COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF CIVIL AVIATION

AVIATION SAFETY DIGEST

No 2

OCTOBER, 1953

Prepared by The Accident Investigation and Analysis Branch

Published by Authority of The Director-General

Foreword

In the first issue of "Aviation Safety Digest" emphasis was placed on the Incident Report and its value for improving safety. Steps are being taken to improve the handling of these reports, but the system needs the full support of everybody, before best results can be achieved.

You may have suggestions that will help to improve the system, or you may be interested to discuss it with us. If so, either call and see us, at the Accident Investigation and Analysis Branch, 499 Little Collins Street, Melbourne, or send us an Incident Report on the system itself.

In this second issue of the Digest a report on the Dove accident near Kalgoorlie is included. Although it is a long time since this accident occurred, a considerable amount of technical investigation has been going on in the intervening period. The story of this accident, particularly the subsequent developments, should still be of intense interest to everyone.

Finally, we wish to correct a statement in the first issue on page 29, under the title "DC-4 Auto Pilots." Further information recently received indicates that the pilot was not told by an Air Traffic Controller at Eagle Farm that an incident report was unnecessary. This error in our report is regretted.

CONTENTS

Page

Foreword

PART I.—AVIATION NEWS AND VIEWS

Sensory Illusions in Flight 5
Who's Air Space 9
Trip Records 12
Airways Facility Failures 13
Acknowledgments 13

PART II.—OVERSEAS ACCIDENTS

Convair Landing Accident — La Guardia 14
Comet Take-Off Accident — Karachi 15
Bonanza Landing Accident — Indianapolis 16
Super Constellation Landing Accident — Fallon, Nevada 18

PART III.—AUSTRALIAN ACCIDENTS

Dove Structural Failure 20
Take-Off Accident — Auster 24

PART IV.—INCIDENT REPORTS

Unauthorised Descent — Hobart 26
DC-4 Fire Extinguisher System 26
How Full Can You Get! 27
QNH Information 27
Propeller Governor Seizures 28
Leigh Creek Aerodrome 28
Arrival Reports — Training Flights 29
Townsville V.A.R. Alignment 30
Mildura Movements 30
The Pilot and Separation Standards 31
Low Flying 31

PART I

AVIATION NEWS AND VIEWS

Sensory Illusions in Flight

At the Bermuda Air Safety Seminar of 1952, organized by the Flight Safety Foundation, a "Safety Award" was presented to Captain P. P. Cocquyt, Chief Pilot of Sabena Airlines, "for developing a theory of sensory illusions which explains several mysterious accidents of the past and which should be helpful in avoiding accidents in future."

The theory expounded by Captain Cocquyt has apparently been received with great acclaim in the aviation industry overseas, and it is thought that the following article, based on this theory, may provoke some interesting discussion and comments.

Introduction

An optical illusion can be defined as a sensory perception of an external object involving a false belief

These illusions are always created in the course of manoeuvres in which the pilot does not follow the sequence of his aircraft's movements. Under these conditions, the imagined position differs from the true position, and in controlling his aeroplane when ignorant of his true position in relation to the three axes of freedom — pitch, roll and yaw — the pilot will act erroneously, providing a potential cause of accidents.

Visibility

Illusions are most likely to occur under conditions of poor visibility, e.g., at night, where the pilot is unable to determine his position visually in relation to his horizon (roll and pitch axes) — as well as he can in relation to aircraft direction (yaw axis).

To illustrate this point, take the case recently reported in an overseas publication which refers to two instances where potential mid-air collisions were involved. Each case concerned aircraft holding at their assigned altitudes under I.F.R. and at night. The pilot of one aircraft visually sighted the other aircraft while in a turn and believed the other was at his altitude. In each instance, evasive manoeuvres were effected by one or the other aircraft and these manoeuvres resulting in near collisions.

Orientation

Vision is the most important factor for orientation in flight. In the absence of sufficient objects, lights or other evidence for visual guidance, tilting the body to either side up to 20° about the longitudinal axis will remain unnoticed (this may be improved by flight experience up to 10°). The rapid termination of such effects may then lead to disorientation.

Psychologically, the strongest visual impression, such as a windshield framework, may define what is estimated to be horizontal, so that under conditions of poor visibility, the familiar relationship between pilot's position and the windshield framework forms the basis of the pilot's perception of the horizon, and as indicated above, the false horizon may differ up to 20° from the true horizon.

Misjudged Height

The most serious of illusions are those which occur about the rolling and pitching axes of the aircraft and which bring about a misjudgement of height.

Many accidents have occurred while landing on or over calm water, as the visual stimuli from the observation of such a surface do not provide the pilot with adequate information for correct estimation of his relative height. The same can be said of operations over flat featureless terrain.

The nature of the visual stimuli must be such that, to be correct, the resulting sensation must give the pilot instantaneous knowledge of his true position or height.

The mechanics of height misjudgement are illustrated in Fig 1 (a) and (b) where the false horizon differs about 10° from the true horizon.

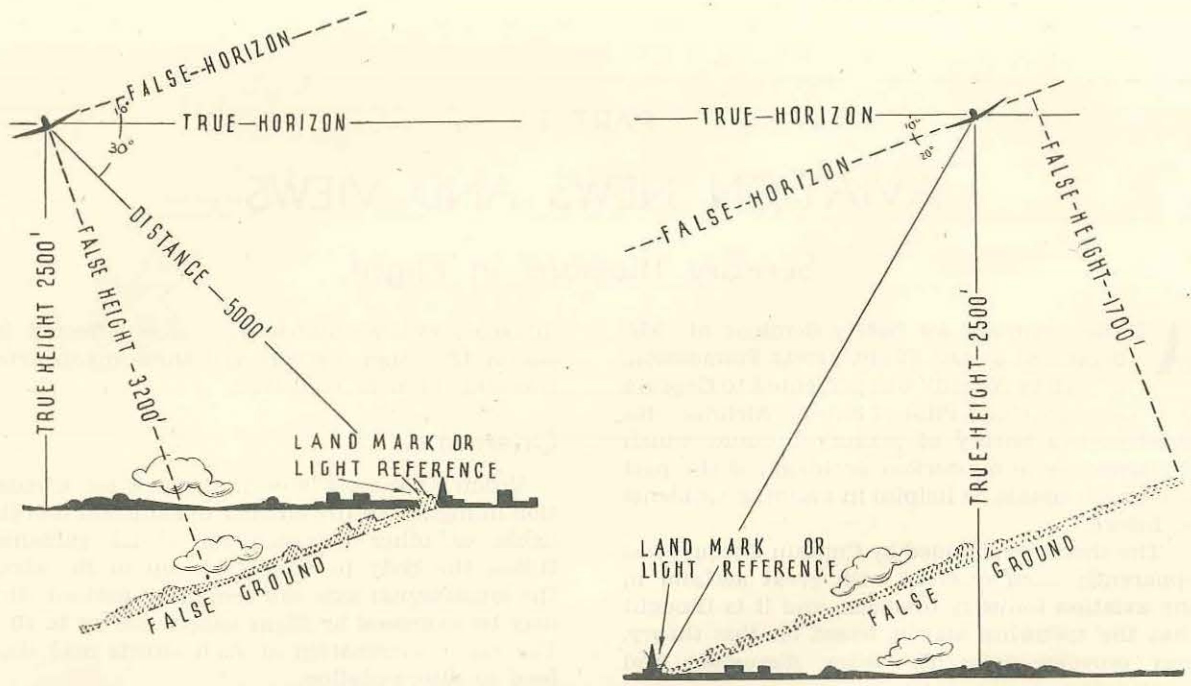


Fig. 1:—False Horizon differing from True Horizon can lead to serious misjudgment of height.

Fig 1 (a) illustrates the case where, because of the pilot's angles of observation of a landmark or light reference in relation to his false horizon, the impression is gained that the aircraft is some 700 feet higher than is actually the case. On the other hand Fig. 1 (b) shows that it is also possible to gain an impression that the aircraft is much lower than the true height.

At altitude, misjudgement of height with relation to some fixed object may not have very serious consequences. However, this becomes very important during the approach configuration where any misjudgement can easily lead to control movements resulting in undershooting or overshooting, as illustrated in Fig. 2, where the effect of "nose high" or "nose down" attitudes is shown to give the impression that the aircraft is overshooting or undershooting.

Similarly, a false impression of height can also be obtained when approaching a sloping runway, the impression of "undershooting" or "overshooting" being dependent on the slope of the runway in relation to the direction of approach. In Fig. 3, which illustrates this point, the runway is assumed to have a slope of about 1½° and the aircraft is descending at about 500 feet per minute, giving an angle of descent of approximately 2½°. In this case, it is shown that the slope of the runway gives an impression which indicates that the aircraft is "undershooting" or "overshooting" by a great deal, and unless pilots are aware of the illusions created by the runway slope, the control of the aircraft can lead to serious over-controlling.

So far, consideration has only been given to illusions presented by the observation of ground objects when the aircraft is moved about the rolling and pitching axes. However, similar illusions can be created during the sighting of airborne objects.

As indicated previously, these illusions can easily arise while aircraft are on a holding pattern, and can lead to evasive manoeuvres which could bring the aircraft in much closer proximity than is actually the case. How illusions

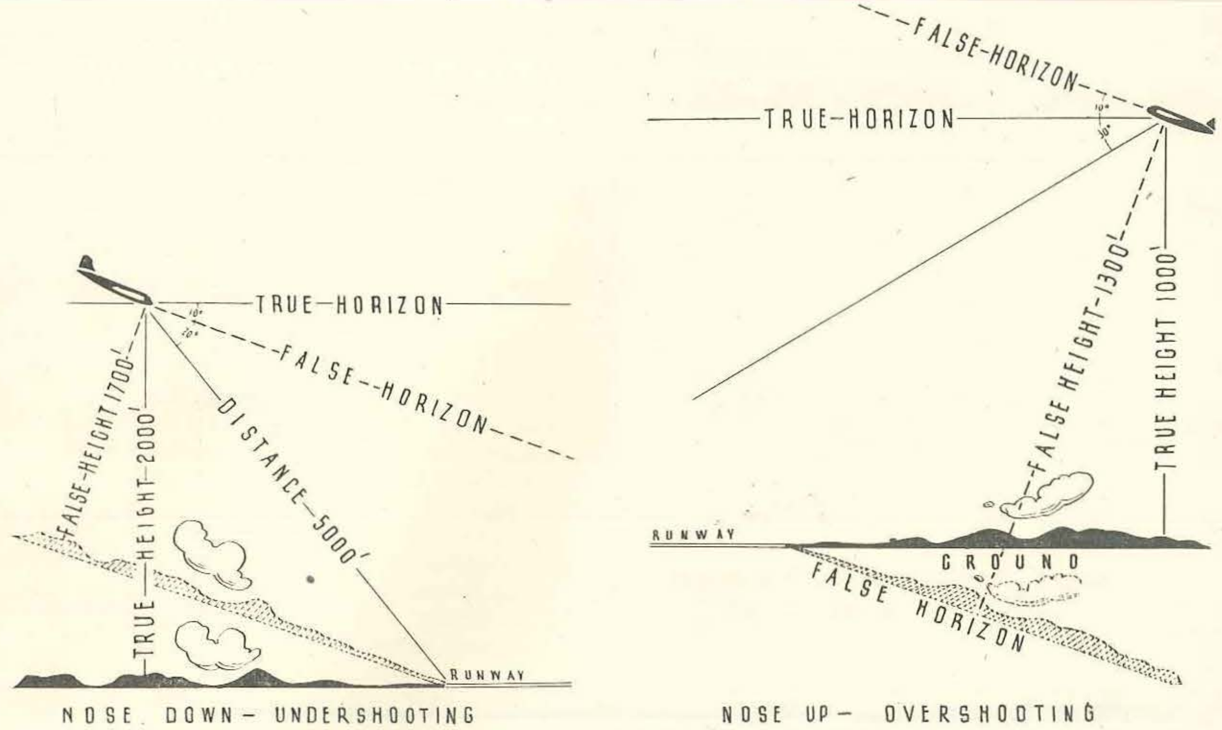


Fig. 2:—Attitude of Aircraft about Pitching Axis can give impression of "Undershooting" or "Overshooting" while approaching to land.

