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A PERSONAL MESSAGE TO PILOTS ENGAGED IN AGRICULTURAL OPERATIONS

In the short period in which it has been my duty as Director-General to read the draft of this Digest before its release for publication, I have been appalled by the needless waste of life it reports among young Australian pilots engaged in agricultural and light aircraft operation. This is in marked contrast to the position in public transport operations where the professional care and skill of experienced airline pilots has made an important contribution to the continued accident-free record.

It has always been recognized that continued flight in close proximity to the ground is fraught with special hazard and flying training establishments, both civil and military, have imposed the most rigid penalties on unauthorized low level operation. In agricultural aviation, however, low level flight is an inescapable and regular feature of daily operation. The hazards involved can only be eliminated by airmanship of a very high order.

A comprehensive knowledge of the aircraft's performance and of the terrain (including obstructions) over which it is to operate is an essential pre-requisite to safe operation. Yet we find cases continually occurring of pilots either operating aircraft beyond safe performance limits or committing the fatal error of flying straight into power lines or other obstructions which could easily have been avoided. In some cases flagrant disregard of simple safety regulations (e.g., aerobatics in a hopper-equipped Tiger Moth at "dot" feet) has added to the growing loss of human life in agricultural aviation.

The simple safety rules which the Department has prescribed for agricultural operations, and which are included in all company operations manuals, provide a very real protection for pilots if they would only observe them with the same unfailing care as do their colleagues in the airline business. But none of those responsible for civil aviation safety has ever been under the illusion that common sense and good airmanship can be achieved solely by regulation. It is up to the individual pilot to recognize the hazards and to take steps to avoid them. Too often the first mistake a pilot makes in low level flight is his last, so that there is not a real opportunity to learn from personal experience.

To any sensible person, however, there is a unique opportunity to learn from the collective fatal experience of others which is so faithfully recorded by my officers in this Digest. It would be no exaggeration to say that those agricultural pilots who choose to ignore this experience go in real jeopardy of their lives.

In conclusion there is, I think, one practical hint which I might be able to pass on as a result of my own reading of previous Aviation Safety Digests. I have noticed that several agricultural accidents occurred on a pilot's last run for the day. This indicates that fatigue at the end of a day's flying might well induce a pilot to relax unconsciously in his concentration and thus commit errors of judgment which otherwise are not easily explainable. So be careful to ensure that your last run for the day is not in fact your very last.

D. G. Anderson.

Director-General of Civil Aviation.

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PART I

AVIATION NEWS AND VIEWS

Ground Effect

(Because of its general interest the following article is reproduced from Pilot's Safety Exchange Bulletin 56-111 *issued by the Flight Safety Foundation, New York, U.S.A.)*

"In an article in a recent issue of 'The MATS Flyer', Major Murray Marks, Office of Safety, Headquarters, 8th Air Force, explained ground effect and detailed its influence on aircraft performance, stability and control. Understanding ground effect and its influences can help you out of a tough spot, if need be; not understanding it can teeter you on the brink of a stall.

'While ground effect is a flight characteristic about which most pilots have very little knowledge, we all experience its results every time we are at the controls of an airplane. When we consider that this phenomenon affects the aircraft during take-off and landing, and that both these critical areas account for the largest number of aircraft accidents, it becomes necessary for all pilots to examine the subject to ensure complete understanding.

WHAT IS GROUND EFFECT?

'Simply stated, in part, it is the change in the airflow over the wings and tail when the aircraft is in close proximity to the ground. This change is caused by the ground surface restricting the vertical component of the airflow which normally flows down from under the wing tip, and then around it to the upper surface of the wing (wing tip vortex).

The influence of ground effect on wing tip vortex is shown in Figure 1A and Figure 1B.

'This reduced wing tip vortex results in a reduction of "induced drag", an undesirable but unavoidable consequence of producing lift.

'Further consideration of the change of airflow by ground effect which restricts the vertical component is its influence on the "lift vector". This results in the required lift being produced with a reduction in the downward angle is therefore reduced which ward deflection of the airstream. The down-results in less induced drag because the lift vector is moved forward. This influence is shown in Figure 2A and Figure 2B.

