash landing.

Cause or Probable cause(s)

The probable cause of this accident was the improper handling of an emergency situation, precipitated by a mechanical malfunction, which resulted in an unsuccessful single-engine go-around.

A contributing factor was the failure of Radar Approach Control to provide complete, accurate airfield data to the pilot.

3. Recommendations

No recommendations are contained in the report.

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ICAO Ref: AR/794

No. 5

British United Air Ferries Ltd., Bristol 170, Series 32, G-AMWA, accident at Guernsey Airport, Channel Islands, on 24 September 1963. Report, dated August 1964, released by the Ministry of Aviation, United Kingdom (C.A.P. 216).

1. Investigation

1.1 History of the flight

The aircraft was returning to Bournemouth from Guernsey on a passenger and vehicle service flight. The co-pilot was flying the aircraft from the left-hand seat, and the pilot-in-command was performing the duties of the co-pilot. The engines were started at 1112 hours GMT. The brakes operated satisfactorily at this time. Following a normal run-up and check of the engines and propellers, the throttles were opened slowly because of a 17 kt crosswind component. The aircraft reached a speed of 50 kt, and the rpm of the port engine began to rise. The pilot-in-command tried to control it by moving back the propeller control lever. The rpm commenced to surge and, as the aircraft's speed was then about 4 kt less than the single-engine safety speed (84 kt), the pilot-in-command ordered the co-pilot to abandon the take-off. According to the testimony of the pilot-in-command following the accident, the brakes had little or no effect, and realizing that the aircraft would overrun the runway, he pulled back both propeller pitch control levers in order to stop the engines. Shortly before reaching the end of the runway the aircraft was turned to the left to avoid the approach lights. The aircraft became airborne for about 33 yd, then passed through the boundary fence of the stopway and struck a bank surmounted by a hedge where its port landing gear collapsed. Thereafter it crossed a hedge-lined road, and the starboard landing gear was deflected rearward. Finally it slid about 60 yd on its belly and stopped near a house. The accident occurred at 1123 hours GMT.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal			
Non-Fatal			
None	3	1	

1.3 Damage to aircraft

The aircraft was extensively damaged.

1.4 Other damage

No damage was sustained by objects other than the aircraft.

1.5 Crew information

The pilot-in-command, age 40, held a current airline transport pilot's licence and an instrument rating. The licence was endorsed in Group I for

Bristol 170 aircraft. He had flown a total of 8 500 hours which included over 7 000 hours as pilot-in-command. His time on the Bristol 170 was as follows: 4 500 hours in command and 500 hours as co-pilot. He was also employed as a training captain on Bristol 170 aircraft.

The co-pilot, age 34, also held a current airline transport pilot's licence and an instrument rating. His licence was endorsed in Group 2 for Bristol 170 aircraft. He had flown a total of about 7 800 hours including 1 600 hours as co-pilot on Bristol 170 aircraft. He had flown many times with the pilot-in-command of the subject flight.

1.6 Aircraft information

The aircraft had a valid Certificate of Airworthiness which did not include a performance group classification. It also had a valid Certificate of Maintenance.

The port engine was installed on this aircraft in October 1962 and had run 1 137 hours since its last complete overhaul. During the months of June and July 1963 the records showed that surging of the port engine was reported on four occasions. On 3 July the air shutter was found to be sticking open. On 5 July the shutter box was removed from the engine during a Check A inspection. The spindles and sprocket bearings were lubricated, and the unit was reinstalled. It then operated satisfactorily.

During a Check I inspection on 16 August the shutter was again sticking open. The shutter and sprocket bearings were lubricated, and no further difficulty with the shutter was recorded.

At the time of the accident the approved maintenance schedule did not require the warm air shutter box bearings to be lubricated between overhauls.

On this flight the aircraft was carrying a payload of one passenger, one car and 1 945 kg of freight. Its total all-up weight was approximately 1 838 kg less than the permitted maximum, and the centre of gravity was within the prescribed limits.

The type of fuel being used on the subject flight was not stated in the report.

1.7 Meteorological information

The weather conditions at Guernsey Airport at the time of the accident were:

wind: 210°/18 kt, gusting to 26 kt; moderate rain;
visibility: 2 NM; cloud: 2/8 - 500 ft, 6/8 - 800 ft,
7/8 - 1 200 ft; temperature: 15°C.

1.8 Aids to navigation

Not relevant to this accident.

1.9 Communications

No information regarding communications is contained in the report.

1.10 Aerodrome and ground facilities

Runway 28 has an asphalt surface and is 4 800 ft long with a grass stopway of 300 ft. After the first 800 ft of runway there is a down gradient of 1.29% for approximately 3 300 ft; the last 800 ft is an up gradient of 1.23%.

1.11 Flight recorders

Flight recorders are not mentioned in the report.

1.12 Wreckage

The aircraft's wreckage was located 330 yd from the end of the runway and 80 yd south of the extended centre line.

The forward part of the fuselage had collapsed in the area of the freight compartment. The passenger cabin sustained little damage. All flying controls were intact. The flaps were retracted. The warm air shutter of the port engine was found jammed in the open position "WARM" and had evidently been open during the ground impacts.

1.13 Fire

There was no fire.

The inertia switches had tripped, and all fire extinguisher bottles had been discharged.

1.14 Survival aspects

The passenger seats had remained securely attached, and no one was injured.

The main exit door was jammed. However, the passenger and the cabin attendant left the aircraft through an emergency exit on the starboard side of the passenger cabin. The pilot-in-command and the co-pilot left the aircraft through the exit in the cockpit roof.

The fire and rescue vehicles of the airport fire service were already on the move when the aircraft left the runway and reached the scene of the accident within two minutes of the aircraft's coming to rest.

1.15 Tests and research

The port engine had only received superficial damage. Its constant speed unit and propeller pitch change mechanism were tested and found to be serviceable. The engine was then installed in another aircraft to determine whether the propeller surge could be reproduced during ground running.

The air intake system is operated by an electric actuator and controlled by a three-way switch which permits either of the following to be selected:

"RAM",	(air intake unit)
"FILTER", or	(air cleaner chamber)
"WARM",	(warm air shutter box)

Housed in the air intake,a rotary shutter serves to put either the "RAM" or the "FILTER" entry of the intake into communication with the warm air shutter box main passage to the carburettor, or to blank off both entries and, at the same time, open a flap type shutter thereby admitting warm air from the engine compartment. The system is not designed to permit a combination of "RAM and WARM".

Since the warm air shutter was jammed in the open position, a serviceable shutter box was installed and arranged so that alternative selection of "RAM" or "WARM and RAM" could be selected. The engine was run and tested with each selection in turn.

The results of the first test showed that the engine response to a slight rearward movement of the pitch control lever was as follows:

i) with "RAM" selected - dead beat no surge
ii) with "RAM and WARM" selected - surge of 200 - 250 rpm

A mixture tuning check was then made and showed that the engine was slightly "rich" - an increase of 15 rpm being obtained instead of the specified decrease of up to 40 rpm. A rig test of the injector confirmed the richness which was due to a particle of foreign matter which partially blocked the normal bleed orifice. After cleaning, the injector was reassembled, and further tests produced acceptable figures of flows and pressures.

Further engine tests were made to determine to what extent the rich mixture may have contributed to the engine surge. The results showed that with "RAM and WARM" selected, a slight rearward movement of the pitch control lever then produced only 100 rpm of surge.

The tests determined that the engine surging was contributed to by -

a) the warm air shutter sticking open and causing turbulence in the air intake, and

b) the rich mixture.

Examination of the shutter box revealed that the cadmium-plated shaft collars of the shutter shaft were seized in the oil retaining type bushes of the shutter box casing. It was concluded after laboratory examination that the plating on the shaft collars was not capable of withstanding the corrosion and fretting to which the parts had been subjected. The build-up of the resultant product, iron oxide, partially closed the pores of the bush and cut off the lubricant.

2. Analysis and conclusions

2.1 Analysis

Since the aircraft's Certificate of Airworthiness did not include a performance group classification, the flight manual did not contain performance data to calculate the distance covered during an abandoned take-off.

It was not possible to determine precisely the distance required for the aircraft to be accelerated to 80 kt and then stopped in the conditions which existed at the time of

the accident. Although it was possible to calculate the distance covered up to the point where the decision was made to abandon take-off, it was not possible to establish reasonably accurately the distance travelled before full deceleration action could be initiated. The brakes could not be applied as soon as take-off was abandoned as this would result in a nose-down moment. The speed of the aircraft was well in excess of its stalling speed. Any attempt to put the tail down would have resulted in the aircraft becoming airborne or in reduction of the main wheel loading to an extent where the braking force would be significant. Therefore, speed had to be lost and elevator application had to be gradual. Also, since the aircraft was at a small angle of incidence, with no flap extension, drag was low and considerable runway distance would be used while the speed decreased sufficiently for the tail to be lowered and full braking applied. Other indeterminate factors were:

1) the effect on braking distance of the wet runway of varying gradient;

2) the braking force of propellers;

3) the time taken for the engines and propellers to assume idling; and

4) the precise actions of the pilot.

In the existing circumstances it appears that the aircraft could not have been accelerated to 80 kt and then brought to a stop on the runway.

Although the measures taken on 5 July to rectify the defects in the port engine were considered satisfactory at that time, the reoccurrence of the same defect on 16 August should have alerted the Operator's maintenance organization to the need for a more thorough investigation in order to eliminate the defect.

2.2 Conclusions

Findings

The crew were properly licensed.

The documentation of the aircraft was in order.

The aircraft was maintained in accordance with an approved maintenance schedule.

The rpm surge of the port propeller was due to a combination of the effects of a rich mixture and the jamming of the warm air shutter intake in the open position.

The pilot-in-command's decision to abandon the take-off was a correct one.

Cause or Probable cause(s)

The pilot-in-command abandoned the take-off due to a malfunction of the port power unit but was unable to bring the aircraft to a stop on the runway remaining.

3. Recommendations

Although recommendations do not appear in the report, some were made by the suppliers of the "oilite" bushes, and the manufacturer of the hot air shutter box took the following action:

1) Collars are to be used in a plain unplated condition.

2) Adequate lubrication is to be given by provision of a hole in the shutter body.

3) Introduction of a revised lubrication maintenance period.

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ICAO Ref: AR/796

No. 6

Trans American Air Transport Ltd., Curtiss Wright C-46F, LV-GGJ, accident on "El Sosneado" Peak, Mendoza Province, Argentina, on 17 May 1960. Accident Report No. 1630, published in Information Bulletin No. 11 (Aircraft Accidents), September 1965, by the National Directorate of Civil Aviation, Argentina.

1. Investigation

1.1 History of the flight

The flight was an international cargo flight to transport seven race horses from Ezeiza Airport to Panama and agricultural material to Lima, Peru. The first stage of the flight, to Santiago, Chile, was expected to take 4-1/2 hours. According to the VFR flight plan which was filed, the aircraft was to fly at 3 000 m. En-route and terminal weather forecasts were provided for the trip to Santiago. Although the take-off was scheduled for 1000 hours*, the aircraft did not depart until 1104 hours. It reported over Junín (1159 hours), General Soler (1310 hours) and San Luis (1400 hours). By the time it reached San Luis the weather conditions had changed completely. The pilot reported over San Rafael (1434 hours), estimated that he would arrive over El Yeso, Chile at 1535 hours, and then requested clearance to climb to 6 000 m. He did not ask for further details on the meteorological situation. Nothing further was heard from the flight following the position report at 1434. The aircraft apparently entered an area of severe turbulence where structural failure occurred, and it struck a mountain peak at an altitude of about 4 500 m. The time of the accident was estimated to be between 1435 and 1455 hours.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	?	?	
Non-Fatal			
None			

The report of the accident does not mention the number of crew members and passengers on the flight.** It states only that five persons were aboard to look after the animals. There were no survivors.

1.3 Damage to aircraft

The aircraft was destroyed.

1.4 Other damage

No objects other than the aircraft sustained damage.

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* local time.

** Lloyd's Weekly Casualty Report dated 24 May 1960 states that "10 people were aboard the aircraft".

1.5 Crew information

No information in this respect is contained in the report.

1.6 Aircraft information

The report does not indicate whether the aircraft had valid certificates of airworthiness and maintenance.

The aircraft was loaded within the acceptable limits. However, seven horses which were being transported in fragile wooden boxes were not properly restrained.

The type of fuel being used was not stated.

1.7 Meteorological information

The following conditions were forecast for the route:

Ezeiza-Mendoza	ceiling and visibility unlimited, mountain passes partly cloudy, visibility 10 km, 2-3/8 altocumulus.
winds:	
Ezeiza-Junín	
at 1 500 m	340°/25 kt
Ezeiza-Mendoza	
at 3 000 m	320°/30 kt
at 4 000 m	270°/30 kt
at 5 000 m	250°/35 kt
at 6 000 m	280°/35 kt

Other forecasts provided were:

Santiago, Chile (between 1200 and 1400 hours)

> cloudy, 4/8 stratocumulus, 2-3/8 at 800 m, 4-6/8 altocumulus at 3 000 m
>
> Because of the late departure from Ezeiza, this forecast for Santiago had expired by the time the aircraft reached San Luis at 1400 hours.

Mendoza (between 1300 and 1600 hours)

> partly cloudy, visibility 6 - 10 km, 4-6/8 stratocumulus and cumulus between 600 and 1 000 m, 4-7/8 altocumulus at 3 000 m, light to moderate turbulence on the Argentine side. Warnings of the formation of huge cumulus clouds towards noon in the southerly passes.

Further information on the meteorological situation is provided in paragraph 1.15 (Tests and research) where the findings are shown of a special study carried out to determine the conditions existing in the vicinity of El Sosneado Peak at the time of the accident.

1.8 Aids to navigation

They are not stated in the report.

1.9 Communications

The pilot reported his position several times while en route, the last report having been received when he was over San Rafael at 1434 hours. Several unsuccessful attempts were made by the control services to re-establish contact with the aircraft.

1.10 Aerodrome and ground facilities

Not applicable.

1.11 Flight recorders

There is no mention of flight recorders in the report.

1.12 Wreckage

The site of the accident was approximately 4 500 m asl on El Sosneado Peak in Mendoza Province.

About 3 500 m before the main point of impact a 5 m section of the right wing and parts of the tail plane and the fuselage were found along with the door of the hold. At the main point of impact the two propellers with their reduction units were found almost together. The engines which had broken loose, struck rocks and came to rest some hundred metres away. The remainder of the wreckage was scattered over an area with a two to three hundred metre radius. The distribution of the aircraft's wreckage showed that it had broken up while in flight.

It was concluded from the examination of the wreckage that at impact the aircraft was making a left turn at a 45° angle of bank, was pitching down at a somewhat smaller angle and that the engines were operating at a speed higher than the cruising speed. Also, based on the fact that the cone of the starboard propeller was found almost intact, and No. 1 engine had incurred greater damage than No. 2, it was concluded that No. 1 engine bore the full force of impact, and that the aircraft had struck the ground with its port side.

1.13 Fire

Fire is not mentioned in the report.

1.14 Survival aspects

On 18 May 1960, the day after the accident, an intense search was begun for the aircraft, however, it had to be called off a week later because of the snowstorms occurring in the accident area at that time of the year. The aircraft was officially declared lost.

The wreckage of the aircraft was found on 21 November 1961 by an inhabitant of the El Sosneado area, and another search was initiated by the Accident Investigation Board and a rescue patrol of the National Police. The site was located, and small pieces of the aircraft were found. Ice and snow prevented the recovery of other aircraft parts or the victims. The investigation could not be started until 8 March 1962 when it again

became possible to reach the accident site, and the seasonal thaw permitted the debris to be located.

1.15 Tests and research

No information regarding tests was contained in the report.

However, a special study of the weather conditions in the El Sosneado Peak area at the time of the accident was carried out and revealed the following:

Mendoza El Plumerillo	-	fair conditions
Cristo Redentor	-	cloud 8/8, low fractostratus and possibility of fractocumulus, ceiling 100/200 m, wind south-southwest 90 km/h
Malargue (Approach zone San Rafael	-	continuous rain, ceiling 200/300 m

The 1500 hour chart for that same area revealed the existence of strong winds, precipitation and blowing snow associated with an active cold front over the zone. The upper air charts also indicated a jet stream from the western sector at 5 500 m with a velocity of 100 - 120 km/h increasing to 300 km/h at 9 000 m. This jet stream, with its thermal and associated fields, brought air masses down from the Argentine hills, a phenomenon known as "Zonda" wind. It was believed that the aircraft encountered strong and, at times, severe turbulence. The pilot could have been alerted to the meteorological conditions of the area by Mendoza Airport or Cordoba Area Control if he had requested such information.

2. Analysis and conclusions

2.1 Analysis

Despite the altitude at which the aircraft was flying and the wind velocity, the parts which fell from the aircraft fell fairly close together. Therefore, they must have broken away almost simultaneously. The disintegration probably began when the bolts of the door of the hold gave way. This was the result of extreme turbulence which caused:

1) the elastic distortion of the fuselage, or

2) the animals, improperly restrained in their fragile wooden boxes, to break out and be hurled against the door. (Pieces of wood 1 in. thick and 2 in. wide were found following the accident.)

The door of the hold opened upwards and was hinged along its entire width to the frame. The frame was fixed to the fuselage plating. Both the frame and the plating were torn off with the door of the hold. As the door broke away it struck the port stabilizer which tore off with the corresponding elevator. Since the port and starboard elevators were linked together, the fracture of the stabilizer could have caused a sudden nose-up, which resulted in the breaking off of part of the starboard wing. Also, the strong vertical gusts may have contributed to the fracture of the wing.

2.2 Conclusions

Findings

No information regarding the qualifications or experience of the crew members is contained in the report.

No mention is made of the aircraft's Certificate of Airworthiness or maintenance history.

The aircraft's load was within the permissible limits, but the cargo of animals had been improperly secured.

Violent turbulent conditions existed in the mountainous area in which the aircraft was flying.

The pilot did not familiarize himself properly with the actual weather conditions existing en route.

In-flight disintegration of the aircraft occurred.

Cause or
Probable (cause(s)

The accident was attributed to the fact that the aircraft flew into extremely violent turbulence, was subjected to stresses greater than those for which it was designed, and in-flight structural failure resulted.

Contributing causes were:

1) insufficient preparation for the flight;

2) inadequate arrangements for the secure carriage of the livestock; and

3) the pilot's failure to familiarize himself with the prevailing weather conditions.

3. Recommendations

No recommendations are contained in the report.

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Non-scheduled International
En route
Airframe - Air
Weather - turbulence in flight

ICAO Ref: AR/880

No. 7

Mayflower Air Services Ltd., de Havilland Rapide DH 89A, Series 6, G-AHLM, accident at St. Mary's Aerodrome, Scilly Isles, on 20 July 1963. Report, dated August 1964, released by the Ministry of Aviation, United Kingdom (C.A.P. 217).

1. Investigation

1.1 History of the flight

The aircraft was engaged on a scheduled flight from St. Mary's Aerodrome in the Scilly Isles to Plymouth carrying a pilot and seven passengers. The take-off run began at 1102 hours GMT from grass runway 15 and almost immediately the aircraft developed a swing which was corrected. The aircraft bounced several times, and about 850 ft from the threshold of the runway it swung sharply to the left, then veered to the right. Although the aircraft should, at this point, have been becoming airborne, the tail wheel appeared to be still on the ground, and the aircraft was not accelerating. It then became airborne for a short distance, still veering to the right, with the tail well down, and descended again as a burst of engine power was heard. The veer to the right became more pronounced, and the right wing went down. The aircraft left the useable part of the aerodrome, continued down a steep slope and cartwheeled when the starboard wing struck a rock. It came to rest on its fuselage with the rear part of the fuselage hanging over a cliff.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal			
Non-Fatal	1	7	
None			

1.3 Damage to aircraft

The aircraft was destroyed.

1.4 Other damage

No objects other than the aircraft sustained damage.

1.5 Crew information

The pilot-in-command, age 57 years, held a commercial pilot's licence with a valid instrument rating and an endorsement in Group I for DH 89A aircraft. His flying

experience amounted to 6 860 hours which included 687 hours on DH 89A aircraft. His time on DH 89A aircraft included 220 hours 55 minutes which had been flown almost entirely on the Plymouth to St. Mary's route during the six months prior to the accident. He was the only crew member on the subject flight.

1.6 Aircraft information

At the time of the accident the aircraft had valid certificates of airworthiness and maintenance. It had been maintained in accordance with an approved maintenance schedule.

The centre of gravity of the aircraft was within the permissible limits.

Rapide aircraft have no performance group classification and have to meet the conditions in the schedule to Regulation 6 of the Air Navigation (General) Regulations, 1960. Regarding take-off, the condition is that the distance required by the aeroplane to attain a height of 50 ft, when multiplied by a factor of 1.33, is not to exceed the emergency distance available at the aerodrome at which the take-off is to be made.

Following a programme of test flights, Rapide aircraft operating scheduled services at St. Mary's were however granted an exemption from the full requirements of the Regulations. For take-offs, the factor of 1.33 was reduced to 1.11.

The maximum all-up weight for take-off in still air conditions on runway 15 is approximately 5 550 lb.* The Operator's records showed that the take-off weight was usually below this figure. However, on the day of the accident the aircraft weighed 5 755 lb. This satisfies the performance requirements for take-off when the surface wind is 5 kt or more, but at the time of the accident the surface wind was calm. Therefore, on this occasion the aircraft was about 205 lb overweight.

The error in the take-off weight resulted from a misinterpretation by the Operator of the effect of the exemption.

The overload of 205 lb would have increased the aircraft's ground run by about 50 ft which would not have been significant in this accident.

1.7 Meteorological information

At the time of the accident (1102 hours GMT) the weather conditions at St. Mary's Aerodrome were as follows:

wind: calm; visibility: 8 NM; cloud: 8/8 at 500-600 ft;
temperature: 15° to 16°C; humidity: over 90%

1.8 Aids to navigation

They are not significant in this accident.

1.9 Communications

No mention is made in the report of communications.

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* The Operations Manual quoted 6 000 lb instead of 5 550 lb as the maximum permissible weight for take-off in calm air on runway 15.

1.10 Aerodrome and ground facilities

St. Mary's Aerodrome is about 100 ft asl. It is severely humpbacked, and its surface is short mown grass. Runway 15, the longest of three, is 1 872 ft long and has a total fall over its length of 7 ft. It slopes up from the threshold on a gradient of 1 in 12, which reduces to 1 in 40 in the first 300 ft. Thereafter it is undulating with a slight rise to the highest point about 900 ft from the threshold. A down slope then begins which becomes 1 in 40 at 1 100 ft from the threshold and 1 in 24 for the last 600 ft. A number of ridges lie across the first 600 ft of the runway.

1.11 Flight recorders

They are not mentioned in the report.

1.12 Wreckage

The structure of the aircraft was badly distorted and burned. Part of the port engine oil drain pipe was found on the runway, 875 ft from the threshold. The port tire was extensively damaged by fire.

1.13 Fire

The aircraft caught fire when it came to rest on its fuselage.

1.14 Survival aspects

The pilot was seriously injured and trapped in the aircraft. He suffered severe burns before rescuers, who arrived quickly, were able to extricate him. The passengers also suffered burns. They escaped through the emergency exit in the roof of the aircraft.

1.15 Tests and research

Both power units and the partly burned port wheel and tire were removed from the wreckage for further examination.

The power units showed no evidence of pre-crash failure or malfunction. The broken oil drain pipe was subjected to a laboratory examination. (There is a section of rubber tubing 7-1/2 inches long at the lower end of the pipe). There was no evidence that the failure of the pipe was due to fatigue or a pre-existing crack. It had fractured because of bending and tension. The failure was consistent with a bending load having been applied to the pipe by the rubber tube coming into contact with the ground. Since full compression of the undercarriage shock absorber would not sufficiently reduce the clearance between the bottom of the tube and the ground, contact can only occur when the main wheel tire is at least partially deflated.

No evidence of structural or service failure was found in the port tire. Any superficial signs of overdeflection would have been destroyed by post-accident damage and fire.

A V-shaped crease was found in the tube of the port tire. The rubber had thinned and split along one arm of the "V". It was believed that this crease had most likely occurred when the new tire was fitted on the aircraft on 17 May 1963.

2. Analysis and conclusions

2.1 Analysis

The oil drain pipe was found on the runway at the point where the aircraft swung sharply to the left. This suggested that a deflation of the port tire may have occurred during the take-off run. Examination of this tire and its tube revealed a split crease which could have caused some pressure loss. However, the post-accident damage made it impossible to determine the condition or state of inflation of the tire at the time of the accident.

A technique of double inflation is carried out when fitting old tubes into new tires in order to eliminate the risk of creasing. This technique was used on 17 May 1963 when the port tire and tube were fitted on the subject aircraft. The detection of creases by subsequent inspection is impossible. Since 17 May 1963 the aircraft had made 300 landings, and no appreciable loss of tire pressure was detected during routine servicing.

If deflation of the port tire did occur during the take-off run it would account for the swing to the left and would have brought the lower end of the oil drain pipe into contact with the ground. The swing could have been so severe that the pilot had to abandon take-off.

The pilot-in-command could not remember the events of the day of the accident. However, he believed that if he had to abandon a take-off from a position near the crest of runway 15, with the aircraft swinging left towards the apron and the rough ground beyond, he would ground loop to the right in an effort to keep clear of obstructions and within the confines of the aerodrome.

In the subject accident, when the aircraft swung left it had already covered nearly 900 ft of the required ground run of 1 150 ft, and it could not have been stopped in the distance remaining. Under the circumstances, the pilot's attempt to ground loop the aircraft was understandable.

2.2 Conclusions

Findings

The aircraft had a current certificate of airworthiness and had been maintained in accordance with an approved maintenance schedule.

The pilot was properly licensed.

The centre of gravity of the aircraft was within the permitted limits, but at the commencement of the take-off the weight exceeded the allowable regulated take-off weight by about 205 lb. However, the excess weight of the aircraft was of no significance in this accident.

The broken oil drain pipe suggests that some loss of pressure may have occurred in the port tire prior to the accident.

The tube of the port tire had been creased during fitting, and the crease had thinned and split. Because of extensive fire damage it was not possible to determine with certainty when the split had occurred.

The pilot abandoned the take-off and initiated a ground loop to the right in an attempt to keep within the confines of the aerodrome.

From the position where the take-off was abandoned, the speed of the aircraft and the downward slope of the ground were such as to preclude the possibility of stopping within the confines of the aerodrome.

Cause or
Probable cause(s)

The accident was the result of a loss of control during an attempt to ground loop the aircraft after the take-off was abandoned. There was insufficient evidence to determine with certainty why the take-off was abandoned.

3. Recommendations

No recommendations were contained in the report.

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ICAO Ref: AR/803

No. 8

Middle East Airlines Co., Viscount 754, OD-ADE, and Turkish Air Force, C-47, CBK 28, were involved in a mid-air collision over Ankara, Turkey, on 1 February 1963. Report, dated 30 April 1963, released by the Department of Civil Aviation, Ministry of Communications, Turkey.

(Comments by the State of Registry of the aircraft appear at the conclusion of the summary)

1. Investigation

1.1 History of the flights

Flight ME 265, the Viscount, was on a scheduled service from Nicosia, Cyprus to Esenboga Airport, Ankara, Turkey with a crew of 3 and 11 passengers. It called Esenboga Approach Control at 1304 hours GMT and advised that it was descending from flight level 185 to 105 and would be over the range at 1307. The controller asked the flight to report when it reached the Gölbasi beacon. It reported over the beacon at flight level 125 and continued its descent expecting to be over Ankara at 1307. At 1305 the controller told the flight it could descend to 6 500 ft and cleared it for a beacon approach. The landing was to be made on runway 03 with an altimeter setting of 1015.5 mb, and the aircraft was requested to report leaving flight level 105. The flight reported that it was going to descend to 6 500 ft and would call over the Ankara beacon. It was then leaving flight level 125 and would call when it reached 105. At 1307 hours the aircraft reported it was at flight level 100 and that it would be over the range in one minute and might have to descend in the holding pattern. It had not checked the Ankara NDB but would report when it did. By 1309 hours it was at 8 000 ft over the Ankara NDB and was continuing its descent to flight level 65. It was to call again over the NDB when inbound. From 1313 hours onward the controller called the aircraft several times without success.

The C-47 departed Etimesgut Airport with three crew members aboard at 1122 hours GMT for an instrument training flight in the southeast region of the Gölbasi beacon. The duration of the flight was planned for 1 hour 30 minutes. In this type of flight the student pilot is normally seated in the left-hand seat, an orange plexiglass panel is placed in front of him on the left half of the windshield, and he wears dark blue glasses. The instructor is in the right-hand seat and is able to maintain a lookout. The training manoeuvres had been completed, and the aircraft was returning to Etimesgut flying under visual flight rules.

The two aircraft collided over the city of Ankara while flying below 7 000 ft in clear weather conditions. The accident occurred between 1312 and 1314 hours.

1.2 Injuries to persons

Injuries	Crew		Passengers	Others
Fatal	Viscount 3	C-47 3	Viscount 11	87
Non-Fatal				50
None				

1.3 Damage to aircraft

Both the Viscount and the C-47 were destroyed.

1.4 Other damage

The falling wreckage of the two aircraft damaged various buildings and houses in Ankara.

1.5 Crew information

Viscount

The pilot-in-command, age 29, held an airline transport pilot's licence which was valid until 30 May 1963. He qualified as a pilot-in-command on Viscount aircraft in August 1962 and had flown a total of 2 925 hours on this aircraft type.

The co-pilot, age 38, had a commercial pilot's licence which was valid until 17 May 1963. He became a co-pilot in June 1960 and had flown a total of 4 200 hours on Viscount aircraft.

Their medical examinations and flight checks had been carried out as required.

No information appeared in the report concerning the hostess.

C-47

The instrument flight instructor, age 33, qualified as a pilot in May 1955 and had a total of 1 452 hours experience on C-47 aircraft.

The student pilot, age 22, became a pilot in July 1962. He had flown 36 hours on the C-47 which included 9 hours and 15 minutes on instruments.

No information was provided in the report regarding the third crew member, a radio operator.

1.6 Aircraft information

Viscount

The aircraft had a certificate of airworthiness valid until 8 February 1963 and had been maintained in accordance with an approved maintenance programme.

The weight of the aircraft and its centre of gravity were within the allowable limits.

C-47

Since its construction the aircraft had flown 2 340 hours and 40 minutes.

The aircraft was airworthy at the time of the accident and had been maintained in accordance with the current regulations and maintenance programmes. The last periodic maintenance was carried out on the aircraft on 3 September 1962. This check was valid until 3 February 1963.

It was carrying no cargo.

The types of fuel being used by the two aircraft were not stated in the report.

1.7 Meteorological information

At 1300 hours the weather conditions at Esenboga and Etimesgut were as follows:

Esenboga

ground wind: 270°/03 kt; visibility: 10 km; hazy; cloud: 4/8 Cu Sc 3 000 ft; QNH: 1015.5 mb; QFE: 29.99 inches; temperature: 5°C.

Etimesgut

ground wind: 210°/10 kt; visibility: 20 km; 5/8 overcast; cloud: 3/8 Cu 3 000 ft, 2/8 Sc 4 000 ft; QFF: 29.98 inches.

At 1320 hours, immediately following the accident, the General Directorate of Meteorology released information on the Ankara weather conditions which included the following:

8 000 ft asl	-	cloud 2/8 stratocumulus
11 000 ft asl	-	cloud 2/8 altocumulus
visibility	-	20 km
wind	-	240°/10 kt

The winds and temperatures at various altitudes were:

5 000 ft	-	240°/11 kt, - 1°C
6 000 ft	-	240°/17 kt, - 5°C
7 000 ft	-	240°/17 kt, - 8°C
8 000 ft	-	240°/17 kt, - 11°C

All the eyewitnesses, who saw the aircraft before the collision occurred and those who saw the pieces fall after the collision took place, said that at that time the weather was cloudless, clear and sunny.

The pilot-in-command of a Turkish Airlines Fokker F-27 (Flight No. 511) which flew over the City of Ankara at 6 500 ft following the accident said that there were no clouds at that altitude. However, at 9 000 and 10 000 ft the cloud cover was approximately 2/8, visibility was about 20 km, and there was sunshine.