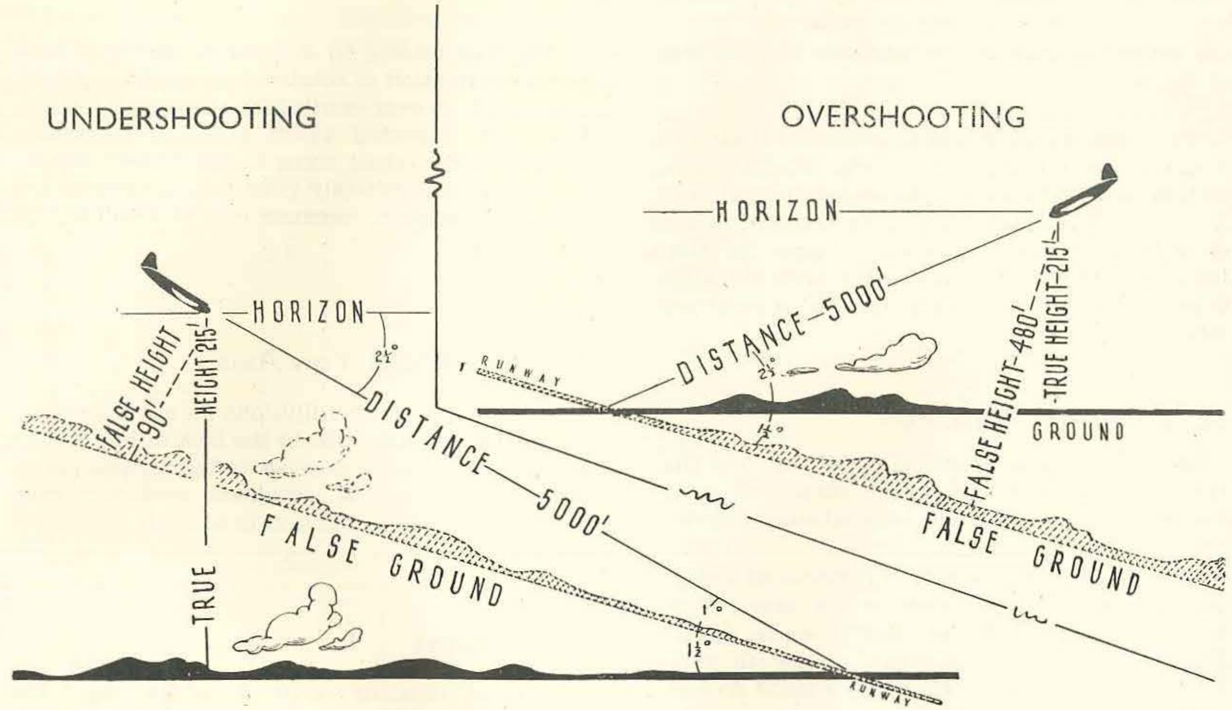


Fig. 3:—ILLUSION PRESENTED BY LANDING ON SLOPING RUNWAY.
Effect of Landing down slope of Runway is to give impression that Aircraft is much lower than it actually is, resulting in correction which can cause "Overshooting."
Effect of Landing up slope of Runway is to give impression that the approach is high, resulting in increasing the rate of Descent and subsequent "Undershooting."

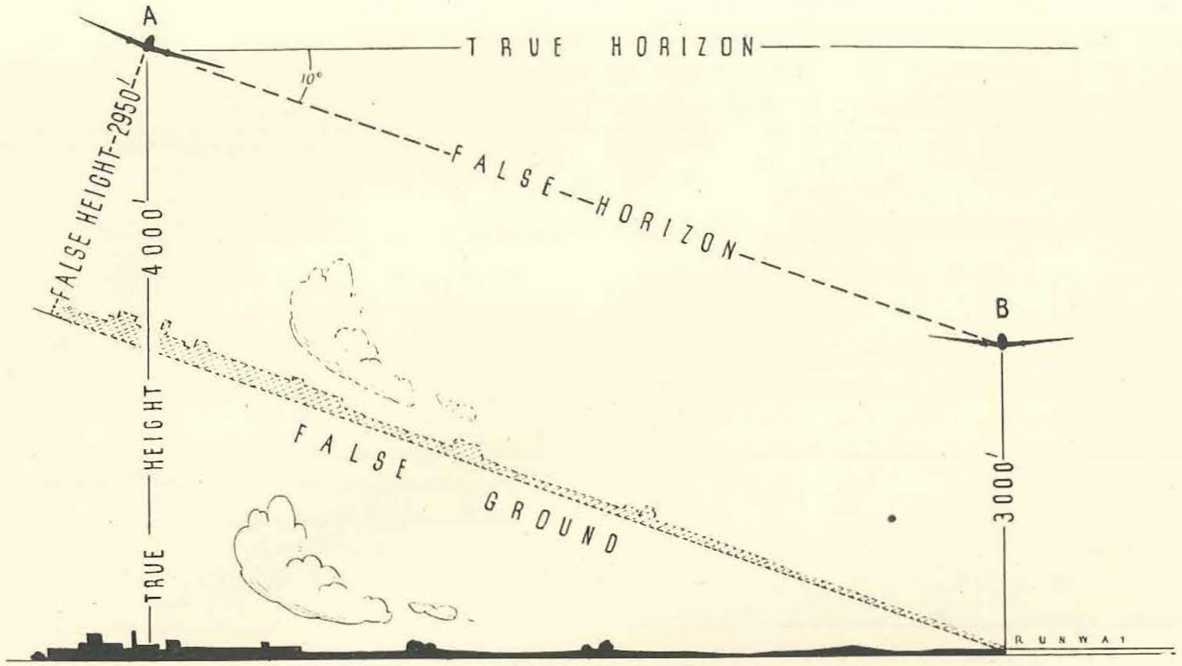


Fig. 4:—Illusions create impression that lower Aircraft is actually at the same altitude.

can effect the pilot in this instance is illustrated in Fig. 4.

From this figure, it can be seen that if aircraft A had a greater than 10° horizon displacement, aircraft B would appear to be higher than aircraft A, and in fact, cases have been recorded where aircraft have mistaken ground lights for stars because of the illusions presented when the angle between the true and false horizon is relatively large.

Acceleration Illusions

In the previous examples, it is assumed that the pilot is flying at constant speed and is not subject to strong pseudo-gravitational forces.

The combined effect of the forces of gravity and acceleration can deprive the pilot of the exact knowledge of his position in space, causing him to make errors as great as 180° in either direction in relation to the three axes of freedom of the aircraft.

Unfortunately, man has no inherent ability to distinguish between the relative effects of gravity and acceleration.

Illusions related to angular acceleration lead to mis-estimation of rotative movement and lead, as a result, to over-controlling the aircraft. Cases have been reported where pilots in recovering from relatively tight turns in instrument conditions have immediately gone into a turn in the opposite direction, because of the tendency to over-control.

Illusions About Yaw Axis

Apparently, optical illusions do not take place about the yaw axis, due to the lack of any strong natural datum such as exists in the vertical plane. Nevertheless, several accidents resulting from sensory illusions in relation to aircraft path have occurred.

Conclusions

Optical illusions occur primarily when the pilot does not follow the sequence of his aircraft's movements. If these illusions can be foreseen, the pilot can take measures to eliminate them by taking the sensation into account only when it is duplicated by instrument readings.

Who's Air Space?

FOR many years, the need for some form of preventative measure to combat the bird hazard to aircraft has been realized, but despite a long period of research into the problem, primarily in the United Kingdom and the United States, no satisfactory method of removing birds from the vicinity of airfields has yet been evolved.

Initial experiments centered around the use of shot-guns, verey cartridges, rockets, scarecrows, dogs, kites and motor transport, but although some initial success was achieved, the birds soon became accustomed to these measures and disregarded them. More elaborate methods such as trained falcons and supersonic projectors have also been studied and applied to a limited degree, but although some minor success was obtained with these methods, the indications were that further tests would have been entirely uneconomical when compared with the very doubtful possibility of obtaining a lasting solution to the problem.

Since it appears that the bird hazard to aircraft, particularly in the vicinity of aerodromes, will be with us for some time, it may be opportune to review the incidence of bird strikes in Australia and to see how serious the problem really is.

General

A review of incident reports for the 1948-1952 period shows that, in the five years, there has been a total of 66 bird strikes to aircraft operating within Australia, while for the first six months of this year, seven cases have been reported. Of this total, 64 strikes have occurred to aircraft operating on regular public transport services.

Operational Phase

An analysis of these strikes shows that 40 out of the 73 reported cases occurred during take-off, and 18 others were experienced while the aircraft was in the "approach and landing" phase. In other words, almost 80 per cent of the bird strikes which occur in Australia occurred during these two phases in flight. A comparison of bird strikes on a yearly basis as a function of operational phase is shown in Fig. 1.

OPERATIONAL PHASE	1948	1949	1950	1951	1952	JAN JUNE 1953	TOTAL
TAKE OFF	6	7	4	7	11	5	40
CLIMB			1			2	3
CRUISE	4	2	2	1			9
DESCENT	1						1
APPROACH & LANDING	4	3	3	4	4		18
UNKNOWN	1	1					2
TOTAL	16	13	10	12	15	7	73

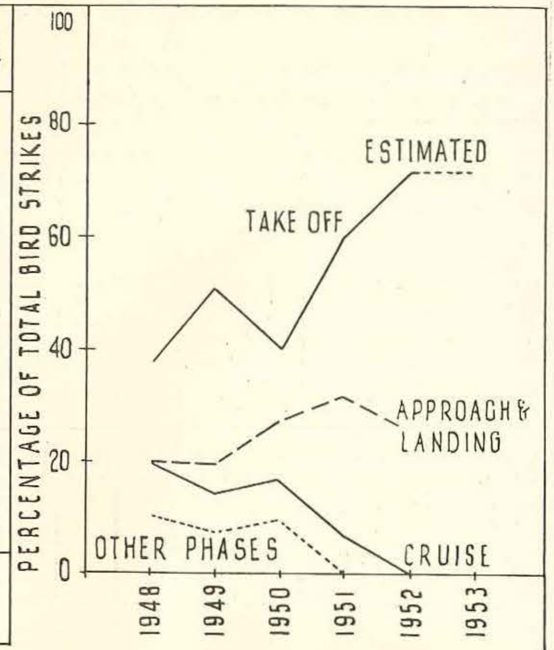


FIGURE 1 COMPARISON OF BIRD STRIKES AS A FUNCTION OF OPERATIONAL PHASE 1948-1953

Besides indicating the general predominance of bird strikes during the take-off phase, Fig. 1 also shows that, since 1950, there has been a definite increase in the number of strikes which have ocurred during this stage of operations. In fact, in this period, the incidence of bird strikes during take-off has risen from 40 per cent. of the total to a present day figure of 75 per cent.

Bird Strikes at Sydney

Although bird strikes have occurred at some thirty-six places in Australia since 1948, the figures indicate that Kingsford-Smith Airport stands out as the place where strikes are most likely to occur. The large number of strikes at that Airport can probably be attributed to the reconstruction works at present in progress, as these works have made delicacies of sea-food more readily available to seagulls, with the result that the number of strikes have increased from one in 1951 to five in 1952, while so far this year, there have been three strikes reported. The present dredging operations are expected to be completed in about twelve months, and it is anticipated that the number of strikes will fall off after that time.