FIG. 1A WING OUT OF GROUND EFFECT

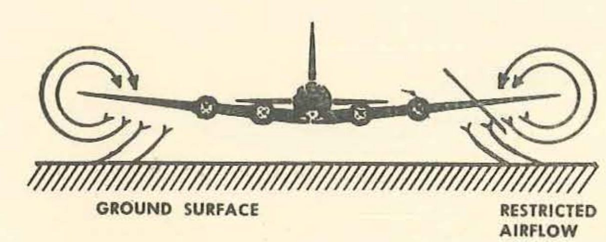
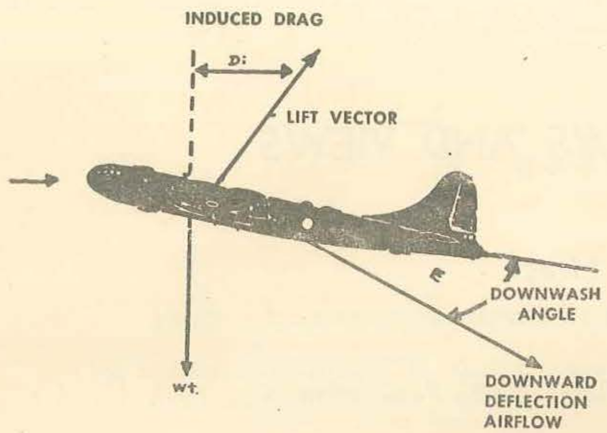


FIG. 1B WING IN GROUND EFFECT



2A AIRCRAFT OUT OF GROUND EFFECT

'It is also interesting to note that the percentage of wing span in relation to the height over the ground has a very definite bearing upon the amount of reduction of induced drag. Comparing two aircraft, of different size wing spans, at the same altitude, the one with the larger wing span will have more ground effect with a greater reduction of induced drag.

'For example, an aircraft with a wing span of 60 feet starts round out in landing at an altitude of 10 feet. Due to ground effect, it experiences a 33.9 per cent. reduction of induced drag. Compare this with another aircraft having a larger wing span of 100 feet which starts round out in landing at the same altitude of 10 feet. Due to ground effect this aircraft experienced a 50

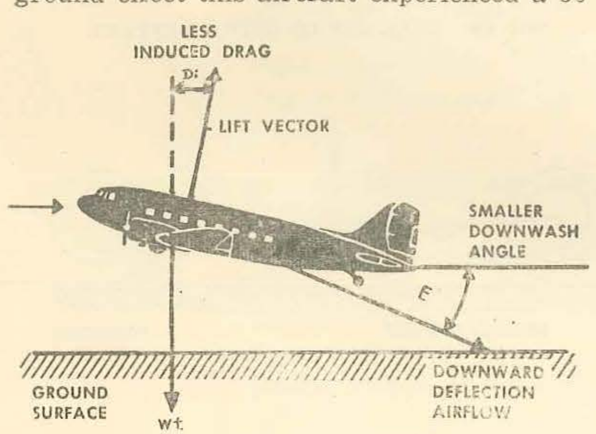


FIG. 2B AIRCRAFT IN GROUND EFFECT

per cent. reduction of induced drag. This is an additional 16 per cent. reduction of induced drag.

'Figure 3 shows the reduction of induced drag due to ground effect in reference to the height relationship of the aircraft with respect to the per cent. of wing span.

'Examination of the influence of ground effect involves two separate considerations. These are the effects on aircraft stability and control.

EFFECT ON PERFORMANCE

'On many occasions, pilots have experienced a "floating tendency" of the aircraft when near the ground, which is especially noticeable during the "flareout" in landing. This is caused by the reduction of induced drag due to ground effect as explained above.

'While "total drag" on an aircraft consists of both "induced drag" and "parasite drag" it is the induced drag that significantly is affected by ground effect. The parasite drag, or barn-door effect, which is produced by gear, flaps, dirty surfaces, and miscellaneous protuberances need not be considered for the purposes of this discussion. However, in the low speed flight regions, as in take-off and landing, the induced drag is by far the largest percentage of the total drag.

'It then follows that a reduction of induced drag will result in a noticeable reduction in the total drag. Under this condition the thrust or power required to sustain the aircraft in flight is also reduced.

'For example, let's assume that an aircraft with a wing span of 116 feet is flying at an altitude of ground effect. With a complete loss of power, the pilot attempts to maintain altitude and the aircraft decelerates at 8 ft. per sec/sec or 1/4G. If the induced drag is 75 per cent. of the total drag for this reduced flight speed, it will account for 6 ft. per sec/sec of the deceleration. In this situation the aircraft has a lift to drag ratio of 4 to 1, or L over D of 4. Therefore, if the aircraft weighs 100,000 pounds then the total drag is 25,000 pounds.

'This situation is depicted in Figure 4.

'This same aircraft, flying at the same airspeed and at the same gross weight, in the ground effect at an altitude of 10 feet in flareout for landing, would have a 50 per

cent. reduction in induced drag. (Ref. Fig. 3.) For this condition the breakdown of the total drag is as follows:

	Pounds
Parasite Drag (same)	6,250
Induced Drag (50% of 18,750 lbs.)	9,375
Total Drag	15,625

'As the total drag dropped from 25,000 pounds to 15,625 pounds, the power of deceleration is now only 5/32 of a G. Therefore, it can be seen that in ground effect, the aircraft would be dissipating airspeed at 5 ft. per sec/sec, only 3/5 (more than half) the rate out of ground effect. Excess airspeed takes longer to dissipate in ground effect and the aircraft therefore has a tendency to float in the flareout.