Two instructor-pilots of two C-47 (military) aircraft which were over Ankara at 1250 and 1330 hours respectively reported no clouds over Ankara.

However, the crew of an American C-130 aircraft reported that over the Ankara radio beacon at 1322 hours there were approximately 6/10 scattered clouds at 5 000 ft, and the visibility was 5 miles.

1.8 Aids to navigation

All the navigation aids on the ground were operational and functioning properly. There was a non-directional radio beacon at Ankara.

1.9 Communications

The Viscount aircraft was in contact with Approach Control at Esenboga Airport, Ankara up until approximately 1309 hours. The pilot's radiocommunications did not conform to the standard international conversation procedures. The controller tried several times to contact the aircraft from 1313 hours onwards but did not receive any reply.

Communications carried out by the C-47 aircraft were not mentioned.

1.10 Aerodrome and ground facilities

Not relevant to this accident.

1.11 Flight recorders

No flight recorder information appeared in the report.

1.12 Wreckage

The wreckage of the Viscount was taken to Esenboga Airport and that of the C-47 was taken to Etimesgut Airport.

Viscount

When the main part of the wreckage struck the ground, fire broke out and caused considerable damage. This made identification of the aircraft parts more difficult. The flaps were at 32°, and the landing gear was down and locked. The engines and propeller blades were severely damaged, but the manner in which the blades were twisted indicated there was power on the engines at the time of the in-flight collision. The tips of the blades of No. 3 propeller had broken off. There were vertical scratches on the paint and skin covering of the starboard side of the fuselage. The front upper part of the cockpit was found without any traces of fire on it. However, the bottom part had been completely destroyed. The fact that the nose landing gear was found far away from the main part of the wreckage and that in the same area the starboard door of the nose landing gear was found crushed indicated that the aircraft had hit something with the bottom right-hand side of its nose.

C-47

The tail unit containing the fin and rudder had been cut off from the fuselage near the water closet window. The pieces from the horizontal stabilizer on the starboard side were found, but no pieces from the horizontal stabilizer on the port side were recovered. Pieces of propeller blades were found in the tail unit. It was subsequently determined that they belonged to propeller No. 3 of the Viscount. Upward traces of paint and metal scratches were found on the skin covering in the vicinity of the door on the port side of the fuselage and extending forward from the door.

1.13 Fire

The fire which broke out where the C-47 fell was extinguished immediately.

Fire also broke out in some of the areas where the Viscount fell and caused substantial damage because of the large quantity of fuel which was being carried. However, the fire was successfully brought under control.

1.14 Survival aspects

The rescue procedures were performed rapidly and satisfactorily.

1.15 Tests and research

A report released by the Faculty of Science, University of Ankara, established that the paint traces on the C-47 were made by the Viscount.

2. Analysis and conclusions

2.1 Analysis

Examination of the scratches on the wreckage revealed that the aircraft collided at a 40° angle. Since the flaps and landing gear of the C-47 were in the retracted position, and the aircraft was descending for approach at the time of the accident, its speed was estimated as being about 120 mph. Because the landing gear of the Viscount was down and locked, and the flaps were found at 32°, the speed of the aircraft was estimated to be about 136 kt. Calculations were made of the flight paths of the various parts of the aircraft, taking into account these speeds and the wind drift. The headings of the Viscount and the C-47 shortly before the accident were determined to be approximately 283° and 243° respectively. The probable position of the collision point over Ankara was also determined. The Viscount should not have been on this heading at the point of collision. The altitude at which the collision occurred was estimated to be under 7 000 ft.

Based on the above it was determined that the in-flight collision had occurred as follows:

The Viscount, cruising on a heading of 283°, collided with the C-47 which was flying on a heading of 243° towards Etimesgut Airport. The lower right-hand side of the Viscount's nose and the starboard wing struck the C-47 from behind at a 40° angle in the door area on its port side. Propeller No. 3 also struck the C-47's left horizontal stabilizer, cutting it off. The blade ends broke off and remained with the tail unit of the C-47 near the base of the left horizontal stabilizer. The blade of propeller No. 4 cut the underside of the tip of the right horizontal stabilizer. Both aircraft flew together for a very short time then separated. The tail unit of the C-47 having been cut off, the C-47 fell vertically immediately thereafter. Prior to being cut off, the left horizontal stabilizer of the C-47 damaged the starboard side skin covering of the Viscount in the vicinity of the passenger cabin windows. This piece of skin covering broke off, and some of the passengers fell out through this hole. The Viscount flew a very short while following the separation of the two aircraft, then nosed down and fell.

2.2 Conclusions

Findings

Both aircraft had valid certificates of airworthiness and had been properly maintained. It was not possible to determine whether there was anything abnormal about the Viscount's flight prior to the collision.

The crew of both aircraft were properly certificated.

The manner of the flight performed by the Viscount aircraft indicates that the flight was not being carried out under IMC conditions.

The Viscount pilot made an estimation error of two minutes on the distance between Gölbasi and the Ankara NDB.

His radiocommunications did not conform to the standard international conversation procedures.

The C-47 was returning to Etimesgut Airport under visual flight rules (VFR) following an instrument training flight.

These training flights are scheduled to be carried out below 7 000 ft with the trainee-pilot behind blind flight panels and the instructor-pilot sitting so as to be able to see outside thoroughly. The flights normally last for 1 hour and 30 minutes, however, the instructor is authorized to extend this period if he deems it necessary.

The C-47 was subjected to an impact from the port side rear at an angle of 40° and from the bottom to the top upwards at an angle of approximately 5 to 10°. The Viscount's flaps were set at 32° down, and the gear was down and locked. The aircraft collided over the City of Ankara at an altitude less than 7 000 ft.

Cause or
Probable cause(s)

The Viscount aircraft had an IFR flight plan but was cruising under VFR conditions when it hit, with the lower side of its nose and with its starboard wing, the C-47 aircraft of the Turkish Air Force between the door on the port side of the fuselage and the tail group at an angle of forty degrees from the left rear and at an angle of approximately five to ten degrees upwards. It cut off, with its starboard side inner (No. 3) propeller, the port side horizontal stabilizer of the C-47 aircraft. The pilots of the Viscount aircraft did not see the C-47 aircraft cruising below 7 000 ft on their right-hand side forward, and the Viscount, having a higher speed, caught up with the C-47 from the left rear. At the last moment the Viscount pilots saw the C-47 and tried to avoid the collision by pulling up, but they did not succeed.

3. Recommendations

No recommendations were made in the report.

ICAO Ref: AR/804

COMMENTS BY THE STATE OF REGISTRY

The Directorate of Civil Aviation, Lebanon, having studied the report prepared by the Turkish Commission of Inquiry and having perused the supporting documents and the details appearing therein, has made the following comments:

"1) This Directorate had delegated a number of experts and specialists to attend the meetings of the Committee of Investigation. In the course of discussions, these experts made several important comments, but the Committee did not take their opinions into consideration. Our Representatives expressed reservations in writing in respect of the considerations outlined in the report and the conclusion reached by the Investigation Committee."

"2) The Turkish Investigation Committee did not take into consideration the presence of a military zone for flight training which extends within the holding and approach pattern allotted to civil aircraft without any co-ordination or direct contact between the military and civil control units."

"3) A contradiction exists between the information contained in the report about the weather conditions and the meteorological reports. The latter are lacking in accuracy and clarity and are thus inadequate to permit reaching the conclusions detailed in the report."

"4) The Committee's report contains no evidence to establish that the Turkish aircraft was flying in accordance with the visual flight rules. The report also does not contain any information in respect of the instructions given to the military aircraft; furthermore, there is considerable deficiency in the information provided about the flight of the military aircraft."

"5) The conclusions of the Investigation Committee do not seem to be in conformity with the International Laws prescribed under the technical annexes to the International Civil Aviation Convention; for example, the laws to which the report refers as a basis for the determination of responsibilities and the ascription of errors apply to aircraft whilst cruising on routes and not to aircraft flying in the holding and approach pattern."

"6) The report clearly shows that the Investigation Committee did not take into consideration all the important elements which are necessary for determining the detailed circumstances and causes of the accident in an objective and complete manner."

- - - - - - - - - - - - -

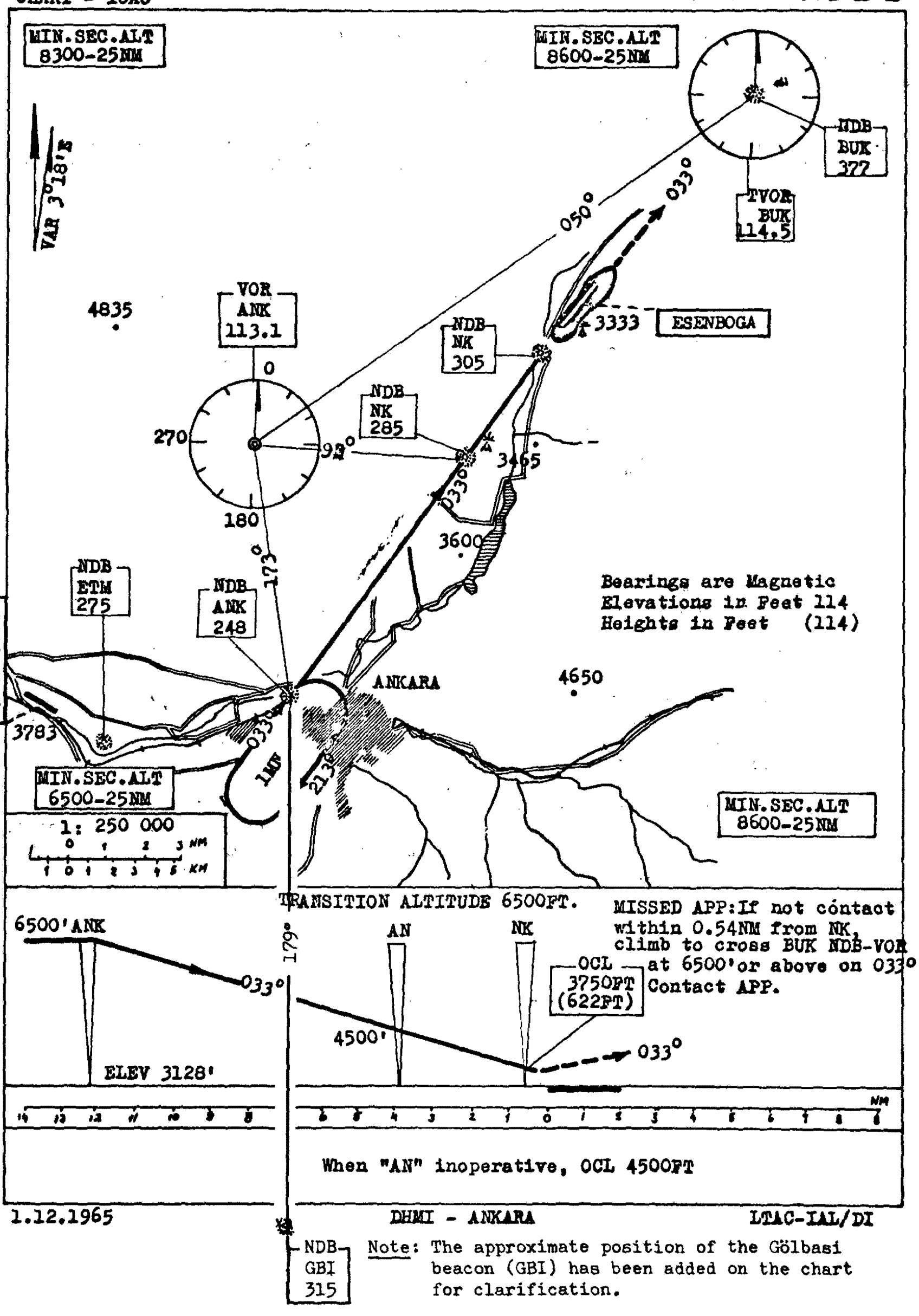
INSTRUMENT APPROACH CHART - ICAO
ELEV 3128 FT
ESENBOĞA TWR 118.1-121.5-3023.5 ANKARA/ESENBOĞA
ESENBOĞA APP 117.9-119.1-121.5 TURKEY
NDB 2
MIN.SEC.ALT 8300-25NM
MIN.SEC.ALT 8600-25NM
VAR 3°18'E
NDB BUK 372
TVOR BUK 114.5
050°
033°
4835
VOR ANK 113.1
NDB NK 305
3333
ESENBOGA
NDB NK 285
270
92°
3465
330°
180
3600
173°
NDB ETM 275
NDB ANK 248
ETIMESGUT
3783
033°
ANKARA
4650
213°
1 MP
MIN.SEC.ALT 6500-25NM
MIN.SEC.ALT 8600-25NM
1: 250 000
0 1 2 3 NM
1 0 1 2 3 4 5 KM
Bearings are Magnetic
Elevations in Feet 114
Heights in Feet (114)
TRANSITION ALTITUDE 6500FT.
MISSED APP:If not contact within 0.54NM from NK, climb to cross BUK NDB-VOR at 6500'or above on 033° Contact APP.
6500'ANK
033°
ELEV 3128'
179°
AN
NK
OCL 3750FT (622FT)
4500'
033°
When "AN" inoperative, OCL 4500FT
1.12.1965
DHMI - ANKARA
LTAC-IAL/DI
NDB GBI 315
Note: The approximate position of the Gölbasi beacon (GBI) has been added on the chart for clarification.

FIGURE 1

No. 9

Union Aéromaritime de Transport, DC-6B, F-BIAO, accident on the slopes of Mount Cameroon, Federal Republic of Cameroon, on 4 May 1963. Report, dated 13 December 1963, released by The Director of Civil Aviation, Cameroon.

1. Investigation

1.1 History of the flight

The aircraft was on a scheduled international flight from Douala, Cameroon to Lagos, Nigeria. It was on charter to Air Afrique. Aboard were 7 crew members and 48 passengers. The aircraft took off from runway 12 at Douala at 1316 hours GMT on an IFR flight plan which specified a routing over M'Banga by the northern passage and a cruising altitude of 16 500 ft. Allowing 28 minutes to reach FL 165, this would mean an average rate of climb of 600 ft/min. The flight was authorized to make a turn to the right when it was about 250 m above the end of the runway. The pilot-in-command reported subsequently that he was taking the southern passage. The control tower at Douala requested the flight to report when passing the radio beacons at Santa Isabel and Calabar. At 1320 hours it reported that it estimated it would be passing these two points at 1330 and 1344 hours respectively. Three minutes later it contacted Brazzaville and reported that it was flying in visual meteorological conditions, at flight level 30, climbing to flight level 165 and that it was estimating leaving the FIR at 04°15N - 08°30E around 1338 hours. At 1325 it contacted Kano and gave the same information about leaving the FIR and its estimated time of arrival at Lagos. Brazzaville and Kano acknowledged receipt of the messages and requested that the flight report on leaving the FIR. The aircraft was seen over Tiko (30 km from Douala) and heard in the vicinity of Buea (6 km from the crash site). Although Brazzaville attempted to contact the flight after 1354 hours, nothing further was heard from the flight. The aircraft struck Mount Cameroon in a straight climb at an altitude of approximately 6 500 ft, i.e. about 800 m below the peak which is about 2 800 m high in this region. The time of the accident was estimated as about 1327 hours, i.e. 11 minutes after take-off. The site of the accident (04°09'30"N - 09°11'10"E) was 3 NM west of Buea and approximately 34 NM and on a heading of 293° from the Douala VOR.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	7	48	
Non-Fatal			
None			

Two passengers survived for a few days. One died on 6 May, the other one on 9 May 1963.

1.3 Damage to aircraft

The aircraft was destroyed by impact, explosions and fire.

1.4 Other damage

No damage was sustained by objects other than the aircraft.

1.5 Crew information

The crew consisted of the following: a pilot-in-command, a co-pilot, a radio operator, a flight engineer, a cabin steward and two assistant stewards. The crew complement was in accordance with the existing regulations.

The pilot-in-command, age 52, held an airline transport pilot's licence and a navigator's licence, as well as an IFR rating renewed on 9 April 1963, and a DC-6B rating. His licences and ratings were valid at the time of the accident. His last flight test had been carried out from 10 to 13 January 1962, after his flying duties had been interrupted for four months for health reasons. Similarly his last link trainer test was carried out on 3 and 4 April 1962. Certain reservations were attached to the results of both tests. While not thinking that could have played a part in the accident, and noting that the pilot-in-command had 6 561 hours' experience with the DC-6B, about half that time being night flying, the Board regretted that the file of the pilot-in-command did not contain the results of more recent tests. It appeared also that the pilot-in-command had neglected to re-validate his restricted international radiotelephony rating which had expired on 4 April 1963.

The co-pilot was 31. He held the required licences and ratings, all valid, as follows: airline transport pilot's licence, DC-6B co-pilot's rating, instrument flight rating, restricted international radiotelephony rating. His last flight test was on 22 March 1963. He had flown a total of 4 811 hours. His DC-6B experience amounted to 3 435 hours of which about 50% were flown at night.

The radio operator, age 27, held a radio operator's licence. His restricted radiotelephony rating had expired on 28 July 1962. His total flying experience amounted to 2 589 hours and included 1 727 hours on the DC-6B. In the 60 days before the accident he flew about 119 hours on the DC-6B.

The flight engineer, age 50, had a flight engineer's licence and a DC-6B rating. His most recent flight test was on 9 January 1962 and on the link trainer it was on 13 to 15 December 1962. His total flying experience amounted to 13 629 hours which included 5 237 at night. At the time of the accident his DC-6B experience was 8 323 hours which included 114 hours flown in the 60 days prior to the accident.

These four crew members all held valid medical certificates at the time of the accident and their flying activity during the three weeks preceding the accident did not substantiate the possibility of fatigue.

They were well acquainted with the Douala-Abidjan coastline and the Mount Cameroon region. Each crew member had flown regular tours of duty lasting from 8 to 10 days in Central and Equatorial Africa with several flights to Douala during each tour of duty.

1.6 Aircraft information

A Certificate of Airworthiness was issued for the aircraft on 28 June 1958.

Since its last periodic overhaul it had flown about 634 hours.

Maintenance on the aircraft had been carried out regularly by the Operator in accordance with the maintenance manual provided. All required DC-6B modifications had been made on the subject aircraft.

At the time of departure from Douala the aircraft's weight and centre of gravity were within the permissible limits.

The type of fuel being used by the aircraft was not stated in the report. According to the load and trim sheet, the aircraft carried 5 442 kg of fuel at the time of take-off from Douala, corresponding to 2 100 US gallons of fuel, which exceeded the amount of 1 700 US gallons recommended by the Company's operations manual for the Douala-Lagos flight.

1.7 Meteorological information

The following conditions existed at Douala Airport at 1316 hours, the time of departure:

temperature: 32.2°C; humidity: 60%; wind: 180°/6 kt;
visibility: 50 km, Mount Cameroun was visible;
cloud: 3/8 cumulus, base 800 m; QNH: 1,010 mb;
QFE: 1,008

M'Banga relayed forecasts to the pilot of the subject flight for the Douala-Lagos portion of the trip. They contained the following information concerning the Mount Cameroon region:

clould: 3/8 cumulus, base 800 m, cloud tops up to 4 000 m, altocumulus around 5 000 m, linked crests (traced for 2 000 m along the route from M'Banga to Calabar)
wind: 0 to 2 000 m: 190 to 220°/4 to 6 kt
2 000 to 3 000 m: 080°/10 kt
above 3 000 m: 090°/20 to 30 kt

While en route the aircraft flew over Tiko Airport which is about 30 km from Douala and 25 km from the accident site. The Chief Pilot of Cameroon Air Transport arrived at Tiko at 1330 hours, i.e. about 3 minutes after the estimated time of the accident. He stated that on his arrival the sky was clear with some cloud. The peak of Mount Cameroon was visible at this time but not its slopes.

The 1400 hour forecast for Tiko was:

skies clearing; cloud: 6 to 7/8, low cloud 3/8 cumulus, base 360 m;
ground wind: 180°/10 to 12 kt; visibility: 30 km.

At the time the aircraft was heard passing the town of Buea, a thin cloud layer of 8/8 covered the Buea region. Persons in this area said that the southern slopes of the mountain were covered with a solid cloud layer having a base of around 4 000 to 5 000 ft.

Later that same afternoon the Chief Pilot of Cameroon Air Transport reported that in the crash area there was a layer of 7/8 stratocumulus, the tops of which may have reached 7 000 ft. (The accident occurred at 6 500 ft.).

At the time of the accident the condensation levels on the slopes of the mountain may have been parallel to the path of the aircraft's climb. Also, since the humidity was increasing due to the dense vegetation on the mountain slopes, the cloud thickness must have increased proportionately as the aircraft approached the mountain.

1.8 Aids to navigation

At Douala the following aids were available: 1 VHF direction finder, 1 VOR, 1 ILS, 1 radio beacon and 1 Locator, however, the direction finder was not operating at the time of the accident because of the fine weather conditions.

On the southern route to Lagos the following aids were available to the aircraft: a marker at Tiko (TI), a radio beacon at Santa Isabel (PA) and a radio beacon at Calabar (CR).

The aircraft was fully equipped and carried among other things 2 VOR-ILS receivers and 2 radio compasses. This equipment was checked in flight during February 1963 and was found to be in perfect working condition.

1.9 Communications

The control tower at Douala receives communications on HF and VHF. However, the recording of messages by the tower does not include a recording of the time.

Communications were good on the day of the accident, and the subject flight exchanged messages with Douala, Brazzaville and Kano.

1.10 Aerodrome and ground facilities

Not relevant to the accident.

1.11 Flight recorders

See paragraph 3, Recommendations.

1.12 Wreckage

The aircraft crashed on the steep slopes of Mount Cameroon at an altitude of 6 500 ft in an uninhabited and highly inaccessible region. It dug a furrow in the woods, approximately 150 m long and 50 m wide, which was mainly oriented 295° magnetic.

The aircraft was intact at impact. It was climbing with its landing gear retracted, and there was no indication of a turn or of an asymmetrical impact. The automatic pilot was presumed to be "off" at the time of impact.

Because of the inaccessibility of the site and the difficulties experienced in bringing anything down the mountain, the Board could only carry out an on-the-spot investigation and removed only a few components such as navigation and communications equipment.

1.13 Fire

Explosions and fire followed the impact and destroyed the aircraft completely. The fire lasted more than twelve hours.

1.14 Survival aspects

There was no contact with the aircraft after 1325 hours, and at 1452 hours Kano announced the uncertainty phase which was followed at 1502 hours by the alert phase. Brazzaville also declared the alert phase at 1600 hours and the distress phase at 1635 hours. Kano did likewise at 1650 hours.

The inaccessibility of the crash site and dense vegetation hindered the search. To reach the site a footpath had to be cut through the undergrowth and could only be used by men carrying light loads or none at all. It was extremely difficult to transport the victims down the mountain and bringing down survivors was even more so.

1.15 Tests and research

On 12 May 1963 flight tests on all the VOR, ILS, radio beacon and locator equipment were carried out. All ground installations were operating normally.

Tests carried out with a UAT DC-6 showed that the ILS was correctly received beyond Tiko. There were no false ILS course lines in the sector northwest of Douala, and there was no distortion of the magnetic field in the approaches to Mount Cameroon. Headings remained constant when the aircraft followed a constant VOR radial.

The operation of the VOR had not been the cause of any comments by Air France crews during the period 1 to 15 May.

Some of the aircraft's electronic equipment was recovered and analysed in Paris. It was determined that, at the time of the accident, the magnetic heading of the aircraft was 305°. One of the VOR-ILS receivers was tuned to 110.3 -(ILS, Douala), the other to 112.9 - (VOR, Douala). The VOR radial marked on the selector was 278°, with the manual switch on the 180° position.

1.16 Operating procedures

The Company's operations manual was found in the wreckage. At the time of the accident it forbade making use of the southern path for the Douala-Lagos route, but authorized it "in VMC only" for the Douala-Cotonou route. The UAT representatives said that this was due to a typing error and that as contained in former manuals up until the beginning of 1963 the southern path was authorized for both routes "in VMC only". Representatives of the competent Administration said that the southern path is not prohibited in VMC for the Douala-Lagos route.

2. Analysis and conclusions

2.1 Analysis

After taking-off from Douala the flight took a heading which led it straight into Mount Cameroon. The actual mean magnetic course flown by the aircraft between Douala and the crash site was 293°. Weather conditions were very favourable and the crew was certainly able to see the ground and Mount Cameroon, at least as far as Tiko. There is no doubt that the route towards Tiko and Mount Cameroon was deliberately chosen by the crew and that the aircraft was flying in instrument meteorological conditions when the crash occurred. It is extremely difficult to explain why the crew continued on the same heading towards Mount Cameroon after having passed over Tiko and even more so after having transferred to instrument flying.

Activities of the crew prior to the subject flight were examined and did not disclose anything indicating a possible indisposition of the crew at the time of take-off. Although the conditions of the bodies did not permit a medico-legal analysis, statements of the passenger who survived for five days after the accident, and the coherence of the crew's transmissions led the Board to conclude that no in-flight intoxication by fuel or hydraulic liquid had occurred.

Examination and tests did not disclose any breakdown or failure of the navigational aids on the ground or of the equipment on board the aircraft. No indication of a loss of control of the aircraft was found. Based on the fact that one of the VOR-ILS receivers was tuned to the ILS Douala, the other to the VOR Douala and that the VOR radial marked on the selector was 278°, (approximately the northern limit of the southern pass), the Board examined the possibility of a confusion between the VOR and the ILS. Assuming that the crew confused the ILS back beam reading with that given by the VOR on radial 278° and that it took a southern safety limit with reference to the back beam (304°), mistakenly read as 278°, it could not fail to strike the mountain. However, this assumption was not accepted by all Board members. If a confusion of VOR and ILS did take place, this could only have been due to general inattention and to a lack of observation of other aircraft instruments.

2.2 Conclusions

Findings

The weight and centre of gravity of the aircraft were within permissible limits at the time of take-off from Douala.

The aircraft and its equipment had been regularly maintained and were in good working order. No indication of any malfunctioning was found.

The crew had valid certificates, licences and ratings to carry out the planned flight. It had sufficient experience on the route.

Navigation aids and air-ground communications equipment were operating, and nothing was found to substantiate any doubt concerning their good working condition. They were ample to provide the aircraft with an accurate route.

Ground winds were southerly, 6 to 12 kt, changing to east 10 kt at 2 000 m. There was no severe turbulence nor any downdrafts over the southern slopes of Mount Cameroon.

The weather was good and could even be considered as exceptionally fine for the area. Visibility at Douala exceeded 50 km.

After having planned an exit via M'Banga in his flight plan, the pilot decided, after take-off, to take the southern passage, which was contrary to the Company regulations in his possession.

Immediately after take-off from Douala, the aircraft climbed along a route which took it over Tiko and straight to the slopes of Mount Cameroon. The foregoing leads to the conclusion that the choice of that route was deliberate.

If an error had been committed with regard to calculating drift or heading, and even if there had been a faulty indication of any component of the aircraft's navigation equipment, a brief navigation check, which would have been possible along part of the route by observing landmarks, could have prevented the accident.

Between Tiko and Mount Cameroon the aircraft was flying in instrument meteorological conditions.

Impact occurred when the aircraft was climbing practically in a straight line.

Cause or
Probable cause(s)

The accident was caused by a lack of caution on the part of the pilot-in-command, who deliberately selected a route which led the aircraft into a dangerous and even prohibited sector at too low an altitude. Also, he neglected his navigation and transferred to instrument flight when approaching the mountain range.

3. Recommendations

The Investigation Board urged the services concerned to take the following steps:

1. Operator should issue precise instructions for operations on the Douala-Lagos, Douala-Cotonou, Lagos-Douala and Cotonou-Douala routes, in order to stress as clearly as possible:

   a) the prohibited sector including the Cameroon mountain range and the safe VOR radial limits;

   b) the altitudes which it is imperative to respect when entering or leaving the northern or southern passage and, when necessary, the manoeuvres required to reach a certain altitude prior to taking a heading.

2. To equip Douala Airport with suitable equipment, such as aerodrome radar, for checking that safety regulations are observed - until such time to ensure such checks by using the VHF direction finder available at Douala. Regulations have been drawn up to this effect.

3. To apply to all public passenger transport aircraft exceeding 5 700 kg the provisions of the Decree of the French Ministry of Public Works and Transport, dated 4 October 1963, regarding flight recorders.

4. To stipulate that operators should adhere strictly to the existing regulations regarding validity of ratings and flight tests of crews.

5. To ensure, during the annual tests by Company instructors, that pilots use correctly and at all times all means available to them on the ground and aboard the aircraft for checking their position en route as well as during the approach.

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ICAO Ref: AR/810

No. 10

Union des Transports Aériens, DC-8, F-BJUV, accident at Tan-Son-Nhut Airport, Saigon, Viet-Nam, on 3 December 1963. Report, dated 20 January 1964, released by The Director of Civil Aviation, Viet-Nam.

1. Investigation

1.1 History of the flight

The aircraft, following a scheduled flight from Bangkok, Thailand, arrived over Saigon Airport at 1130 hours GMT. It was cleared to land and touched down normally about 600 m from the threshold of runway 07. The first part of the runway was dry at the time. No reverse thrust was applied. The aircraft rolled 1 500 m, encountering an unexpected, dense rain squall at about the 1 850 m line of the runway. The pilot began, at a normal speed, to turn the aircraft into taxiway 07. The aircraft's nose wheel then began to skid on a film of water, 1 or 2 cm in depth. The nose gear pointed sideways to the path of the aircraft and went, at an angle of 45°, into a ditch, about 50 cm deep, parallel to the taxiway, and bent backward. The rear starboard wheels jumped this ditch, crossed a protective road and entered a second ditch parallel to the first. The aircraft finally came to rest on a 170° heading, about 100 m from the edge of the main runway on loose and soggy ground. The accident occurred at 1135 hours GMT.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal			
Non-Fatal			
None	10	72	

1.3 Damage to aircraft

The landing-gear was substantially damaged. The airframe was slightly damaged.

1.4 Other damage

No objects other than the aircraft sustained damage.

1.5 Crew information

The pilot-in-command, age 41, held an airline transport pilot's licence. He had various type ratings, including one for DC-8 aircraft, as well as an instrument rating. He had flown a total of 1 500 hours on the DC-8, which included 150 hours flown during the 90 days prior to the accident.

The co-pilot, age 34, also held an airline transport pilot's licence and DC-8 and instrument ratings. He had flown 800 hours on the DC-8 of which 150 hours were flown during the 90 days before the accident.

The radio operator and flight engineer, 45 and 38 years of age respectively, were properly certificated, and each had flown 1 200 hours on the DC-8.

These four flight crew members had served seven or eight years in the Far East and were familiar with Tan-Son-Nhut Airport and its approaches, having made landings by day and by night on the new runway.

All had valid medical certificates.

The remainder of the crew was made up of 3 hostesses and 3 stewards.

1.6 Aircraft information

The aircraft's certificate of airworthiness was valid until 7 May 1964. It had flown 8 971 hours since manufacture, and the airframe had not undergone any general overhaul. No technical defects had been found in the aircraft's airframe, its engines or its accessories.

At the time of the accident the aircraft's gross weight (91.8 tons) and centre of gravity (24.9%) were within the allowable limits.

The type of fuel being used by the aircraft was not stated in the report.

1.7 Meteorological information

The weather conditions at Tan-Son-Nhut Airport at 1123 hours GMT (12 minutes before the accident) were as follows:

ceiling:	3/8 Cb	500 m
	5/8 Sc	1000 m
visibility:	3 - 5 km	
wind:	160°/9 - 10 kt	

The controller relayed weather forecasts to the pilot during the approach, but no mention was made of a rain squall, which the pilot encountered on the final third of the runway. Rather heavy rain was reported to be still falling about ten minutes after the accident. Showers at this time of year are rare, sparse and localized.

1.8 Aids to navigation

Not relevant to the accident.

1.9 Communications

Communications between the tower and the flight during the approach were recorded on tape. No difficulties were reported.

1.10 Aerodrome and ground facilities

The concrete runway had been in use about one year and was in excellent condition. It was 3 036 m long and 45 m wide and had efficient drainage so that even if the last portion of the runway were covered with water, tire grip should still have been good.

A concrete taxiway, W7, was built at the same time as the runway and was also in good condition. It had a slight camber to allow water to run off.