However, even though the bird strike figures for Sydney indicate that the presence of birds on this Airport should be viewed with some concern, the apparent high rate is tempered somewhat when considered in relation to the aircraft movements at the aerodrome. Fig. 2, showing the comparison of bird strikes as a function of aircraft movements, indicates that there is one bird strike for every 10,000 movements at Sydney, with the possibility of the rate increasing slightly during 1953.

It would appear, then, from the available information, that the possibility of actually striking birds during operations from Sydney is relatively small, even though birds are almost continually in residence on the airport.

Bird Strikes and Aircraft Damage

Even though the chance of actually experiencing a bird strike is fairly remote, pilots will still be concerned about the odd bird which may come through the windscreen at a critical stage of flight. An analysis of aircraft damage from bird strikes on the basis of stage flights and hours flown may serve to allay some of the pilots'

	1948	1949	1950	1951	1952	1953 ESTIMATED
MOVEMENTS	54136	48971	47147	52453	49697	48000
BIRD STRIKES	1	2	3	1	5	6
BIRD STRIKES PER 10,000 MOVEMENTS	0.18	0·41	0·52	0·19	1·0	1·2

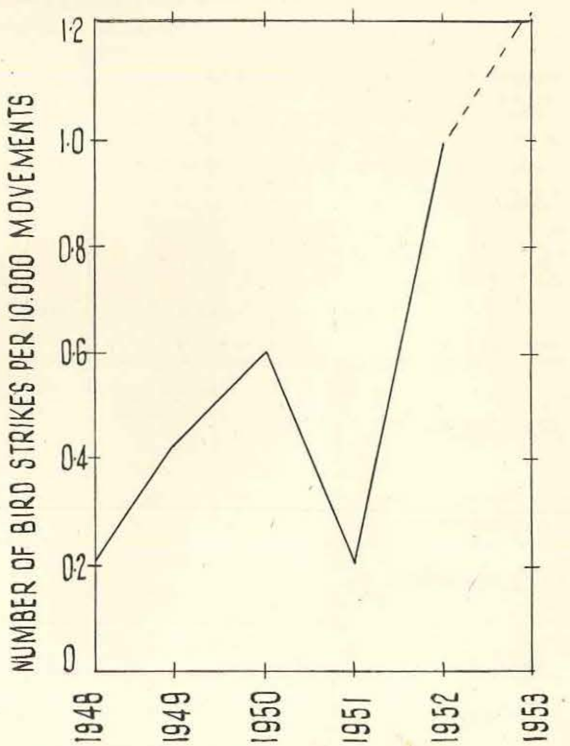


FIGURE 2 COMPARISON OF BIRD STRIKE RATES AT SYDNEY AS A FUNCTION OF AIRCRAFT MOVEMENTS

	1948	1949	1950	1951	1952	Yearly Average
Bird Strikes to Regular Public Transport Aircraft	13	11	9	10	14	11.4
Bird Strikes causing damage to Regular Public Transport Aircraft	10	8	8	6	10	8.4
Bird Strikes causing cockpit window damage to Regular Public Transport Aircraft	6	2	2	4	7	4.2
Stage Flights	135,713	150,451	163,416	178,341	177,713	161,127
Stage Flights per Bird Strike causing damage to Aircraft	13,571	18,806	20,427	29,723	17,771	20,060
Stage Flights per Bird Strike causing cockpit window damage to Aircraft	22,619	75,250	81,708	44,588	25,388	49,911
Hours Flown	234,931	253,559	275,875	306,989	293,391	272,949
Hours flown per Bird Strike causing damage to Aircraft	23,493	31,695	34,484	51,165	29,339	34,037
Hours flown per Bird Strike causing cockpit window damage to Aircraft	39,155	126,794	137,938	86,747	41,913	86,505

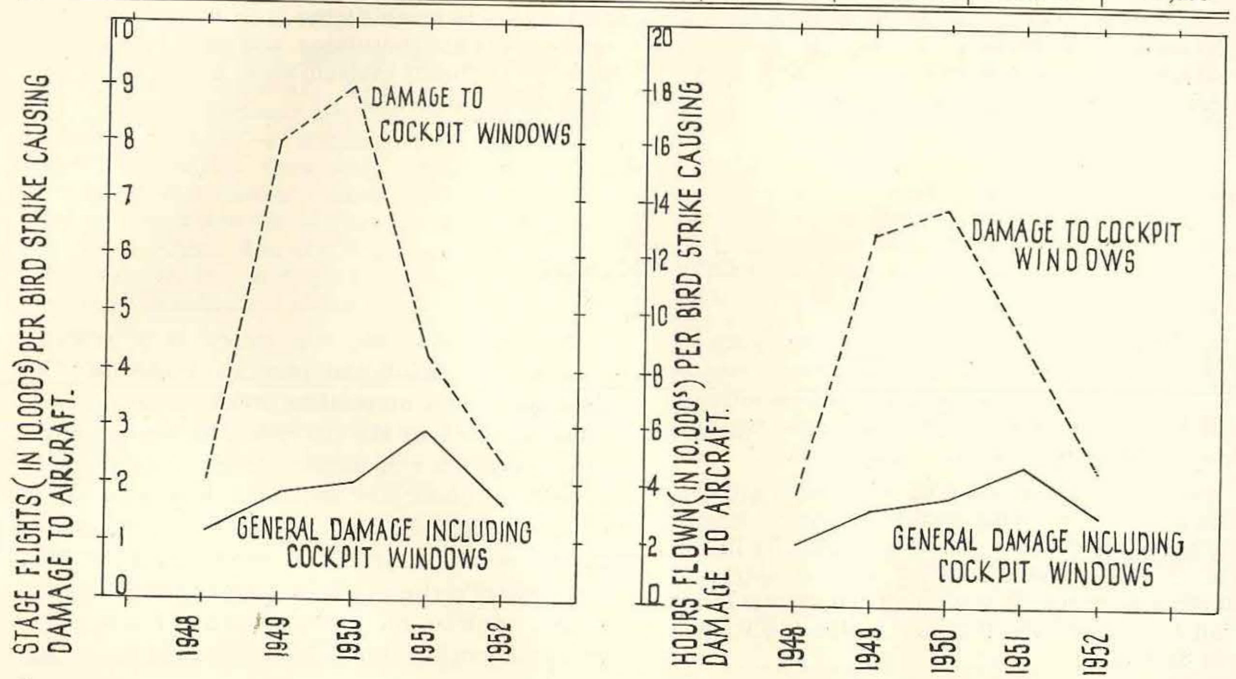


FIGURE 3 COMPARISON OF AIRCRAFT DAMAGE DUE TO BIRD STRIKES AS A FUNCTION OF STAGE FLIGHTS AND HOURS FLOWN

worries in this regard. In making comparisons along these lines, figures for regular public transport operations are used only, firstly because of the difficulty in obtaining figures for other types of operation and secondly because bird strikes are apparently more likely to occur on this type of operation.

A table showing the incidence of bird strikes causing damage, as a function of hours flown and stage flights, is shown in Fig. 3. This Table indicates that, over the five-year period under discussion, approximately 75 per cent of the bird strikes to regular public transport aircraft resulted in some form of damage, while half of the 75 per cent. caused damage to cockpit windows. Fortunately, any damage incurred during a bird strike is normally of a relatively minor nature, and only on very rare occasions have cockpit windows actually been broken. In fact, there in only one case in our records where pilots have suffered injuries from flying glass, and these were only of a minor nature.

Fig. 3 shows that, on an average taken over the last five years, some form of damage from a bird strike can be expected once every 20,000 stage flights, or once every 34,000 hours flown, while a pilot can expect that his cockpit windows will be damaged once in every 50,000 flights or, alternatively, once in 87,000 hours. Actually, the figures for 1952 are well below the five year average, due probably to the high incidence of bird strikes at Sydney, where, as indicated previously, available records show a bird strike about once in every 10,000 movements.

Besides the damage aspect as related to the possibility of pilot injury, one other aspect of damage has arisen as a result of a recent incident report. On this occasion, an aircraft struck a bird during take-off and the starboard landing light glass was smashed. The pilot subsequently found that the loss of the glass had an adverse effect on the slow speed flying characteristics of the aircraft, in that the starboard wing stalled before the port on landing. There have been quite a few instances of landing light glasses being broken by birds, and pilots may well take precautions under such conditions by approaching at slightly higher speeds to counteract any tendency of either wing to stall unexpectedly.

Conclusion

The figures quoted in this article are based only on statistics obtained from incident reports, and although it is possible that many more bird strikes have actually occurred than are shown in our records, the figures do serve to indicate that the presence of birds on or near aerodromes constitutes more of a potential than an actual hazard, and since all experiments to date have failed to find a suitable means of removing the birds, they must be accepted as a normal flying risk.

However, in countries where the incidence of bird strikes is much higher than in this country, experiments are continuing, and should a suitable measure be finally evolved, we in Australia will be more than interested.

Trip Records

DURING recent months, the investigation of at least three incidents concerning engine failures in flight have shown that aircraft captains are, in some cases, not including full details of the incident on the trip record.

On two occasions recently, captains have had difficulty in feathering following engine failure but no mention was made of the difficulty in the trip record, although entries were complete in all other respects. It was only from sources other than the trip record that the feathering trouble was discovered.

As you know, the trip record is a written resume of a flight and provides a method for the pilot to pass on positive details of any occurrence incident to the operation of the aircraft, to the persons responsible for its maintenance. Therefore, pilots are requested to ensure that all their entries in the trip record are complete to the maximum possible degree, even to the point where certain facts may appear to be superfluous. Entries on a trip record are one case where too much detail is far better than too little.

Airways Facility Failures

ON a few occasions when an aircraft captain detects some failure or off-normal operation of an airways facility, he does not report the matter immediately to the nearest aeradio station, although an Air Safety Incident Report is usually submitted on his observations after the flight is completed.

The success of the investigation of any occurrence which is not normal to the operation of the facility is dependent, to a large extent, on the time taken to get the person responsible for looking after the equipment on the job. This applies irrespective of whether the fault is detected by ground personnel, monitoring equipment, or by a report from a pilot.

Aircraft captains can materially assist in speeding up investigations by immediately reporting anything which in their opinion is out of the ordinary as far as the operation of the facility is concerned. On many occasions, an aircraft report will follow soon after the occurrence has been detected on the ground, but instances can arise where the effect noticed by the pilot will go undetected for some time if the matter is not reported.

It is requested, then, that on every occasion where an aircraft captain notices something which is not normal to the operation of the facility, he report the matter as soon as possible to the nearest aeradio station. In making such a request, we do not intend that the in-flight report should take the place of an Incident Report, which should be used to verify and amplify the information given to the aeradio station.

In addition, an Air Safety Incident Report is not applicable only to a particular occurrence, but is one of a pattern of reports on one or many installations of the facility concerned, and therefore assumes a double importance.

By immediately reporting any off-normal operation of a facility, aircraft captains are helping to improve the service which is provided for their benefit.

Acknowledgments

IN the March, 1953, issue of the "Accident and Incident Summary," under the heading of Overseas Accident No. 266, we published an account of a DC-4 crashing into the sea at Sandspit, British Columbia, following an attempted precautionary landing. In concluding the article, it was stated that the probable cause of the accident was the high approach to the airstrip and the attempt to again become airborne at insufficient airspeed.

The information contained in this article was based on the report issued by the United States Civil Aeronautics Board. However, as this accident occurred in Canada, that country was charged under the ICAO Convention with the responsibility of conducting the investigation.

We have now received a copy of the Canadian Report on the accident which indicates that the causes of the accident were considered to be failure of No. 1 engine and pilot error — a somewhat different determination of the probable cause from that quoted in the United States Report.

In a letter accompanying the Canadian Report, the Director of Air Services suggested that, as it was quite possible that accidents to other foreign aircraft would occur in Canada in the future, the source of the information on which our summaries were based should be quoted in order that possible misunderstandings which may occur when the report of the country of occurrence differs from that of the country of registration of the aircraft may be avoided.