THIS MAY SAVE YOUR LIFE

'A multi-engine aircraft may experience a partial power failure (loss of one or two engines) so that flight at altitude cannot be maintained. However, due to the significant decrease in induced drag when in ground effect, this same aircraft may be able to sustain level flight when operating in close proximity to the ground or water. This situation has been experienced many times and is a matter of record.

'This is an emergency procedure, and would be limited, over land, by terrain features. It is especially useful to know when engaged in transoceanic flights.

'In many instances, aircraft preparing to ditch, began to maintain airspeed and altitude in level flight when ground effect was entered close to the water. With power available from the remaining engines, they continued flight at this low altitude and after a period of time sufficient fuel was consumed which reduced the gross weight. This permitted them to climb to higher and safer altitudes, and to safely reach destination.

THIS CAN KILL YOU

'While entering ground effect as in landing reduced induced drag, which, in turn, reduced the thrust or power required for flight, leaving ground effect, as in take-off has an opposite effect. In this case, the thrust or power required for flight can be increased over that required when in ground effect.

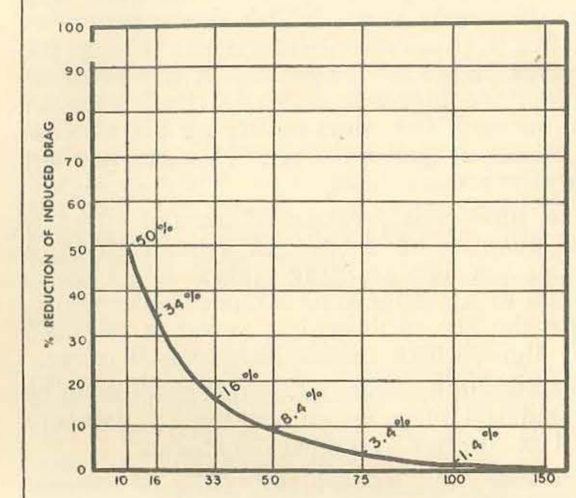


FIG. 3 ALTITUDE OF WING ABOVE GROUND IN % OF WING SPAN

'For example, an aircraft which is heavily loaded, may become airborne because, due to the influence of ground effect, the power available is sufficient to sustain flight. However, once ground effect is left, due to the increase in induced drag, this power may not be enough to maintain flight. The aircraft may either stall out of control or "mush" down and back into the ground, resulting in an aircraft accident.

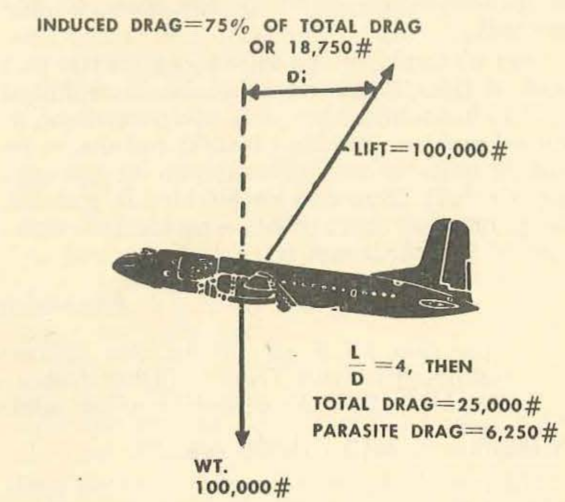


FIG. 4 AIRCRAFT OUT OF GROUND EFFECT

'The importance of rigidly adhering to Standing Orders cannot be over-emphasized. It is mandatory for pilots to compute and use the "unstick speeds" which are published in the appropriate instructions. Using the recommended speed for take-off will preclude premature flight at a critical time (loss of engine on T.O.), thus nullifying the adverse influence of ground effect. This can prevent an aircraft accident.

'A final consideration of ground effect is its influence on range. In ground effect, a maximum lift to drag (max L/D) ratio exists at a slower true airspeed. Therefore, with the loss of drag, less power is required for flight, which results in increased range.

'Extending range in this manner should be considered only as an emergency measure and is limited by terrain features.

'While this procedure would be advantageous for conventional aircraft, it would be prohibitive for jets. This is due to the exorbitant rate of fuel consumption of jet engines at low altitudes which would have an adverse effect.