The last part of the runway and the taxiway were extremely wet. However, their profile and the water drainage system precluded a depth of water in excess of 1 or 2 cm.

A protective road had just been completed parallel to taxiway W7, 37.5 m from its centre line. It was bounded on either side by two ditches, 50 cm deep, which were not marked. The one nearest the taxiway was 32 m from it.

The high intensity night lights were functioning at the time of the accident.

1.11 Flight recorders

No flight recorder information was included in the report.

1.12 Wreckage

The accident occurred at the end of runway 07 of Tan-Son-Nhut Airport, about 100 m from the edge of the main runway.

The nose gear of the aircraft did not appear to have sustained much damage. However, all its components were severely damaged and had to be scrapped or sent for a general overhaul.

The aircraft's tires were in good condition at the time of landing.

The steering control cables were intact, and the upper torque link was firmly jammed in a direction corresponding to a turn to port by the aircraft (about 75°).

The handle of the emergency brake had not been moved, and the brake air pressure was correct.

1.13 Fire

There was no fire.

1.14 Survival aspects

The controller notified the fire department about ten minutes after the accident occurred. Five minutes later they arrived at the scene of the accident to evacuate the passengers.

The delay in giving the alert was due to the controller's belief that the aircraft, after a normal landing, was proceeding to the parking apron. It was only ten minutes later, when the aircraft failed to show up on the apron despite repeated radio calls, that it was decided to dispatch a vehicle to find out what was happening and to declare the alert.

1.15 Tests and research

Following the accident, a pressure test done on the right-hand front tire of the port gear confirmed that there was a leak in the tire. This probably resulted from tears made during the landing.

2. Analysis and conclusions

2.1 Analysis

A normal approach was made, and the aircraft touched down normally about 600 m from the threshold of the runway. The pilot, relying on the 2 400 m of runway remaining before taxiway W7 at the end of the runway, did not apply reverse thrust.

The runway was practically dry until just after the 1 800 m line when the aircraft entered the dense rain squall. Thereafter, the aircraft's wheels made heavier marks which confirmed the wet state of the runway and made it possible to trace the path of the aircraft during its landing roll.

According to the wheel marks, the aircraft proceeded in a straight line on the right half of the runway, with the left wheel close to the centre line. At the 2 400 m line brake marks, normal for a wet runway, were clearly recognizable. At 2 650 m the marks veered left towards the taxiway. There appeared to be a certain instability in the forward landing gear, but there was no sign of skidding. After another 300 m, the instability of the nose gear and the veer of the aircraft became more pronounced, and the rear wheels of the port gear shimmied. Then the bogie of the left gear probably became unlocked. The tire marks then suggested vigorous braking which appeared to become stronger on the port side. Also, the front wheels of each undercarriage braked the aircraft more than the rear ones. There were still no signs of skidding. Around the 3 000 m line the turn of the aircraft to port increased, and the merging tracks of the nose wheels indicated a significant deflection. From then on it was assumed that the gear pointed sideways to the path of the aircraft, and the skidding tires caused the aircraft to overshoot the taxiway. The nose gear entered the first unmarked ditch, and the rear starboard wheels, after having jumped over the first ditch, went into the second ditch on the other side of the road. The aircraft continued on another 10 m before finally coming to rest.

2.2 Conclusions

Findings

The crew were properly certificated. They were all familiar with this airport and had made landings by day and night on its new runway.

The aircraft had a valid certificate of airworthiness. It had no certificate of maintenance, but no defects had been found in its airframe, engines or accessories. The aircraft's trim (i.e. centre of gravity) was within the allowable limits.

The aircraft touched down on a dry runway. No reverse thrust was applied. The pilot braked the aircraft in the usual way then entered a rain squall after a roll of about 1 500 m. Tire grip on the wet runway surface may have been reduced, but the pilot assumed that normal deceleration would reduce his speed to zero by the end of the runway. Owing to poor visibility because of rain, the latter must have come into view fairly suddenly, and the pilot braked heavily but did not use the emergency brake. Perhaps there was no time to do so.

Believing, however, that the speed of the aircraft was not excessive, he negotiated the turn into taxiway W7 and, at first, the aircraft responded normally to the controls. A certain instability in the forward landing-gear became evident. As the turn to the left became more pronounced, the nose wheels turned sideways to the path of the aircraft, probably owing to the wetness of the surface, and the aircraft overshot the taxiway on the right side and was stopped by two unmarked ditches.

Cause or
Probable cause(s)

The accident was attributed to the following:

1) excessive speed at the end of the runway possibly due to:

   a) failure to reverse thrust;

   b) insufficient use of brakes;

   c) poor tire grip owing to rain water on the runway during braking, resulting in insufficient deceleration;

   d) the development of MET (wind) conditions in this zone.

The above confirms the confident state of mind of the pilot when he began the turn into W7, which was missed because he underestimated his speed.

2) insufficient steering effect of the nose wheels, possibly due to:

   a) excessive rearward displacement of the centre of gravity, even though the overall trim (centre of gravity) was within limits;

   b) excessive angle of turn applied to the nose wheels, which slid sideways to the direction of the aircraft and ceased to fulfil their steering function;

   c) low coefficient of tire friction due to the presence of water on the runway, which led the pilot to tighten the angle of turn with the consequences indicated in (b).

3. Recommendations

No recommendations were contained in the report.

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ICAO Ref: AR/809

No. 11

United Arab Airlines, de Havilland Comet 4C, SU-ALD, crashed into the sea 11 miles west of Santa Cruz Airport, Bombay, India, on 27 July 1963. Report released by the Director of Civil Aviation, United Arab Republic.

1. Investigation

1.1 History of the flight

Flight 869 was a scheduled international flight from Tokyo, Japan to Cairo, United Arab Republic via Hong Kong, Bangkok, Bombay and Bahrein. A crew change was effected at Bangkok. Based on the tape recordings of messages exchanged between the aircraft and Santa Cruz approach and radar control, the flight was reconstructed. It was uneventful until 2016 hours GMT when it reported arriving over the Santa Cruz VOR at 7 000 ft. It was cleared to descend to 4 000 ft over the VOR and was requested to report what type of approach would be carried out for landing on runway 09. The aircraft reported it would follow the ILS back beam procedure. It was advised by Santa Cruz approach that the back beam of the ILS was not flyable but that it could home on the 270° radial of the VOR. The aircraft agreed to do a VOR let-down for runway 09, and shortly thereafter reported it was leaving 7 000 ft outbound over the sea on the 272° radial of the VOR. At 2018 Santa Cruz radar, which was monitoring the flight, warned it that if it flew more than 6 or 7 miles west of the field it would run into very heavy turbulence. Shortly thereafter the flight requested permission to make a left-hand procedure turn instead of the normal right-hand turn. This was granted. At 2019 the flight commenced the procedure turn inbound. Santa Cruz radar advised the flight that it was then 6 miles west-northwest of the field. Flight 869 acknowledged this message and was not heard from again. During the turn in severe turbulence and heavy rain the pilot lost control of the aircraft. It was found later on that the aircraft had crashed into the sea 9 NM west of Madh Island at approximately 2020 hours.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	8	55	
Non-Fatal			
None			

1.3 Damage to aircraft

The aircraft was completely destroyed.

1.4 Other damage

No damage was sustained by objects other than the aircraft.

1.5 Crew information

The pilot-in-command, age 47, held an airline transport pilot's licence which was valid until 24 October 1963. His instrument rating was also valid, and he had held a type rating for the Comet 4C since 19 March 1962.

His total flying experience on various types of aircraft amounted to 14 841 hours. As pilot-in-command, on Comet aircraft, he had flown 1 473 hours including 277 hours during the 90 days prior to the accident.

The co-pilot, age 28, also held a valid airline transport pilot's licence and an instrument rating. Since 6 July 1961 he had held a type rating for Comet 4C aircraft (Group II).

His total flying experience as co-pilot amounted to 5 463 hours including 475 hours on the Comet of which 30 hours were flown within the 90 days preceding the accident.

No further information regarding the other crew members was contained in the report.

1.6 Aircraft information

The aircraft's certificate of airworthiness was valid until 23 June 1964.

A certificate of maintenance was issued for the aircraft on 18 July 1963 and was valid for 125 hours or one month, whichever occurred first.

The maximum gross weight of the aircraft permitted for this flight was 73 000 kg. At the time of the accident the aircraft's gross weight was 54 450 kg.

According to the flight manual the centre of gravity limits are 15.5% to 29.5% of the mean aerodynamic chord. The centre of gravity at the commencement of flight was 16.5% MAC.

The type of fuel being used on the subject flight was not mentioned in the report.

1.7 Meteorological information

Moderate monsoon conditions prevailed over Bombay and its vicinity on the night of the accident. There were no cyclones or depressions affecting the area.

At 1951 hours the following weather conditions for Santa Cruz Airport were passed to the flight by the approach controller:

wind: 110°/10 kt; visibility: 3.5 km; weather conditions: rain;
clouds: 3/8 at 240 m, 3/8 at 270 m and 6/8 at 2 400 m;
temperature: 24°C; QNH: 1002.9 mb

A TU 104 aircraft, which was approaching the airport from the west half an hour before the Comet, reported severe turbulence in the vicinity of the airport. As the radar picture of the weather remained unchanged when the Comet arrived, the radar operator warned the crew of the Comet twice regarding the turbulence reported.

1.8 Aids to navigation

Aids available on the ground were:

NDB, VHF omnidirectional radio range, responder beacon, ILS with markers and locators, aerodrome light beacon and runway lighting

The airport authorities issued a Notam in March 1963 advising that the back beam of the ILS was not flyable.

The aircraft was equipped with the following:

radio compass, VOR, DME, ILS, Doppler, weather radar, and Smith flight system

1.9 Communications

The aircraft exchanged messages during the approach with Santa Cruz approach and radar control up until the time of the accident. All frequencies used were functioning properly.

1.10 Aerodrome and ground facilities

The aircraft was to land on runway 09 which was 10 500 ft long.

1.11 Flight recorders

No flight recorder information was included in the report.

1.12 Wreckage

The exact location of the main wreckage could not be determined. Its approximate location was estimated by the Indian Navy as 19°05,8'N 72°40.4'E, i.e. about 9 NM west of Madh Island. A dinghy and three bodies were found at this location. A few pieces of wreckage attached to the dinghy were also recovered and were identified as belonging to the Comet.

1.13 Fire

No traces of fire were found on the few pieces of wreckage which were recovered from the sea.

Witnesses in the crash area, who heard a loud noise coming from the direction of the sea, did not see any fire before or after the accident.

1.14 Survival aspects

Search and rescue operations were carried out by the Indian Navy. There were no signs of life in the accident area.

1.15 Tests and research

No information concerning tests was included in the report.

2. Analysis and conclusions

2.1 Analysis

It was not possible from examination of the few pieces of wreckage available to determine the aircraft's attitude just prior to impact. The condition of the recovered bodies indicated that the aircraft hit the water at a high speed. The partial disintegration of the aircraft was caused by the high inertia forces of impact. The possibility of a mid-air explosion was discarded because the wreckage and the victims were not scattered over a wide area.

Santa Cruz approach control instructed the pilot to report at 4 000 ft over the VOR. However, the pilot did not follow these instructions. Instead he began his westbound leg of the let-down procedure over the sea from 7 000 ft.

At 2019 the Santa Cruz radar operator advised the flight that its position was 6 miles west-northwest of the airport. During the investigation the radar operator stated that he meant to say west-southwest and that actually the aircraft never was west-northwest of the airport. The radar operator also said that according to the flight's path on the radar screen, the right-hand turn was interrupted shortly after the pilot was advised that he was west-northwest of the airport, and a left-hand turn was begun. This may have been corrective action on the part of the pilot to conform to the information received from the radar operator. It appeared that while carrying out the turn in severe turbulence and heavy rain, the pilot lost control of the aircraft.

2.2 Conclusions

Findings

The pilot and co-pilot were properly certificated.

The aircraft's certificate of airworthiness and certificate of maintenance were valid at the time of the accident. The gross weight and centre of gravity of the aircraft were within the prescribed limits. No defects concerning the aircraft were reported or discovered during the investigation.

All ground installations at Santa Cruz were functioning normally at the time of the accident.

Severe turbulence was known to exist west of the airport, and the Santa Cruz radar operator warned the pilot of the subject aircraft about it on two occasions.

The pilot had intended to make an instrument approach to runway 09 using the back beam of the ILS. However, as the back beam was not flyable, he was advised that he could use the 270° radial of the VOR.

Although the pilot was instructed to report at 4 000 ft over the VOR he started the westbound leg of the let-down procedure over the sea from 7 000 ft.

At 2019 the radar operator advised the pilot that the aircraft was 6 miles west-northwest of the airport when in actual fact it was west-southwest.

Immediately thereafter a right-hand turn was started but was discontinued and was followed by a left-hand turn. During this turn in heavy rain and turbulence the pilot lost control of the aircraft, and it crashed into the sea.

Cause or
Probable cause(s)

The Committee was faced with difficulties during the course of the investigation due to the fact that neither the exact location of the wreckage could be fixed nor the wreckage salvaged. Moreover, the accident occurred suddenly with no airborne emergency reported and late at night over the sea in limited visibility. There were no eyewitnesses. However, in the presence of the facts available, it can be concluded that the accident was probably due to loss of control while turning in severe turbulence and heavy rain.

3. Recommendations

No recommendations were contained in the report.

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ICAO Ref: AR/806

No. 12

Northwest Airlines, Inc., Douglas DC-7C, N 290, crashed in the north Pacific Ocean west-southwest of Annette Island, Alaska, on 3 June 1963. Civil Aeronautics Board (U.S.A.) Aircraft Accident Report, File No. 1-0009, released 21 April 1964.

1. Investigation

1.1 History of the flight

Northwest Airlines Flight 293 was a Military Air Transport Service (MATS) charter flight from McChord Air Force Base (AFB), Washington to Elmendorf AFB, Alaska. The duration of the flight was estimated as approximately 5 hours 26 minutes. Aboard were 6 crew members and 95 passengers. The passengers included military personnel, dependents, Department of Defence employees and a Red Cross employee. Prior to departure the passengers were briefed concerning the flight and were requested not to carry any flammable or explosive items aboard the aircraft. The lower fuselage baggage compartments were checked before loading, but nothing unusual was found. No examination was made of the baggage put aboard the aircraft. Following take-off from McChord at 1535 hours GMT on an IFR flight clearance, the aircraft climbed under radar control to 14 000 ft, its assigned cruising altitude, which it reached at 1552 hours. The crew reported over all compulsory reporting points as planned. At 1807 the crew reported the aircraft had passed over Domestic Annette* at 1806 flying at 14 000 ft. They estimated Domestic Sitka at 1837 and requested a clearance to climb to 18 000 ft. No reason for the requested change in altitude was given. A radio operator at Sandspit, British Columbia then advised Flight 293 that Flight 5 of Pacific Northern Airlines (PNA) had estimated reaching Domestic Annette at 1806 flying at 18 000 ft. Flight 293 did not acknowledge this transmission. At 1809 the Sandspit operator tried to contact Flight 293, in order to clear it to 16 000 ft, but could not. Further attempts to contact the aircraft were unsuccessful. Anchorage Air Route Traffic Control Centre issued an alert notice at 1916 hours. An emergency was declared at 1935, and a search was then initiated. An RCAF aircraft sighted debris from the aircraft on the following day.

It was subsequently determined that the aircraft crashed into the sea at about 1816 hours at a position estimated as 54°14'N - 134°41'W, i.e. approximately 116 NM west-southwest of Annette Island, Alaska.

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* Domestic Annette is a geographic fix at 54°14'N - 130°40'W. It is located at the intersection of an ADF bearing of 208° magnetic from Annette Island low frequency range and the 286° magnetic bearing from the Sandspit low frequency range. A supplemental aid to its location is a relative radar bearing of 058° to Forrester Island, Alaska, at a distance of 32 NM.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	6	95	
Non-Fatal			
None			

1.3 Damage to aircraft

The aircraft was destroyed.

1.4 Other damage

No other objects sustained damage as a result of this accident.

1.5 Crew information

The pilot-in-command, age 54, held an airline transport pilot's certificate and ratings for various types of aircraft including the DC-7. His total flying time of 15 465 hours included 3 665 hours on the DC-7. During the 90 days preceding the accident he had flown 239 hours on this aircraft type. His last proficiency check on the DC-7 was in February 1963 and his last route check from Seattle to Anchorage was in September 1962. His ground training and air/sea rescue training were current. He had seven days rest prior to the subject flight. His last medical examination was in February 1962 when he received a Class I certificate with a limitation that he should possess corrective glasses for near vision when making use of his airman's certificate.

The co-pilot, age 41, held an airline transport pilot's certificate, a DC-7 rating and a flight engineer's certificate. He was checked out on this type of equipment as a co-pilot in March 1957 and as a pilot-in-command in December 1962. He had flown a total of 11 489 hours including 635 hours on the DC-7. His ground training and air/sea rescue training were also current. He received a first class medical certificate in March 1963 which contained no limitations.

The flight engineer, age 47, held a flight engineer's certificate and a mechanic's certificate. He had flown a total of 7 700 hours including 1 431 hours on the DC-7. His last proficiency check was on 26 March 1963. His ground training and air/sea rescue training were also current. In October 1962 he received a Class II medical certificate with the following limitations: "Holder shall wear corrective glasses and shall have available a second pair of corrective glasses ..."

The three cabin attendants (one steward and two stewardesses) were properly trained for their duties.

1.6 Aircraft information

Flight 293 was operating under the provisions of a contract which required that the carrier operate all flights under the Civil Air Regulations that apply to scheduled air carrier operation within the United States, or those engaged in over-water flight, whichever was appropriate. The contract also required Northwest Airlines to maintain

this aircraft in accordance with the Civil Air Regulations that pertained to the maintenance of Northwest aircraft engaged in scheduled passenger service.

The aircraft had just completed a scheduled maintenance inspection on 2 June.

On 3 June it was ferried to McChord Air Force Base from Minneapolis, Minnesota. No difficulties were reported concerning the aircraft, and there were no carry-over maintenance items entered in the log on the aircraft's arrival at McChord. Therefore, no maintenance was required or performed on the aircraft at McChord.

A pre-flight inspection was carried out by the Northwest Airlines maintenance crew chief at McChord. No discrepancies were found. He also checked the emergency equipment aboard the aircraft. A further inspection of the aircraft and its survival equipment was conducted by an Air Force maintenance man. He also found that everything was in order.

According to the weight and balance sheet, at take-off the aircraft's gross weight was 123 171 lb, and its centre of gravity was 29.8% MAC. The maximum permissible gross weight was 127 558 lb, and the permissible centre of gravity range was from 17.2% to 32.5% MAC.

The aircraft was serviced with 2 021 gal of 115-145 octane gasoline from an Air Force refuelling unit and with 38 gal of oil from a Northwest Airlines servicing vehicle. The fuel met the specifications for aviation fuel. On the subject flight the aircraft carried enough fuel for 7 hr 45 min of flight. The fuel weighed 23 00 lb.

1.7 Meteorological information

The crew reported to the Seattle-Tacoma (SEA-TAC) Airport at 1315 hours where the pilot-in-command discussed the forecast weather and the flight plan with the dispatcher. The dispatcher stated that he had studied the U.S. Weather Bureau prognostic charts, as well as teletyped information which included area forecasts, regional forecasts, terminal forecasts and weather reports pertinent to the proposed flight. Copies of these documents were attached to the flight plan provided to the pilot-in-command.

The aircraft was to cruise at 14 000 ft between layers or on top of clouds. No other altitude offered better weather conditions.

The forecasts indicated an occluded front just east of Annette with occasional moderate turbulence expected near the front to an altitude of 22 000 ft and light to moderate icing expected west of the front - also scattered rain showers. Cloudiness of varied types and heights was depicted along the route with bases of the lowest indicated at 1 000 to 2 000 ft and tops going up to as high as 18 000 - 22 000 ft.

Another weather briefing was held at 1534 hours at McChord AFB where the crew reported to MATS operations. A horizontal weather depiction chart was provided which included U.S. Weather Bureau, USAF and Canadian Department of Transport weather data. The forecast was essentially in agreement with the earlier forecasts. Along the route from Port Hardy to Sandspit, light rime icing was to be expected at 14 000 ft.

PNA Flight 5 was over Domestic Annette at 1806 at 18 000 ft on the same route as Flight 293. The pilot-in-command testified, following the accident, that he was intermittently in clouds and noted light icing in the vicinity of Domestic Annettee. His original

cruising altitude was 16 000 ft but between Port Hardy and Sandspit he requested a change to 18 000 ft to get out of an area of light icing. He also encountered light turbulence along the route.

1.8 Aids to navigation

The aircraft was fitted with an ADF receiver.

1.9 Communications

Contact was maintained with the flight up until 1807 hours (i.e. about 2 hr 35 min after take-off) when it requested a change in altitude. No difficulties had been reported by the crew.

The pilot-in-command of PNA Flight 5, which was over Domestic Annette at 1806 (about 10 minutes prior to the estimated time of the accident), stated that heavy precipitation static near Domestic Annette blocked out communications on his high frequency radio.

1.10 Aerodrome and ground facilities

Not relevant to this accident.

1.11 Flight recorders

No mention of flight recorders was made in the report.

1.12 Wreckage

On 4 June at 0322 hours an RCAF aircraft sighted floating debris at a position determined by radar and Loran fixes to be 54°21'N - 134°39'W. (This is about 35 NM west of Domestic Annette). The debris consisted of uninflated life rafts, clothing, aircraft components and personal belongings.

Approximately 1 500 lb of aircraft wreckage were recovered.

About 60 passenger seat back cushions were recovered. In many instances they contained the aluminum seat back frames, which were extremely deformed, and most were broken in several pieces. Impact forces had collapsed many of the frames downward and sideward. A number of seat back covers, with the life vest storage compartments still zipped shut, were salvaged with the life vests in their intact plastic containers.

None of the survival equipment which was recovered showed signs of attempted use.

A few personal effects showed signs of blackening and possible charring. Laboratory examination showed that burning had occurred on one side only. Some of the recovered clothing had wood chips, splinters, and scraps of decorative cabin interior adhering to it. None had penetrated the material. The degree of damage to the clothing ranged from none at all to severe shredding and tearing.

1.13 Fire

There was no evidence of fire or explosion in flight. However, fire after impact burned portions of items floating on the water.

1.14 Survival aspects

As stated, an alert notice was issued at 1916 and an emergency was declared at 1935 hours. The sea and air search which followed was based on the last reported position of the aircraft and Flight 293's flight plan. Taking part in the search were aircraft of the USAF, the Coast Guard and the RCAF. A Japanese surface vessel, the Hosei Maru, also assisted.

Debris was sighted the following day, but no victims were recovered. All debris was taken to Annette Island for examination.

The search was terminated at 0400 hours on 7 June. Although periodic sweeps of the area followed, nothing further was found.

1.15 Tests and research

No tests were mentioned in the report.

2. Analysis and conclusions

2.1 Analysis

The take-off from McChord AFB appeared to be normal, and no problems or malfunctions were reported by the crew. While en route, the flight, cruising at 14 000 ft, reported over all reporting points as expected. Having passed over Domestic Annette it requested clearance to climb to 18 000 ft. The request may have been made to avoid turbulence or icing encountered en-route or for passenger convenience during the serving of meals. From Port Hardy north the flight was conducted in conditions favourable to icing.

Shortly after 1807 hours a radio operator at Sandspit advised the flight that PNA Flight 5 had estimated reaching Domestic Annette at 1806. The fact that this message was not acknowledged may indicate that the accident occurred about this time, or the emergency was such as to require the attention of all the cockpit crew and/or caused a loss of airborne communications.

The U.S. Navy Oceanographic Office computed a probable impact point based on drift induced by general water circulation and wind conditions. Based on the estimated impact area, reported winds and currents, it was determined that the wreckage would have drifted in a northeasterly direction at .94 kt to the point where it was discovered.

The location of the impact area, the last known ground speed and the last reported position combined to indicate that the aircraft was airborne from 5 to 9 minutes after its last radio transmission. Because of the inherent inaccuracies of automatic direction finder bearings due to instrument interpretation, atmospheric interference with radio signals, and the radio beam width at Domestic Annette, it was possible that a position error of as much as 10 NM could have occurred when the crew believed they were over Domestic Annette.

A number of adult life vests were recovered still encased in their plastic containers, with the zippers closed. It was, therefore, believed that either there was insufficient time to alert the passengers to prepare for a water landing, or they were unable to take appropriate action due to unusual aircraft attitudes.

The fragmentation of the aircraft indicated that it struck the water at a high speed. Also, the damage to the seat backs showed that forces were applied to the top of the seats. This indicated that the aircraft's fuselage struck the water nearly inverted. The concentration of the wreckage and the fact that none was found outside the general area showed that the aircraft was probably intact at impact.

2.2 Conclusions

Findings

The crew members were all well qualified and experienced on the route from McChord AFB to Elmendorf.

Checks made by the FBI, the USAF, the Army and the Coast Guard regarding the personnel aboard the aircraft on the subject flight revealed nothing of significance.

The aircraft and its powerplants had been correctly maintained in accordance with the approved procedures and directives.

At the time of departure from McChord AFB the aircraft was airworthy, and its gross weight and centre of gravity were within the allowable limits.

Sufficient survival equipment was carried aboard the aircraft.

About 2 hr 35 min after take-off the aircraft requested a change in altitude from 14 000 to 18 000 ft. No explanation was given for the change, and nothing further was heard from the aircraft.

Light icing and turbulence were reported in the area.

It crashed into the sea shortly thereafter, for reasons unknown, and all 101 persons aboard perished.

There was no evidence of a fire or explosion in flight.

There were no known missile firings in the area and the only aircraft known to be flying in the area at that time was Pacific Northern Airlines Flight 5.

Cause or
Probable cause(s)

There was not sufficient evidence available to determine the probable cause of the accident.

3. Recommendations

No recommendations were contained in the report.

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ICAO Ref: AR/811

No. 13

Sterling Airways Ltd., DC-6B, OY-EAP, accident at Copenhagen Airport, Denmark, on 13 April 1963. Report, dated November 1963, released by the Directorate of Civil Aviation, Denmark.

1. Investigation

1.1 History of the flight

On 12 April 1963, at 1521 hours GMT, Sterling Airways' DC-6B, OY-EAP, took off from Las Palmas Airport in the Canary Islands on a three-engine ferry flight bound for Copenhagen. After an intermediate refuelling stop at Barcelona, the aircraft departed again at 2224 GMT for Copenhagen. It contacted Copenhagen ATC when passing Michelsdorf on 13 April, at 0238 GMT. It was then at FL 110 which was maintained until the aircraft, when over ROBBY NDB, was cleared to descend to FL 45. At 0253 GMT, when passing PRESTO NDB at FL 60, the aircraft reported that Copenhagen Airport was in sight, whereafter the flight was performed with visual contact to this airport's runway 04. When passing marker beacon CODAN on the north coast of Stevns, the aircraft descended to 3 500-4 000 ft, the speed being normal, i.e. 170 kt. About 1-1/2 minutes later flaps were set to 20°, whereafter the speed in the course of the next few minutes was slowly reduced to 145 kt at which rate the undercarriage was extended and the flap angle was increased to 30°. The altitude was then approximately 1 500 ft and the approach towards the clearly visible runway was continued in a shallow glide. The approach was rather low, for which reason the engine power had to be increased several times in order to reach the runway. On short final - probably immediately before passing the first approach lights - the pilot-in-command ordered full flaps. The speed was then 110-130 kt and the height still rather low. Shortly after the flaps were fully extended the aircraft showed a tendency to bank which the pilot-in-command tried to counteract by applying aileron control. When the aircraft was 100-200 m from the runway threshold, the pilot-in-command realizing that he no longer had sufficient control to make a safe landing decided to abandon the landing. He ordered "pulling-up, full power, gear up, flaps twenty". The speed was then around 100 kt. The flight engineer immediately pushed the propeller pitch selector lever forward to full RPM position and thereafter advanced the throttles, at the same time moving the landing gear lever to the "up" position. When power was applied the aircraft immediately made a violent bank and an uncontrollable right-hand turn. About 10 seconds later the starboard wing tip hit the ground about 200 m beyond the threshold of runway 04 and 80 m to the right of the centre line. This caused the disintegration of the outer portion of the starboard wing whereupon the aircraft crashed. The aircraft came to a stop 220 m further on with its nose pointing roughly to 240°. The accident occurred at 0304 GMT, i.e. one hour before sunrise.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal			
Non-Fatal	2		
None	1		

1.3 Damage to aircraft

The aircraft was damaged beyond repair.

1.4 Other damage

No other damage was reported.

1.5 Crew information

In accordance with the flight manual only the minimum crew consisting of 2 pilots and one flight engineer were on board to carry out this ferry flight with one engine inoperative.

The pilot-in-command, age 43, held a valid Swedish Airline Transport Pilot's Licence, Class I, and also a Danish letter of validation. His last check flight was on 23 August 1962 under the supervision of the Danish Directorate of Civil Aviation after which he was granted a DC-6B rating. His total flying time at the time of the accident was 9 617 hours; 768 hours of which were as pilot-in-command on DC-6B aircraft.

The co-pilot, age 29, held a Danish Airline Transport Pilot's Licence Class III with instrument rating valid until 10 July 1963. His total flying time amounted, at the time of the accident, to 1 770 hours including 171 hours on DC-6B in the employ of Sterling Airways.

The flight engineer, age 42, held a Danish flight engineer's licence. His flying experience totalled about 4 000 hours, including 590 hours as flight engineer on Sterling Airways DC-6B.

All crew members' fatigue indexes were within the permissible maximum value at the time of the accident. All crew members were subjected to the sobriety test after the accident; no indication of alcohol was found.

1.6 Aircraft information

The Certificate of Airworthiness of the aircraft was valid until 27 August 1963. Of its total flying time of 33 819 hours, 103 hours had been flown since the last obligatory periodic inspection on 3 April 1963 and 36 hours since the last service check made on 9 April 1963. Sterling Airways' DC-6B fleet is maintained in accordance with an overhaul and inspection programme approved by the Directorate of Civil Aviation, Denmark. Nothing was found indicating that the aircraft maintenance was not carried out satisfactorily or that defects in the aircraft, other than the defective engine No. 4, could have affected the airworthiness of the aircraft. According to the approved Flight Manual ferry flights with one engine inoperative may be made provided the propeller of this engine has been removed or feathered.

The landing weight, approximately 31.5 t, was far below the maximum permissible landing weight. Location of the centre of gravity at the time of the accident was 15.5% MAC, i.e. well within the permissible range.

The type of fuel was not specified in the report.

1.7 Meteorological information

Weather conditions at Copenhagen Airport, Kastrup on 13 April at 0250 and 0320 hours were: wind: 310°/09; clouds: 1/8 at 800 ft; visibility: 15 km; no precipitation; barometric pressure at sea level varied from 1 016 to 1 017 mb (QNH). According to the crew the approach procedure was made in visual meteorological conditions in favourable weather.

At the time of the accident dawn was breaking on the horizon.

1.8 Aids to navigation

Runway 04 was not equipped with ILS.

1.9 Communications

Communications were normal.

1.10 Aerodrome and ground facilities

Aerodrome and ground facilities were adequate and normal. The lighting system of runway 04 was adequate and working perfectly at the time of the accident.

1.11 Flight recorders

No flight recorder was mentioned in the report.

1.12 Wreckage

A study of tracks on the ground and of the wreckage indicated that the starboard wing first hit the ground in a steep bank to the right of the runway approximately 80 m from its centre line and approximately 210 m beyond the runway threshold. No. 4 engine propeller was found quite straight, indicating that it had been stationary, while the other three propellers were twisted.

1.13 Fire

Fuel from the starboard wing was set on fire. The fire was observed from the control tower and the Airport's Fire Fighting Service was on the scene and had the fire under control within a few minutes. Fire damage was slight.

1.14 Survival aspects

The two pilots immediately evacuated the aircraft through the windows in the cockpit. When they realized that the flight engineer had not come out the pilot-in-command opened the foremost emergency exit on the port side, entered the aircraft and found the flight engineer unconscious in his seat. The pilot-in-command got him out of his seat and back to the emergency exit. The flight engineer then recovered sufficiently to leave the aircraft unassisted.