Overseas accidents are summarized in this publication purely for their interest value, and, as we do not wish to embarrass or inconvenience anyone by their use, we have decided to adopt the suggestion from Canada. As from this issue of the Digest, the source of information will be quoted in every summary of an overseas accident.

PART II

OVERSEAS ACCIDENTS

Convair Landing Accident — La Guardia

A CONVAIR 240 crashed on to Runway 13, La Guardia Field, New York, on 6th February, 1953, after the aircraft developed a violent yaw to the right and became uncontrollable at a low altitude while on final approach. First contact made with the runway was with the right main landing gear, then the right propeller and the right wing tip. Six passengers received minor injuries, while the aircraft sustained major damage.

The accident was investigated by the Civil Aeronautics Board and the following summary is based on the report prepared by the Board.

Just short of the field boundary on final approach and at an altitude of about 100 feet, the pilots heard an unusual sound on the right side of the aircraft similar to that made when the propellers are put into reverse pitch. At the same time as the sound was heard, the aircraft veered sharply to the right. Although the captain immediately applied left rudder and aileron, the yaw rapidly became worse, and he then closed the starboard throttle. By this time the aircraft was uncontrollable and struck the runway an instant later.

An examination of the aircraft did not disclose any failure or malfunctioning of either engine, the aircraft structure, or evidence that the left propeller had changed pitch. However, an examination of the right propeller blades, which were bent and curled aft in the accident, showed that, at the time of impact, the blades were at almost zero geometric pitch. Since this indicated that the right propeller may have reversed during final approach, the investigation of the accident was centred upon this possibility.

Investigation

In general, propeller blades over-travel the low pitch stop for one of two reasons, namely, improper operation of the propeller controls or by malfunction of the propeller mechanism.

Normally, the propellers cannot be put into reverse pitch until the aircraft is on the ground, as it is not until the weight of the aircraft is on the wheels that the contacts of an electrical swich on the left main landing gear are closed. The closing of these contacts energizes a solenoid which in turn unlocks the throttle reversing mechanism on the pilot's pedestal, and permits rearward movement of the throttle into the reverse quadrant.

The throttle locks can also be released manually by either pilot pulling a manual over-ride control handle conveniently located on each side of the pedestal. Outward movement of this control has the same effect on the throttle lock as energizing the solenoid. The solenoid plunger and manual over-ride control mechanism are spring-loaded and it is therefore necessary for the pilot to hold the handle out to enable him to pull the throttles into reverse range while the aircraft is airborne. The throttle cannot be retarded past the idle position when the handle is in the "IN" position.

As a result of a previous incident involving an unwanted reversal of both propellers of a CV.240 while airborne, an item had been included in the "before-landing" cockpit check list that it must be positively determined that the over-ride control was "IN." Both pilots testified that they were fully acquainted with the instructions regarding the checking of the manual over-ride control, and were definite that it had not been operated during the flight or during the final approach. In addition, both stated that its position had been checked during the "before-landing" check.

It was therefore concluded that the over-travel of the propeller blades past the low pitch stop was not in any way due to improper operation of the propeller controls.

Every known possibility was explored to determine whether electrical or mechanical malfunctioning of the propeller, or of its control mechanism, could have occurred, but no reason

could be found for the overtravel. Considerable attention was devoted to the low pitch (high r.p.m.) limit switch, since the failure of this switch to open the circuit at low power would cause the propeller to move into the pitch range below the high r.p.m. limit, but extensive testing of the circuit failed to locate any faults in the circuit.

The reverse pitch relay of both propellers were found in the normalising position. Had the right propeller been reversed by rearward movement of the throttle past the idle stop, the reverse pitch relay would have been actuated to the "Latched" position and would have remained latched until the normalising relay was actuated. This latter operation normally occurs when a ground is furnished to the normalising relay coil by closing the high r.p.m. limit switch, which occurs when the propeller is returned to the high r.p.m. limit pitch position of 26° positive. The fact that the blades were found in nearly flat pitch while the reverse pitch relays were found in the normalising position indicates that this did not occur.

Conclusion

At the conclusion of the investigation, it was determined that the probable cause of the accident was loss of control of the aircraft during final approach due to high drag from the right propeller which was induced by the blades moving beyond the high r.p.m. limit stop. The reason for this unwanted propeller action could not be determined.

Comet Take Off Accident — Karachi

AT 0335 hours on the morning of 3rd March, 1953, a Comet aircraft on a delivery flight crashed during take-off at Karachi Airport, Pakistan. The aircraft, after overrunning the runway and crashing into a dry river bed, caught fire and burnt out. The crew of five and the six passengers were all killed. The accident was investigated by the Pakistan Government, and, although no official report has yet been received, the following information was contained in a press release issued after the Court of Inquiry.

The weather conditions at the time of the accident were good, with no wind and a visibility of six miles, while the runway which was used is paved for 7,500 feet and has an over-run of 600 feet of hard rolled sand. The runway lighting consists of high intensity lights on both sides of the runway, and threshold lights at both ends. Taking into account the prevailing conditions, and the length of runway and over-run available, the aircraft was loaded to the maximum permissible take-off weight of 114,868 pounds.

Several eye-witnesses saw the whole of the take-off run of the aircraft until the time it plunged into the river bed and caught fire. All of these eye-witnesses agreed that the take-off was abnormal in that the nose was maintained in an unusually high attitude for practically the whole of the take-off run.

In addition to the evidence of these witnesses, definite and clear marks on the runway showed that the tail bumper of the aircraft had been in contact with the runway for considerable periods. It would appear, then, that the aircraft never actually became airborne.

There was no evidence to indicate that any attempt had been made to abandon the take-off at any stage. However, there were indications that the abnormally nose-high attitude of the aircraft was corrected at the end of the runway and the aircraft was just beginning to become airborne when the starboard undercarriage hit the culvert just outside the perimeter fence.

The official inquiry considered that the accident was due to the nose of the aircraft being lifted too high during the take-off run, resulting in a partially stalled condition and excessive drag. This did not permit normal acceleration and prevented the aircraft from becoming airborne within the prescribed distance. The pilot appears to have realised that the nose was excessively high and took corrective action, but this was too late to prevent the aircraft striking an obstruction immediately beyond the airfield perimeter fence before it became airborne.

A contributory cause was that the pilot, who had limited experience in Comet aircraft, elected to take-off at night at maximum permissible take-off weight for the prevailing conditions. These circumstances required strict adherence to the prescribed take-off technique which was apparently not followed.

Comment

This accident, and the previous similar one at Rome, were both considered to be due to pilot error in that, on each occasion, the captain committed an error of judgment in not appreciating the excessive nose-up attitude of the aircraft during take-off.

However, two similar accidents in such a short space of time must raise the question of whether the handling characteristics of this type of aircraft on take-off are such as to allow dangerous attitudes to be assumed too easily.

By comparison with piston engined aircraft, the use of greater nose-up attitude during take-off is not uncommon in jet aircraft, particularly military types. However, because of the low weight/power ratio of military aircraft, the excess power which is available on take-off means that the thrust is sufficient to allow the aircraft to adopt a nose-up attitude during take-off and still climb away while in this configuration. But in the Comet, with its higher weight/power ratio, once the longitudinal axis exceeds a critical angle, there is not sufficient power available to accelerate the aircraft away from the ground.

The possibility of adopting an excessive nose-up attitude during take-off has been attributed in certain quarters to the lack of "feel" or "feed-back" from power - operated controls, which means that under some circumstances and, in particular, where external visual reference is not available, the possibility of over-control, with the resultant nose-up attitude is always present.

As the indications are that power-operated controls are here to stay, it would appear that the solution to the problem of over-control rests in two directions, namely the devising of some form of "attitude indicator" which will show the pilot when he is approaching the critical angle during take-off, and the training of pilots to familiarize them completely with the techniques required when aircraft controls do not give the "feedback" which in present day control systems bears a direct relation to the magnitude of movement of the controls.

Bonanza Landing Accident — Indianapolis

On 21st August, 1952, a Beech Bonanza crashed short of Runway 31 at Weir Cook Airport, Indianapolis, Indiana. The Bonanza was making a final approach behind a Constellation and when about 300 feet from the runway, was thrown, without prior warning, into a right vertical bank at an altitude of about 75 feet and side-slipped to the ground. The three occupants of the Bonanza were seriously injured, and the aircraft was demolished.

The subsequent investigation by the Civil Aeronautics Board indicated that the Bonanza crashed as a result of severe turbulence in the wake of a Constellation.

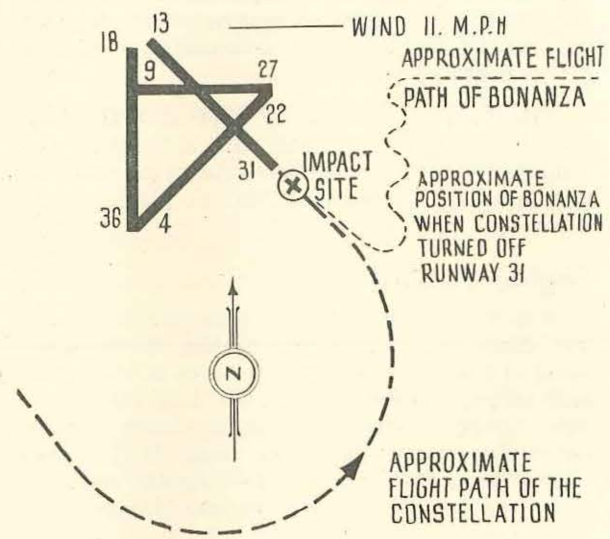
The Flight

The Bonanza was approaching Indianapolis under V.F.R. conditions with the wind from the west at 11 m.p.h. When about five miles south-west of the airport, the Bonanza was given landing instructions for Runway 27. Shortly afterwards, the pilot reported $2\frac{1}{2}$ miles from the field and on a straight-in approach to Runway 27. Permission was given to continue.

The Constellation was also preparing to land at the airport and was making its downwind leg to the west of the airport. At the time the Bonanza had reported $2\frac{1}{2}$ miles from the field, the Constellation had been cleared to land on Runway 31 and was making a left hand approach.

Soon after, the Controller advised the Bonanza to swing over and use Runway 31 and to follow the Constellation. The Bonanza immediately turned left, made several S turns in order to increase the time interval behind the Constellation, and then made a wide right turn to align on Runway 31 for final approach. The right hand turn was made as the Constellation touched down.

During final approach, the Bonanza was suddenly thrown into a right vertical bank, and struck the ground right wing first, then described a partial cartwheel towards Runway 31 as the nose and left wing struck the ground.



PROBABLE FLIGHT PATHS AND RELATIVE POSITIONS OF CONSTELLATION AND BONANZA DURING LANDING APPROACHES

Investigation

The Constellation approached to land at 120-125 m.p.h., and after landing made a right turn at the intersection of Runways 9 and 31. Although the Constellation was equipped with propeller reversing, it was not used. After the Constellation had cleared the duty runway, the captain glanced back and saw the Bonanza about 20-25 feet above the ground in a vertical bank.

The Bonanza approached at about 80 m.p.h. —stalling speed being 55 m.p.h.—and the pilot estimated that his horizontal separation with the Constellation was 3,000-4,000 feet, a distance which he stated that he would normally maintain in any approach. Subsequent timed approaches and landings of Constellations from a point about 300 feet from the end of the runway to the time the aircraft turned off the runway showed that the time separation between the Constellation and the Bonanza was slightly more than half a minute.

Although the final approach of the Bonanza was made in accordance with Company instructions, the accident could have been prevented had the approach been made with greater separation, while a higher approach speed may have prevented the accident, or permitted the aircraft to be controlled to a greater degree. Air speed is definitely a factor in a pilot being able to maintain control and to effect recovery when encountering unexpected conditions such as were experienced on this occasion.