STABILITY AND CONTROL

'By comparing the downward deflection airflows, as shown in Figure 2A and Figure 2B, it can be seen that the downwash is closer to the tail surfaces in ground effect. As the ground effect is increased (flight closer to the ground) the downwash effect of the wing engulfs the tail surfaces thereby reducing the load on the tail. This results in a downward pitch at the nose of the aircraft.

'For example, if the tail is located 100 feet back of the CG and the down load is reduced by 1,000 pounds, then the downward pitching moment would be 100,000 pounds. As this is quite a load to overcome to prevent the aircraft from pitching into the ground, the pilot must exert positive upward elevator control to counteract it.

'Aircraft designed with high tails experience very little downward pitch from ground effect as the tail is practically out of the effective downwash of the wing.' "

COMMENT

A particular point for consideration highlighted in the foregoing discussion is the marked reduction in performance when an aircraft climbs out of ground effect. There have been several accidents in Australia in recent years, involving aircraft with a marginal performance, in which control of the aircraft was lost at low altitudes after take-off. The reduction of performance out of ground effect was a factor of considerable magnitude in most of these accidents.

The foregoing article also indicates the wisdom of calculating and using take-off safety speeds.

Other points to note are—

(a) Because of the reduced drag the rate of acceleration after take-off is greatest in ground effect.

(b) At the same altitude ground effect has a greater influence on the aircraft with the larger wing span.

(c) A decrease in backward stick force can be expected as the aircraft climbs out of ground effect; conversely there is an increase as the aircraft enters ground effect.

(d) Having regard to the nature of the terrain a greater range can be achieved in ground effect because of the reduced drag.

(e) Because maximum lift to drag ratio is obtained for a lower true airspeed in ground effect the tendency to float becomes more marked with an increase in approach speed.

Attention I.L.S. Users

Now that I.L.S. is coming into operational use with Australian civil operators the following extract from a Safety Bulletin issued by the Flight Safety Foundation should receive the attention of all pilots using the instrument landing system.

"CHECK . . . AND CHECK AGAIN

"Reported experiences of erroneous glide slope indications prompt re-emphasis of the importance of cross-checking altimeter and glide slope indications during any I.L.S. approach.

"There are several types of failures that may occur to aircraft I.L.S. equipment that will not be indicated by the flag alarm. When the flag alarm is visible, it only indicates that a strong or fairly strong course-forming

signal is not being received. The following are those conditions in which the flag alarm may *not* indicate failure:

(a) A mechanical failure or "sticking" of the cross pointer indicator.

(b) Failure in the wiring that connects the cross pointer indicator to the localizer and glide slope receivers.

(c) Faulty receiver tube that may result in an indication of broadening of the localizer or glide slope course.

(d) Defective or failed components of the localizer or glide slope receiver course-forming units that may cause a shift in the "on course" indications.

Check and double-check altimeter indications against glide slope indications when you are over the outer and middle markers inbound on any I.L.S. approach."

Since the precautions to be exercised during an I.L.S. approach apply equally to the system in use in Australia the foregoing procedure should be always adopted.

POSTSCRIPT

Although proper pilot monitoring will avoid any sticky situations arising from malfunctioning of the I.L.S., the Department, in order to provide added safety, has produced a comparatively simple piece of ground equipment which will enable the pilot to rapidly check the correct operation of the airborne equipment. This is the Standard Signal Radiator and operates on a special channel. To check, the test channel is selected and if the needles execute a standard pattern of manoeuvres, the equipment is satisfactory. This check takes up to 15 seconds.

An I.L.S. check should be carried out immediately prior to commencing descent and if the equipment was satisfactory at this check, the possibility of malfunctioning during the subsequent descent would be extremely remote. Nevertheless, as continuous monitoring is not provided for the airborne equipment, it will be still necessary to check and double check altimeter indications against glide slope indications.

Sulphur Dust Fires

A sulphur dust fire during an aerial agriculture dusting operation is summarised in this Digest. To date, relatively little aerial sulphur dusting has been carried out in this country and this is the first instance of a sulphur dust fire. However, there have been a number of such fires overseas and as sulphur can be easily ignited, the necessity for exercising extreme care in sulphur dusting operations cannot be overemphasised.

Sulphur has a very low ignition point and is highly combustible when atomised with air, as occurs during dusting operations. Also, sulphur picks up electrical charges readily, which, under atmospheric conditions of low relative humidity, may result in combustion. In the industrial handling of sulphur particular care is taken to prevent the formation of a cloud of sulphur dust because of the danger of explosion. Sulphur has been known to ignite when thrown from a shovel due to static electricity. These examples show why special precautions are taken in industry to prevent the formation of a cloud of sulphur dust, which can explode so easily. In aerial dusting a sulphur cloud is unavoidable; it follows that every possible precaution must be taken to prevent fires or explosions.