1.15 Tests and research

The four propellers with corresponding propeller governors were examined and bench tested with a view to ascertaining the engine power applied at the time of the

accident. It was concluded that No. 4 engine was feathered and that the three working engines were not set to maximum power (2 500 BHP) but to a power between 1 800 and 2 200 BHP. This corresponded to the 53" MP setting, which the flight engineer believed he remembered.

2. Analysis and conclusions

2.1 Analysis

Amongst the operational limitations for carrying out ferry flights with one engine inoperative, the following restriction is listed in the DC-6B Flight Manual: Flights with non-scheduled aircraft shall be performed in accordance with daylight contact flight rules.' It was established that the accident occurred in the hours of darkness, which is in conflict with this provision. However, considering the extremely good visibility and the excellent lighting facilities on the runway, this did not seem to have contributed to the accident.

It is also clearly stated in the DC-6B Flight Manual that during the final approach with one engine inoperative the flaps shall not be lowered to more than 30° until the pilot is positive that he will be able to complete the landing; this is in order to maintain an adequate climb performance on three engines only.

The Manual also gives the procedure for carrying out an overshoot on three engines. This procedure presumes that the overshoot will be performed with flaps lowered to 30° only and landing gear extended, i.e. the configuration between approach and landing in which OY-EAP was until the pilot-in-command ordered full flaps about 1 km from the landing threshold. It would seem that the aircraft during the entire final approach was flying at a fairly low altitude and at a speed which was rather below normal. This, and the low weight of the aircraft, would seem to indicate that the selection of full flaps was not justified in the present case, as the aircraft hardly had more energy (speed and height) than was necessary to bring it, in its actual configuration, to the runway. In selecting full flaps, without increasing the engine power at the same time, the pilot-in-command allowed the accumulated energy to become exhausted before the aircraft reached the landing runway with the result that the speed necessary for a safe manoeuvring of the aircraft on three engines was no longer available at the end of the final approach.

2.2 Conclusions

Findings

The aircraft was airworthy within the limitations specified in the flight manual for ferry flights with one engine inoperative.

The weight and the centre of gravity of the aircraft were within prescribed limits.

The crew members were duly licensed.

The regulations governing flight, duty and rest time contained in the Company's operations manual were observed in respect of all crew members.

There was no indication that technical defects in the aircraft, apart from the inoperative engine No. 4, had any bearing on the accident.

The operational limitations for ferry flights with one engine inoperative were not complied with. The flight was, contrary to the provisions of the Flight Manual, carried out as an IFR flight. This must, however, in the circumstances, be regarded as having had no bearing on the accident. The flight was carried out on the order of the Company's Flight Operations Officer who, like the pilot-in-command, overlooked this provision.

The accident occurred during performance of a pull-up manoeuvre, when the aircraft was in a configuration in which it was not certificated to carry out such a manoeuvre. This is clearly stated in the Flight Manual.

By order of the pilot-in-command to lower flaps to landing position, the aircraft was brought into the above-mentioned landing configuration at a time when its altitude and speed, in relation to the remaining approach distance, probably did not warrant such disposition.

Cause or
Probable cause(s)

During the approach to runway 04 with the starboard outer engine inoperative, the speed of the aircraft decreased to a value critical for safe manoeuvring. Because of this the pilot-in-command attempted an overshoot. In the course thereof he lost control of the aircraft which, in a heavy bank, went into an uncontrolled right-hand turn, its starboard wing hit the ground, and the aircraft crashed.

That the aircraft got into the above-mentioned critical situation must,to an essential degree, be attributed to the fact that the pilot-in-command selected full flaps at a time when the altitude and speed of the aircraft in relation to the distance from the runway threshold did not justify such disposition.

3. Recommendations

No recommendations were contained in the report.

4. Action taken

Following the subject accident the crew members went through a special training programme and submitted to medical tests and test flights.

Also, a warning was issued against premature application of full flaps in cases where multi-engined aircraft are approaching to land with one engine inoperative.

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ICAO Ref: AR/801

Commercial (ferry flight) international
Landing
Loss of control
Pilot - improper use of flaps

No. 14

Lloyd Aereo Boliviano, DC-6B, CP-707, crashed on a mountain in the Tacna District, Peru, on 15 March 1963. Report, dated April 1963, released by the Directorate General of Civil Aviation, Bolivia.

1. Investigation

1.1 History of the flight

Flight 905/15 was a scheduled international flight from Cochabamba, Bolivia, to La Paz, Bolivia, and Arica, Chile, and return via the same stops. Three crew members and 36 passengers were aboard.

The aircraft departed from Arica on the return flight at approximately 1327 hours Bolivian time. It was to be an eight-hour, VFR flight, and the aircraft was to cruise at 17 000 ft. Eight minutes after take-off the crew advised Air Traffic Control at Cochabamba of the departure time, the number of passengers aboard, the aircraft's weight and the amount of fuel being carried. Between 1347 and 1348 the air traffic controller at La Paz advised that Panagra flights 701 and 393, flying at 22 000 and 21 000 ft were estimating Charaña at 1355 and Arica at 1351 respectively. Flight 905/15 acknowledged the message. ATC at La Paz called the flight at approximately 1400 hours, and several times thereafter, to report on the new positions of the two Panagra aircraft, which were in the Arica zone but received no reply.

It was determined subsequently that the aircraft crashed into Chachacomani Peak (latitude 17°49'00", longitude 69°50'00"W) in Peruvian territory near the Chilean border at an altitude of 14 250 ft, sometime between 1351 and 1355.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	3	36	
Non-Fatal			
None			

1.3 Damage to aircraft

The aircraft was destroyed.

1.4 Other damage

No damage was sustained by objects other than the aircraft.

1.5 Crew information

The pilot-in-command, age 40, was the Chief Pilot of Lloyd Aereo Boliviano and had been with the Company for fourteen years. He held an airline transport pilot's licence and was last checked on the La Paz-Lima route in November 1961. He had flown a total of 10 069 hours, including 7 774 as pilot-in-command of which 1 319 hours had been flown on the DC-6B. During the 30 days before the accident he had flown 85 hours on the DC-6B.

The co-pilot, age 29, had a private pilot's licence and had flown 4 034 hours as co-pilot including 910 hours on the DC-6B. During the 30 days prior to the accident he had flown about 48 hours on the DC-6B.

The flight engineer, age 30, held a private pilot's licence. He had flown 5 144 hours as co-pilot including approximately 102 hours on DC-6B aircraft. During the 30 days before the accident he had flown 64 hours on the DC-6B.

All three passed their most recent medical examinations in October 1962.

1.6 Aircraft information

The aircraft had a valid certificate of airworthiness. The last airworthiness check of the aircraft was made on 10 November 1962. It had flown 1 686 hours since its last major overhaul, and the airframe and engines had undergone adequate and systematic periodic maintenance checks.

The weight and balance sheet for the aircraft was incorrectly filled out at Arica. It showed a margin of 249 kg between the aircraft's weight and the maximum permissible. It was found subsequently that the margin was, in fact, 1 298 kg, i.e. the difference between the aircraft's gross weight at take-off (36 632 kg) and the maximum authorized (37 930 kg) in case of landing restrictions at the aerodrome of destination. It was also estimated that at the time of the accident the aircraft's gross weight was 35 965 kg, which was less than the maximum allowable.

On departure from Arica the aircraft was carrying 1 600 gal of fuel weighing approximately - 4 240 kg. The position of the centre of gravity was not mentioned in the report.

1.7 Meteorological information

The following weather conditions were forecast for the subject flight:

> "In high terrain, during the early hours of the morning, cloudy, altostratus, with cumulus below, changing to partial cloudiness in the afternoon. On the high plateaus, generally cloudy, stratocumulus, cumulus, local showers. Coast cloudy, partly cloudy, stratocumulus."

The Tacora Passes were expected to be open, and the winds forecast were as follows:

10 to 14 000 ft: 200°/10 kt
15 to 18 000 ft: 300°/15 kt
winds on the coast: 5 - 10 000 ft: 180°/8 kt
15 000 ft: 200°/8 kt
20 000 ft: 240°/10 kt

An analysis of the weather data provided by Charaña indicated that the strato-cumulus and cumulonimbus cloud bases were lowest during the day. It also showed that the Tacora Passes remained open, stratus and cumulonimbus clouds and showers being concentrated west-southwest and northwest of Charaña. This indicated a predominance of low clouds and rain in the passes.

Even in clear weather, there is continuous and severe turbulence at midday throughout the mountain zone of the country. The formation of cumuliform clouds and of cumulonimbus cloud, (2/8 were reported by Charaña), indicated that the weather conditions in the area were marginal for flights conducted below 17 000 ft.

Two Panagra aircraft were flying the route at 21 000 and 22 000 ft in the vicinity of the accident at about the time it occurred. The crew members said that the Tacora Volcano pass was cloudy and rainy and that it was not open for VFR flight even above 17 000 ft. Information provided in their statements included the following: ".. We flew IFR in rain and clouds from a point immediately southwest of Charaña outside the Tacora pass." "The Tacora pass was covered by stratus of the low type. The zone of the accident as well as the Tacora mountain itself appeared covered with clouds. We could see through the pass at 16 500 to 17 000 ft over the top of the clouds and light rain."

1.8 Aids to navigation

The aids available along the route were not indicated in the report.

The aircraft was equipped with the following aids: two VHF VOR/localizers, two VHF glide scopes (ILS), one marker beacon, two automatic radio compasses and weather radar. All were in satisfactory working condition.

1.9 Communications

The aircraft carried an HF transceiver and a VHF transmitter.

Communications were normal until 1350 when the aircraft exchanged messages with Cochabamba. This was the last contact.

1.10 Aerodrome and ground facilities

Not relevant to the accident.

1.11 Flight recorders

No mention of flight recorders was made in the report.

1.12 Wreckage

The aircraft first struck the mountain peak at an altitude of 14 250 ft, leaving a scar on the rocky terrain caused mainly by the right lower part of the aft fuselage. Propellers No. 3 and 4 struck immediately thereafter. The wreckage was scattered over a uniformly ascending area 400 ft wide and 900 ft long up to an altitude of 14 550 ft on a true compass heading of 80°. The first impact made a crater about 24 ft wide and 3 ft deep.

The distribution of the wreckage and the almost complete disintegration of all the wing surfaces and components, centre section of the wing and right side of the stabilizer showed that those were the parts that were destroyed first, and the most completely. The parts and components of the left side, of relatively larger size, were dispersed and fell further away than those of the right.

1.13 Fire

The general distribution of the wreckage showed that there was no fire such as could have been produced by the approximately 1 400 gal of fuel aboard the aircraft at the time of the accident. This was due to the violence of the impact loads, which atomized the fuel. The explosion which followed impact produced only slight burns on the wreckage, which showed no signs of intense heat. Ninety percent of the wreckage bore no marks of fusion, fire or soot.

1.14 Survival aspects

No information was contained in the report concerning the search for the aircraft.

All the supports of the passenger seats were broken, and the frames were twisted. A number of the seats had disintegrated completely. Some of the seat belts had broken under tension, and others apparently were not fastened at impact.

1.15 Tests and research

No information in this respect was contained in the report.

2. Analysis and conclusions

2.1 Analysis

Communications received from the aircraft while en route were normal, and no difficulties were reported regarding the flight up to the time of impact.

The aircraft was supposed to be flying VFR at 17 000 ft. However, it could not fly in accordance with its flight plan because of the prevailing weather conditions. Other pilots, of aircraft in the area around the time of the accident, stated that the Tacora Volcano pass was closed to low level visual flight, and there was low stratus cloud, rain and severe turbulence in the area.

Based on the wreckage pattern, the collision with the peak occurred as follows. There was no structural failure of the aircraft or its engines prior to impact. The aircraft first hit the peak with the lower right rear portion of the fuselage and propellers No. 3 and 4. At the time it was in a pronounced climbing attitude practically parallel to the slope of Chachacomani Peak, which has a gradient of 55° at this point. After impact the aircraft's trajectory on the surface of the peak sloped 23.5° upwards for a distance of 300 ft and the underside of the fuselage, particularly the right side disintegrated, and main components broke away. The aircraft continued climbing along a line approximately parallel to the surface of the peak, i.e. at a nose-up angle of about 55°. The wing centre section, the lower part of the fuselage and a portion of the passenger compartment came to rest against a large rock 300 ft further on. The rest of the top and left parts of the fuselage and the seats continued on for some distance, together with 20 passengers, who were thrown forward in free fall.

All four propellers had blades broken at the roots. Splinter analysis showed a typical static rupture on all the propeller blade fragments found. The position of the propeller blades could not be an indication of their exact pitch before the crash since the distribution valves had been moved from their original position as a consequence of impact. However, the position of the blades that remained on the hubs did provide evidence of high power and rpm.

The damage to the four engines was similar. There was more damage to the lower cylinders than to the others. All engines had their gear shafts and impeller shafts broken by rapid deceleration. This confirmed they were running at high power at impact.

The manner in which the aircraft was destroyed, the uniform distribution of the wreckage, and the high degree of disintegration led to the conclusion that the aircraft was flying at a speed of approximately 180 kt. At that speed impact loads would be high. This would account for the magnitude of the break-up. The majority of the main structural parts showed the characteristics of instantaneous ruptures of the static type, which resulted from loads well in excess of their structural limits. The loads were a combination of compression, torsion, flexion and shearing. None of the parts showed signs of a free fall. The destruction of the aircraft resulted entirely from impact loads. An explosion followed impact.

The pilot-in-command knew his position with respect to the pass normally used in this part of the mountain range. This was established by the trajectory of the wreckage, which was oriented on a true heading of 80°.

The normal pass orientation is 50°. This means that on account of the weather the aircraft flew farther north looking for a better pass. It then needed a heading of 80° to intercept the usual route to Charaña.

The time of the accident was between 1350 Bolivian time (when the aircraft made its last contact with Cochabamba) and 1400 hours (the approximate time of the unanswered call from Air Traffic Control at la Paz).

This represents an en-route flight time from Arica to the crash site of between 18 and 28 minutes, of which the average is 23, during which the aircraft flew a distance of 68 NM at an average true airspeed of 177 kt.

2.2 Conclusions

Findings

The crew members on the subject flight were duly qualified.

The aircraft had a valid certificate of airworthiness and had been properly maintained. Its gross weight at the time of departure from Arica was below that authorized for the Arica-La Paz segment of the trip.

Except for the fact that the aircraft's dispatch form was incorrectly filled out, the flight dispatching requirements had been satisfactorily completed.

Because of the existing weather conditions, the aircraft could not fly in accordance with its flight plan which called for VFR flight at 17 000 ft. Instead, it was flying at approximately 14 000 ft.

A study of the area of the accident proved that 16 000 ft was the minimum altitude at which the Tacora pass could be flown VFR in visual meteorological conditions.

Examination of the wreckage and of its distribution indicated clearly that at impact the engines were functioning at high rpm, and there was no structural failure of the aircraft prior to impact.

Cause or
Probable cause(s)

A flight under visual flight rules was attempted below the minimum altitude indicated in the flight plan in weather conditions that were marginal for this type of operation and were associated with the severe turbulence which usually exists in that region (western area).

3. Recommendations

No recommendations were contained in the report.

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ICAO Ref: AR/805

No. 15

Aaxico Airlines, Inc., C-46F, N 67941, crash-landed near Great Falls, Montana, on 14 August 1963. Civil Aeronautics Board (U. S. A.) Aircraft Accident Report, File No. 1-0010, released 1 May 1964.

1. Investigation

1.1 History of the flight

LOGAIR (logistic air support) Flight 1814, a cargo flight, originated at 0525 hours mountain standard time at Hill Air Force Base (AFB), Ogden, Utah and proceeded to Boeing Field, Seattle, Washington and Malmstrom AFB, Montana, where it arrived at 1308 hours following an uneventful trip. The approach to runway 20 appeared normal, but the aircraft made a hard landing, and the right engine subsequently stopped. However, it was restarted, and the aircraft was taxied to the ramp parking area. No significant discrepancies were noted in the aircraft's engine log, and the flight crew made no attempt to determine the cause of the right engine's stopping.

Another crew, consisting of a pilot-in-command and a co-pilot, took over the aircraft for the return flight to Hill AFB via Minot AFB, North Dakota and Ellsworth AFB, Rapid City, South Dakota. Ground observers heard the right engine backfire several times after starting. The pilot-in-command shut down both engines and determined that the right engine fuel selector valve was not properly seated. Both engines were then restarted and ran normally, and the aircraft checked out properly on run-up.

After a normal take-off from Malmstrom AFB at 1404, power was reduced to Maximum Except Take-off (METO) which was 2 550 rpm and 44 in. Hg, and a left turn was initiated. About 500 ft above the surface, climb power of 2 500 rpm and 38 in. Hg was established. Both engine oil inlet temperatures were between 95 and 100°C. After about 10 minutes of climb at airspeeds varying from 125 to 130 kt, the aircraft was about 20 miles from Malmstrom AFB at an altitude of 4 500 ft. The right engine oil inlet temperature gauge was indicating 115°C at this time. (The FAA-approved Flight Manual for Aaxico Airlines shows the maximum authorized inlet oil temperature as 93°C.) The left engine oil inlet temperature gauge still indicated between 95° and 100°C.

Power was then reduced to 2 250 rpm and 34 in. Hg, and the rate of climb was between 0 and 100 ft/min. The left engine oil inlet temperature gauge then read just under 95°C, and the right engine's gauge read between 100 and 105°C. The aircraft was climbed for 10 more minutes at this setting, then the pilot-in-command brought the engine to cruise power for a few minutes. Shortly thereafter he realized that he needed more altitude and again increased power to 2 400 rpm and 38 in. Hg. The climb was resumed, and the pilot-in-command stated that the right engine oil inlet temperature rose to 120°C, and the oil pressure dropped to 50 lb. When the aircraft had reached 5 500 ft the pilot-in-command noticed the right engine oil gauge indicated only 20 gal of oil remaining out of a total of 30 gal.

At about this time the right engine began to backfire so the engine was shut down, the propeller was feathered, the left engine was set at 2 400 rpm, and the aircraft was in a slight descent at an airspeed of from 100 to 105 kt. The cowl flaps of the left engine were placed in trail position. Prior to shutdown of the No.2 engine, the cowl flaps were left at the closed position, oil pressures remained at about 50 psi, and cylinder head temperatures remained at about 200°C. The aircraft was then 50 NM east-northeast of Malmstrom AFB and 12 miles past Geraldine Airport, Montana.

Course was reversed to return toward Malmstrom AFB and a gradual descent of from 100 to 200 ft/min was begun. When the pilot-in-command saw Geraldine Airport he believed he was 300 to 400 ft above the terrain.

The aircraft flew west past Geraldine Airport, and power was increased to 2 550 rpm on the left engine. The airspeed dropped to 100 kt, and the aircraft was descended to a lower altitude because the pilot-in-command believed that ground effect would help him to maintain altitude. He then turned the aircraft to the northwest where the terrain appeared to be lower. The airspeed dropped to below 100 kt, and the pilot-in-command went to "full power". Airspeed dissipated through 95 kt, and altitude could not be maintained. Several turns then had to be made to avoid the rolling terrain. At this time the left inlet oil temperature gauge indicated 130°C, cylinder temperature 200°C, and the airspeed had dropped to 90 kt.

The aircraft approached a dry lake, and the co-pilot suggested the possibility of a landing on the lake. However, as the pilot-in-command could still maintain 90 kt with METO power, he did not consider this necessary.

The airspeed then dropped below 90 kt, and the pilot-in-command realized he would have to make a crash-landing. Shortly thereafter the aircraft crashed in a plowed field and skidded into a small earthen dam approximately 35 miles east-northeast of Malmström AFB. The co-ordinates of the site were 47°42'N - 110°30'W. The accident occurred at approximately 1500 hours.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	1		
Non-Fatal	1		
None			

1.3 Damage to aircraft

The aircraft was substantially damaged.

1.4 Other damage

No damage was sustained by objects other than the aircraft.

1.5 Crew information

The pilot-in-command, age 41, had flown a total of 15 834 hours. He held an airline transport pilot's certificate with single and multi-engine land ratings for C-46, DC-4, DC-6 and DC-7 aircraft. He received his C-46 rating in 1950 and since that time had flown 5 807 hours on the C-46 as pilot-in-command. His latest C-46 proficiency check was passed successfully on 15 June 1963 when he also requalified as pilot-in-command on this aircraft type. On 1 July he was assigned as pilot-in-command on C-46 aircraft, and at the time of the accident he had accumulated 108 hours of C-46 pilot-in-command time on LOGAIR missions.

The co-pilot, age 43, had flown a total of 13 606 hours including 113 hours on C-46 aircraft. He held an FAA airman's certificate. His most recent line and proficiency checks were on 5 July 1963 and 17 June 1963 respectively.

There were no other crew members aboard the flight.

1.6 Aircraft information

The aircraft was transferred from Aaxico to Capitol Airways in 1960, then to Zantop Air Transport in 1962 and back to Aaxico in 1963. By using the pro-ration formula authorized in FAA Advisory Circular No. 121-1 establishing the time remaining before next overhaul for another operator acquiring the aircraft, Aaxico gained 791 hours.

The right engine was last overhauled and zero timed on 13 November 1962. It had been installed on and removed from two other aircraft prior to its installation on this aircraft on 26 June 1963 with 814 hours since overhaul. Although the aircraft was under lease at the time, this installation was accomplished under the supervision of an Aaxico maintenance representative. All writ-ups on the engine subsequent to its last overhaul revealed no significant chronic malfunctions or items to suggest future failures.

The gross take-off weight of the aircraft was 47 124 lb, which was below the maximum allowable of 48 000 lb. The centre of gravity was also within the allowable limits.

While at Malmstrom AFB, 260 gal of 115/145 octane fuel were added to bring the total fuel aboard to 600 gal.

1.7 Meteorological information

The weather conditions at Malmstrom AFB at the time of departure were:
scattered clouds at 7 000 ft, visibility 55 miles, temperature 89°F, dew point 47°F, wind 310°/17 kt, altimeter setting 29.98.

1.8 Aids to navigation

Not relevant to the accident.

1.9 Communications

During the emergency, no attempt was made to establish radiocommunications with any facility.

1.10 Aerodrome and ground facilities

Malmstrom AFB has a field elevation of 3 525 ft amsl. Terrain east of Malmstrom within 25 to 30 NM rises to heights of more than 5 000 ft. Elevations then decrease en route to Minot AFB and average 2 500 to 3 000 ft over the plains areas.

Geraldine Airport is located 1 statute mile south of the city of Geraldine, Montana. It has an east-west, hard-surfaced, 2 900 ft runway at an elevation of 3 180 ft msl. There are no approach obstructions, and the airport is situated on level terrain 37 NM east-northeast of Malmstrom AFB. The runway had been extended from 2 500 ft to 2 900 ft and was resurfaced the day before the accident. (The shortest landing distance permitted by Civil Aeronautics Manual 42 for the subject aircraft, under the existing conditions, was approximately 3 380 ft.)

1.11 Flight recorders

No flight recorder information appeared in the report.

1.12 Wreckage

The aircraft was found at the foot of a small earthen reservoir dam which is approximately 3 500 ft in elevation. The fuselage was on a heading 90° to the left of the original ground path. 750 ft from the point of initial ground impact. The crash site was located at the bottom of a steep slope over which the aircraft passed.

The cockpit area was torn open with the cockpit lying on its right side approximately 90° to the fuselage. The fuselage and wings were intact but buckled or wrinkled in various areas. The flaps were found in the "up" position. Flight and engine control cables were either severed or jammed at various positions within the fuselage.

The two propeller assemblies were extensively damaged as a result of ground contact.

1.13 Fire

There was no fire.

1.14 Survival aspects

No information in this respect was contained in the report.

1.15 Tests and research

Examination of the right engine indicated that the front master rod bearing had failed and had been flattened and squeezed out over the link pins that connect the link rods to the master rod cluster. Metal particles clogged the lubrication hole in the front crankpin, and the front crankpin journal was scored and imbedded with metal. The secondary counterbalance and the rear master rod bearing and cam bearings were all heavily scored.

Metal particles were present in the nose case, the scavenger screens and pumps, the oil cooler, the front crankpin journal, and the lubrication holes of the front counterweight bearing. Many of the oil system jets were clogged by metal particles.

The right engine oil pressure regulator valve was stuck in the "full pressure" or minimum by-pass position, and its appearance indicated that it had been subjected to considerable heat. There was no evidence of any foreign material in the valve.

2. Analysis and conclusions

2.1 Analysis

No evidence of pre-impact failure was found in the propeller, fuel or oil systems of the left engine. Examination of the right engine together with the pilot-in-command's statement and observations of witnesses, all confirmed that this engine had been operating for some time at an excessively high oil temperature with a failure in progress. The high temperature was due to the failure of the front master rod bearing. This resulted in a rise in friction and higher than normal oil temperature. The normal oil flow and cooling were not adequate to compensate for the added heat conduction. The engine oil system became contaminated with sludge and metal as the bearing failure progressed with the final overtravel and breakup of the pistons.

The pilot-in-command tried to lower the oil temperatures by descending the aircraft with engine power reduced. However, the oil inlet temperature continued to be excessive even after power reductions.

When the aircraft was about 500 ft above the ground after take-off, oil inlet temperatures on the right engine began to exceed maximum allowable temperatures. The Board believed that a reasonably prudent pilot would have made a determined effort to lower the temperatures and if they did not decrease would have returned to the aerodrome of departure.

Witnesses observed black smoke coming from the right engine as the aircraft progressed eastward. The continued excessively high oil inlet temperature and the drop in oil pressure after power reduction should have been an indication to the pilot-in-command of an abnormally operating engine.

When the aircraft was about 500 ft above the terrain (3 500 msl) and within 50 NM of its departure point, the right engine began to backfire, and the pilot-in-command shut it down and feathered the propeller. Normal feathering was reflected in the pilot-in-command's statements and in the examination of the propeller assembly.

The pilot-in-command then reversed course and began a 100 to 200 ft/min descent.

According to C-46F performance criteria in Federal Aviation Regulations, Civil Aeronautics Manual 42, the aircraft, under the existing conditions, should have been able to operate on one engine and maintain a 50 ft/min climb within altitudes well above the accident site.

The landing distance required for the aircraft's weight and configuration was greater than the 2 900 ft available at Geraldine Airport. However, it was felt that the aircraft could have been landed there and braked to a stop with a minimum of damage to the aircraft and without loss of life.

The aircraft was flying low, with uneven terrain on all sides, and the pilot-in-command had to fly in the directions of lowest elevations. This required constant heading changes during which the aircraft banked to 45°, at times. As a result, the airspeed continued to decrease. The left engine oil temperature had increased appreciably beyond normal operating limits although the pilot stated that the power was normal for the density altitude. Considering the aircraft's manoeuvres and density altitude, the

fact that the airspeed dropped below 100 kt is not abnormal. The flight with constant banks and turns continued to bleed off airspeed and prevented the aircraft from obtaining its normal single-engine rate of climb in time to avoid contacting the terrain. When airspeed dropped below the best METO climb speed of approximately 113 kt, and then reduced further to airspeeds below minimum control speed (V_{MC}), it was obvious that a landing had to be made.

There were several areas where an emergency landing could have been carried out successfully. However, the pilot-in-command did not take advantage of them. He stated that he selected a field for the emergency landing, however the Board felt that although the pilot was aware of the imminence of a crash-landing, the crash area was selected for him by circumstances over which he had no control at the time.

The Board concluded that he improperly assessed his engine instrument readings, lacked knowledge and training in areas of aircraft performance and displayed poor judgement.

2.2 Conclusions

Findings

The crew were properly certificated.

Following the last overhaul of the aircraft's right engine in November 1962, no significant malfunctions had been reported.

Regarding the left engine, there was no evidence of pre-impact failure in its propeller, fuel or oil systems.

The aircraft had been operated 791 hours beyond the approved overhaul time limit.

At the time of departure from Malmstrom AFB, the aircraft's gross weight and centre of gravity were within the authorized limits.

About 20 miles from Malmstrom, when the aircraft had reached an altitude of 500 ft, the co-pilot noticed that the right engine oil inlet temperature gauge was indicating 115°C, which was 22° higher than that recommended in the flight manual used by the Company. This resulted from failure of the front master rod bearing. Efforts were made to lower the oil temperatures, but they were unsuccessful.

About 50 NM from Malmstrom the right engine began to backfire; so it was shut down, and the propeller was feathered.

The aircraft then turned back towards Malmstrom AFB and passed near Geraldine Airport where there was a landing strip available, which was shorter than that required for the subject aircraft. No attempt to land at Geraldine Airport was made.

After passing Geraldine Airport the aircraft had to constantly make heading changes and turns to avoid striking the uneven terrain which surrounded it. This caused the airspeed to continue decreasing. When it had dropped below 90 kt, the aircraft had to be crash-landed.

Cause or
Probable cause(s)

The pilot-in-command failed to effect a proper and timely assessment of a power plant malfunction. This was followed by improper judgement and technique during a single-engine emergency operation.

3. Recommendations

Following the investigation of this accident, the Board recommended to the Federal Aviation Agency:

- that the pro-ration formula used in FAA Advisory Circular No. 121-1 be reviewed to assure that the time since overhaul of airframes cannot be adjusted, as a result of transfer of aircraft, beyond the approved actual time since overhaul;
- that the aircraft records of Aaxico Airlines' fleet of C-46 aircraft be reviewed in order to assure that no other aircraft are being operated beyond their approved overhaul time limit by virtue of application of the pro-ration formula.

4. Action taken

By March 1964, the Federal Aviation Agency had carried out an investigation of the maintenance practices of Aaxico Airlines and had taken steps which resulted in improved engine performance and reliability of C-46 aircraft belonging to this Company.

Regarding the FAA's Advisory Circular 121-1 pertaining to the transfer of aircraft from operator to operator, the Agency considered the pro rata time control system described in the Circular to be basically sound. The unusual combination of circumstances, which resulted in the overhaul time combination obtained by Aaxico, was not anticipated when AC 121-1 was prepared. Therefore, in view of experience, the FAA, in March 1964, studied a revision intended to preclude intentional or inadvertent time accumulation in the transfer transactions.

ICAO Ref: AR/813

No. 16

Standard Airways, Inc., Lockheed Constellation L-1049G, N 189S, accident at Manhattan Municipal Airport, Manhattan, Kansas, on 28 May 1963. Civil Aeronautics Board (U.S.A.) Aircraft Accident Report, File No. 1-0007, released 28 April 1964.

1. Investigation

1.1 History of the flight

The aircraft was operating under a military contract as Civil Air Movement (CAM) Flight 388C. It was serviced at the Company's maintenance base at Long Beach, California and flew to Daggett, California, where it arrived at 1245 hours central standard time. The crew consisted of a pilot-in-command, a co-pilot, a flight engineer, two stewardesses and a pilot/observer. Sixty-four U.S. Army personnel then boarded the aircraft and were briefed by a stewardess regarding emergency exit locations, emergency equipment and procedures. The aircraft took off from Daggett at 1345 for Manhattan, Kansas on an IFR flight plan, however, this flight plan was cancelled at 1720 hours when in the vicinity of Salina, Kansas. The letdown to Manhattan Municipal Airport was made in clear weather, and the aircraft entered a normal left-hand traffic pattern for a VFR approach to runway 21. The flight then entered an extended down wind leg at an altitude of 2 500 ft msl, and the aircraft was turned onto a left base leg for runway 21 at which time the before-landing checklist was completed. The landing gear was extended, the flaps were set at 60% and 2 400 rpm was selected for all propellers. Shortly thereafter the No. 3 propeller surged to about 2475 rpm so the flight engineer placed the No. 3 propeller control switch in the manual position, decreased rpm to 2400 and repositioned the switch to automatic. The rpm then remained nearly steady. A left turn onto the final approach was completed at an altitude of approximately 900 ft above ground level and at an airspeed of 140 kt. During the final portion of the approach 100% flaps were extended, and the airspeed was reduced to 120 kt. At about 170 ft above ground level the right wing started down, the aircraft yawed to the right, and an abnormally high rate of descent was noticed by the pilot-in-command. He, therefore, added considerable power to all four engines. Control forces increased immediately, and the rate of descent increased alarmingly. According to the pilot/observer, the No. 3 reverse light came on about 75 ft above the ground. Within seconds the aircraft struck the ground. Initial impact occurred in a wheat field, 546 ft from the threshold of runway 21. The aircraft bounced once and continued through the wheat field on all three landing gears until it struck an embankment, 3-1/2 ft high, located 176 ft from the threshold of the runway. The nose gear and the right landing gear were torn off at this point, and the right wing separated when the aircraft contacted the threshold of the runway. The aircraft slid 774 ft down the runway, losing its left landing gear and the left wing. The fuselage finally came to rest on a heading of approximately 270°, 72 ft from the right side of the runway. The accident occurred at about 1746 hours.