Comment

Turbulence induced by an aircraft in flight can, under certain conditions, be very hazardous. However, the degree of danger present in any particular portion of such turbulence is subject to many variables and cannot be accurately predicted.

Wing-tip vortices are caused by the air at increased pressure under the wing tending to flow outboard around the tip to the area of reduced pressure above the wing. The magnitude of the vortices is dependent on several factors including the shape of the wing, the amount of lift being produced, and the angle of attack at which the wing is operating.

The relationship of these factors is such that a large heavy aircraft breaking its descent to flare out for a landing causes very powerful wing-tip vortices. Extended wing flaps can also cause powerful vortices. Severe turbulence may be induced by propellers, wing tips and flaps, the severity depending upon the combination of circumstances and aircraft involved.

Super Constellation Landing Accident — Fallon, Nevada

ON 7th December, 1952, a Lockheed 1049 was extensively damaged during an emergency landing at Fallon, Nevada.

The aircraft was en route from New York to San Francisco with one intermediate stop and the flight proceeded in a routine manner until near Lovelock, Nevada, when, at about 1740 hours, a complete power loss was experienced from No. 3 engine. When the engineer attempted to restart the engine it oversped, so the captain reduced airspeed to 170 m.p.h. and feathered No. 3 propeller.

The captain decided to continue to San Francisco, and shortly afterwards passed abeam of the Naval Air Station at Fallon, where it was noted that weather conditions were good.

About 25 minutes after No. 3 engine failed, No. 4 engine failed also, and as power could not be restored, the propeller was feathered and an emergency declared. Reno, Nevada, was about 10 minutes flying time away but as the weather there was below minima, it was decided to return to Fallon, about 40 miles away where the weather was good and where the wind of 5-m.p.h. was nearly aligned with the 7,000 feet Runway 07.

The captain decided to use the wing flaps at the take-off position while circling Fallon, and directed the flight engineer to crank the flaps down manually. However, before he was able to locate the crank he was recalled to his station when the captain decided to dispense with the flaps. Meanwhile, the first officer had manually pumped down the landing gear which extended fully and locked.

The aircraft made contact about 126 feet down the runway at an airspeed of about 150 m.p.h. The nosewheel was immediately put on the ground to effect steering and the captain attempted to apply the brakes. He discovered at once that he had neither nose wheel steering nor brakes. The hand pump selector valve was set on "brakes," the brake selector valve was left on "Normal" and the first officer used the hand pump in an attempt to get hydraulic pressure.

Almost concurrently, the captain placed Nos. 1 and 2 propellers in reverse pitch, and the aircraft veered to the left and off the runway. Propeller controls were moved to restore the forward pitch to No. 1 and 2 propellers, but the aircraft continued to the left of the runway into soft dirt, through a ditch and then through several piles of gravel. The right wing, with the right landing gear, was torn from the fuselage at the wing fillet. As the right wing stub dragged on the ground, the aircraft swerved to the right and came to rest a short distance beyond on its nosewheel, left main wheel and aft part of the fuselage.

The crash occurred after dark at 1853 hours. Fire trucks were alongside the aircraft within a matter of seconds and prevented a possible fire by applying fire extinguishant at places where fire might develop.

Engine Failure

Nos. 3 and 4 engines were dismantled and it was found that the teeth of the intermediate gears of the front cam gear train of both engines had failed, causing immediate and full power loss. These engines had accumulated a total time since new of 52.43 and 31.27 hours respectively, and the failures appear to have been due to the design, the manufacture and inspection of the gears.

There had been similar failures previously in other engines of the same model, and, as a result, the manufacturers had, prior to this accident, started a modification programme to incorporate a four pinion cam drive instead of the original two pinion drive. The purpose of the modification is to distribute the load and thus lessen the stress on individual gears.

Hydraulic System

It may be pertinent at this point to explain some of the facts concerning the hydraulic system of the Super Constellation.

Each of the four engines is fitted with an hydraulic pump. Those on Nos. 1 and 2 furnish jointly—or individually in the event of failure of either No. 1 or No. 2 engines—hydraulic pressure to supply boost for the aircraft's flight controls and for certain other purposes. This is known as the primary hydraulic system.

Pumps on Nos. 3 and 4 engines furnish jointly —or individually if either No. 3 or No. 4 engines fail—hydraulic pressure to effect, among other things, wheel braking, nose wheel steering, wing flap motion and landing gear operation. This is known as the secondary hydraulic system. It can supplement the primary hydraulic system, but the reverse is not possible.

If Nos. 3 and 4 engines are inoperative, there is no means of obtaining nose wheel steering, the wing flaps must be cranked by hand, and

the landing gear must be lowered with the hydraulic hand pump. However, normal braking can still be effected by pressure from two accumulators instantly available by merely positioning the brake selector valve from NORMAL to EMERGENCY. In the EMERGENCY POSITION, accumulators allow 10 full applications of the brakes if the system is free of air. In practice, with the system not completely bled, there are at least six brake applications available.

Crew Training

The aircraft's secondary hydraulic system completely lost its source of energy with the feathering of Nos. 3 and 4 propellers. However, there was no malfunctioning of the hydraulic system as such, nor was there malfunctioning of any component of the hydraulic system, including the mechanism for emergency braking. The simple fact of the case is that the emergency braking mechanism was not used.

Before landing at Fallon, the crew went through the company's cockpit check list for normal operation. This list did not have the emergency braking procedures specified, but the manufacturers' check list which was on the engineer's table included an abbreviated emergency braking procedure. The flight engineer cannot readily see the accumulator pressure gauge or the brake selector valve. The positioning of the brake selector valve is primarily a pilot function and the flight engineer has no specific duties in connection with the use of the emergency braking system. Therefore, the flight engineer would have no reason to believe that the emergency braking system was not being utilized properly.

After landing, the captain attempted to brake as he should have done, and as would be proper and successful with the predecessor types of Constellations on which he was highly experienced. His transition period of training for Lockheed 1049 aircraft included four days of ground training and four hours flight training, which included a landing and braking with Nos. 3 and 4 propellers windmilling, and, consequently, with the secondary hydraulic system operative and furnishing adequate braking pressure without the need to use the accumulators. At the time of the accident, the captain of the aircraft had only 104.10 hours experience on Lockheed 1049 aircraft.

The reason for the emergency braking system not being used can rest only in the fact that the company's transition training was omissive in that it did not emphasise sufficiently the differences in the emergency braking system on the Super Constellation as against that used on earlier Constellation models. The captain demonstrated his unfamiliarity with the hydraulic system by attempting to brake the aircraft immediately after touchdown, and only then realizing that he had no brake pressure, while the fact that he attempted to steer the aircraft soon after touch down further illustrates his lack of knowledge of the system. Since the company's own operating manual for the 1049 did not include emergency braking procedures, the company should have specifically instructed crews to use the Lockheed operating manual and check list which was aboard the aircraft and which did contain the correct procedures.

Although the company may be criticized for not issuing definite instructions relative to the particular aircraft, this does not relieve the captain of his responsibility of assuring himself that he is thoroughly familiar with the aircraft he commands, its systems and their proper use.

The Civil Aeronautics Board, who investigated the accident, and on whose report the above information is based, determined that the probable cause of the accident was the improper use of the emergency braking system during the course of an emergency landing. A contributory factor was inadequacy of the company's Lockheed 1049 conversion training programme relating to the differences in emergency procedures from former Lockheed aircraft.

PART III

AUSTRALIAN ACCIDENTS

Dove Structural Failure

At 1336 hours on 15th October, 1951, DH. 104 aircraft VH-AQO owned and operated by Airlines (W.A.) Ltd., departed Perth, Western Australia, on a scheduled flight, designated as No. 849, for Kalgoorlie, Western Australia. The pilot of VH-AQO informed Kalgoorlie Aeradio, at 1518 hours, that the aircraft would be landing in seven minutes and requested landing instructions, whereupon Kalgoorlie Aeradio asked VH-AQO to stand by. At 1520 hours, Kalgoorlie Aeradio transmitted landing instructions to VH-AQO, but no acknowledgment or further communications were received from the aircraft. Subsequently the wreckage of VH-AQO was found 14 miles west of Kalgoorlie Airport. All the occupants, comprising a crew of two and five passengers, were killed and the aircraft was destroyed on impact.

The Flight

This was the second of two scheduled flights by VH-AQO from Perth to Kalgoorlie and return on 15th October, 1951. The first flight was without incident although the Captain reported several minor defects on return to Perth including "aircraft flies left wing low." These defects were attended to before the second flight, which departed Perth at 1336 hours with five passengers and 556 lb. of freight. The gross weight of the aircraft was below the authorized maximum and its centre of gravity was within the prescribed limits.

The aircraft proceeded at its planned altitude of 9,000 feet in fine weather with slight turbulence. Position reports were received from the aircraft at the designated points and at 1506 hours, twenty minutes before E.T.A., it was cleared to descend into Kalgoorlie Airport. At 1518 hours VH-AQO passed "landing in seven" to Kalgoorlie Aeradio, whereupon the aircraft was asked to "stand by one." Kalgoorlie Aeradio passed the landing instructions at 1520 but did not receive any acknowledgment. After a few seconds the aircraft was again called but still no reply was received. Both Kalgoorlie and Perth continued to call VH-AQO at frequent intervals on various frequencies but as nothing further was heard Emergency Procedure was introduced at 1538 hours.

A ground search located the wreckage 14 miles west of Kalgoorlie at approximately 2300 hours that night.

Examination of the Wreckage

The port wing was located some 500 yards west of the bulk of the wreckage. Still attached to the port wing were the port engine, portion of the centre section main spar lower boom, and the rear wing attachment bracket. Damage to the wing indicated that it had landed on the inboard end, with no forward movement, and had then fallen onto its top surface.

The radio-compass loop, forward cabin escape hatch, port wing root fillet, perspex dome and a large piece of perspex from the cockpit window were also found west of the main wreckage and up to 800 yards away. These components apparently came off while the aircraft was still in the air, and this could be accounted for by the port wing folding over, contacting the top of the fuselage and knocking off the radio-compass loop and perspex dome, and distorting the roof of the fuselage which would "spring" the forward cabin escape hatch and break the cockpit perspex.

The aircraft, minus the port wing, literally "burst" on impact, and the components, contents and occupants were scattered in a "V" shaped area up to 300 feet east of the point of impact. The cockpit disintegrated and all instruments and controls were destroyed. The floor of the cabin was compressed into a small mass and all cabin seats and accessories were completely destroyed. The nose wheel assembly was broken into several pieces and scattered. The rear section of the fuselage and the empennage were extensively damaged, all empennage aerofoils being broken off and crushed.

The starboard wing was smashed by the impact, approximately 12 feet of the outer wing being hurled over a fence for a distance of some 60 feet. The remaining portion of the wing, with the starboard undercarriage still attached, was on the opposite side of the centre line of the distribution of the wreckage, and was extensively damaged and distorted. The starboard engine, substantially damaged with every external component smashed, was found at the point of impact.

Discussion of the Evidence

It was evident early in the examination of the wreckage that the port wing had parted from the aircraft prior to the main impact. No evidence could be found of any object on the ground which the aircraft might have struck before the main impact, nor was there any apparent damage to the port wing that could have been caused by the wing striking an object prior to separating from the aircraft.

The marks of impact and the distribution of the main wreckage indicated that the aircraft, minus the port wing, had dived into the ground at a very steep angle.

The time at which the aircraft struck the ground is reasonably well established by three wristlet watches found at the scene of the accident, each of which had stopped at 1520 hours. Therefore, as the flight was apparently perfectly normal until the last message was transmitted from the aircraft at 1518 hours, it is obvious that the port wing severed from the aircraft between 1518 hours and 1520 hours. From an analysis of the position of the components, and assuming the pilot reported his positions correctly and maintained an approximately constant descent path until the wing failed, it has been estimated that the aircraft was at a height of between 2,000 and 3,000 feet when the wing severed from the aircraft.