Sparks from the engine exhaust are an obvious source of danger. Sulphur will ignite at a temperature of approximately 500°F, depending on its form. The temperature of exhaust gases is about 1500°F when discharged from the cylinder. Although the gases will cool considerably before coming in contact with the air, potential fire hazards still exist. For this reason the exhaust outlet should be placed as far away from the sulphur discharge as possible and so positioned that the exhaust gases will not be blown into the dust path during a pull-up at the end of a run. If possible, the exhaust system should be so arranged that exhaust gases will not be discharged under or along the bottom of the fuselage. The most desirable location for the exhaust system is above the top wing with the outlet directed outward and upward.

If the exhaust system is not well clear of the dust discharge, it is essential to maintain the system free from leaks and to use the best grades of lubricating oil to minimise carbon formation. The throttle should never be opened suddenly, except in an emergency, as the sudden blast will throw sparks from the exhaust. Further, as the pull-up at the end of a run directs the exhaust downwards towards the dust path, it is a good practice to close the hopper gate before effecting the pull-up to reduce the possibility of fire.

On the other hand, several sulphur dust fires have occurred when the hopper gate has been slammed shut to cut off the flow of sulphur at the end of a swath. These fires have resulted from the pressure by the gate on the sulphur dust which had collected in the opening causing sufficient friction to ignite the dust. To avoid this, the hopper gate should be fitted in such a manner that it will not bind and the opening designed to minimise the accumulation of dust. Ferrous metals should never be used for hopper gates due to the possibility of a spark when the gate is actuated. An aluminium gate is preferred over other non-ferrous metals because of its excellent heat conducting properties, which tend to prevent heat generated at a given point remaining localised.

Where tail skids are fitted to aircraft, sparks can be caused by the skid striking stones or other objects whilst on the ground which can ignite any sulphur dust on the aircraft in the vicinity of the tailskid. Whilst such sparks cannot be avoided, the fire hazard can be reduced by keeping the fuselage (interior and exterior), tail surfaces, etc., free from sulphur dust.

Metal parts of an aircraft, isolated from each other by insulating materials, may accumulate unequal static charges of electricity giving rise to spark discharges between these parts which are capable of igniting sulphur dust. Thus, it is essential that aircraft engaged on dusting sulphur should be completely bonded and also provided with static discharge rods on each wing tip. If it is not possible or practicable to completely bond all parts of the aircraft, at least the fuselage aft and in the vicinity of the hopper, the fittings adjacent to the hopper and the hopper itself should be bonded.

Dusting with a dirty aircraft coated with sulphur dust and oil is looking for trouble. Compartments where dust can collect should be properly ventilated and fitted with access openings for inspection and removal of dust. If these spaces cannot be properly ventilated, it is probably advisable to seal them off completely.

The majority of fires during sulphur dusting, have occurred in conditions of low relative humidity. Therefore, as relative humidity is usually lowest during the middle of the day, a further precaution is to carry out sulphur dusting operations only in the early morning or late afternoon, preferably in the early morning.

Finally, in order to delay the spreading of a sulphur dust fire, the lower portion of the fuselage in the vicinity and aft of the hopper can be covered with a fire resistant material. Thus, if the fire precautions fail, the pilot will be accorded valuable time in which to land.

PART II

OVERSEAS ACCIDENTS

Landing Accident: Tri-State Airport, Huntington, West Virginia

(This summary is based on the report of the Civil Aeronautics Board, U.S.A.) (18/27/104)

A Martin 404 was damaged extensively when it overran the Tri-State Airport, Huntington, West Virginia, at approximately 1850 hours on 15th January, 1956. No injuries resulted to either crew or passengers.

THE FLIGHT

The aircraft was on a scheduled flight from Chicago, Illinois, to Charlotte, North Carolina, with intermediate stops, including Louisville, Kentucky and Huntington, West Virginia. The flight was routine to Louisville, where a landing was made at 1731 hours.

At 1750 hours, the aircraft departed from Louisville carrying 680 gallons of fuel and 32 passengers for a gross take-off weight of 42,913 pounds. En route, the captain requested and received an I.F.R. clearance, via V-4 Airway to cruise at 5,000 feet, and was given the latest Huntington weather. This indicated the ceiling to be 1,000 feet, visibility one mile, wind calm, light snow and that braking action was "poor" on the snow-covered runway.

Charleston approach control cleared the flight for an approach to Tri-State Airport at Huntington. The aircraft crossed the end of runway 30 at an estimated speed of 90-95 knots at an altitude of 50-100 feet and passed over almost one-half of the length of the 4,600 foot runway before touching down. The crew was unable to stop the aircraft within the confines of the airport and the aircraft nosed over the brink of a slope approximately 100 feet beyond the end of the runway.