A rapid and orderly emergency evacuation followed. Small fires were ignited in the wing and fuselage fuel tanks during the impact sequence, but they did not reach major proportions until after the aircraft was completely vacated.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal			
Non-Fatal		1	
None	6	63	

1.3 Damage to aircraft

The aircraft was substantially damaged by impact and destroyed in the resultant fire.

1.4 Other damage

No damage was sustained by objects other than the aircraft.

1.5 Crew information

The pilot-in-command, age 44, held a valid airline transport pilot's certificate with ratings for several aircraft including the Lockheed Constellation. He had flown a total of approximately 16 200 hours including 3 287 hours in the Lockheed Constellation and 357 hours in the Model 1049G. He had undergone an FAA en-route inspection on 12 August 1962 and had satisfactorily completed a Company proficiency check on 9 March 1963. He held a valid FAA first-class medical certificate.

The co-pilot, age 39, held a valid FAA commercial pilot's certificate with multi-engine land and instrument ratings. He had flown a total of 9 000 hours including 2 500 hours in L-1049G/H type aircraft. He satisfactorily completed his last FAA flight proficiency check on 31 December 1962. His FAA first-class medical certificate, dated 12 October 1962, stated that he should possess correcting glasses for near vision while exercising the privileges of his airman's certificate.

The flight engineer, age 39, held a valid FAA flight engineer's certificate. He had flown 4 395 hours as flight engineer including 1 150 hours in L-1049G/H and 749 type aircraft. On 3 November 1962 he completed an equipment and proficiency check and an FAA en-route check.

The pilot/observer was assigned to this flight to observe operating procedures prior to transitioning to L-1049 aircraft.

The two stewardesses were satisfactorily certificated and had completed emergency evacuation training on Constellations. One of them was to undergo her initial stewardess proficiency line check on the subject flight.

1.6 Aircraft information

The aircraft was certificated by the FAA on 3 August 1962.

The only maintenance required at the Company's maintenance base in Long Beach, California prior to departure for Daggett was the replacement of the Y-lead,

high tension ignition leads, and spark plugs of cylinders No. 12 and 13 on the No. 3 engine.

At Daggett a visual ramp inspection of the aircraft was carried out by FAA and MATS inspectors. The only discrepancy noted was a small area of corrosion on the underside of the aft fuselage in the vicinity of the lavatory service area. The aircraft required no servicing or maintenance, and there were no carry-over maintenance items reported.

At the time of take-off from Daggett, the aircraft's gross weight was computed as 116 520 lb. Its gross weight and centre of gravity were both within the prescribed limits.

At the time of the accident the aircraft had a total time of about 19 804 hours, including 796 hours since its last overhaul. No. 3 engine and No. 3 propeller had total times of 14 048 and 7 649 hours respectively.

The type of fuel being used by the aircraft was not stated in the report.

1.7 Meteorological information

The FAA Flight Service Station located at Manhattan Municipal Airport reported the weather conditions at the airport as follows: surface wind: west-northwest 6 kt; altimeter setting: 29.97 inches. The skies were clear, and visibility was 15 miles.

1.8 Aids to navigation

Not relevant to the accident.

1.9 Communications

No information in this respect was provided in the report.

1.10 Aerodrome and ground facilities

There is no air traffic control tower at Manhattan Municipal Airport. The field elevation is 1 060 ft amsl. Runway 21 is 5 500 ft long and 100 ft wide.

1.11 Flight recorders

Flight recorders were not mentioned in the report.

1.12 Wreckage

The aircraft struck the ground 546 ft from the approach end of runway 21. The right main landing gear and nose gear were subsequently sheared from the aircraft, and the right wing separated from the fuselage. When the aircraft slid down the runway, the left main landing gear had failed, and the left wing had separated.

1.13 Fire

Fire broke out following impact. It destroyed the fuselage and both wings.

1.14 Survival aspects

As stated, there was a rapid and orderly evacuation of the aircraft. The passengers and flight crew members left the aircraft through emergency exits and the rear passenger door.

1.15 Tests and research

Examination of the engines revealed the following discrepancies affecting the airworthiness of the engines:

1. The fire extinguisher manifold to the No. 2 PRT on the No. 1 engine had a wear hole 5 inches from its outlet.

2. The magneto lead connector plug on the No. 2 engine was not safetied.

3. Connector plugs for the left and right cowl flap actuators on the No. 2 engine were safetied backwards.

4. The spark plugs in engines No. 3 and 4 were not the approved type for TC18DA series engines.

5. The timing ring lock nut of the left distributor of the No. 4 engine was not safetied.

6. The retaining nut of the No. 2 PRT on the No. 4 engine was not safetied.

The electric propeller assemblies were extensively damaged by impact. The damage was generally concentrated on the blades and slip ring assemblies. Only No. 3 propeller assembly showed evidence of operating failure prior to impact. The No. 3 propeller was at a blade angle of plus 1° in the reverse pitch range. The specified low blade angle setting is 23.7°.

Detailed examination of the No. 3 propeller power unit revealed that the threaded brake cage of the pitch change motor was unscrewed three threads and the two cage lock safety bolts were missing. The armature of the pitch change motor was free to rotate. The brake clearance was .052 inches. (The specified brake clearances range from .008 to 018.) Two of the brake cage locking bolt slots were worn excessively, with the wear pattern extending into the cage retaining threads. The lower cage shoulder showed indications of wear by the locking bolts. The outer diameter of the splined disc duplex brake plate assembly contained two areas of heavy battering. Two of the brake cage window struts showed signs of heavy battering in the unscrewed direction in the area above the normal position for the brake cage wrench.

1.16 Maintenance aspects

The Civil Air Regulations require the carrier to prepare and maintain a maintenance manual which contains full information pertaining to the maintenance, repair, and inspection of aircraft and equipment. All repairs, alterations and maintenance are to be performed in accordance with procedures set forth in the manual.

The procedures used by Standard Airways for component identification and time control were implemented through the use of the Cardex system in conjunction with the manual and aircraft flight log.

A review of the maintenance records of N 189S showed that they did not provide an accurate history of the aircraft and engine components. Many instances of inaccurate, erroneous and incomplete data were found as well as evidence of time controlled components remaining on the aircraft beyond replacement times.

Also, maintenance records for the failed propeller power unit (No. 3) were conflicting and incomplete. From them, accurate component time control information could not be obtained.

On 18 - 19 February 1963 a MATS (Military Air Transport Service) inspection team inspected the Company's maintenance facility at Long Beach, California. The results of the inspection were satisfactory. The only discrepancy noted was that the component time control cards were not being kept up-to-date.

On 9 April 1963 the FAA met with Standard Airways to rectify deficiencies in the Company's maintenance programme. It was agreed that a closer monitoring of logbooks and maintenance records was needed. Also, the FAA was to continue inspecting the Company's records and maintenance manuals, and the Company was to make the necessary revisions and corrections as soon as possible. The completion date of this project was not to exceed 27 May 1963. However, as of the date of the accident, 28 May 1963, it had not been completed.

2. Analysis and conclusions

2.1 Analysis

At impact the aircraft was in a right bank of approximately 15° and aligned slightly to the right of the runway centre line. The three landing gears were down and locked, and the wing flaps were symmetrically extended to the full down position.

There was no evidence of any aircraft structural or system failure prior to impact.

The No. 3 propeller assembly was at a blade angle of +1° at impact. This was 22.7° below the specified low blade angle setting and in the reverse pitch range. The threaded brake cage locking bolts were missing, and the cage had unscrewed three threads. This resulted in an excessive brake clearance of .052, which rendered the brake incapable of propeller control.

It was evident from examination that the brake cage was not properly tightened the last time it was installed and was subjected to repeated cycles of loosening and tightening over a prolonged period of time.

The wear patterns on the cage safety bolt slots were indicative of repeated cycling predominantly in the loosening direction. These repeated cycles of loosening and tightening eventually caused failure of the safety lock bolts. This was evident from the battered condition of the splined disc duplex brake as well as the wear patterns on the top and lower surfaces of the inboard brake cage ring. After the failure of the safety lock bolts, the cage would tend to unscrew to whatever extent would be provided by the cycling action of the pitch change motor in addition to normal vibration effect.

It was determined that the propeller power unit was installed in the No. 3 position of another aircrat (N 9742Z) on 10 July 1962, following an overhaul on 6 July. All propeller units were adjusted on this aircraft on 6 January 1963. Then on 4 February 1963, No. 3 propeller unit was removed and installed in the No. 3 position on the subject

aircraft (N 189S) where it remained until the time of the accident. According to the aircraft's flight logs, no further adjustment was made.

According to the manufacturer's maintenance manual, a cage wrench shall be used when installing the brake cages on the power units. However, maintenance personnel at Standard's Maintenance Base stated that, since there was no cage wrench on the Base, a strap wrench was used for this purpose. Because of the tapered surface of the cage, it is considered highly unlikely that proper tightening of the cage would be obtained through the use of a strap wrench. This may explain why two different cage assemblies wore through the safety bolts and became unscrewed at nearly the same time - No. 3 cage on N 189S, which failed on 28 May 1963, and No. 2 cage on N 9742Z, which failed subsequently on 3 June 1963.

The crew of N 189S stated that the No. 3 propeller rpm surged when approach power was being established for the landing at Manhattan. This surging was due to the lack of adequate propeller brake action. As the airspeed and power were reduced for landing, the synchronizer continued to maintain the selected 2400 rpm. However, with the brake inoperative on the No. 3 power unit, the blades of that propeller continued to move to a lower blade angle in order to maintain the selected rpm as the airspeed was reduced. Eventually, the blades went beyond the low limit switch and into the reverse pitch range. The fact that this propeller had moved into the reverse range was confirmed by the observer/pilot, who saw the No. 3 reverse light come on when the aircraft was 75 ft above the ground.

With the No. 3 propeller in the reverse pitch range, the increased drag would tend to yaw the aircraft to the right, the right wing would drop due to loss of lift behind the propeller disc, and an increased rate of descent would result. Addition of engine power at the airspeed involved (115 kt or less) resulted in forward thrust from engines No. 1, 2 and 4 and negative thrust with high drag forces from engine No. 3. The combination of these forces, at the airspeed and altitude at which N 189S was operating, resulted in an accelerated descent that could not be overcome prior to contact with the ground.

Descent rate calculations using known factors of weight, airspeed, engine power and aircraft configuration were made by the Lockheed Aircraft Corporation. A descent rate of approximately 730 ft/min prior to the propeller malfunction was calculated using the above factors. Since absolute values for loss of wing lift and drag, due to reversal of the No. 3 propeller, were not available, assumed values of 15% loss of lift over the right wing and 6 000 lb increase drag were used. It was found that with all engines developing approach power, the No. 3 propeller in reverse thrust, and No. 1, 2 and 4 propellers in forward thrust, the descent rate would increase to about 1 845 ft/min. Then, with about 50 inches of engine power applied to this combination, it was indicated that the descent rate would eventually decrease to about 535 ft/min.

The calculations were intended only as a rough approximation of the relative magnitudes of the unexpected increase in descent rate with which the pilot was suddenly confronted.

Using the same conditions as used in the calculations, a series of L-1049G flight simulator runs were conducted to obtain more information concerning aircraft controllability. Data supplied to the simulator produced a 15% lift loss over the right wing due to propeller reversal and a less conservative drag value of about 9 000 lb. The result of these tests, although qualitative, produced an initial descent rate of approximately 1 800 ft/min and indicated that under these prescribed conditions of flight, successful recovery could not be effected.

2.2 Conclusions

Findings

The crew were properly certificated.

The Company's maintenance organization did not provide adequate maintenance records for N 189S nor did it ensure the performance of proper maintenance practices or inspection procedures necessary for adequate standards of airworthiness.

At take-off the aircraft's gross weight and centre of gravity were within the allowable limits.

The approach was normal, according to witnesses, until the aircraft reached a point 1/3 of a mile from the airport.

Because of improper tightening of the brake cage on No. 3 propeller power unit during the last installation, the cage safety lock bolts failed after repeated cycles of loosening and tightening. This resulted in an excessive brake clearance which rendered the brake incapable of propeller control. With the brake inoperative, the blades of No. 3 propeller continued to move to a lower blade angle and eventually went into the reverse pitch range. As a consequence, the aircraft yawed to the right, the right wing dropped, and an increased rate of descent followed. The application of engine power in the existing circumstances led to a loss of control from which recovery was not possible, and the aircraft struck the ground.

Cause or
Probable cause(s)

The probable cause of the accident was the in-flight reversal of the No. 3 propeller due to a propeller power unit malfunction resulting from improper maintenance practices and inspection procedures.

3. Recommendations

During the investigation of this accident the Board made the following recommendations to the Administrator of the Federal Aviation Agency:

1. that the maintenance and overhaul procedures and practices of Standard Airways and any other maintenance agencies involved be reviewed for compliance with current regulations and accepted practices;

2. that all threaded type brake assemblies be removed from service and replaced by the later bolted design;

3. that a mechanical low pitch stop assemby be incorporated in Curtiss electric propellers as expeditiously as possible.

4. Action taken

The FAA's Western Region was requested to carry out the review suggested in Recommendation No. 1 above. This was accomplished following the subject accident.

In a letter dated 30 July 1963 the FAA advised that corrective measures had been instituted concerning the recommendations made by the Board. An Aircraft Maintenance Bulletin was issued on 24 July 1963 advising the FAA's air carrier inspectors that, if the older threaded type brake cage units were not properly tightened and locked, the cage unit could back off, rendering the brake and low pitch stop ineffective. Also, an airworthiness directive was being prepared which would require replacement of older threaded brake cage units with newer bolted configurations.

On 25 November 1963 an Airworthiness Directive (No. 63-24-1) was issued requiring replacement of brake cages within 100 hours' time in service after the effective date of the airworthiness directive.

With regard to recommendation No. 3, that the installation of mechanical low pitch stops be made mandatory, it was not felt that there was sufficient justification to require them since some corrective action had already been taken or would be applied as a result of the subject accident. Also, in view of the fact that the propeller incorporates an electrical low pitch stop actuated by blade angle to prevent unwanted travel below the stop, there is no evidence to support a mandatory requirement to back up the electrical low pitch stop with a mechanical low pitch stop, which, while contributing little to safety, would impose a considerable financial penalty on the affected operators.

It was felt that closer surveillance of the threaded type brake cage units and replacement of the threaded units with bolted configurations would preclude the possibility of further Curtiss propeller brake failures.

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ICAO Ref: AR/814

No. 17

Aaxico Airlines, Inc., C-46F, N 67935, accident at McCarran Field, Las Vegas, Nevada, on 25 September 1963. Civil Aeronautics Board (U.S.A.) Aircraft Accident Report File No. 1-0011, released 19 May 1964.

1. Investigation

1.1 History of the flight

LOGAIR (Logistic Air Support) Flight 14/25 was being operated as an air cargo flight from Hill Air Force Base (AFB), Ogden, Utah, to Nellis AFB, Nevada, and Norton AFB, California and return. The only occupants of the aircraft were a pilot-in-command and a co-pilot. Following an uneventful flight the aircraft arrived at Nellis AFB at 2000 hours Pacific daylight saving time where it spent 49 minutes on the ground. Having checked the weather reports available, a VFR flight plan was filed by the pilot-in-command for the trip to Norton AFB. No maintenance or refuelling was accomplished at Nellis AFB. At 2049 hours the aircraft took off from runway 20 and climbed at a rate of about 400 ft/min at an indicated airspeed of 125 kt. About 10 minutes after take-off, a steady fire warning light for the left engine was noted when the aircraft was climbing between 6 500 and 7 000 ft. At that time the aircraft was about 10 NM south of McCarran Airport. The No.1 engine was shut down, and the propeller was feathered. Also the crew pulled the firewall shutoff handle, actuated the CO_2 bottles and reversed the aircraft's course. The fire warning light and bell continued to indicate a fire, however, a visual inspection of the engine by the co-pilot failed to disclose any indication of fire. About one minute after the emergency occurred, the crew contacted Nellis Tower and declared an emergency. Radio contact was then established with McCarran Tower. After making the 180° turn to return to McCarran, the pilot-in-command found the aircraft was lined up with runway 1, and, since he was familiar with this runway, he decided to use it. Because of his apprehension of wheel well fire, a rapid descent was made at an airspeed of 155 kt for a straight-in approach. About one mile from the end of the runway and 500 ft above the ground, the pilot-in-command retarded the No.2 throttle, pulled the nose up to reduce the airspeed to 130 kt, and extended the flaps to the full down position. The co-pilot, as instructed, extended the landing gear. During the approach the pilot-in-command had difficulty observing the geardown safe-indication light (which was set to the dim position) because of other lights which were illuminated near the gear indicator lights. According to the pilot-in-command, the aircraft passed over the runway threshold at an altitude of 100 ft and an indicated airspeed of 105 kt. The pilot-in-command was not certain that the landing gear was down and locked when the aircraft was about one third of the way down the runway, so he momentarily applied full power to the No.2 engine to ensure adequate hydraulic pressure. Power was then fully retarded, and the aircraft touched down more than half way down the lighted part of the runway. The flaps were retracted immediately and after rolling about 500 ft the brakes were applied. During the heavy application of the brakes, which started about 4 775 ft beyond the first runway light, the landing gear retracted, and the aircraft slid to a stop 180 ft beyond the end of the runway. The accident occurred at 2103 hours.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal			
Non-Fatal			
None	2	-	

1.3 Damage to aircraft

The aircraft received substantial structural damage.

1.4 Other damage

No objects other than the aircraft sustained damage.

1.5 Crew information

The pilot-in-command, age 33, had flown a total of 5 276 hours including 1 668 hours on the C-46 aircraft. He held a currently effective airline transport pilot's certificate and a multi-engine land C-46 rating. He qualified as pilot-in-command on C-46 aircraft on 18 June 1963, and his last line check on C-46 aircraft was on 24 June 1963. He had landed on runway 01 at McCarran Field previously.

The co-pilot, age 39, had flown 1 251 hours of which 246 hours were on C-46 aircraft. He held an FAA airman's certificate with commercial privileges, and instrument single and multi-engine land ratings. His last proficiency flight check on the C-46 was on 22 June 1963.

They had both completed a 40-hour ground school on the C-46 on 14 June 1963 in which they received two hours of instruction on C-46 Fire Detection and Extinguishing.

Also, both crew members held valid medical certificates.

1.6 Aircraft information

The maintenance and aircraft flight logs revealed that a previous false fire warning occurred on the right engine on 8 July 1963, but there was no record of any on the left engine. There were no chronic malfunctions of the fire detection system appearing in the aircraft log. The records indicated that the aircraft had been operated for long periods of time at oil pressures below specifications, and was being partly maintained by uncertificated mechanics.

No maintenance was carried out on the aircraft while at Nellis AFB.

Prior to leaving Nellis AFB a pre-flight inspection was carried out, and the fire detector system was tested and found to be functioning properly.

On departure from Nellis, the gross take-off weight of the aircraft was 42 616 lb, which was well below the maximum allowable of 48 000 lb, and the centre of gravity was at 24.1% MAC, which was within the allowable limits.

The type of fuel being used on the subject flight was not mentioned in the report. The aircraft carried sufficient fuel for 4 hours of flight.

1.7 Meteorological information

Prior to the Nellis-Norton portion of the flight,the pilot-in-command checked the local, en-route and terminal weather reports which were available at Nellis AFB.

Immediately after the accident,a special weather observation was taken which indicated a clear sky, visibility more than 15 miles, temperature 81 °F, dew point 41 °F, wind from the west-southwest at 8 kt, and the altimeter setting was 30.03 inches.

The accident occurred during the hours of darkness.

1.8 Aids to navigation

They were not relevant to this accident.

1.9 Communications

No communications difficulties were mentioned in the report. Shortly after taking off from Nellis AFB, when it had reached a point about 3 miles south of Nellis, the flight established radio contact with McCarran Departure Control. When the emergency occurred the flight immediately contacted Nellis AFB and then McCarran Tower.

1.10 Aerodrome and ground facilities

McCarran Field has an elevation of 2 171 ft. Runway 01, which was used for the landing, was 6 503 ft long but only 5 878 ft of it was lighted. The longest runway 07/25 was 9 995 ft long.

1.11 Flight recorders

Flight recorders were not mentioned in the report.

1.12 Wreckage

The aircraft was found 180 ft beyond the end of runway 01 with the fuselage on a heading of 346° magnetic. (See Figure 2) Its main landing gears were retracted. The landing gear actuation lever was found in the "down" position. The bottom of the fuselage had been scraped extensively. The left propeller was feathered, and the right propeller blade angle was at 21° at the time of impact.

1.13 Fire

There was no ground fire.

A small flash fire could have occurred in the exhaust deflector which could have been ignited by the exhaust leakage from the No.1 exhaust adapter.

1.14 Survival aspects

The two crew members left the aircraft through the left rear cargo door.

1.15 Tests and research

Examination of the left engine revealed that the No.1 exhaust adapter which mounts on the No.1 cylinder was cracked from the weld seam to the clamp flange. The No.1 and 3 rocker-box covers showed evidence of oil leakage, and the exhaust collector ring deflector aft of the No.1 and 17 cylinders revealed evidence of heat blistering and heavy soot deposits.

The CO_2 fire bottles in the nacelle of the left engine had been discharged.

Investigation showed that the left engine fire warning light and bell would come on when 24-volt DC power was on the line. It was also found that an "open circuit" existed in the right fire warning bell located in the nose section.

Checking of the landing gear revealed that no failures had occurred prior to impact. The right engine hydraulic pump and the system pressure regulator were bench-tested and found to be satisfactory.

A flight test was flown in another C-46 aircraft to determine the interval of time the landing gear would be in transit at various airspeeds with only the right engine hydraulic pump operating. While maintaining a true airspeed of 120 kt, the landing gear and flaps were simultaneously extended to the full down position with the right engine power fully retarded. The landing gear required 12 seconds to extend and lock while the flaps required 18 seconds to extend to the full down position. During the 12 seconds the landing gear was in transit, the aircraft traversed 4/10ths of a mile. Gear and flaps were then simultaneously retracted. The flaps retracted in 3 seconds and the landing gear in 23 seconds. At a true airspeed of 105 kt, the landing gear extended and locked in 14 seconds Also, the flaps retracted in 3 seconds, and the landing gear retracted in 23 seconds. During the final landing, the idled right engine maintained at least 2 000 rpm on the approach before flare-out and touchdown, and the hydraulic system pressure remained at normal operating pressure of 1 300 psi.

2. Analysis and conclusions

2.1 Analysis

Ten minutes after a normal take-off from Nellis AFB, when the aircraft was climbing between 6 500 and 7 000 ft, a fire warning light was noticed for the left engine. Following the accident a failure was found in the exhaust adapter of the No.1 cylinder of the left engine which would have allowed sufficient heat from the exhaust to activate the fire warning light and bell. It was also feasible that the oil leak from the No.1 exhaust rocker-box cover could have permitted oil to seep to the exhaust deflector behind the No. 1 and 17 cylinders. A small flash fire could have occurred in the exhaust deflector which could have been ignited by the exhaust leakage from the No.1 exhaust adapter. The charred and burned appearance of the exhaust deflector indicated that a small localized fire or excessive heat may have activated the fire detector aft of the No.1 cylinder. However, after the engine was shut down and the CO_2 fire extinguisher bottles discharged, the fire warning light and bell should have ceased to operate since the ambient temperature in the fire detector zone would decrease. The fire warning bell and light remained

on until after the aircraft came to rest. The fire bell cut-out switch was not actuated by the crew because they did not know that it existed on this aircraft.

It was believed that a short circuit in the fire warning system allowed the fire warning light and bell to remain on after the engine was shut down. The wiring installation of the system, together with the normal vibration of a reciprocating engine, could have caused the fire warning signal to remain on until either the cut-off switch was activated or power was removed from the system.

Following the emergency the flight turned back towards McCarran Field, and a fast approach was made because of the pilot-in-command's concern for a wheel well fire. About one mile from the end of the runway he nosed up the aircraft to reduce speed, extended the flaps to the full down position and ordered the co-pilot to lower the landing gear. The co-pilot stated that he did as instructed. The tower personnel could not observe the landing gear or flap positions because of intense darkness.

The fire warning bell rang continuously, preventing verbal instructions between the pilot-in-command and the co-pilot. This could also have made the gear warning horn inaudible.

As stated, the pilot-in-command had difficulty in determining gear-light indication. To ensure adequate hydraulic pressure he momentarily applied almost full power to the right engine. This was unnecessary since it could not increase hydraulic pump output. A flight test showed that the hydraulic pump of only one engine is at full capacity during the approach to supply sufficient hydraulic pressure for landing gear and wing flap extension or retraction.

The Board concluded that the landing gear was down and locked when the aircraft passed over the runway threshold, but the co-pilot actuated the gear lever to the "up" position in anticipation of a missed approach. The gear began to retract because the weight of the aircraft was off the gear. When power was retarded, the co-pilot became aware that a go-around was not contemplated and repositioned the gear lever to the "down" position where it was found following the accident. However, insufficient time remained for the extension and locking of the landing gear. All three gears subsequently collapsed under the weight of the aircraft as the landing roll speed diminished, and the aircraft slid to a stop on its fuselage.

2.2 Conclusions

Findings

Both crew members were satisfactorily certificated and were experienced on the C-46. The pilot-in-command was familiar with runway 01 at McCarran Field as he had landed on it prior to the day of the accident.

According to the aircraft's records, a false fire warning had occurred on the right engine previously, but none appeared to have occurred on the left engine. Also the aircraft had been operated for long periods of time at oil pressures below specifications, and was being partly maintained by uncertificated mechanics.

No maintenance was required at Nellis Air Force Base.

At take-off the aircraft's gross weight and centre of gravity were within the permissible limits.

While climbing following take-off,a fire warning light for No.1 engine was observed. It was later found that the No.1 exhaust adapter of the left engine had failed. Exhaust leakage resulted. Also oil may have seeped to the exhaust deflector behind No.1 and 17 cylinders and a small flash fire occurred. This may have activated the fire detector aft of the No.1 cylinder. After the engine was shut down and the fire extinguisher bottles were discharged the fire warning bell and light should have ceased to operate. However, they stayed on, probably because of a short circuit in the system.

The crew did not know of the fire bell cut-out switch on the aircraft.

The aircraft then returned to McCarran Field where a fast approach was made. The aircraft was nosed up, flaps were extended full down, and the landing gear was lowered. Having passed the runway threshold, the co-pilot anticipated a missed approach, and the Board believed that he actuated the gear lever to the "up" position, although he could not actually recall having raised the gear or attempting to raise it. The gear was then repositioned to "down". Shortly thereafter all three gear collapsed, and the aircraft slid to a stop overshooting the runway.

Cause or
Probable cause(s)

The probable cause of this accident was the improperly executed approach and landing procedures during an emergency single-engine operation resulting in an overshoot.

3. Recommendations

Following the accident, it was recommended that the maintenance and inspection practices and procedures of this airline be reviewed and improvements be made where necessary to ensure acceptable airworthiness standards.

In view of the fact that between 1 July and 19 September 1963 eleven R-2800B engine failures had occurred, four of which had resulted from failure of the exhaust valve, it was suggested that consideration be given to time limiting exhaust valves for use on C-46 series aircraft.

4. Action taken*

Following this accident, the Federal Aviation Agency investigated the maintenance practices of the airline.

Significant action taken by the FAA and the airline was as follows:

1. Violation action was being taken against the airline in connexion with replacement of engine components by non-certificated military personnel.

2. The airline issued instructions to its flight crews prohibiting the use of non-certificated, unqualified mechanics for maintenance.

3. The airline elected to replace the maintenance supervisor at Hill Air Force Base.

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* This action also pertains to Summary No.15 in this Digest (accident to C-46F, N 67941 at Great Falls, Montana, on 14 August 1963).

4. A fleet campaign directed toward erratic oil pressure problems was conducted on all C-46 aircraft. The campaign included removal of oil coolers and temperature regulators to manufacturers' specifications. Furthermore, engines with low oil pressure tendencies, having low-capacity oil pumps, were converted to high-capacity pumping by changing the drive/driven gear ratio.

5. The following related actions were also implemented: reduction of cruise horsepower; revised operational procedures to avoid operation under unloaded cylinder pressures; avoidance of rapid changes in cylinder temperatures; revised inspection procedures requiring boroscope inspection of all cylinders at 200-hour intervals; compression check of all cylinders and revised ignition procedures.

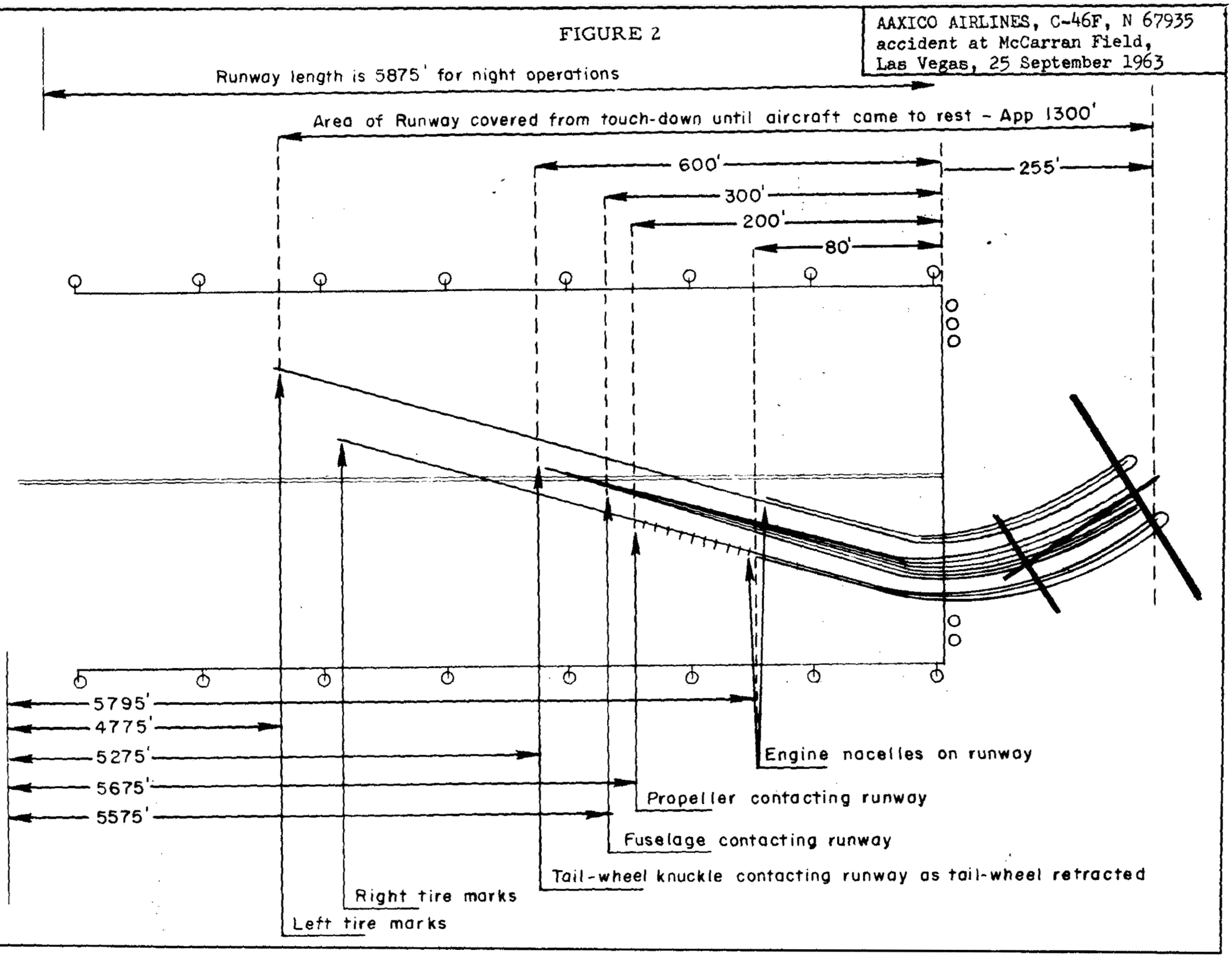
6. The FAA handled the exhaust valve problem as an overall industry problem by Airworthiness Directive action. The Airworthiness Directive required, in essence, replacement of all exhaust valves during the next engine overhaul.