It was apparent from a superficial examination, in situ, of the portion of the centre section main spar lower boom attached to the port wing, and the parts of the lower and upper booms found in the vicinity of the main wreckage, that the centre section main spar boom had failed prior to the aircraft striking the ground.

VH-AQO was manufactured in 1946 and was the first of this type of aircraft to be issued with a Certificate of Airworthiness in Australia. At the time of the accident VH-AQO had flown some 9,000 hours mostly in Western Australia over dry arid country where the average gust pattern is relatively severe.

The DH.104 centre section beam is constructed with upper and lower flanges of channel section machined from rectangular section D.T.D. 363A extruded bar. The outboard ends of each member are machined to provide massage hinge attachments from the inboard ends of the wing spar boom members. The bases of the channels face outwards while the toes are riveted to sheet metal webs forming a complete box pattern.

The centre section main spar of VH-AQO sustained substantial damage in the accident, the upper member being in two major pieces (with a portion of one missing) and the lower member in three pieces. Most of the sheet metal web had been torn away. The various pieces of the assembly in the original relative positions are shown in Fig. 1.

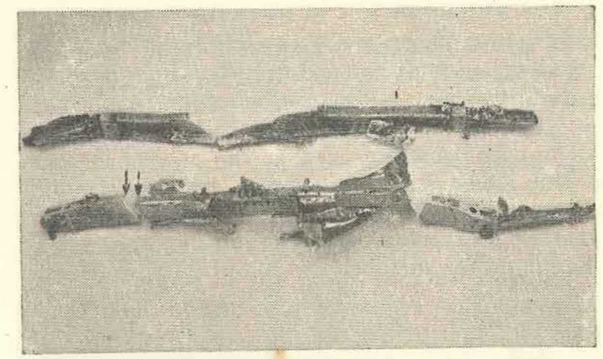


Figure 1.—Fractured Portions of Centre Section, Main Spar Boom, assembled in their original relative positions. Port side of assembly is at left, starboard side at right. Arrows indicate fracture surfaces illustrated in Figures 2 and 3.

Visual examination of the fracture surfaces of all pieces showed failure of the assembly to have originated at a zone of fatigue-cracking in the rear rib of the lower channel at a position approximately 11 inches inboard from the port extremity (the position of fatigue-cracking is indicated by the arrows in Fig. 1). From the origin, the cracking extended down the full depth of the rear rib and into the base of the channel; its extent relative to the full cross-section of the channel is shown in Figs. 2 and 3, while Fig. 4 shows the effected zone in greater detail. All of the remaining fractures were of the rapid type

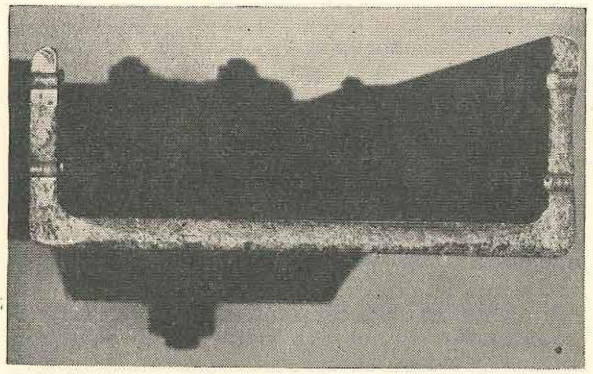


Figure 2:—

Fracture surface on outboard portion of lower channel member 11 inches from port end of centre section showing fatigue-cracking in near rib of channel (left).

such as ordinarily results from application of a single overload. Fractures resulting from over-stressing in tension, bending, torsion and impact were all present.

As shown in Figs. 2, 3 and 4 fatigue-cracking had originated at a rivet hole in the rear rib of the lower channel section. Visual, radiological and fluorescent examination of the rivet holes in the corresponding area at the starboard side of the lower member, showed no evidence of similar cracking in this region. There was no evidence of fatigue-cracking at any other rivet hole in either member.

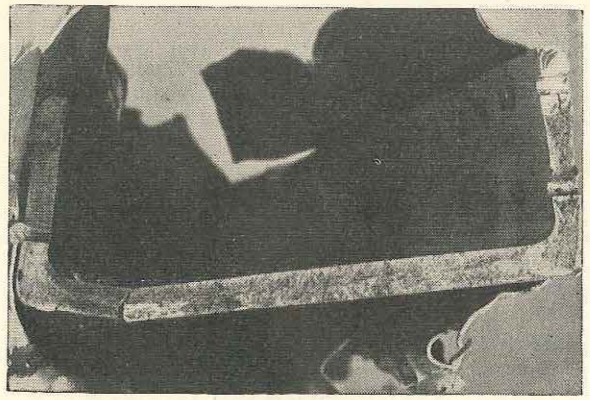


Figure 3:—

Fracture surface on inboard portion of lower channel, mating with fracture shown in Fig. 2.

Examination of the zone in which fatigue-cracking had developed (see Fig. 4) showed that cracking had progressed, prior to failure of the structure, by alternate slow and rapid propagation, to such an extent that the crack covered the full depth of the channel rib and extended about $\frac{3}{4}$ inch into the base of the channel (as measured on the outer surface); the mechanism of its development can be traced in detail by reference to Fig. 4. A primary fatigue crack originated at the outer end of the upper rivet hole (arrow 1 in Fig. 4) and progressed through about 30 per cent of the section between the rivet hole and the edge of the rib. At that stage, a rapid jump from the then extremity of the fatigue crack occurred, this rapid crack occupying the dark band indicated by arrow 2 in Fig. 4. This was followed by further slowly progressing (fatigue type) cracking, a further rapid crack, then more fatigue-cracking and so on until the full section above the rivet hole had cracked through. (The zones of fatigue and rapid cracking can be seen in Fig. 4 as alternate bright and darker bands respectively). Further fatigue cracks originated at the lower surface of the upper rivet hole (arrows 3 in Fig. 4). These cracks appeared to have originated after the primary crack and to have developed contemporaneously with it. They had progressed by the same mechanism of alternate slow and rapid propagation to reach the extent indicated between arrows 4 (Fig. 4). From the line indicated by these arrows, the crack spread rapidly through the remainder of the section down to the lower rivet hole. Slow (fatigue) cracking then commenced at eight separate origins along the lower surface of the lower rivet hole and progressed for a distance of 1/32 inch approx. at which stage rapid cracking over a length of about $\frac{1}{4}$ inch occurred. This was followed by a further small amount of fatigue cracking (the bright V-shape mark indicated by arrows 5) and rapid cracking to the lower corner of the channel. Then followed more alternate steps of slow and rapid cracking, this stage being shown by the series of alternate bright and darker rings at the corner zone of the fracture. A further small zone of slow cracking (arrows 6) was present in the base of the channel at a position about $\frac{3}{4}$ inch from the corner; this was the final position of fatigue-cracking and represented the extremity of the crack which existed prior to complete failure of the assembly.

Microscopic examination of sections cut from the upper and lower members showed the structure of the material to be normal for this type of alloy; there was no evidence of any feature which might predispose the alloy to premature

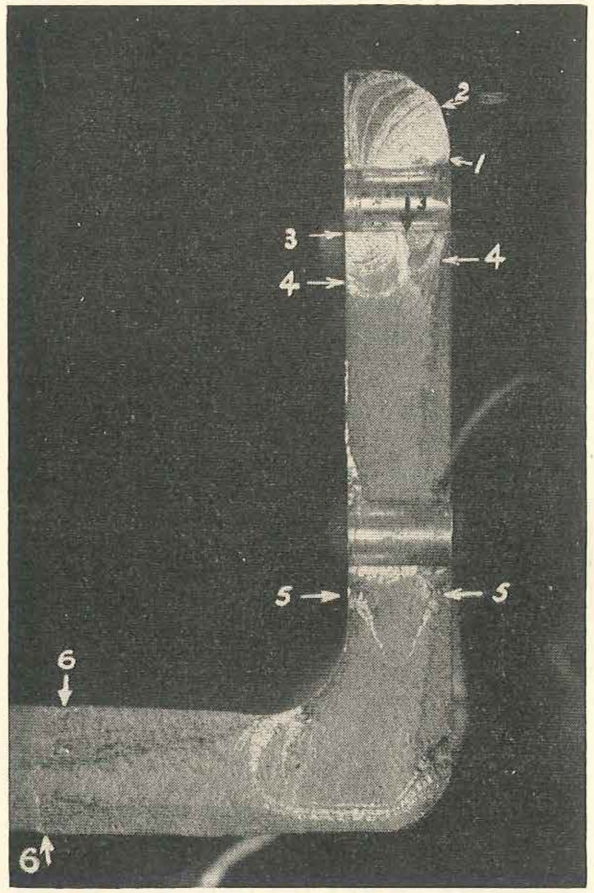


Figure 4.—Fracture Surface of Rear Rib of Lower Channel Member, showing extent of fatigue cracking. Numbered arrows refer to mechanism of crack development described in text of report.

or brittle failure. Examination of macro-sections showed no evidence of extrusion or manufacturing defects in either member; the hardness of each was substantially uniform, both ranging between D.P.N. 180 and 200. The surface finish on both channels was good, and anodising had been effectively carried out. There was no evidence of corrosion on either member.

As previously stated it was strongly suspected, during the initial examination of the wreckage on the morning after the accident, that the port wing had failed due to structural failure. Consequently, all other DH. 104 aircraft in this country were immediately grounded and inspections to their main spars carried out. The inspection of the centre section main spar lower boom of DH. 104 aircraft VH-AZY, which had flown 8,515 hours under similar conditions to VH-AQO, revealed cracks at both the port and starboard ends at approximately the same positions as in VH-AQO and confirmed the original suspicion. No evidence of cracks was found in any other DH. 104 aircraft, none of which had flown anywhere near the number of hours of the above two aircraft

It is apparent from the above that the failure of the main spar of VH-AQO and the cracks in the main spar of VH-AZY were due to fatigue. Extensive calculations made since the accident indicate that the design of the aircraft resulted in stresses, in level flight and under the gust conditions normally experienced in Western Australia, sufficiently high to cause fatigue failure at approximately the 9,000 hours both aircraft had been in service, without any abnormal load being experienced.

In the light of this accident it is clear that insufficient importance had been attached to the justification, by testing or analysis of this structure from the point of view of fatigue, in the original Type Record of the aircraft. However, it had not been the practice in the past to consider the fatigue life of a wing structure on a quantitative basis.

The Cause of the Accident

From the evidence it was concluded that:—

1. The cause of the accident was loss of control when the port wing became detached from the aircraft in the air due to a structural failure in the centre section main spar.
2. The failure of the centre section main spar was due to a fatigue failure of the material in the lower boom of that component during normal flying operations.
3. The failure of the main spar at the number of hours it had been in service was consistent with the theoretical life estimate of that spar, as calculated since the accident.
4. The material (D.T.D. 363) as used in the original design of the lower boom of the main spar of DH. 104 type aircraft was critically loaded from a fatigue point of view under normal operating conditions.
5. Prior to this accident it was not the practice for the fatigue life of a component to be calculated or determined by test, nor were detailed requirements in respect to fatigue stipulated by airworthiness authorities.

Action Resulting from this Investigation

Prior to the crash of VH-AQO, and crashes in America due to similar structural failures in Martin 2-0-2s, structural fatigue was not widely believed to be a practical source of danger to civil aircraft. Much work was going on throughout the world in the field of fundamental research on fatigue, but this work had not reached the stage where any conclusive and convincing arguments could be produced for taking positive action on fatigue in civil types of aircraft. Indeed, so little was known about the subject that there was serious danger of erroneous conclusions being drawn from the existing body of knowledge. It was a tragic, ironical fact that the first two types of civil aircraft in the world on which a serious experimental effort was made to check the fatigue life of the wing structure in the design stage were the Dove and the Martin 2-0-2.