INVESTIGATION

The aircraft arrived over the Huntington H-facility* at 1842, and then in accordance with prescribed procedure, flew outbound 017 degrees magnetic and made a procedure turn, descending to 700 feet above the ground before returning at 197 degrees magnetic over the H-facility. The aircraft then proceeded to and passed directly over the airport and its single runway at about a 90-degree angle. Both pilots stated that all airport runway lights were sharp and clear through snow precipitation. A check of the windshield wiper and leading edge of the wing showed no ice. After crossing the airport the captain made a left turn of about 270 degrees, concluding the turn at an estimated three-fourths of a mile from approach end of runway 30. Both pilots stated that again they could see all runway lights at that time.

Final approach was continued with landing gear down and flaps fully extended. The end of the runway was crossed at an estimated airspeed of 90-95 knots at an altitude of 50-100 feet. Just before touch-down the captain advised the first officer that he intended to use propeller reversing "because of snow on the runway and possible poor braking".

Upon touch-down the first officer raised the reverse thrust lockout flag, permitting propeller reversal before the aircraft's weight was on its landing gear, and the captain used reverse thrust beyond the normal reverse range into the emergency reverse range. The first officer observed the No. 1 propeller reversing light come on slightly before No. 2 came on. According to the captain, No. 2 propeller lagged momentarily. Forward visibility was completely cut off by surface snow blown forward and up by the reverse thrust. The captain noted a slight change in heading on the flux gate compass and

* An "H-facility" is a non-directional radio transmitter used for homing and navigational fixes.

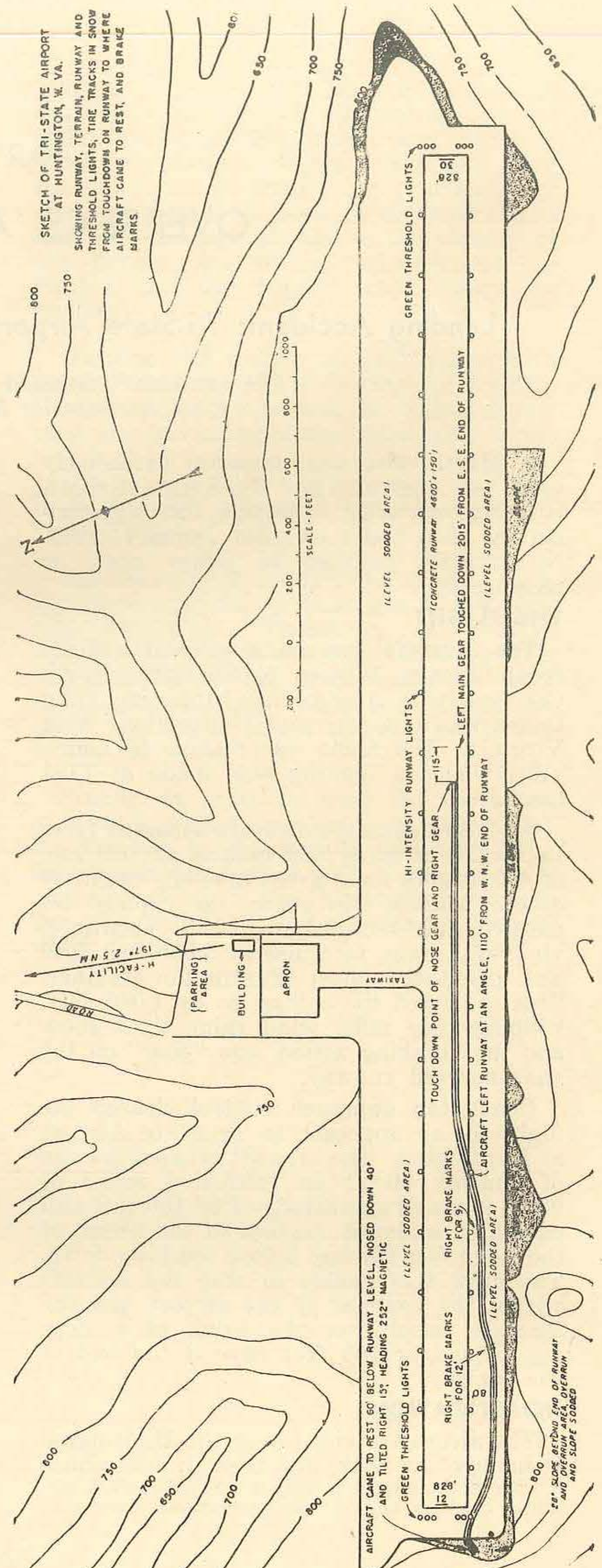
reduced r.p.m. in order to see where he was headed because of sharp drop-offs in the terrain near the runway edges, particularly to the left. When visibility was regained he realised that he was then going off the left edge of the runway. This was at a point about 1,400 feet beyond touch-down and about 1,100 feet short of the far end of the 4,600 foot runway (see sketch).