7. Regarding the FAA's Advisory Circular 121-1 concerning the transfer of aircraft from operator to operator, the FAA was studying a revision intended to preclude intentional or inadvertent time accumulation in the transfer transactions.

ICAO Ref: AR/817

FIGURE 2

AAXICO AIRLINES, C-46F, N 67935
accident at McCarran Field,
Las Vegas, 25 September 1963



No. 18

Mohawk Airlines, Inc., Martin 404, N 449A, accident at Rochester-Monroe County Airport, Rochester, New York, on 2 July 1963. Civil Aeronautics Board (U.S.A.) Aircraft Accident Report, File No. 1-0008, released 20 May 1964.

1. Investigation

1.1 History of the flight

The aircraft was flown from New York to Ithaca and Rochester as Flight 115 early in the afternoon of 2 July. The flight to Rochester was routine, and the aircraft arrived there at 1542 hours eastern daylight time where it terminated. After a one-hour layover N 449A was then due to depart Rochester at 1645 hours as Flight 112, a scheduled passenger flight to White Plains, New York, and Newark, New Jersey. The crew, consisting of a pilot-in-command, a co-pilot and a stewardess, which had flown the aircraft from Ithaca to Rochester, was to fly on Flight 112. Forty passengers boarded the aircraft at Rochester at approximately 1640 hours at which time a thunderstorm was approaching. The pilot-in-command was observed to be in the right-hand seat and the aircraft was cleared to runway 28. It taxied out and braked to a stop near the take-off runway. There was no engine run-up prior to take-off. According to the passengers and the local weather observer, there was hail, heavy rain and strong winds with gusts up to 40 kt at this time. At approximately 1648 the aircraft was cleared for take-off. The crew requested a left turn out immediately after take-off to avoid thunderstorms approaching from the west. The flight was told that the winds were 340°/15 kt, and that it could make a left turn out. This was acknowledged, and nothing more was heard from the aircraft. The take-off and the lift-off were carried out by the co-pilot who was in the left-hand seat. As the aircraft gained altitude it entered a "wall of rain". The left wind dropped, the aircraft levelled out, buffetting followed, and the right wing dropped. The aircraft was righted, then the left wing dropped again, and the aircraft struck the ground 220 ft south of the centre line and 4 668 ft from the threshold of runway 28, and cartwheeled. It came to rest 566 ft south of the centre line and 5 022 ft from the threshold of runway 28, on a magnetic heading of 280° in a drainage excavation, approximately 6 ft deep, adjacent to the take-off runway. The accident occurred at 1649 hours.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	2	5	
Non-Fatal	1	35	
None			

1.3 Damage to aircraft

The aircraft was destroyed by impact and subsequent fire.

1.4 Other damage

No objects other than the aircraft sustained damage.

1.5 Crew information

The pilot-in-command, age 39, had flown a total of 15 970 hours including 414 on Martin 404 aircraft. He held a currently effective FAA airline transport certificate with numerous ratings including one for the Martin 404. His last proficiency and line checks on the Martin 404 were on 8 January 1963 and 10 April 1963 respectively. On 1 June 1963 he passed a first-class FAA flight physical with the following limitation: " ... holder shall wear correcting lenses while exercising privileges of his airman's certificate."

He had previously been involved in a wheels-up landing accident and an in-flight propeller reversal incident and had been reprimanded at least twice for infraction of company rules. Although he had passed a combination type rating and proficiency flight check on 8 January, he had failed a flight check on 5 January. The checkpilot who passed him on 8 January was later censured for his action. Testimony adduced at the public hearing regarding his proficiency was confusing. Although he was described by some as "below average" and "a hazard", he was also spoken of as "a good pilot".

The co-pilot, age 31, had flown 3 439 hours including 795 hours on the Martin 404 aircraft. His FAA commercial pilot's certificate was currently effective, and he had single and multi-engine land and instrument ratings. He completed his transition training to Martin 404 aircraft on 15 December 1962 and was recommended for a type rating. His last proficiency check on the Martin 404 was on 16 March 1963. He passed a first-class FAA flight physical without waivers on 24 April 1963.

1.6 Aircraft information

The aircraft had flown a total of 29 818 hours.

No maintenance repairs were carried out on it at Rochester.

While at Rochester the aircraft was serviced with fuel. No indication of the type of fuel used was indicated in the report.

The computed weight and balance of the aircraft at lift-off were determined to have been within allowable limits.

1.7 Meteorological information

As stated, the crew which was to fly Flight 112 from Rochester, New York to White Plains, New York also flew the last segment of the previous flight (No. 115) from Ithaca to Rochester. A Mohawk Customer Service Agent* at Ithaca prepared a

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* Personnel not certificated as dispatchers were delegated responsibility for certain functions of dispatching at each of Mohawk's outlying stations. These delegated functions included dissemination of weather information and signing of the flight plan release form. The personnel authorized to perform these functions were titled "Customer Service Agents".

flight plan release for the last segment of Flight 115. The Ithaca agent testified that he placed the 1400 Service A* weather sequence, the latest terminal weather forecast and the flight plan release on the operations counter. A 1400 Service A weather sequence was found in the aircraft wreckage with a flight plan release. No other weather documents were found.

At 1415 the U.S. Weather Bureau's severe local storms unit at Kansas City, Missouri issued an aviation severe weather forecast. Rochester, New York is within the Cleveland Office's responsibility for weather forecasting. At 1430 the Cleveland Office issued SIGMET No. 1 ** amending the existing area forecast to conform to the Severe Weather Forecast. It advised of "severe thunderstorms or isolated tornado ... severe turbulence ... hail of 1-1/2 inches diameter, surface wind gusts to 65 kt." The SIGMET was then disseminated over Service A weather teletype.

At 1445 the Cleveland Office issued an amended Rochester terminal forecast valid from 1445 to 0100 which mentioned "scattered thunderstorms and a chance of isolated tornadoes."

All Mohawk stations were notified at 1453 hours of the conditions mentioned in SIGMET No. 1 and were also advised of "a squall line which was forming in Ontario to vicinity Buffalo and Youngstown, expected to intensify and move eastward at 40 kt. Company Pireps (pilots' reports) indicate a line of thunderstorms through Western Pennsylvania from north of Johnstown extending southeastward and building rapidly. Expect these thunderstorms to move eastward."

When the pilot-in-command took over N 449A to fly the last segment of Flight 115 from Ithaca to Rochester he was told by the pilot who had flown the previous segment (New York to Ithaca) of a squall line approximately 75 to 80 miles northeast of Ithaca and that "it looked pretty bad."

Flight 115 took off from Ithaca at 1508. No copy of the flight plan release nor copies of the required weather documents were retained in the Ithaca station file as required by Mohawk's Operations Manual.

The pilot of another Mohawk flight, who was flying from Toronto to Buffalo at approximately the same time, said that when about 20 - 25 miles west of Buffalo he paralleled an enormous return that almost filled up the entire left side of the radar scope on the 30-mile range. At approximately 1545 he reported these storms to the company radio operator at Utica, and the message was acknowledged. When reaching Buffalo he telephoned the Utica Dispatch Office at 1600 to discuss the severity of the storms which he had previously reported but was told that the Mohawk Dispatch Office had not received the 1545 message. (The message was actually received by the radio operator between 1535 and 1540. Mohawk stations were connected with the dispatch office by a private line teletype circuit. Operational information and special company weather bulletins were also sent over this circuit. In-flight aircraft of Mohawk Airlines could be contacted via company radio.)

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* Service A is a teletype circuit which is used to collect and disseminate weather information. Mohawk had no Service A facilities at Rochester.

** A SIGMET is a message designed primarily for aircraft in flight, warning of weather conditions potentially hazardous to transport category (and other) aircraft.

Prior to the departure of Flight 112 from Rochester Airport, the following documents were provided to the pilot-in-command for examination and signature: the local 1600 sequence report obtained from United Air Lines by an informal arrangement, the 1453 company weather warning, the flight plan release form and the 1545 dispatch release message. Not included were the 1415 aviation severe weather forecast, the 1430 SIGMET or the 1445 amended Rochester terminal forecast. There was no evidence that the pilot-in-command had examined the documents, but there was testimony that they were not brought to his attention.

At the time of the aircraft's departure, thunderstorms were approaching the airport from the west. There was thunder, lightning, hail and it was raining hard. The winds were strong with gusts up to 40 kt.

At the approximate time of the accident (1649) the Weather Bureau Observer was taking an observation for a special report which was completed at 1652. Visibility at that time was about 1/2 mile, and he noted rain and hail 1/2 inch in diameter. The wind was east-southeast.

1.8 Aids to navigation

They were not pertinent to this accident.

1.9 Communications

The crew were in radio contact with the FAA Rochester Tower Ground Controller up until approximately 1648 hours, i.e. about one minute before take-off and the accident which followed immediately.

1.10 Aerodrome and ground facilities

The aircraft was taking off from runway 28 at Rochester Airport at the time of the accident. Runway 28 has a concrete surface and is 5 500 ft long and 150 ft wide. One witness stated that the runway lights were on at the time the aircraft took off.

1.11 Flight recorders

No flight recorder information appeared in the report.

1.12 Wreckage

The forward section of the aircraft was reduced to a mass of torn, twisted and compressed metal. The centre section remained intact and attached to the centre wing panel, sustaining only interior damage.

Both engines were torn from the aircraft and were relatively intact. All propeller blades were intact prior to impact. Impact markings showed that the left propeller blade angle was 34°, and the right propeller blade angle was 33°.

1.13 Fire

Fire broke out following impact. It was brought under control four minutes after the accident occurred.

Fire and crash equipment had been alerted at 1644 hours when lightning was believed to have struck the telephone wires and set off the siren. The crash equipment had then returned to its quarters at 1648 when it was found that the tower had not activated the siren.

The fire department was subsequently advised by the tower at 1649 that an accident had occurred and responded immediately.

1.14 Survival aspects

At impact all twenty double passenger seats were torn free from their attachments. Most seats were thrown free of the wreckage.

No information appeared in the report as to the manner of evacuation of the aircraft's occupants.

1.15 Tests and research

Tests of the propeller governors indicated that at impact the rpm of the left and right engines were 2 760 and 2 830 respectively. Rated take-off rpm is 2 800.

The ground speed at impact was calculated to be 92 kt.

2. Analysis and conclusions

2.1 Analysis

The investigation revealed no evidence of malfunction or failure of the control system or power plants. No evidence of structural failure was found.

There appeared to be a lack of procedures to ensure the relay of information to personnel charged with the initial responsibility of dispatching flights. This was based on the fact that the pilot of another Mohawk flight from Toronto to Buffalo reported severe weather conditions to Mohawk company radio, but this report did not reach the Mohawk Dispatch Office.

At Rochester, the 1600 Service A sequence report and the 1435 Mohawk weather message were presented to the pilot-in-command of Flight 112 prior to departure. He was not given the 1415 aviation severe weather forecast, the 1430 SIGMET or the 1445 amended Rochester terminal forecast. This was contrary to the Civil Air Regulations.

The fact that Flights 115 and 112 were not provided with the latest available weather forecasts and the forecasts were not attached to the dispatch release form indicates that the dispatching of these flights was contrary to the Company's Operations Manual and Civil Air Regulation 40.503(b).

At 1545, i.e. one hour before departure, the Utica dispatcher transmitted to Rochester the release message for Flight 112. No subsequent attempt was made by the Utica controlling dispatcher to reassess the worsening weather conditions or advise the pilot-in-command of Flight 112, prior to departure, of the severity of the approaching weather.

When Flight 112 took off, a severe thunderstorm was over Rochester Airport. It moved over the field from the west-northwest along with heavy rain, hail, wind gusts and shifting winds. On becoming airborne the aircraft entered heavy rain, severe turbulence and strong down draughts. Shortly thereafter it encountered a wind shift of about 180° from the northwest (a head wind) to the southeast (a tail wind). The northwesterly winds were approximately 20 kt with gusts in excess of 40 kt while the southeasterly winds were about 10 - 15 kt.

The Board found that the Weather Bureau forecasts for the area were accurate, and their distribution was proper and timely. It was revealed that the control tower received a special weather observation from the Weather Bureau at 1645 which was not brought to the attention of the pilot. This observation indicated the beginning of a thunderstorm at Rochester at 1640, however, this must have been apparent to the pilot-in-command when he began the take-off.

Examining the FAA's surveillance of Mohawk's operations, it was revealed that the air carrier inspectors applied a doctrine of "substantial compliance". The Board found that the following examples showed that this doctrine did not provide the minimum standards of safety provided by the Civil Air Regulations:

- lack of formal agreement regarding the source and availability of weather information relied upon at Rochester;

- failure of the Rochester and Ithaca stations to prepare and maintain the required files;

- failure of Customer Service Agents to meet the minimum requirements of the Mohawk Operations Manual and the Civil Air Regulations regarding the preparation and distribution of weather and flight documents.

Both the aircraft dispatcher and the pilot-in-command are independently responsible for determining that the flight can be made in safety. The pilot-in-command must review the documents provided by the dispatcher and analyze their contents. There was considerable evidence that this was not done.

The pilot-in-command did not have the minimum of 250 hours command time on this type of aircraft, required by the Company's Operations Manual, to allow the co-pilot to occupy the left-hand seat on take-off. Also, the co-pilot did not have twenty-four months' active service and 900 hours of flight time on Convair aircraft (applicable also to the Martin 404), required by the Company's Operations Manual, to occupy the left-hand seat.

Furthermore, evidence revealed that the crew failed to carry out the pre-take-off checklist prescribed in the Company's Operations Manual.

2.2 Conclusions

Findings

Although the pilot-in-command was satisfactorily certificated, contradicting evidence concerning his proficiency was given at the public hearing. He was previously involved in an accident and an incident and had been reprimanded at least twice for infraction of company rules.

The co-pilot had neither sufficient active service nor flight time on the Martin 404 to allow him to occupy the left-hand seat and to be at the controls of the aircraft. Also, the pilot-in-command had insufficient command time on this type of aircraft to allow the co-pilot to do so.

No defects concerning the aircraft were found.

The computed weight and balance of the aircraft at lift-off were within the allowable limits.

The Company's dispatching procedures were inadequate.

Prior to taking off on the last part of Flight 115 (Ithaca to Rochester) and on Flight 112 (Rochester to White Plains, New York), the aircraft was improperly dispatched. In both instances the crew were not provided with all available documents on the weather situation to be expected.

Although the pilot-in-command had not been provided with a special weather observation received from the Weather Bureau, he was certainly aware of the thunderstorm since, prior to commencing take-off for Flight 112, he requested authorization to make a left turn immediately after take-off to avoid a thunderstorm.

The aircraft took off into heavy rain, hail, wind gusts and shifting winds. The storm's intensity should have been obvious to the pilot at once.

Shortly after entering a "wall of rain", loss of control occurred, and the aircraft struck the ground.

The failure of the pilot-in-command to properly appraise the weather conditions and his attempt to take off into a severe thunderstorm raised serious doubts as to his judgement.

Cause or
Probable cause(s)

The probable cause of the accident was a loss of control during an attempted take-off into a severe thunderstorm.

3. Recommendations

No recommendations were contained in the report.

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ICAO Ref: AR/816

No. 19

New York Airways, Inc., Boeing-Vertol 107-II helicopter, N 6673D, accident at New York International Airport (Idlewild), Jamaica, New York, on 14 October 1963. Civil Aeronautics Board (U.S.A.) Aircraft Accident Report, File No. 1-0012, released 24 June 1964.

1. Investigation

1.1 History of the flight

Flight 600 was a regularly scheduled helicopter flight from Idlewild to Newark International Airport with an en-route stop at the Wall Street Heliport in Manhattan. The aircraft had been ferried from LaGuardia Airport to Idlewild for a change of equipment, arriving at Idlewild at 1213 hours eastern daylight time. No difficulties were experienced during this flight. Three crew members and three passengers were aboard the helicopter when it took off from Idlewild at 1233 hours. Ten seconds later an unintelligible static or clatter effect was heard on the Idlewild Tower frequency. The local controller in the tower cab observed the separation of a rotor blade or blades and subsequent impact of the helicopter with the ground. Eyewitnesses' accounts indicated that the structural failure occurred when the aircraft had reached an altitude of about 150 ft and that subsequently the aircraft crashed tail first. Fire broke out following impact.

When notification of the accident was received, New York Airways voluntarily suspended all passenger flights.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	3	3	
Non-Fatal			
None			

1.3 Damage to aircraft

The helicopter was destroyed by impact and fire.

1.4 Other damage

No damage was sustained by objects other than the aircraft.

1.5 Crew information

The crew consisted of a pilot-in-command, a co-pilot and a flight attendant.

The pilot-in-command, age 42, held an airline transport pilot's certificate with ratings in the Sikorsky S-55, S-58, the Vertol 44 and Vertol 107 (VFR only). He had flown a total of 7 850 hours which included 1 050 hours in the Vertol 107-II. His last flight check was accomplished on 25 September 1963.

The co-pilot, age 37, also held an airline transport pilot's certificate with ratings for the Vertol 44 and the Vertol 107 (VFR only). He had flown a total of 5 718 hours with 853 hours in the Vertol 107-II. His last flight check was also carried out on 25 September 1963.

Both held valid FAA medical certificates.

1.6 Aircraft information

The helicopter had been maintained in accordance with applicable regulations of the Federal Aviation Agency.

The drive system of the Vertol 107-II consists of:

- a mix box which is a gearing assembly to mix the power from the burbine engines into a single drive system;

- a forward transmission to transmit power to the forward rotor head;

- an aft transmission to which the mix box is bolted, and which transmits power to the aft rotor head; and

- a synchronizing shaft which provides synchronization between the rotor heads, and transmits power from the mix box to the forward transmission.

The history of the aft transmission assembly revealed that two different mix boxes were mated to the aft transmission and that in both cases metal shavings were found in the assembly. It was determined that the metal shavings were AISI 4130 steel, which is only contained in the bearing liners of the mix box and of the aft transmission. At the time of the accident, the aft transmission assembly had accumulated 610 hours since overhaul (TSO) and 1 339 hours total time (TT).

Computations indicated that the aircraft's gross weight (13 985 lb) and its centre of gravity were well within the allowable limits.

The amount and type of fuel being used on the subject flight were not stated in the report.

1.7 Meteorological information

A local weather observation, made three minutes after the accident, indicated high scattered clouds, visibility 8 miles and wind south-southwest at 12 kt.

1.8 Aids to navigation

Not relevant to this accident.

1.9 Communications

Ten seconds after the aircraft took off at 1233 hours, an unintelligible static or clatter effect was heard on the Idlewild Tower frequency.

1.10 Aerodrome and ground facilities

Not relevant to this accident.

1.11 Flight recorders

No flight recorder information was contained in the report.

1.12 Wreckage

The wreckage examination indicated that the helicopter had crashed tail first in a left bank of 45°, about 800 ft from the lift-off point and that the aft rotor assembly, the aft rotor drive shaft assembly and aft pylon had separated in flight. The forward green rotor blade and aft yellow and green rotor blades had collided and disintegrated, and the outboard section of the forward green blade was found 3 020 ft from the crash site on an azimuth of 321°. There was no evidence of fatigue on any failed section of any of the six rotor blades.

1.13 Fire

Fire broke out following impact. It consumed most of the aircraft.

1.14 Survival aspects

When the tower personnel saw the rotor blade(s) separate from the helicopter and saw the latter strike the ground, they immediately initiated the prescribed emergency procedures.

1.15 Tests and research

A test run was performed at Vertol in an effort to duplicate the fatigue failure of the quill shaft. An aft transmission was mounted on the test stand, which has an adapter to represent the mix box. A tapered shim was utilized to introduce 1/2° of misalignment on the quill shaft. Normal lubrication was provided for 35 hours at 100% of torque. This produced some fretting and slight wear of the silver plate on the quill shaft. The test conditions were then altered to provide only 1/4° of misalignement for the next 50 hours. Examination at the end of this time revealed the silver plate was worn off in a single spot on each of three teeth. A magnaflux inspection failed to indicate any cracks. The normal lubrication was then stopped, and the 1/2° misalignement shim was reinstalled. Following 50 hours operation under these conditions with only 50% torque, the subject quill shaft evidenced transverse cracks across three of the spline teeth. The quill shaft had now accumulated 135 hours on the test stand. Sixteen more hours of operation produced additional cracks and a previous crack had propagated through the wall of the shaft and was visible around 90° of the inner circumference. The test continued another 10 hours to a total of 161 hours. At this time the largest crack had turned 90° and traversed the unsplined centre portion of the shaft, running into the splines on the forward end. A 10% loss in developed torque was experienced during this 10 hours, and the test of this quill shaft was discontinued. A Vertol staff engineer testified at the public hearing that the test equipment had no provision for reversing or altering the loads on the shaft splines while the equipment was operating, thus precluding the simulation of a typical flight spectrum. Consequently, a direct relationship between the test hours and actual flight hours does not exist.

2. Analysis and conclusions

2.1 Analysis

No evidence of pre-impact operational distress was found on the two jet engines.

Detailed examination of the drive system of the helicopter revealed that fatigue failure had occurred in the quill shaft, which transmits the drive force from the mix box to the aft transmission, as well as in three of the six stepped studs which hold the mix box collector gear bearing retainer in place. It was also found that the two jets (a finger jet and a plug jet), which were designed to lubricate the quill shaft, were plugged with metal shavings.

The Board did not believe that the fatigue failures of the three stepped studs contributed to the quill shaft failure but rather they were the result of fatigue progression in the shaft.

Tests performed on a quill shaft, with normal lubrication, under exaggerated conditions of misalignment failed to produce significant wear. It was, therefore, felt that if a misalignment condition existed in the aft transmission (S/N TA 9-10), it did not significantly affect the quill shaft (S/N TA-102). However, during the subsequent operation at only 50% torque, with the lubrication jets blocked, the fatigue cracks developed within 50 hours of operation.

The first shavings were found in the mix box (S/N A 11-102) before it was mated with the aft transmission (S/N TA 9-10). It was, therefore, concluded that the shavings had been introduced into the lubrication system as a result of the initial boring operation by the manufacturer. Additional shavings may have been introduced during subsequent boring operations on either the aft transmission or mix box. Following discovery of the plugged lubrication jets, two changes were incorporated in the manufacture and overhaul of transmission assemblies. Plastic plugs were inserted in the oil passages during the boring operation on the liners, and all plug type lubrication jets were removed prior to the flushing of cases during overhaul. These changes were to reduce the possibility of metal shavings becoming lodged in the narrow passages of the case, or in the orifices of the jets during the boring or flushing procedure.

The initial operating time limitations governing the overhaul intervals on new aircraft and components are determined by the FAA's Maintenance Review Board. The Board's component sampling programme requires two samples of the aft transmission assemblies at 150 and at 200 hours, and three samples at each of the following: 400, 600, 800 and 1 000 hours of operation. If the exhibits sampled are found to be satisfactory, the overhaul limitation on all aft transmission assemblies is then increased to the next plateau.

The Principal Air Carrier Maintenance Inspector for New York Airways, and the Supervising Inspector of ACDO #34 testified that the in-service experience of all parts in use, and not just those which are used as exhibits in the sampling process, are evaluated before deciding whether an increase in overhaul time should be granted. They both indicated that there did not appear to be any history of time-related failures or malfunctions in aft transmission assemblies.

However, according to the overhaul records for the six aft transmission assemblies operated by New York Airways, there were 17 unscheduled removals prior to

the next prescribed overhaul time. With the exception of the selected samples, no transmission assemblies operated to their scheduled 200-hour or 400-hour overhauls without premature removal. Also, only one of the six assemblies reached the 400-hour plateau without prior removal for repair. This assembly was one of three used in the sampling programme. Following the approval of the 600-hour overhaul time there were eight instances of early removals of the six transmissions involved. Half of these had not attained the previously prescribed overhaul interval without requiring repair. The last revised Operations Specifications-Maintenance, which increased the overhaul interval to 800 hours, was effective 11 October 1963.

The Board felt that the number of premature removals of aft transmissions was excessive. The overhaul records of sampled and unsampled assemblies showed that an increase beyond a 400-hour TSO, without additional operating experience, was unwarranted. Sprag clutch failures and excessive wear of bearing liners were remedied. However, the operating experience of the aft transmissions in general did not show a satisfactory performance record. There is no secondary or backup provision for the mix box, synchronizing shaft, or either transmission, and the satisfactory performance of these components is essential to the safe operation of this helicopter.

It was acknowledged by the FAA witnesses at the public hearing that verbal approval of revisions to the Operations Specifications-Maintenance, which was given New York Airways orally by an FAA maintenance inspector, was not in compliance with existing regulations which required written approval of the supervising inspector. The requirement for written approval does ensure that the supervising inspector, removed from the day-to-day contact with the carrier, will be able to exercise an independent check on the recommendations of the inspector-in-charge with respect to liberalizations in the carrier's Operations Specifications.

2.2 Conclusions

Findings

The crew were properly certificated and had adequate experience on this type of helicopter.

The helicopter had been maintained in accordance with the applicable FAA regulations.

Its gross weight and centre of gravity were within the allowable limits.

Immediately after take-off, when the helicopter had reached an altitude of approximately 150 ft, fatigue failure occurred in the quill shaft. This failure occurred because two jets, which were supposed to lubricate the quill shaft, were blocked with metal shavings. These shavings had been introduced into the lubrication system during boring operations by the initial assembler and possibly during subsequent overhaul boring operations by the manufacturer.

Fatigue failure had also occurred in three of the six stepped studs which held the mix box collector gear bearing retainer in place. The Board believed that their failure had not contributed to the quill shaft failure but was the result of fatigue progression in the shaft.

A review of the overhaul history of the aft transmission assemblies indicated an unsatisfactory performance record, and the Board therefore suggested remedial action.

Cause or
Probable cause(s)

Fatigue failure of the drive quill shaft due to contamination of the lubrication system in the aft transmission assembly.

3. Recommendations

On 6 November 1963, the Board recommended the following action to the FAA:

1) Overhaul of aft transmission and mix box, including installation of a new quill shaft prior to resumption of operations;

2) Reduction of overhaul period for above assemblies to 200 hours;

3) Overhaul of above assemblies prior to next flight in case of sudden engine stoppage or other abnormal loading of aft transmission and/or mix box.

4. Action taken

With regard to the foregoing recommendations, the following action was taken by 31 December 1963:

1) The transmissions and mix boxes of the Vertol 107 helicopters operated by New York Airways were all overhauled. (There are no other civil domestic operators of this helicopter.) Also, following the Board's initial findings of a failed quill shaft towards the end of October 1963, the FAA, on 1 November 1963, issued an emergency Airworthiness Directive* which established a 120-hour maximum service life for the quill shafts, and required immediate removal of all quill shafts, inspection for any wear on the spline faces of the quill shafts or input pinion and collector gears, and the inspection of oil jets P/N 107D2268-1 and P/N 107D2214-1. Following compliance with this directive, New York Airways restored passenger operation on 4 November 1963.

2) A reduction in the overhaul period of the aft transmission and mix box was considered.**

3) The problems of sudden stoppage and other abnormal loadings were carefully investigated. It was not considered that the occurrence of these loads was of sufficient frequency to introduce a fatigue problem from this source.

* Copies of the emergency airworthiness directive (AD 63-24-4) were provided to the governments of other countries using Vertol 107 helicopters and to the United States military services. In addition, the manufacturer directly provided information concerning the necessary corrective procedures to all operators to whom they had delivered Model 107 helicopters.

** As of June 1964, Recommendation No. 2 had not been fully implemented.

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ICAO Ref: AR/820

No. 20

Trans-Canada Air Lines, Vickers Armstrong Vanguard 952, CF-TKV, accident near Rocky Mountain House, Alberta, on 6 May 1963. Report No. 1958, released by the Department of Transport, Canada.

1. Investigation

1.1 History of the flight

Flight 502 was on a scheduled domestic flight from Vancouver, British Columbia to Edmonton, Alberta. It was to fly from Vancouver to Princeton, thence via Red Airway 75 from Princeton over Enderby and Rocky Mountain House to Edmonton. Based on the crew's testimony, the aircraft was cruising at 21 000 ft asl on instruments in thin stratus cloud. The indicated airspeed was 260 kt (approximately 360 kt TAS). Light subsidence was encountered after passing Enderby but no turbulence. After a slight tremor and anticipating possible turbulence, the fasten seat belts sign was put on, and power was reduced. About 35 miles southwest of Rocky Mountain House (latitude 52°22'N, longitude 115°04'W) a violent jolt of turbulence was encountered at about 1115 hours mountain standard time, before all the occupants had fastened their seat belts. The indicated airspeed was down to 420 kt at this time, and the aircraft dropped 800 ft. The flight smoothed out, and the indicated airspeed was kept at 225 kt. Shortly thereafter a second violent jolt occurred. The flight continued on, and the aircraft was over Rocky Mountain House by 1120 hours from where it continued to Edmonton without difficulty.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal		1*	
Non-Fatal	1	30	
None	4	33	

* An elderly passenger died from a heart attack.

1.3 Damage to aircraft

The aircraft received superficial damage to the cabin interior.

1.4 Other damage

No other objects sustained damage as a result of this accident.

1.5 Crew information

The pilot-in-command held an airline transport pilot's licence and had a total of 19 000 hours flying experience. He had flown 1 800 hours on Vanguard aircraft including 240 hours during the 90 days prior to the accident.

The co-pilot also held an airline transport pilot's licence and had flown 8 000 hours, including 1 800 on the Vanguard of which 50 hours were flown during the 90 days prior to the accident.

1.6 Aircraft information

A certificate of airworthiness had been issued for the aircraft.

1.7 Meteorological information

The weather briefing provided to the crew at Vancouver covered the appropriate forecast for the Vancouver and Edmonton Regions and included study of the surface and upper air charts. Heavy cumulus and cumulonimbus clouds were expected up to 25 000 ft and possibly higher. A jet stream was expected between Hope, British Columbia and Edmonton, and winds were to be westerly at speeds of over 100 kt from 18 000 ft asl and upwards. Turbulence was possible because of the strong winds at the relatively low levels. The crew of Flight 503, who had just arrived from Edmonton, reported that they had encountered en-route turbulence, subsidence and strong head winds. This report was also shown to the crew of Flight 502.

The weather conditions at Rocky Mountain House around the time of the occurrence were: broken cloud at 4 000 ft, visibility 40 miles, temperature 49°F, wind from the northwest at 10 mph.

1.8 Aids to navigation

Not relevant to this accident.

1.9 Communications

No communications difficulties were mentioned in the report.

1.10 Aerodrome and ground facilities

No relevant to this accident.

1.11 Flight recorders

No flight recorder information was contained in the report.

1.12 Wreckage

Not applicable.

1.13 Fire

Not applicable.

1.14 Survival aspects

Although the fasten seat belts sign was put on and the passengers were told by the stewart to fasten their seat belts, the turbulence was encountered before all of them could do so.

1.15 Tests and research

No information of this sort was contained in the report.

1.16 Terrain encountered en route

Red Airway 75 lies at right angles to the main range of the Rockies (between Enderby and Rocky Mountain House), which rises to 10 000 ft asl with a number of peaks over 11 000 ft. Immediately east of the main range, the ground level drops to 5 000 ft or less. A number of ridges lie east of and parallel to the main range. These ridges, rising to 8 000 or 9 000 ft asl are spaced 6 to 7 miles apart.

2. Analysis and conclusions

2.1 Analysis

It was believed that under the conditions existing at the time, a weather phenomenon known as a mountain wave probably existed in the area where the accident occurred.

In mountain waves, vertical currents of air extend to a considerable height over the terrain features causing the waves. The strength of the up and down draughts in a mountain wave may increase in situations where a series of parallel ridges exists as at this location. The area of turbulence in a mountain wave remains stationary over the terrain feature and does not move with the general movement of the air encountered. It therefore follows that entry ground speed will affect the severity of the turbulence encountered. Flight 502, flying eastbound with a tail wind of more than 100 kt, would encounter the mountain wave at speeds of over 200 kt faster than Flight 503, which was flying westbound with a head wind of over 100 kt at the same indicated airspeed.