The Dove and the Martin 2-0-2 crashes not only brought home the practical importance of fatigue, but they also enabled the research information then available to be correlated with the realities of airline service. As a result, airworthiness authorities and research establishments throughout the world have given the problem of structural fatigue the highest priority.

It now appears that all aircraft in which high strength aluminium alloys have been used to their capacity of stress are potentially subject to fatigue. This criterion makes virtually all the large postwar aircraft suspect to a degree.

It must now be the object of every airworthiness authority, for each type of aircraft for which it is responsible, to:—

(a) establish which portions of the structure are "critical" from the point of view of fatigue — i.e., which parts will fail first due to fatigue;

(b) to set a "safe life" for these critical components.

The critical components then have to be either modified or replaced before each individual aircraft passes total hours corresponding to the safe life.

In many cases the safe life can be shown to be far beyond any possible service life of the aircraft. Where this can be conclusively proved, fatigue ceases to be a practical worry in that type. However, in other cases "safe lives" within the possible operating life have to be established. Unfortunately, the fundamental data on fatigue in service is still very far from complete, and so the calculation of safe lives is by no means an exact science. Generally speaking it is necessary to compensate for lack of basic data and knowledge by conservatism in calculation. This will sometimes mean that mandatory safe lives set from time to time can be extended as more basic data becomes available and enables more accurate estimates to be made.

Action taken in Australia has generally followed these broad lines. Types on the Australian register are being progressively examined for "critical areas" and "safe life" in an order of priority based on the general stress levels in the structure. Types of aircraft on the Australian register which have more total hours than overseas aircraft of the same type are being examined first. An excellent working liaison has been established with overseas authorities and the very latest data and ideas are being applied as they come to hand. The Australian Aeronautical Research Laboratories, at Fishermen's Bend, Victoria, which have made very major contributions to the fundamental knowledge on fatigue, are co-operating with the Department in this work.

As the fundamental knowledge necessary for complete mastery of the problem of fatigue is still incomplete, it is impossible to guarantee that no more in-flight failures will occur. However, everything possible is being done to prevent such failures, and it is confidently expected that the measures being adopted will, in fact, achieve their aim.

Take - Off Accident — Auster

At approximately 1225 hours on 1st March, 1953, an Auster J5 aircraft crashed into Vanimo Harbour shortly after take-off from Vanimo airstrip, New Guinea. The aircraft sustained substantial damage on impact and sank in 20 to 30 feet of water. The pilot was killed and the two passengers received minor injuries.

It was established from the testimony of the passengers and a number of eye-witnesses that the take-off and initial climb were quite normal and that at a height of approximately 300 feet, a fairly steep turn was commenced to the left. After the aircraft had turned through some 120 degrees the turn was arrested and the aircraft laterally levelled. However, almost immediately the nose and starboard wing dropped and the aircraft fell away in the manner of a stall.

Although the investigation revealed that the aircraft was poorly maintained, a thorough examination of the wreckage failed to detect any evidence of structural failure or malfunctioning which may have caused the accident, nor was

there any suggestion in the evidence of the passengers or eye-witnesses of any engine or airframe malfunctioning which may have resulted in loss of control of the aircraft. However, it was established that the airspeed indicator and tachometer had been unserviceable for some time prior to the accident.

Apparently, it was the usual custom of this pilot to carry out a steep turn shortly after taking off from Vanimo airstrip and to return over the strip. On this occasion an attempt was made to straighten the aircraft after it had turned some 120 degrees, which in conjunction with the evidence of the passengers and the subsequent stall suggests that the aircraft approached the stall during the turn. According to the passengers' evidence the attempted recovery from the turn (or initial stall indication) was made with full opposite aileron and full back stick. This coarse and incorrect use of the controls when the aircraft was near the stall undoubtedly resulted in the aircraft stalling completely.

The pilot was in current flying practice and had over 2,000 hours flying experience, mostly on Auster aircraft. In view of his experience it is considered that he could have safely flown an Auster without the assistance of an airspeed indicator or tachometer during normal manoeuvres. However, the increase in stalling speed in a steep turn, particularly with the aircraft loaded near its maximum permissible all-up-weight, as it was in this case, necessitates special care in the execution of such a turn.

There is no record of the pilot having practised stalling or spinning for some time, and it is thought that his stall recovery technique may have been poor. This is supported to some extent by the evidence concerning his use of the controls when the aircraft was at the stall. The manner in which the aircraft initially fell away and continued to fall away is consistent with the control stick being held back. Whilst the 300 feet of altitude available when the aircraft first stalled should have been ample for recovery to have been effected, it may possibly have distracted the pilot to some degree and contributed to the incorrect recovery technique.

Cause

The probable cause of the accident was incorrect technique on the part of the pilot in effecting recovery from an inadvertent stall.

The stall probably resulted from a lack of care on the part of the pilot in the execution of a steep turn at a low altitude without the assistance of an airspeed indicator or tachometer.

Violations

The evidence indicates that the pilot committed breaches of the following Air Navigation Regulations:—

Regulation 239 —Banked the aircraft at an altitude below 500 feet above terrain after take-off.

Regulation 225(A)—Operated the aircraft with an unserviceable airspeed indicator and tachometer.

Regulation 227 —Took off at an all-up-weight which exceeded the maximum permitted for Auster Aircraft operations at Vanimo airstrip.

Regulation 38 —Operated the aircraft without a current Certificate of Safety.

Regulation 244 —Carried a passenger who was not provided with, and consequently did not wear, any form of safety belt during the take-off.

PART IV

INCIDENT REPORTS

Unauthorised Descent — Hobart

(311/53)

During the morning of 14th February of this year, the weather at Hobart was generally poor, and as no early improvement was expected, one DC-4 en route for Hobart and one CV.240 holding over Hobart returned to Launceston. After the CV.240 had set course for Launceston, Hobart A.T.C. suggested to Launceston Operations that a DC-3 at Launceston remain there instead of proceeding to Hobart, as it was unlikely that the Hobart weather would improve in the near future.

However, the captain of the DC-3 elected to proceed to Hobart and at 0102Z reported over Ross Homer at 5,000 feet, giving his Hobart E.T.A. as 0123Z. The Hobart weather was passed to the aircraft and the captain was advised that the aerodrome was closed to landings. A few minutes later, he was further advised that no clearance to descend below 4,000 feet would be granted because of the prevailing weather conditions. The aircraft arrived over Campania Homer at 0123Z and was cleared to descend to 4,000 feet.

At 0127Z, the aircraft reported its position over the Inner Marker in cloud at 4,000 feet and was instructed to hold 4,000 feet on the standard holding flight path. However, some nine minutes later the captain reported contact through a break in the cloud and requested a clearance to make a V.F.R. approach. This request was not granted, but at 0138Z, the aircraft was sighted about eight miles south-east of the field below an overcast layer, the base of which was estimated to be about 1,000 feet. The day minimum for Hobart is 1,730 feet.

The captain advised that he intended to land and landing instructions were then provided. The landing was completed at 0141Z under fluctuating conditions which were still below the landing minimum.

The main point of this incident was that the captain of the DC-3 deliberately disobeyed a valid Air Traffic Control instruction by making an unauthorised descent.

As a result of the investigation into the occurrence, the captain's First Class Airline Transport Licence was suspended for a period of four months as from 11th May, 1953. The suspension did not affect his capacity to hold a Third Class Airline Transport Licence.

Being aggrieved by this decision, he applied for an independent Appeal Board to be constituted to consider the suspension.

The Appeal Board began taking evidence on 16th July, and, on 22nd July, gave its decision confirming the period of suspension of four months.

DC-4 Fire Extinguisher System

(476/53)

A DC-4 had commenced its take-off run when the captain noticed that the fire warning light for No. 2 Zone of No. 1 Engine was on. The engines were throttled back, the fire extinguisher selector was selected to No. 1 engine and the fire extinguisher discharge control pulled. The aircraft then returned to the tarmac.

An investigation revealed that no fire had taken place and the warning lights had come on due to a broken wire. It was also found that the fire extinguisher had failed to operate owing to the fact that the cutting head had not punctured the seal.

The cutting head and control system were suspected as faulty but, when tested, both operated satisfactorily and no reason could be found for the cutting head not having punctured the seal had the discharge handle been pulled out far enough to complete the operation.

The inference was, then, that the failure of the extinguisher bottle to discharge was due to the captain not having pulled the discharge handle hard enough.

However, during a subsequent lay-up of the aircraft, a check on the fire extinguisher system showed that although the head appeared to operate satisfactorily, the cutter did not always travel down far enough to pierce the seal. Further investigation revealed that the failure of the cutter to do so was due to the lead screw female insert not being correctly "staked" in position, with the result that although the cutter itself rotated, the lost motion prevented sufficient down travel to pierce the seal.

It was extremely difficult to detect such a condition in the aircraft and this led to the initial incorrect conclusion that the discharge handle had not been pulled hard enough.

How Full Can You Get !

(V.T. 120)

On completion of a recent airline flight the captain verbally reported that his aircraft appeared to be more sensitive on the elevator control than usual. Acting on this information the Maintenance Foreman at Melbourne proceeded to carry out an external inspection of the aircraft concerned. During this inspection he observed an area of condensation on the after belly of the aircraft at a point where the fuselage sweeps up towards the tail. In order to determine the reason for this condensation, portion of the flooring was lifted and a quantity of water, estimated to be some 60 gallons, was discovered in the under floor section.

Subsequent investigation revealed that the wash basin water tank refuelling line had burst, apparently because of corrosion, thus allowing a quantity of water to seep under the floor each time the tank was refilled. Although drain holes were provided in the lower fuselage skin, these were blocked off for reasons concerned with the everyday operation of the aircraft. Thus water continued to collect until such time as the amount of water was sufficient to slightly effect the fore and aft trim of the aircraft.

Although it is difficult to imagine that a defect of this nature would have remained undiscovered for very much longer, it is also difficult to gauge the effect of a few more gallons, in the under floor section, on the fore and aft trim when the nose wheel was lifted during take-off.

The incident is particularly significant, however, because it emphasises that accidents can have their origin in a defect or incident of a relatively simple nature. It is also worthy of note that the possible ultimate cost of relatively simple defects which remain undiscovered is directly related to the type of aircraft in which it occurs. Their discovery, as in this case, requires a high degree of interest and diligence in the performance of all duties associated with aircraft operations.

Following this incident, all other aircraft of the same type were inspected and drain holes in the fuselage opened up. Further, suitable instructions have been incorporated in the maintenance manual to ensure adequate inspections at regular intervals.

Q.N.H. Information

(969/53)

When approaching Bombay on 26th June, the captain of a Qantas Constellation requested the radio officer to obtain the latest weather and QNH in millibars. However, the reply from Bombay gave the QNH as 29.55 inches. The radio officer immediately requested the QNH in millibars and was given 1007mbs. However, in the meantime, the captain had checked the Conversion Table and found that 29.55 ins. is equivalent to 1000.7 mbs.

The radio officer asked Bombay to confirm the millibar value and in reply Bombay stated "QNH 29.55 ins. 1007 mbs."

Shortly afterwards, the co-pilot contacted Approach Control and, in the descent instructions, the QNH was quoted as 1000.7 mbs.

In submitting his report on this matter, the aircraft captain stated—

> "Considering the smallness of the millibar on an altimeter, and the parallax error involved, I would say that it was physically impossible to set it accurately to 0.1 millibars. I suggest the dropping of the decimal point, giving a QNH within 15 feet, rather than a QNH which might be accurate, but could be up to 250 feet out."

Having regard to all the altimeter errors which can occur,, e.g., lag on descent, it does seem unrealistic to worry about 15 feet particularly when this figure is related to the present weather minima.

This Department will therefore propose at the 4th Session, MET Division, ICAO, in March, 1954, that the fractions of millibars be deleted from the QNH values given to a pilot with his aerodrome weather information.