The captain then applied right rudder and right brake and increased the reverse thrust, taking more from No. 2 than from No. 1, bringing the aircraft to course approximately paralleling the runway. Again blown snow blocked visibility and again the captain reduced power to regain it. He realised he was again turning to his left, away from the runway, and quickly applied right rudder and right brake to change direction. This accomplished its purpose until the aircraft was parallel to and approaching the end of the runway. Again the captain applied maximum reverse and lost all forward visibility.

During this relatively short period the aircraft maintained a course generally parallel to and at the left of the runway until, when nearing the end, it was turning to its left. It then went slowly over the brink some 100 feet beyond the runway. Both propellers remained in reverse thrust with varying amounts of power being used throughout the landing roll. Nose-wheel steering was not used to correct the swerves.

Just after the aircraft rolled over the brink of the slope the captain shut off all electrical power to lessen the possibility of fire. The aircraft came to rest on a ledge about 186 feet beyond, and about 60 feet below the level of, the runway. The rough terrain sloped downward about 28 degrees; the aircraft was nose-down even more to 40 degrees and tilted 15 degrees to the right. All passengers deplaned via the left front loading door without disorder despite the difficulty induced and augmented by darkness and slippery, rocky, sloping terrain.

Examination of the landing gear latching mechanism revealed that all three landing gears were extended and locked, and that the nose gear steering cylinder was intact and in normal operating condition. Examination of the brake system failed to reveal any indications of operating distress, and all hydraulic lines were intact. An examination of the engines, propellers, propeller



governors and main landing wheels revealed no evidence of failure or pre-crash condition which would cause malfunctioning.

The captain held a valid airline transport pilot certificate with a total of 9,680 flying hours, of which 2,351 hours were flown on Martin 404 aircraft and 535 hours of instrument flying. He had made 11 previous landings at Tri-State Airport—all at night and all in Martin 404 aircraft.

ANALYSIS

The captain attributed the first swerve to the left to a momentary lag in the No. 2 (right) engine. This would cause more, or quicker, reverse thrust on the left engine than on the right and consequently result in a tendency to yaw to the left. But it seems unlikely that any momentary lag in the No. 2 engine caused the initial swerve because the aircraft travelled a good 1,000 feet before swerving. (This distance would have taken 7.4 seconds at an assumed average speed of 80 knots.)

Subsequent swerves to the left, as the aircraft continued generally parallel to the runway, occurred as the captain attempted to use maximum reverse thrust to stop the aircraft on the airport. The given braking condition of "poor" did not carry with it a warning against landing; it was merely information for the captain to use as he saw fit.

The captain could not explain why he landed so far down the runway after a final approach. There was little or no wind, and if the aircraft had crossed the boundary at 50 feet altitude and at the conventional speed of 90-95 knots, then the touch-down should have been well within the first quarter of the runway. It seems probable that there was some misalignment of the final approach to the right of the runway as a result of overturning during the close-in circling approach. The fact that the captain advised the first officer to raise the reverse flag before touch-down indicates that he realised he was then critically far down the runway and wanted to be sure of instantaneous reversal on demand.

The Board concluded that the captain made his last turn into final somewhat higher, closer, or faster than he would have during better visibility. Visibility of one mile was exactly at authorised minimum.

PROBABLE CAUSE

The Board determined that the probable cause of the accident was improper approach and subsequent landing too far down a snow-covered slippery runway.

Landing Accident — Vickers Viscount — Midway Airport, Chicago

(This summary is based on the report of the Civil Aeronautics Board, U.S.A.) (18/27/97)

On 20th February, 1956, at approximately 0811, a Vickers Viscount crashed during the final portion of a landing approach at Midway Airport, Chicago, Illinois. Minor injuries were suffered by a few of the 37 passengers and the crew of five. The aircraft was substantially damaged.

THE FLIGHT

The aircraft was on a regular scheduled flight from Detroit, Michigan to Chicago and departed from Detroit at 0700. When in the vicinity of Chicago, the captain reported to the Chicago tower and was cleared to land on runway 31R.

The aircraft was observed to make a right turn on to final approach and appeared to descend in a normal manner until over the eastern boundary of the airport at an altitude of 25 to 50 feet above the ground. At this point the aircraft appeared to decelerate and descend rapidly. It struck the ground in a slightly nose up attitude several hundred feet short of the threshold of the runway, and the top of the fuselage broke open adjacent to the wing spar to fuselage attachment. As the aircraft proceeded down the runway the landing gear retracted and the aircraft slid on its belly until it came to rest to the left of the runway, 1,626 feet beyond the point of initial impact. All occupants left the aircraft through emergency exits or the main cabin door.