2.2 Conclusions

Findings

A certificate of airworthiness had been issued for the aircraft.

Both the pilot-in-command and the co-pilot held valid airline transport pilots' licences and had considerable flying experience.

Prior to departure from Vancouver the crew were advised that en route they should expect to encounter heavy cloud, a jet stream, westerly winds of over 100 kt from 18 000 ft upwards and possible turbulence.

In view of the type of terrain over which the aircraft flew, it was believed that it had entered a mountain wave in which turbulence existed. The fact that the aircraft entered the mountain wave flying with a tail wind of 100 kt caused the turbulence to be more severe.

Cause or
Probable cause(s)

The aircraft encountered severe turbulence in a mountain wave.

3. Recommendations

No recommendations were contained in the report.

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ICAO Ref: AR/837

No. 21

Serviços Aéreos Cruzeiro do Sul S.A., Convair 340, PP-CDW, accident at Congonhas Airport, São Paulo, Brazil, on 3 May 1963. Report released by the Brazilian Air Ministry.

1. Investigation

1.1 History of the flight

The aircraft was on a scheduled domestic flight from São Paulo tc Janeiro with 5 crew and 45 passengers aboard. Following an eight-minute del to heavy traffic, the flight was cleared to take off* from São Paulo. One minu take-off the pilot-in-command reported to the tower that the aircraft's No. 2 e was on fire, and he would return to the airport. A left turn was begun, and it i presumed that the pilot feathered No. 2 propeller. He began the down-wind leg runway 16 and asked the tower operators whether anything abnormal could be seen regarding the aircraft's No. 2 engine. The tower operators, from whom No. 2 engine was hidden by the fuselage, reported that they could not see anything abnormal. Presumably the pilot then unfeathered the propeller which started windmilling. Approximately abeam the tower, the aircraft began to lose altitude and when it started the final turn its altitude was very low. The aircraft was probably nosed up and stalled with a bank angle of 45°; it first struck a house with its nose and left wing, then hit the ground (elevation - 800 m) and made a 260° turn on its left wing. The accident occurred at night in a well illuminated, densely populated area.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	4	33	
Non-Fatal	1	12	
None			

1.3 Damage to aircraft

The aircraft was destroyed.

1.4 Other damage

The aircraft struck a house.

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* Aside from one reference in the report to a São Paulo weather bulletin for 1936 hours local time, no mention of time was made.

1.5 Crew information

All the pilot-in-command's ratings were valid. He had flown a total of 11 997 hours including 8 010 hours as pilot-in-command and instructor on Convair 340 aircraft.

The co-pilot had flown 2 536 hours including 800 hours on the Convair 340.

Both the pilot-in-command and the co-pilot had considerable flying experience including night flying. Their recent activities and working hours did not indicate the possibility of fatigue.

No information regarding the qualifications or experience of the other three crew members was provided in the report.

1.6 Aircraft information

The aircraft had flown a total of 17 960 hours. It had undergone progressive maintenance, the last overhaul having been carried out on 14 December 1962.

The operating times of the engines were as follows:

	No. 1	No. 2
total hours	1 708	7 126
since last overhaul	593	1 095

The aircraft's maintenance history revealed no severe, continuous or irreparable discrepancies in the engines. The temperature readings had never exceeded the maximum permissible.

At take-off the aircraft's gross weight was 1 260 kg below the maximum permissible. Its centre of gravity was also within the allowable limits at take-off.

The type of fuel being used was not indicated in the report.

1.7 Meteorological information

Not relevant to the accident.

1.8 Aids of navigation

The non-directional radio beacon and rotating beacon at São Paulo were operating normally.

1.9 Communications

No difficulties were mentioned in the report regarding the communications between the flight and the tower.

1.10 Aerodrome and ground facilities

The airport at São Paulo is at an elevation of approximately 800 m.

All aerodrome facilities were operating normally and did not contribute in any way to the accident.

1.11 Flight recorders

Flight recorders were not mentioned in the report.

1.12 Wreckage

Following impact with the ground the fuselage broke at its centre section.

1.13 Fire

Fire broke out following impact.

1.14 Survival aspects

There was no panic aboard the aircraft during the emergency.

The steward was in the cockpit at take-off when the emergency occurred. The pilot-in-command told him to take a seat in the passenger cabin and fasten his seat belt. He did so, taking a seat on the left-hand side of the aircraft in the penultimate row. Although he was injured at the time of the accident, he was the only surviving crew member.

1.15 Tests and research

Two test flights were carried out Galeão Airport/Rio de Janeiro, which is at sea level, to try and establish the cause of the subject accident using all available data. A Convair 340, at the same weight as PP-CDW, carried out two simulated take-offs at an altitude of 800 m over the airport, which corresponds to the elevation of Congonhas Airport/São Paulo. The take-off run was reconstructed from the performance curves. The aircraft climbed to a simulated altitude of 150 m (950 m over the airport), then the sound of the overheating warning bell was simulated, and No. 2 propeller was feathered immediately. Following a 180° turn the No. 2 propeller was unfeathered but although the shut-off valve was opened to prevent engine damage the fuel tank valve was left closed, and the propeller began windmilling. The instruments for No. 2 engine indicated the following:

> rpm: 1 500 to 1 600; fuel flow: zero; manifold pressure: variable, i.e. according to the position of the throttle, BMEP: zero.

When the propeller was unfeathered the aircraft could not maintain altitude. Speed was maintained at 105 kt (12 kt below V_2), and the aircraft gradually lost altitude at the rate of 300 to 500 ft/min. The power on engine No. 1 was increased to take-off power, and speed was reduced to 100 kt. About 1 000 m past the point where the aircraft arrived abeam the runway threshold, a turn was begun to enter the simulated base leg. The aircraft stalled at 95 kt and passed through the altitude of 800 m, the same elevation as at the accident site.

No flaps were used during the test flights. The flaps of PP-CDW were found about 50% open. If the pilot had not retracted the flaps during the feathering procedure, the aircraft should have climbed at least about 70 m. If he had been using the flaps in

the final stage of the flight this should have reduced the stall speed to 90 kt. However, this would not have altered the results very much.

It was, therefore, concluded that whatever the reason was for the unfeathering of the right propeller, it was carried out immediately after the aircraft entered the down-wind leg.

1.16 Convair 340 aircraft - engine fire and overheating warning system

Exhaust pipes of the Convair 340 are equipped with butterfly valves, which are controlled from the cockpit and are designed to regulate the ejection of exhaust gas.

When overheating occurs, a bell rings and an automatic control moves the butterfly valves to the "trail" position. This facilitates the expulsion of the exhaust gas and results in the reduction of the temperature. When the temperature arrives below 600°F the bell stops ringing. The bell's ringing can only be interrupted when:

1) its electric circuit is disconnected; or
2) its respective fuse is pulled "off" on the fuse panel.

In order to determine which engine is overheating, the speed of one engine is reduced and the position of the butterfly valve control is noted. If the bell continues to ring, power is again applied to this engine and the same procedure is repeated for the other engine. However, if it still continues ringing, the feathering of each propeller is carried out in turn. The temperature of the feathered engine is quickly reduced, and the bell will cease to ring. If the bell still continues ringing, this indicates a short circuit in the system. On the other hand, fire in the engines is indicated by two lights for each engine without any sound warning.

2. Analysis and conclusions

2.1 Analysis

Although the surviving steward and one ground witness mentioned a fire in engine No. 1, the Board did not believe that such was the case. The steward, who went to sit at the rear of the passenger cabin at the time of the emergency, said that he heard a bell, and that it ceased to ring when the pilot-in-command applied the appropriate procedure recommended in case of engine fire. However, it was found during the test flights that with the cockpit door closed, the fire warning bell could only be heard up to the second row of seats. Furthermore, when listeners were told of the bell and the door was left open, the bell could be heard up to the fifth row. It was therefore believed that the steward would not have been able to hear the warning bell from where he was seated. It was also believed that the ground witness may have mistaken the glare of the anti-collision light for a fire in No. 1 engine.

In view of its engine exhaust system, the aircraft does not show, even at night, the characteristic glare of flame ejection.

Because of the shape of the Convair 340 engines fairing, the only exits available for the flames of an engine fire would be the cowl flaps. Pilots, who had experienced engine fires, confirmed unanimously that the glare of flames coming out through the cowl flaps is so intense that hardly any engine fire could fail to be seen.

When the pilot-in-command notified the tower that he would return to the airport because of a fire in engine No. 2, he did not indicate how he had reached that conclusion. He probably interpreted incorrectly the ringing of the bell as a fire warning and presumed it was in No. 2 engine. Evidence showed that he carried out the procedure recommended in cases of engine fire. He feathered the propeller and, among other things, he pulled out the shut-off valve handle as a safety procedure and also in order to be able to trigger the fire extinguisher. With No. 2 propeller feathered, the aircraft entered the down-wind leg and continued flying level. It was considered that the pilot probably unfeathered the propeller at this time for any of the three following reasons:

1) he had no confirmation that there actually was a fire in engine No. 2;
2) he concluded that the warning was false and everything was normal; or
3) No. 1 engine on its own could not keep the aircraft flying.

These three possibilities are discussed hereunder:

1) After having carried out the procedures for fire in No. 2 engine the pilot-in-command found that the warning bell was still ringing. Having no confirmation of abnormality on No. 2 engine from the tower operators, he decided to unfeather No. 2 propeller. However he did not re-open the shut-off valve and therefore No. 2 engine did not restart, and its propeller windmilled. Under these circumstances the aircraft, at its present weight and altitude, could not keep its altitude even with No. 1 engine at maximum take-off power. Although the indications of the No. 2 engine instruments, which the tests showed to be 1 500 to 1 700 rpm, zero fuel flow, and zero BMEP, should have clearly indicated the situation, it might have taken some time for the pilots to realize the reason for these abnormal indications.

   A possible explanation for the improper unfeathering operations was that they were carried out hurriedly on the assumption that a fire or an overheating existed in No. 1 engine.

2) This hypothesis was considered unlikely. Should the pilot have reached the conclusion of a false warning, there was no reason for a hurried unfeathering of the propeller. As it appears that between the time of feathering and unfeathering of propeller No. 2 the necessary procedures were not carefully followed, it was concluded by the crew that it was unlikely that some malfunction had occurred in the wiring of the alarm system.

3) The third hypothesis considered the possibility that following the unfeathering of propeller No. 2, engine No. 1 could not keep the aircraft in the air. Based on testimony of the steward, ground witnesses and the tower controllers, it was concluded that the false fire interpretation occurred just after take-off. The unfeathering should actually have occurred before completion of the first 180° turn prior to entering the down-wind leg. The aircraft should have climbed a little. Examination of engine No. 1 did not reveal any failure which would have caused lack of power. The unfeathering of No. 2 propeller should have improved flight conditions if, on restarting the engine, every step of the unfeathering procedure had been carried out correctly.

2.2. Conclusions

Findings

The crew were properly certificated and had considerable flying experienc including night flying, on the subject aircraft.

No reference was made in the report to the aircraft's certificate of airworthiness. The most recent overhaul of the aircraft prior to the accident was carried out on 14 December 1962. The aircraft's gross weight and centre of gravity were within the permissible limits.

For unknown reasons, the alarm bell, which indicated overheating, rang immediately after take-off. The pilot-in-command, believing engine No. 2 was on fir presumably feathered No. 2 propeller. As the flight entered the down-wind leg, it wa unfeathered, but the shut-off valve was not re-opened, and the propeller began windmi Although engine No. 1 was still operating at take-off power, the altitude could not be maintained. When entering the last turn to base leg, the aircraft was very low, and the pilot presumably tried to lift the nose to avoid striking buildings near the airport. This caused the aircraft to stall. At this time one of the crew probably used the flaps Shortly thereafter the aircraft banked 45°, struck a house and crashed to the ground.

It is highly probable that if the pilot had refeathered No. 2 engine when he started losing altitude, he could have maintained altitude and landed safely.

Cause or Probable cause(s)

PRIMARY

Probable pilot error. Improper procedure on unfeathering No. 2 engine.

SECONDARY

Probable material failure of one or both engines overheating.

3. Recommendations

No recommendations were made in the report.

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ICAO Ref: AR/823

No. 22

British European Airways, Vickers Viscount V-802, G-AOJC, accident at Cointrin Airport, Geneva, Switzerland, on 9 September 1963. Report No. 1963/38/167, dated 16 June 1964, of the Federal Board of Inquiry into Aircraft Accidents, Switzerland.

1. Investigation

1.1 History of the flight

Flight 556 took off from London, England at 1158 hours GMT on a scheduled international flight to Geneva, Switzerland, with a crew of 4 and 30 passengers. The co-pilot was at the controls during the entire flight. Shortly after reaching the Paris area the steward reported that a flap on the port wing was damaged. The pilot-in-command investigated and saw that a plate covering the flap control mechanism, attached to the upper wing surface by screws, had come loose and was protruding upwards about 5 to 8 cm. He decided not to use flaps for the landing at Geneva as he suspected that screws had come loose and lodged in the flap mechanism. The aircraft manuals were consulted by the crew and an approach speed of 135 kt, a threshold speed of 125 kt and a landing speed of 115 kt were selected for the flapless landing at Geneva.

The approach to Geneva Airport was made on instruments and at 1346 hours when the aircraft was at 1 500 ft, runway 23 was sighted. The approach was continued visually and a speed of 135 kt was maintained. This speed was reduced to 125 kt by the co-pilot just prior to crossing the runway threshold. The nose of the aircraft was higher than normal because of the fact that no flaps were used. At 1349 hours, the aircraft touched down 250 m beyond the runway threshold at a speed of 115 kt, first with its main undercarriage and then with its nose gear. The landing appeared to be normal until approximately halfway down the runway when the aircraft lost its nose wheels. The nose of the aircraft lowered a little more than usual, and this was followed by a noise like the bursting of a tire coming from the nose gear well, succeeded by a shuddering noise and violent vibration of the aircraft. At a speed of about 30 kt the aircraft began to swing to the left onto taxiway 6 where it came to rest a few metres down the taxiway. No brakes were applied. The aircraft had covered a total distance of 1 550 m since touchdown.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal			
Non-Fatal			
None	4	30	

1.3 Damage to aircraft

The aircraft was substantially damaged.

1.4 Other damage

No damage was sustained by objects other than the aircraft.

1.5 Crew information

The pilot-in-command, age 42, held an airline transport pilot's licence which was valid until 21 December 1963. He had flown over 10 000 hours, including 1 026 hours on Viscount aircraft.

The co-pilot, age 40, also held an airline transport pilot's licence which was valid up until 17 December 1963. His flying experience amounted to 5 900 hours, including 890 hours on Viscount aircraft.

The two other crew members were a steward and a stewardess.

1.6 Aircraft information

The aircraft's certificate of airworthiness was valid until 14 January 1964.

The aircraft had been in service 14 000 hours and had made approximately 10 000 landings.

The maximum permissible take-off and landing weights for this aircraft are 29 257 kg and 26 535 kg respectively. The aircraft's actual landing weight (about 25 200 kg) and its centre of gravity on the subject flight, were within the prescribed limits.

The Viscount's nose gear is equipped with twin wheels and is designed to support a vertical load of 8 900 kg (19 700 lb) at a friction coefficient of 0.8. The wheel axis is governed by a light alloy sleeve at the lower end of the shock strut.

The sleeve of the subject aircraft had been in service for 13 378 hours, during which 8 622 landings were carried out. Since the last inspection for cracks, it had been in service for 992 hours, during which 786 landings were carried out.

The type of fuel being used on the subject flight was not indicated in the report.

1.7 Meteorological information

The weather conditions at Geneva Airport at 1250 hours on the day of the accident were:

wind: ENE, 4 kt; cloud: 1/8 cumulus at 3 000 ft, 3/8 cirrus at 30 000 ft; visibility: 6 km.

1.8 Aids to navigation

Not relevant to the accident.

1.9 Communications

No communications carried out by the flight were mentioned in the report.

1.10 Aerodrome and ground facilities

Runway 23 is concrete and is 3 900 m long and 50 m wide. Taxiway No. 6 enters the runway from the left, at an angle of approximately 135°, about 1 800 m from the runway's threshold. The runway was dry and in good condition at the time of the accident.

1.11 Flight recorders

No flight recorder information was contained in the report.

1.12 Wreckage

The nose gear and inboard propellers were destroyed.

1.13 Fire

There was no fire.

1.14 Survival aspects

Following the accident, all occupants evacuated the aircraft.

1.15 Tests and research

Examination of the mechanism of the port wing flap confirmed the observation of the crew that two screws were missing and one of them appears to have been lost during the flight.

Inspection of the nose gear showed that damage began with the rupture of the sleeve at the lower end of the shock strut. This part was totally destroyed and was not, therefore, available for examination.

Investigations and tests conducted on other components revealed the following:

- the material used in manufacturing the sleeve was according to specifications. Factory tolerances had been observed.

- the direction of application of the load was the same as the direction in a normal landing.

- the surface and edges of the fractures did not present symptoms of failure due to fatigue, but characteristics indicative of sudden rupture due to excess load.

Information supplied by the United Kingdom authorities revealed that a number of these sleeves have been found in recent years with cracks and other traces of corrosion due to the difference in electrical potential between the light alloy in the sleeve and the steel in the adjacent part. The majority of cracks discovered were found along a vertical line in the front part of the sleeve, corresponding to one of the fracture lines of the part incorporated in the aircraft involved in the accident. A subsequent modification, which consisted in inserting a phosphorated bronze jacket between the two parts, sufficed to remedy the phenomenon. This modification had been made to the subject

aircraft. A general check of these components was made by the airline after the accident; similar cracks were found on two aircraft.

A check of the tell-tale instruments on the main landing gear did not bring to light any abnormal strains on this part of the structure.

2. Analysis and conclusions

2.1 Analysis

Because of flap damage, which was observed while en route, a flapless landing was carried out at Geneva.

According to the statements of the crew of the subject flight, and a ground witness, who was at a point about halfway down runway 23 on the north side, the landing was normal up until the point where the aircraft lost its nose wheels.

The markings and deposits of rubber and metal left on the runway showed that the aircraft first contacted the runway with its main starboard undercarriage, then with its port undercarriage 70 m farther on and finally with its nose gear 38 m after that. The tire marks made by the nose gear were very pronounced and widened rapidly. This indicated that the impact of the nose gear on the runway was fairly violent. This was due to the fact that the nose gear was in a higher position above the runway during the flapless landing than it would have been during a normal one. The point of impact of the nose gear leg was located about 11.50 m beyond and on the same axis as the point of impact of the nose wheels. The metal marking extended from there to the point at which the aircraft came to rest. The last tire marks made by the nose gear were about 6.3 m beyond the point of impact of the nose gear leg to the left of the metal marking. The first contact of propeller No. 2 with the ground occurred about 70 m ahead of the point of impact of the nose gear leg. Identical deposits from propellers No. 2 and 3 appeared again about 470 m farther on and continued as far as the point at which the aircraft finally came to rest.

The main landing gear was not subjected to any abnormal loads, and the landing did take place within the permissible operating limits. Although it could not be definitely established, there was considerable evidence to support the theory that a local weakening of the sleeve, due to cracks or fissures, contributed to the failure.

2.2 Conclusions

Findings

The crew were properly certificated.

The aircraft had a valid certificate of airworthiness. It had been in service 14 000 hours and had made approximately 10 000 landings.

The aircraft's actual landing weight and its centre of gravity were within the prescribed limits.

While en route from London to Geneva it was observed that a flap on the port wing of the aircraft was damaged, and the pilot-in-command decided to carry out a flapless landing at Geneva. The landing appeared normal until the aircraft lost its nose wheels about halfway down runway 23 and swung off the runway onto taxiway 6 where it came to rest.

The main landing gear was not subjected to any abnormal loads, and the landing took place within the permissible operating limits. However, since it was a flapless landing, the position of the nose gear was higher than normal and the impact of the nose wheel tires on the runway was fairly violent.

It was also considered that a weakening of the sleeve at the lower end of the shock strut, due to cracks or fissures, contributed to the failure.

Cause or
Probable cause(s)

The Board determined that the accident was due to failure of a component of the nose gear structure during a landing made without flaps, probably under the contributing influence of a local weakening of the component.

3. Recommendations.

No recommendations were made in the report.

ICAO Ref: AR/844

ACCIDENT TO BEA VISCOUNT, G-AOJC, AT GENEVA, SWITZERLAND, 9 SEPTEMBER 1963

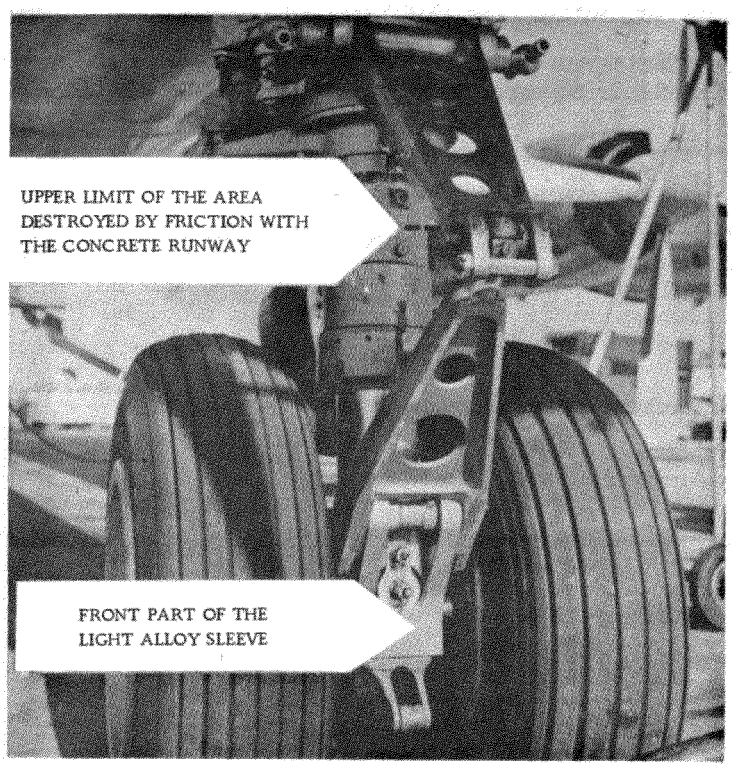

FIGURE 3

LOWER PART OF THE NOSE GEAR

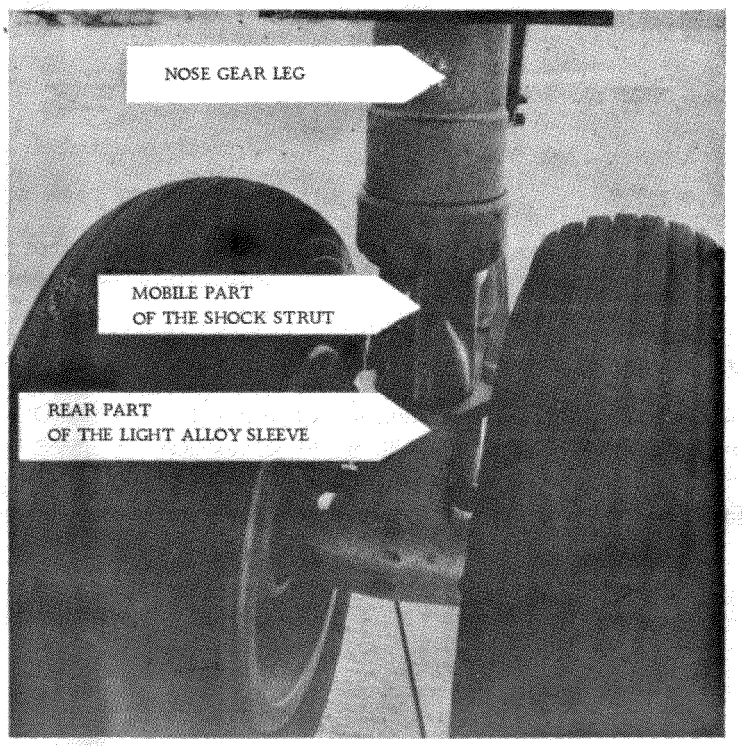

FIGURE 4

No. 23

West Coast Airlines Incorporated, Fairchild F-27, N 2707, accident at Calgary Airport, Alberta, Canada, on 24 August 1963. Report No. F-314, released by the Department of Transport, Canada.

1. Investigation

1.1 History of the flight

West Coast Airlines Flight 794 left Spokane, Washington, (USA), at 2238 hours mountain standard time on 24 August 1963 on a scheduled international flight to Calgary, Alberta. The route flown was Spokane direct to Cranbrook, British Columbia, thence via Blue 3 to Calgary. At 2333 hours Flight 794 reported to Calgary Terminal Control at 17 000 ft. The flight was then cleared to the Calgary VOR station at 13 000 ft and requested to report by the Dyson Intersection. This was acknowledged and on request the latest Calgary weather was provided to the flight together with the altimeter setting (30.07 in.Hg) and the runway to be used (28). Flight 794 reported by Dyson at 2338 and was cleared to maintain 10 000 ft. They were offered and accepted radar vectors to the localizer serving runway 28 and were then cleared for an approach. The flight was given a vector of 040° and advised it was south of the VOR station. At 2346 hours the flight was advised it was 14 miles south of the localizer. Following successive vectors of 350° and 310° the flight was advised at 2351 hours it was 1-1/2 miles south of the localizer and clearance was issued for a straight-in approach on interception of the localizer. Thirty-three seconds later the flight was informed it was 2 miles from the outer marker intersection and then at 2352 hours that it was over the outer marker intersection at which time it was requested to call the control tower. The flight called the control tower and reported over the intersection following which it was cleared to land on runway 28 and provided with wind information. An acknowledgement of this at 2352 hours was the last transmission from the aircraft. It was determined subsequently that the aircraft struck the ground about 8 000 ft before the threshold of runway 28 and 420 ft to the right of the centre line of that runway. It slid for a distance of about 800 ft before coming to rest. At the time of impact (2355 hours) the aircraft was approximately in a 5° nose-down attitude.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal			
Non-Fatal	2	2	
None	1	10	

1.3 Damage to aircraft

The aircraft was destroyed.

1.4 Other damage

No other damage was reported.

1.5 Crew information

The pilot-in-command held a United States airline transport pilot's licence with an instrument rating and had accumulated a total of 19 687 hours flying experience. He had a total of 3 219 hours on F-27 aircraft, including 153 hours in the 90 days prior to the accident. He had flown the route 19 times of which 5 flights terminated at night. This included 8 flights into Calgary since January 1963, one of which was at night. His night flying experience was 3 309 hours, his actual instrument experience 2 689 hours and his simulated instrument experience 550 hours.

The co-pilot held a United States commercial pilot's licence with an instrument rating and had accumulated a total of 4 230 hours flying experience. He had a total of 488 hours on F-27 aircraft including 169 hours in the 90 days prior to the accident. His night flying experience was 630 hours and his actual and simulated instrument flying experience was 465 hours.

1.6 Aircraft information

A United States Certificate of Airworthiness had been issued for this aircraft. It was established that the aircraft had been properly maintained and there were no faults likely to have contributed to the accident.

The weight (32 106 lb) and centre of gravity of the aircraft were calculated to be well within the allowable limits at the time of the accident.

The type of fuel was not specified in the report.

1.7 Meteorological information

The weather at Calgary Airport was reported to have been broken cloud at 1 400 ft, scattered cloud at 600 ft, visibility 15 miles, temperature 48° F, dewpoint 47 °F, and the wind from the north-northwest at 15 mph. The crews of two aircraft which landed 1 hour before and 30 minutes after the accident respectively reported the ceiling at 400 to 500 ft above ground with some scattered clouds around 300 ft. The subject flight was clear of cloud between 4 200 and 4 300 ft, which is about 650 to 750 ft above ground.

1.8 Aids to navigation

The instrument approach system for runway 28 consists of a localizer on 109.5 Mc/s. There is no glide path. The outer marker is formed by the intersection of the localizer and either the 172° radial of the Calgary VOR, the southeast leg of the Calgary low frequency range, or a 039° magnetic bearing from the Alpha beacon (now called Yankee beacon). The outer marker intersection is 4.8 NM from the threshold of runway 28. All available radio aids were operating and serviceable before and after the accident.

1.9 Communications

No difficulty in communications was reported.

1.10 Aerodrome and ground facilities

Runway 28 at Calgary Airport is 8 000 ft long by 200 ft wide, and the threshold elevation is 3 542 ft ASL. The runway lights are a clear, variable, medium intensity system. There are 5 green threshold lights on either side of the threshold. The approach lights are a low intensity system consisting of double-unit yellow 100 W lamps. The poles are 200 ft apart and extend 3 000 ft east of the threshold. All lights were on and serviceable at the time of the accident.

1.11 Flight recorders

A flight recorder was carried and was operating during the flight. The acceleration parameter was not recorded due to a defective diamond on the stylus. The recorder was functioning normally in respect to the other parameters. The readout of the flight recorder tape was as follows:

a) Altitude - There was nothing significant in the altitude until the flight reached the outer marker intersection. The aircraft crossed the outer marker intersection at slightly over 4 900 ft and entered a continuous descent until ground impact at an altitude of about 3 575 ft just under 2 minutes later. This gave an average rate of descent of about 650 ft/min.

b) Indicated airspeed - The indicated airspeed over the outer marker intersection was 111 kt and varied between 111 kt and 106 kt until about 15 seconds before impact. During the last 15 seconds of flight the airspeed decreased from 106 kt to 88 kt at impact.

c) Magnetic Heading - The aircraft crossed the outer marker intersection on a heading of 305°. Twenty-seven seconds later the heading was 269°; after a further 25 seconds the heading was 282°; 54 seconds later it was 294° and at impact a further 10 seconds later it was 281°. The average heading between 305° and 269° is 287°. The aircraft was flown 18° either side of the average heading between the outer marker intersection and the impact point.

1.12 Wreckage

The wreckage trail extended for 800 ft from first impact on an average heading of 277° magnetic. Parts were shed from the aircraft until the fuselage minus undercarriage, wings and tail unit came to rest on a heading of 346° magnetic.

1.13 Fire

No fire was reported.

1.14 Survival aspects

Survival aspects were not mentioned in the report.

1.15 Tests and research

The pitot static system was subjected to exhaustive tests in view of the nature of the accident. There were certain leaks in the system, some of which were probably a result of impact forces. In any case it is not considered they would have contributed to the accident.

2. Analysis and Conclusions

2.1 Analysis

The elevation of the threshold of runway 28 at Calgary Airport is 3 542 ft above sea level. The co-pilot stated that after passing the outer marker intersection the aircraft was flown through the localizer and then back on. He did not recall any difficulty in getting established on the localizer. The pilot-in-command stated that only small corrections in heading were made after passing the outer marker intersection. The co-pilot stated that when the aircraft reached 4 500 ft he read altitudes for every 100 ft descent. He first indicated they broke out of cloud at 4 200 ft but later revised this to say that he observed the runway at 4 200 ft and so informed the pilot-in-command. He called out "approaching minimum" between 4 200 and 4 100 ft. He considered the aircraft was low when he observed the runway from 4 200 ft, but after observing the 4 000 ft altitude he was occupied with other matters and did not follow the descent by instruments or by looking outside. The pilot-in-command reported he remained on instruments until the co-pilot reported the runway was in sight at which time his altimeter indicated about 4 200 ft. He then looked out and found the aircraft was out of the clouds and he could clearly see the runway lights. He noted the runway was still some distance ahead and considered he would have to close the distance before continuing the let down. He then returned to instrument flying. He stated that he remembered applying power, however, during subsequent questioning, he indicated that he remembered that he wanted to add sufficient power to maintain altitude and was in the process of doing so when the aircraft struck the ground. He was not aware of how much power he had succeeded in applying. The co-pilot first reported that between 4 200 and 4 100 ft the pilot-in-command began to add power but later changed this to say that the pilot-in-command had his hand on the throttles, but he did not recall hearing any rpm increase prior to impact. The pilot-in-command stated that at the time of impact his altimeter indicated a height of just under 4 000 ft and not less than 3 957 ft, and the co-pilot stated that after the aircraft was on the ground both altimeters indicated the terrain elevation. Technical examination established little power was being developed on impact. From the evidence of the flight recorder in respect to indicated airspeed and altitude it is considered unlikely there were any power changes between the outer marker intersection and the impact point.

2.2 Conclusions

Findings

The crew were properly licensed and were suitably experienced for the flight.