Propeller Governor Seizures
(501/53)

While en route from Melbourne to Sydney at 15,000 feet, the propellor governor on the port motor of a Convair 240 became faulty, allowing the r.p.m. to increase uncontrolled. As it was not possible to feather the engine, the airspeed was reduced and the left throttle was retarded to prevent the r.p.m. exceeding safe limits. Height was lost to 8,000 feet, where a combination of rated power on the starboard motor and 17 inches manifold pressure on the port engine with an airspeed of 125 knots held the left motor r.p.m. steady at 2,600.

Height was then regained to 9,500 feet and the flight continued to Canberra. The descent was made using flap to maintain 125 knots and the landing was completed without further incident.

An investigation of the propellor governor showed that a defect was caused by the governor drive shaft seizing in the drive shaft bush. Seizure of the drive shaft caused a blockage of the oil supply, thus rendering the propeller uncontrollable.

About six weeks after the above incident, a DC-6 was climbing from 13,000 feet to 19,000 feet en route Honolulu to San Francisco when No. 4 engine suddenly lost all useful power. After checking fuel and oil pressure, the engine was feathered with difficulty and a return made to Honolulu.

The inspection of the faulty engine showed that the propeller feathering pump, feathering motor and propeller governor were all defective, the feather motor pump being burnt out, apparently due to excessive rise when attempting to feather and unfeather.

The difficulty experienced in feathering the motor was caused by the governor drive shaft seizing in the drive shaft bush and locking the pilot valve in the on-speed position.

The propeller governor units in the Convair 240 and DC-6 are identical, and the failures reported in the two incidents referred to here were both due to the drive shaft seizing in the bush due to insufficient clearance between the shaft and the bush.

No actual tolerances for this clearance had been quoted by the propeller manufacturers, but after considerable experimental work and testing, a specific figure has now been determined and all future installations will comply with this tolerance.

Leigh Creek Aerodrome
(3104/50)

On 19th December, 1950, an aircraft captain submitted an Air Safety Incident Report concerning an inaccurate terminal forecast for Leigh Creek and, in concluding his report, stated –

"The wind velocity at Leigh Creek when we landed was north-east at 30/35 m.p.h., and as we had to use runway 089°, this gave us a considerable cross-wind component. I would like to mention here that on each occasion that I have landed at Leigh Creek, and there has been a wind above 10 to 15 m.p.h., it has not been in the direction of either of the existing runways, but more often from about 045°, and occasionally from 120°.
Another runway running NE-SW would alleviate the problem considerably."

This report was the first of many which followed in the next two years, and all were basically the same in that they suggested that a NE-SW landing direction was desirable because of the apparent frequency of winds from these directions.

On receipt of the first report, investigations into Leigh Creek wind conditions were commenced, but the only information available at the time was from wind roses for the period 1945-50 from Copley, about five miles south of Leigh Creek, and Farina, about 35 miles to the north. This information, when applied to Leigh Creek did not bear out the statement in the initial report, as the figures obtained indicated that the usability of the existing runways was about 97 per cent., which was well within the minimum usability laid down by ICAO.

However, it was appreciated that these figures could be misleading, firstly because they were not obtained at Leigh Creek, and secondly because wind roses take only direction into account and do not consider velocity. It was therefore decided to set up a Dynes Anemometer at Leigh Creek and record wind information for a period of twelve months. The recording was commenced early in 1952, the delay being occasioned by the time taken to obtain and set up the anemometer.

At about this time, replies were sent to all pilots who had forwarded incident reports on this subject, indicating that the decision on the provision of a third runway would be dependent on the review of anemometer readings for a twelve-month period.

On 5th September, 1952, a report was received suggesting that an area from the eastern end of the 269° runway to a point south of the junction of the two runways be graded as an emergency landing run. At this time, anemometer readings had been recorded for a period of about seven months, and a study of these readings indicated that a third landing strip would be an advantage. Accordingly, a landing strip bearing 061°M length 3,450 feet, width 300 feet, approaches clear to 1 in 40 was graded and brought into use by NOTAM on 24th February of this year.

DIAGRAM SHOWING APPROXIMATE POSITION OF 061° M. LANDING STRIP AT LEIGH CREEK

The twelve-month recording of anemometer readings has now been completed and shows that the actual usability provided by the existing 089° and 159° runways is only about 93 per cent. Therefore, the need for a third landing direction is clearly indicated.

The new 061° landing strip has raised the aerodrome usability to 98 per cent. and will permit landings to be accomplished at Leigh Creek without having to suffer the difficulties of large crosswind components, and will also eliminate the need to by-pass Leigh Creek when excessive crosswind components exist on the 089° and 159° runways.

Arrival Reports – Training Flights
(387/53)

A DH. 82 aircraft departed from Casino, N.S.W., at 0800 hours for a cross country training flight to Coff's Harbour and return. Prior to departure from Coff's Harbour the pilot lodged flight details which gave the Casino ETA as 1400 hours.

When the aircraft had not reported its arrival at Casino by 1500 hours, and en route stations had advised that the aircraft had not been sighted, the R.A.A.F. were advised of the details of the overdue aircraft and the Uncertainty Phase was instituted.

Two civil DC-3s were diverted to search the probable route followed by the DH. 82, while further telephone calls were made to South Grafton and Ballina to see if the overdue aircraft had landed there.

At approximately 1540 hours when all efforts to locate the missing aircraft had failed, the Alert Phase was introduced. However at 1555, Coff's Harbour was informed that the DH. 82 was in the hangar at Casino.

The pilot concerned was on his first solo cross-country flight, and after landing at Casino, had sought his instructor who, unfortunately, had had an accident and was in hospital. The pilot was then faced with the problem of advising Coff's Harbour of his arrival, but was ignorant of the procedure to be adopted, as he had been relying on the assistance of the instructor in this regard.

Unable to find anyone to assist him, he finally lodged a telegram at Bonalbo Post Office for despatch to Coff's Harbour through the normal channels.

The failure of the pilot to report his arrival by the use of the facilities provided for the purpose resulted in needless expense and a great deal of inconvenience to all concerned.

This incident reveals a lack of briefing and a poor standard of training in the elementary principles of cross-country flights, and reflects adversely on the instructor responsible for the training of the pilot concerned.

To obviate the possibility of similar incidents, flight instructors should ensure that pupils in their charge are competent in every respect to make solo cross-country flights before the certification, as required by A.N.O. Appendix 40.1.7.15, is made.

Townsville V.A.R. Alignment

(721/52)

For some time, pilots operating on the North Queensland routes have been agitating for a re-alignment of the visual legs of the Townsville V. A. R. Suggestions concerning the re-alignment of the southern visual leg resulted in this course being re-aligned on Bowen towards the latter part of 1952.

However, at that time, the Department was not prepared to accede to suggestions that the northern visual leg should be re-aligned to conform with the 33 Mc/s Range alignment.

The reasons advanced by aircraft captains in advocating a re-alignment of the northern leg was that the standard descent path passed directly over Mt. Marlow (700 feet) and, although the minimum altitude was 1,210 feet by day and 1,410 feet by night, emergencies could arise where it would be necessary to descend below minimum altitude. Under these circumstances, Mt. Marlow would present a grave danger.

The Department's primary reason for wishing to retain the present alignment was that the Townsville V.A.R. was one of a chain which provided route guidance along the east coast of Australia, and any re-alignment would upset the continuity of the chain. In addition, the day minimum of 1,210 feet gave a terrain clearance of 500 feet over Mt. Marlow, and this was considered adequate, even in emergency conditions.

Nevertheless, aircraft captains still continued to suggest that the northern leg be re-aligned, contending that the use of the Townsville V. A. R. as a route guide was of secondary importance when compared with the advantages it provided as a descent aid.

In view of the persistence of the suggestions, the main operating companies were requested for their views on the matter, and when they supported the suggestions for re-alignment, the Department agreed.

The bearings of the re-aligned legs are as follows:—

North West Visual — 309°T — Instrument Descent.

South East Visual — 120°T — Aligned on Bowen.

South West Aural — 209°T — Aligned on Charters Towers.

North East Aural — 029°T — Sector designation only.

Mildura Movements

(522/53)

Whilst on the down-wind leg of a circuit preparatory to landing at Mildura, the pilot of an Auster noticed a DC-3 taxying towards the runway on which the Auster intended to land. The DC-3 turned cross-wind and the Auster continued the approach. However, when the Auster was about level with the aerodrome boundary, the DC-3 turned on to the runway and began to take-off. The Auster turned sharply to the right and landed on the grass beside the runway. During the final stages of the landing, the Auster pilot was in extreme difficulty because of the slipstream from the DC-3.

Prior to take-off, neither captain nor the first officer of the DC-3 saw the Auster and the first indication they had that the Auster was landing was when they saw it to the right of the DC-3 shortly after the full take-off power had been applied.

There seems little doubt that the DC-3 captain did not exercise sufficient vigilance before take-off and was primarily to blame for the incident. However, it is considered that the pilot of the Auster would have shown better airmanship by either extending his circuit to allow the DC-3 to take-off before he landed, or by carrying out another circuit for the same reason.

Despite the provisions of A.N.R. 139(6), light aircraft should avoid as far as possible delaying regular transport aircraft at aerodromes where both operate concurrently.

Airline captains are reminded of their responsibilities for the safety of their aircraft and passengers, and the consequent need for particular vigilance when operating at an aerodrome where light aircraft are known to be in the circuit area.

The Pilot and Separation Standards

(768/53)

En route from Hay to Melbourne via Mangalore, the captain of a DC-3 reported over Deniliquin in visual conditions at 5,500 feet and requested a clearance to join the air-route at Mangalore at 6,000 feet, the Mangalore ETA being 0235Z. A clearance with a void time of 0238Z was granted.

At 0220Z, a DC-4 on the Sydney — Melbourne route reported at Benalla at 6,000 feet and gave a Mangalore ETA of 0239Z. The DC-3 captain, realizing that standard separation would not exist if he entered the controlled route at 6,000 feet, called Melbourne to see if his original clearance of 6,000 feet still applied. On being informed that it did, the captain then requested and received permission to descend to 4,000 feet.

The investigation of this incident showed that the DC-4 was cleared from 8,000 feet to 6,000 feet at 0156Z, the Mangalore ETA at that time being 0248Z. The amended altitude of the DC-4 was entered on the Benalla flight progress strip in Melbourne Area Control, but the Controller failed to make the appropriate amendment on the Mangalore strip.

When the DC-3 requested a clearance to enter the controlled route, the clearance was granted with a void time of 0238Z to ensure 10 minutes separation with the DC-4 at Mangalore. However, an amended Mangalore ETA of 0239Z for the DC-4 was received shortly after, but when entering this on the Mangalore strip, the fact that the DC-4 altitude had not been amended on the strip meant that the actual traffic situation was not apparent to the Controller. Therefore, when the DC-3 queried his clearance to join the air-route at 6,000 feet he was told his clearance still applied.

This incident occurred as a result of a lapse in vigilance on the part of the Controller, in that he issued a clearance which would not have provided the required separation. Suitable action has been taken in regard to the Controller concerned.

The action of the DC-3 captain in requesting permission to descend to 4,000 feet when it became apparent to him that the necessary separation would not exist on entering the controlled route prevented a possible serious incident developing and he is to be commended on taking the initiative to ensure that standard separation was maintained.

Low Flying

(1808/52)

On 13th November, 1952, a Wackett aircraft struck high tension wires in the township of East Pakenham. The aircraft was flown by the owner, who held a Student Pilot Licence, and had taken off from Pakenham East aerodrome a few minutes previously.

Subsequent investigation indicated that the aircraft was deliberately flown at a low altitude over the town and proceedings against the pilot for violation of the Air Navigation Regulations were instituted.

In the resulting court hearing, the pilot was found guilty of an offence under Regulation 133 and was fined £50 in default distress with £9.17.9 costs.