The aircraft was airworthy and intact prior to impact. The weight and centre of gravity of the aircraft were calculated to be well within the allowable limits at the time of the accident.

The weather was above the approved minima.

The operation of the airport and associated facilities was normal.

Other aircraft approached and landed on this runway before and after the accident without difficulty and did not report any weather phenomenon.

The aircraft descended under low power with a rate of descent of 650 ft/min from the outer marker to the impact point.

The aircraft was manoeuvred in excessively large heading changes between the outer marker intersection and the impact point.

A loss of airspeed occurred during the final 15 seconds of flight.

The co-pilot did not monitor the final stages of approach visually or by reference to his instruments.

Cause or
Probable cause(s)

The pilot-in-command failed to maintain the approved minimum altitude on approach.

Failure of the co-pilot to monitor the final stages of the approach is considered to be a contributing factor.

3. Recommendations

No recommendations were made in the report.

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ICAO Ref: AR/838

PART II

AIR SAFETY ARTICLES

T - T A I L S

By Captain John A. Morrison,
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(From the May 1965 issue of Aerospace Safety Magazine, published by the United States Air Force)

The MIG-15's entry into the Korean War opened a new era in the age of aviation. The great advance in performance over World War II aircraft introduced new problems for the pilots involved in jet versus jet aerial combat. The MIG also brought with it some stability and control characteristics that gave its pilots a bad time. On several occasions the MIG was seen to "dig in" or "pitch up" during a high G turn. At least two confirmed victories over the MIG were attributed to the airplane entering an uncontrolled manoeuvre from a hard turn.

Ten years later "pitch-up" is still a fearsome characteristic. There are a lot of aircraft flying today with pitch-up possibility. Pilots of these airplanes use caution and avoid the area of pitch-up because of the resulting uncontrolled manoeuvre.

Why is the MIG configuration popular today?

The high-tail swept-wing configuration was dictated by performance requirements. An aircraft so designed will cruise efficiently in the high subsonic Mach range (0.85 to 0.95). Wind tunnel tests of the XF-104A showed the high-tailed configuration to have lower overall drag than any other configuration.

A sweep angle of 30 to 35 degrees will increase the speed at which the drag-divergence occurs due to Mach number (Fig. 1).

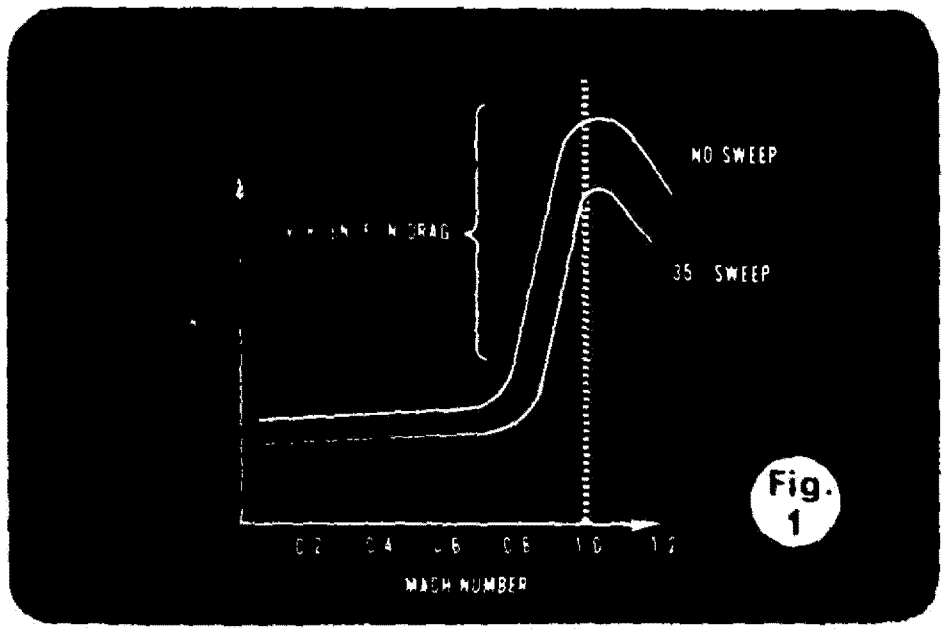
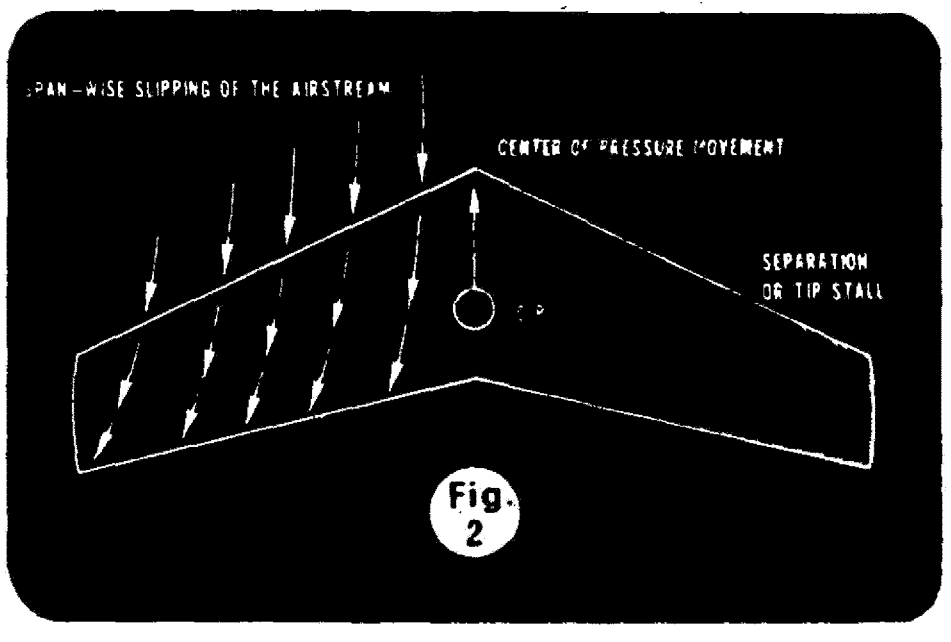


Fig. 1

The delay in drag-divergence becomes the most important design criteria for flight at high subsonic speeds. If the tail is up high out of any air flow interference, it will be more effective. The higher degree of effectiveness will allow it to be physically smaller with a smaller thickness to chord ratio. Thus the parasite drag and the induced drag of the tail will be less. The airplane will cruise at a higher Mach number using less power and its overall range, endurance and rate of climb will be better. Thus, economics play a deciding role in the basic aircraft design.

The increase in performance doesn't occur without penalty; the high-tail aircraft configuration has a pitch-up possibility. Both the swept-wing and the high-tail contribute to the aircraft instability, the wing because of its airflow patterns. The pressure gradient along the wing surface causes span-wise slipping of the airstream (Fig. 2).



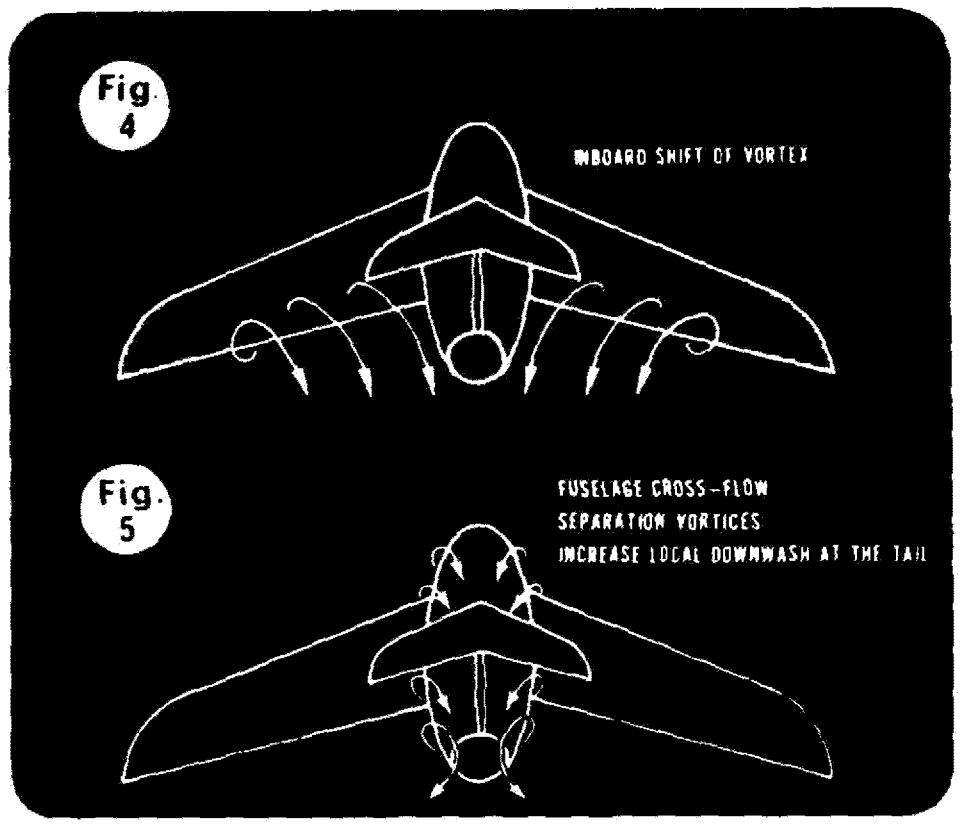
This produces a thicker boundary layer of air near the tip. Air flow separation will occur first at the tip and thus the stall occurs first at the tip.

The wing tip stall causes the centre of pressure to move forward. As the centre of pressure moves forward the moment created is a nose up moment.

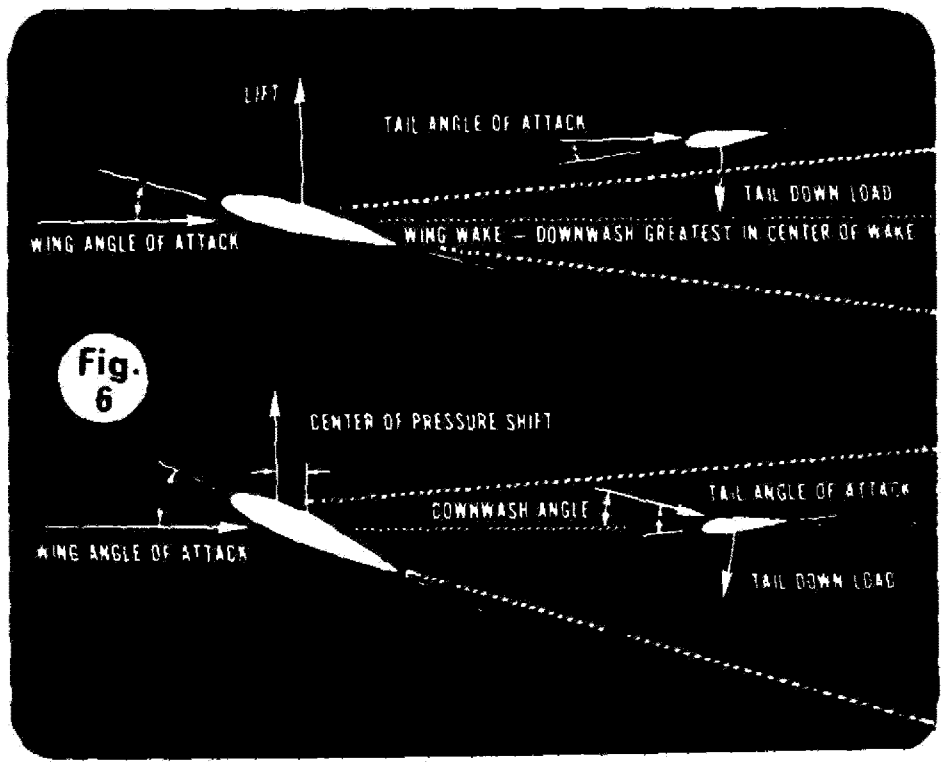
Airfoil and control surfaces at the rear of the airplane are used to stabilize and control the moments on the airplane. The horizontal stabilizer gets its name because of the function it performs. By virtue of its position behind the wing, it operates in airflow from the wing. Airflow over the wing is deflected up by the shape of the wing. This air must come back down and this change in air flow pattern is known as downwash (Fig. 3).

An airplane moves through the air fast enough so that the deflected air is still on its way down when it arrives at the tail. As a result, downwash reduces the angle of attack at the tail. Also, the amount of downwash at the tail will increase as the wing angle of attack increases, and an increase in downwash has a destabilizing effect.

When the airplane wingtips stall, the wing vortex shifts inboard increasing the local downwash at the tail (Fig. 4). At high attack angles (approaching stall) the air flow across the fuselage separates and the resulting vortices also increase local downwash at the tail (Fig. 5). Thus the tail suffers a decrease in effectiveness and stabilizing ability as the airplane angle of attack increases.



By placing the tail high enough it can be kept out of this region of downwash and it will not show a decrease in effectiveness with angle of attack. But if it moves from an area of no interference to an area of strong downwash (Fig 6), then a sudden and significant loss in stability can occur. The angle of attack at which the tail enters the downwash



area is determined by the height of the horizontal stabilizer. However, since the vertical distance is limited by the structure of the vertical stabilizer it is practically impossible to get the tail high enough to avoid the pitch-up region completely.

The pilot can fly the airplane into this region in several ways:

(1) slowing down while holding altitude, or

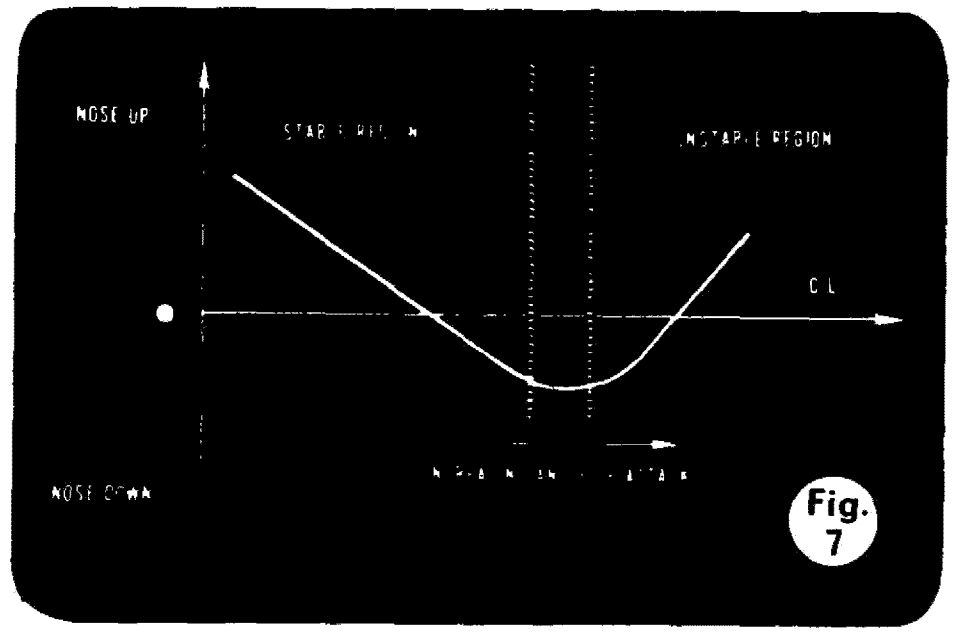
(2) holding a high pitch attitude as the rate of climb decreases, or

(3) as is most common, tightening a turn as the airspeed bleeds off.

The latter is what happened to the MIG-15 pilots. Those fellows usually had their attention to flying distracted by a Sabrejet behind them. The MIG's immediate survival depended upon its ability to turn. So the pilot kept pulling it in and suddenly without much warning, "pitch-up!"

The unstable flight regime that exists in this aircraft configuration establishes a control limit for the airplane. Trying to fly the airplane in this region is just as foolish as trying to fly a low tail airplane past its stall limit.

If we examine a plot of pitching moment versus lift of the high-tail, swept-wing airplane we can see why it is that the aircraft can suddenly pitch nose up. Technically we apply the term "pitch-up" to a longitudinal static instability that can occur with this aircraft configuration at high angle of attack. The plot of pitching moment coefficient versus lift coefficient shows a stable region for low values of CL and a transition to an unstable region at high CL's. The unstable region is caused by the horizontal stabilizer being moved into an area of strong downwash (Fig. 7).



The slope of the Cm versus CL curve indicates the longitudinal static stability level of the airplane. If the airplane is flying in equilibrium in the stable region and experiences a nose-up disturbance the resulting increase in CL indicates a nose-down moment is created. Thus there is a tendency to return the airplane to its undisturbed position. Conversely, if the disturbance occurs with the airplane in the unstable region, the moment created tends to reinforce the nose-up disturbance, hence the instability.

The static stability of the airplane is obvious to the pilot during normal flying. If the airplane is trimmed for cruising flight and the control column is bumped or the airplane flies through some air distrubances, the static stability is indicated by the tendency of the airplane to return to its undisturbed position. If the airplane did not come back toward the original position, but rather continued to pull up similar to a loop, then the airplane would be statically unstable.

The plot shows the high-tail, swept-wing airplane to have an angle of attack area where the airplane becomes unstable. The suddenness and severity of the instability depends upon the design of each particular airplane. If the longitudinal control were adequate and entry into the unstable area slow enough, a good pilot could fly the airplane out of this region once he noticed the nose starting up.

The MIG-15 entered the unstable region without warning. The pilot soon discovered the manoeuvre was violent and beyond his control. Operational use of this aircraft was a dilemma. The MIG pilot had two choices. Stay out of the high CL region and get shot down or use the region and if pitch-up occurred, use the published recovery technique. His published recovery technique leaves a little to be desired by our standards. He had a white line painted vertically on the centre of the instrument panel. In the event an uncontrolled manoeuvre was entered, he was to hold the stick on the line. If the airplane did not recover, he would bail out. The pitch-up characteristic was the price the MIG-15 paid for its performance.

There are many aircraft today with a similar configuration; among them the USAF F-101 Voodoo, F-104 Starfighter, C-141 Starlifter, BAC 111, Boeing 727 and the Douglas DC-9. The airplanes are fitted with warning devices to tell the pilot when he is approaching the unstable region. Horns and stick shakers are such devices. In addition, the control systems incorporate devices to automatically push the stick forward in order to prevent inadvertent entry into the pitch-up. The pilots are provided sufficient control authority so they can "fly-out" of an approach to the instability.

These modern airplanes are fool-proof; but they're not damn-fool proof and it still requires the pilot to have knowledge of the stability and control characteristics of his equipment. He must know his operational limitations and keep his attention on the business of flying.

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INSTRUMENT NAVIGATION

Physiological Aspects of Instrument Flying

By Captain Raymond L.Kuhlman, former Editor of the MAC Flyer,
(Military Airlift Command), Scott Air Force Base, Illinois, U.S.A.

The crash site was just off the end of the runway. The jet had started a missed approach from a practice VOR/ILS low approach. The men on the night shift in the control tower watched as the aircraft levelled off, began to climb, then suddenly pitched down and nosed into the ground.

After a meticulous examination of the wreckage, the investigation team published its findings. The aircraft had no mechanical difficulties. All four engines were producing full power at impact. Flight controls had not malfunctioned. Pathology reports likewise cleared the crew; there was no evidence of carbon monoxide or alcoholic poisoning, no hyproxia or deficiency in blood sugar.

But a mission flown to reconstruct the flight produced a few interesting observations. There was total blackness in the area of the crash. Once past the runway, there were no ground lights for visual reference. And since the jet was much lighter than its normal mission take-off weight, it accelerated much more rapidly. This induced the sensation of a steep climb. It doesn't take much imagination to figure what could have happened there. A sudden passage into complete blackness, combined with the sensation of a steep climb - the pilot probably felt he was going straight up and really shoved that yoke forward.

One of the hardest parts of instrument flying is learning to completely disregard signals from the body's equilibrium organs. In fact, most of the time spent in instrument flight training is actually used in learning to ignore these false sensations.

An example of this is the person who can fly perfectly in the instrument trainer, yet is literally all over the sky when actually under the hood. No one becomes an accomplished instrument pilot unless he learns that his body sensations are always wrong when they disagree with the total picture presented by the flight instruments.

But disregarding a lifetime's worth of learning to balance yourself is difficult at best. A far better method would be to avoid the flight situations which produce spatial disorientation, or vertigo, whenever possible. Let's see what causes these sensory illusions and if you really can avoid them.

Losing direct contact with the ground causes a lot of internal problems. Your sense of balance is normally maintained through a learned ability to interpret sensations from your eyes, muscles, joints, tendons, skin, abdominal organs, and a part of the inner ear called the vestibular organ.

Sometime during the course of undergraduate pilot training, most of us were exposed to the drawings of this vestibular organ, a three-dimensional pretzel found in the inner ear. Since this is a pretty important apparatus for maintaining equilibrium, and the prime cause of false sensations, we'll review its functions briefly.

As three-dimensional pretzels are hard to come by, for illustration we'll use something more readily at hand. A martini glass. This has to be the thin-stemmed type, because of the nature of the demonstration.

Holding the partially filled glass (olive removed) by the stem, start spinning it between your fingers. Note that at first the liquid in the glass remains stationary, then gradually starts spinning and catches up. If you stop the glass' rotation suddenly, or even slow it, the liquid keeps moving for a time. Suddenly reversing the direction of spin will have the glass and liquid moving in different directions.

Your head, in effect, has a set of three of these martini glasses at right angles to each other in each ear. Sensors inside each ring detect any difference in motion between the glass and the liquid within. When your head moves to either side, it causes a sensation in one ring; when it moves up and down, a sensation in a second; and when it moves back and forth, a sensation in the third ring.

What happens when all three get going at once causes more sensations than a discotheque go-go girl. You can get the feel of this with a turning chair, preferably with arms, seat belt and firm base. After tilting your head back, have someone spin the chair. Then snap your head forward. The result is a completely uncontrollable loss of equilibrium and a feeling of tumbling out of the chair sideways.

This would really incapacitate a pilot and explains why head movement should be kept to an absolute minimum during instrument turns. Leaning forward and bending slightly to reset a course line will activate the fluids in all three rings. Straightening up could cause the same type equilibrium loss you got in the chair. This could result in a sloppy turn, if not a complete spin-in.

If you watch a person demonstrating the turning chair effect, one of the things you'll notice is that he searches frantically for an outside object to get a visual lock on some fixed reference. This identifies the eyes as the second sensory organ and also explains why turning and head motions seldom cause vertigo when flying VFR. Picking up an outside point for visual reference helps the brain orient itself. When on instruments, either in darkness or weather, your eye can't fix on anything outside the cockpit. Equilibrium is easily lost and hard to regain.

The remainder of the sensors can be grouped under nerve stimuli, the old "seat of the pants" flight references. While these sensations are important in detecting impending stalls during low-speed or high-G flight regimes, they're no good for blind flying. The increased G-force in a level,co-ordinated turn produces the same seat pressure as a climb. Releasing this back pressure while rolling out after a prolonged turn will make you feel like you're entering a dive.

In unco-ordinated flight, a variety of sensory illusions can occur when flying by the seat of the pants. A skidding turn will feel like a bank in the opposite direction. A slip will feel like a much steeper degree of bank. A sudden pull-up may feel like a high-G turn. The trouble here lies in the fact that, on the ground, gravitational cues are used to orient yourself to the earth. But in flight they can only orient you to the center of gravity of the aircraft.

Several tests have been run to see how well people can determine an aircraft's attitude when blindfolded. In static tests, non-pilots were found unable to detect slow pitch changes less than 24 degrees up and 11 degrees down. Experienced pilots, on the other hand, could detect pitch changes of 7 degrees up or 4 degrees down.

But simulated flight manoeuvers were a different story. In judging whether the aircraft was climbing, diving or level, pilots were wrong 39 per cent of the time. In judging whether in a left or right bank, or level, they erred on 37 per cent of the test. But when pitch and bank manoeuvers were combined, the error rate jumped to over 60 per cent.

Most of your false sensations while flying on the gauges will be a combination of effects on the inner ear and the seat of the pants organs. Since light G-forces and turns slower than two degrees-per-second will have little effect on those sensors, we can put them to work in our favour. Most disorientations are caused by erratic or at least not very precise flying. Keeping rates of roll-in and roll-out of turns equal, and G-forces constant throughout a particular manoeuver will keep the old body clued in. If the aircraft should wander into a bank by itself, a slow roll-out will usually prevent disorientation. A sharp return to straight-and-level will have you feeling you're turning the other way for quite some time and make subsequent manoeuvers difficult. And don't transfer control of the airplane to the other pilot while in a bank, climb or dive unless it's an emergency.

One other source of disorientation comes from visual reference to a false horizon. A long stretch between two cloud layers is a good place to get this. It's also a good place for a mid-air collision, so you have to be on the lookout, but refer to your instruments frequently. Otherwise you'll be setting yourself up for a good case of vertigo when you start a climb or descent through one of the cloud decks.

Fatigue doesn't cause sensory illusions but it will compound them. Studies of fatigue and instrument flying have shown that the tired pilot is less self-critical and his nerves are more sensitive. This triples his susceptibility to disorientation. He will be more prone to false sensations, yet rougher in his instrument flying and more likely to induce disorientation. Two common times for vertigo to occur are while bracketing a final approach course or on a precision final in turbulence. A break before starting an instrument approach, even if it's only sitting back while the other pilot takes over, maximum use of the auto-pilot and close monitoring by the co-pilot of even routine approaches are good ways to guard against these effects.

Instrument flying requires ignoring many strong sensory illusions, and the rapid acceleration and high performance of the newer jet transport and service mission aircraft add to the problem. The accomplished instrument pilot counteracts these adverse effects by giving himself every advantage. He keeps head movements to a minimum, especially when turning or accelerating, doesn't reset course lines or other instruments during a turn. He makes roll-in and roll-out of turns smoothly co-ordinated and at a constant rate. And he believes only what his instruments tell him.

From the MAC Flyer.

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UNDERSHOOT

(From Aviation Safety Digest No. 43, dated September 1965, published by the Department of Civil Aviation, Australia)

Approaching to land in gusty conditions, a four-engined jet airliner undershot the runway and touched down on a soft, grassed area 50 ft short of the threshold. Wheel ruts four inches deep were gouged out of the grass surface and clods of earth were thrown on to the runway, but the aircraft suffered no damage.

The captain said later that the first officer was making the landing from the right-hand seat, under his supervision. The wind was gusting between 25 and 40 kt and the approach was made at a speed 10 to 20 kt higher than the nominated approach speed to allow for the effect of gusts. Immediately after crossing the fence at 130 kt indicated, the aircraft encountered a down-draught and sank rapidly. The first officer checked the descent, but the aircraft touched down, skipped, then settled firmly on the runway. The captain did not know until later that the initial touchdown had been made short of the runway.

Following this incident, the operator issued a circular to all crews reminding them of the need to guard against undershoots. The circular pointed out that the incident had probably been caused by the crew focusing their attention on the beginning of the runway, thereby placing the aircraft in a potentially dangerous situation during the final stages of the approach. Had the crew focused on the recommended touchdown point on the runway, the sudden loss of height from the down-draught would have placed the aircraft on the runway instead of the grass. The operator's circular also contained a reminder that pilots of large jet aircraft sit a long way ahead of the main landing wheels and that allowance has to be made for this in selecting the aiming point on the runway.

Undershoots in large aircraft are a frequent source of incidents and have been responsible for a number of accidents. It is therefore worth examining, in a little more detail, some of the factors that contribute to this tendency.

Incorrect Aiming Point

As this particular incident demonstrates, an undershoot can occur when a pilot selects the threshold itself as the aiming point for his approach. Because the wheels of a heavy aircraft in the approach attitude may be as much as 25 ft below the pilot's eye level, they follow a path during the approach which is parallel to, but considerably lower than, the pilot's line of vision down to the aiming point. In such case, a pilot making a standard approach at an angle of 2-1/2 degrees to the runway would need to select an aiming point as much as 600 ft down the runway to make sure that the approach path actually being followed by the main wheels did not intersect the ground short of the runway.

Also to be considered is the fact that the flare in a large aircraft is usually made when the main wheels are about 50 ft above the ground. In a standard 2-1/2 degree approach aimed at the threshold, this would involve commencing the flare while the aircraft is still about 1 700 ft short of the runway. The risks arising from misjudgement of the flare height or from an unexpected sink late in such an approach need no emphasis.

Excessive Airspeed

Sometimes an approach to land is made initially at a speed above that required for a normal approach. The pilot has then to dissipate the excess speed during the final approach phase by gradually raising the nose of the aircraft. As he does so, however, the apparent position of the threshold is lowered and for the pilot the impression can be one of gaining height. A premature touchdown can easily follow. This illusion is accentuated in modern swept-wing aircraft, which normally approach in a pronounced nose-up attitude.

Approach Speed Below Normal

An aircraft's normal approach speed is designed to provide an adequate margin above the stall. Where this safety margin is infringed by approaching at a lower speed, the chances of the aircraft "mushing" or stalling prematurely are greatly increased. The main causes contributing to this hazard are the rise in stalling speed which occurs with the increase in load factor or "g" during the flare, and loss of airspeed as a result of wind gradient. It should also be remembered that the correct approach speed of a heavy aircraft is derived from its stalling speed, which, in turn, is a function of its landing weight. Hence, underestimating the weight of an aircraft at the time of landing will result in a low approach speed.

What has been said so far applies generally to visual approaches, but when the landing phase is complicated by a rapid transition from instrument to visual flight during an instrument approach, errors are much more easily made. An aircraft making an ILS approach is stabilized on a flight path defined by the electronic glide slope which intersects the runway approximately 1 000 ft beyond the threshold. But at the moment of breaking through to visual flight, a change both in flight reference and configuration has to be accomplished by the pilot in a short space of time. This naturally tends to unsettle the flight conditions which he has previously established by reference to instruments; after readjusting himself to the visual cues he now has available, the pilot has to apply landing flap and reduce the air speed by some 20 kt before crossing the threshold. It is at this stage that the aircraft is frequently allowed to descend below the approach path provided by the electronic glide slope. Although the change in the configuration of the aircraft contributes to this tendency, the prime cause is believed to be switching from the ILS "aiming point" approximately 1 000 ft along the runway to a visual aiming point at the threshold itself. To eliminate the possibility of such an undershoot, a pilot becoming visual on an ILS approach must select a visual aiming point which is also 1 000 ft along the runway.

Primarily, it is up to pilots to school themselves in this technique, but because this could involve a break with long-established habits, it has been recognized that some form of external assistance is required. The Department has already taken steps to this end. Distinctive runway markings have been placed 1 000 ft from runway thresholds so that pilots can concentrate on keeping this marking, instead of the threshold, at a constant angle below the horizon during their approach. Markings have also been provided at distances of 500 and 1 500 ft from the threshold, so that, as well as an aiming point, the pilot is offered a positive indication of distance along the runway. Overall, the markings have the effect of diminishing the prominence of the threshold, thereby assisting the pilot to avoid focusing his attention on it during an approach to land.

Probably the biggest step forward in the elimination of the undershoot problem has been the development of Visual Approach Slope Indicator Systems (VASIS). Visual

Approach Slope Indicator Systems are at present being installed at a number of airports, initially on runways not served by electronic glide slopes and on those which have too few, or perhaps misleading visual cues, for approach judgement - e.g., approaches over sloping terrain or over water.

Wherever a Visual Approach Slope Indicator is installed, pilots should make use of it at every opportunity, not only for the assistance it offers during that particular approach, but also for the experience it affords in flying the correct approach path. In this way, selection of the proper aiming point should eventually become a matter of habit in all visual approaches. When this happens, then perhaps we can expect a significant reduction in the number of landing accidents which can be labelled - - - "UNDERSHOOT."

- 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.

The following publications are prepared by authority of the Secretary General in accordance with the principles and policies approved by the Council.

ICAO FIELD MANUALS derive their status from the International Standards, Recommended Practices and PANS from which they are compiled. They are prepared primarily for the use of personnel engaged in operations in the field, as a service to those Contracting States who do not find it practicable, for various reasons, to prepare them for their own use.

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.

AIR NAVIGATION PLANS detail requirements for facilities and services for international air navigation in the respective ICAO Air Navigation Regions. They are prepared on the authority of the Secretary General on the basis of recommendations of regional air navigation meetings and of the Council action thereon. The plans are amended periodically to reflect changes in requirements and in the status of implementation of the recommended facilities and services.

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