INVESTIGATION

The Chicago weather at 0720 was reported as: sky clear, visibility 6 miles; smoke; wind north-northwest 7. Runway 31R was clear except for approximately two inches of ice and snow along the edges. The aircraft touched down on its main landing gear on the east taxiway 414 feet short of the threshold of the runway, and tyre marks were visible throughout the distance to the runway. No nose gear marks were found. The next discernible marks were slashes made by the Nos. 1 and 2 propellers, as the blades of these propellers struck the ground. These marks started 343 feet from the runway threshold, and were regularly spaced a distance of 30 and 50 feet, respectively. Additional marks indicated that the fuselage had contacted the ground 258 feet in front of the threshold. First slash marks made by the Nos. 3 and 4 propellers were found at a point 113 feet before the threshold. It was determined from the pattern of marks that in proceeding down the runway the aircraft gradually swerved and crossed the left boundary of the runway approximately 1,200 feet beyond the initial contact point. The aircraft came to rest on a heading of 355 degrees, i.e., inclined at 45° to the runway. The main landing gear and the nose gear were found retracted. The captain said that to the best of his knowledge neither he nor the first officer touched the landing gear selector lever after it had originally been put in the down and locked position.

There was no evidence to indicate any inflight failure or malfunctioning of the airframe or flight controls.

The first officer testified that the flight was routine until the final portion of the approach to Chicago. He said that the captain flew the aircraft from the left pilot's seat and that during the approach he followed the captain's instructions with regard to lowering the landing gear and flaps, etc., and still had his left hand on the flap lever when over the east boundary of the airport. At this point the captain reduced all power and simultaneously called for 47 degrees of flaps. As the first officer moved the flap control to 47 degrees he felt the aircraft decelerate and settle. Glancing at the instrument panel he saw that three of the four 17-degree pitch lights were lighted. The 17-degree pitch lights are actuated by a blade switch on each of the four propellers when the blades are at 17 degrees or below and warns the pilots that the blades are below the 21-degree pitch position, which is normally the minimum inflight blade angle. The filament of one of the light bulbs was found to be broken when tested during the investigation. The first officer said: "I knew that that was an abnormal situation, and the only way I could think to get out of it was to apply power . . ." Consequently, he pushed the throttles forward quickly and when they were three-quarters fully forward the aircraft struck the ground; he immediately closed all throttles. The captain said that during the flight he did not see any of the propeller warning lights come on, and that he did not know that the first officer advanced the throttles during the latter part of the approach.

In addition to the four 17-degree pitch warning lights, a warning light is provided in the cockpit that is illuminated when the four 21-degree pitch lock solenoids are energized. The 21-degree pitch lock functions as an inflight low pitch stop. The design of the propeller provides that this stop be withdrawn when the pitch lock solenoid, which is incorporated in the propeller control unit, is energized and the blade angle required to maintain the selected r.p.m. is less than 21 degrees. Three factors which determine the blade angle are selected r.p.m., power output of the engine, and airspeed. Energization of the pitch lock solenoids normally is accomplished by switches which are closed by the telescoping action of the landing gear upon landing and when the throttle-actuated switches are closed by retarding the throttles below the take-off position. An emergency switch is provided in the cockpit to de-activate the pitch lock solenoid circuit should it be energized in flight for any reason, as would be indicated by the pitch lock solenoid warning light. Subsequent to the accident, the wiring of this circuit and the warning light were checked and found to be capable of normal operation.

ANALYSIS

The captain stated that early in the landing approach the landing gear selector lever was placed in the down position, and the three green lights, indicating the gear was down and locked, were observed. He further said that to his knowledge this lever was not touched again; the first officer agreed with this statement. Shortly after initial ground contact, the nose gear and the two main gears retracted. Examination of the landing gear components disclosed that the down lock pins were not sheared, the hydraulic selector valve and its electrical actuator were found in the gear-retracted position, and the cockpit selector lever was found in the gear-up position. These facts, and other evidence definitely indicate that the system was actuated hydraulically by movement of the cockpit selector lever. It is considered likely that the landing gear selector was moved unknowingly by a crew member following impact. It is also believed that the gear retraction minimized the possible serious consequences of the fuselage break. Considerable thought was given to the possibility that the aircraft stalled. The captain testified the speed of the aircraft was approximately 105 knots at the time of the drop. This is well above the stalling speed of the aircraft which, under existing conditions, would have been approximately 81 knots. It is thought that the slight nose-up attitude at the time of touchdown was not of sufficient magnitude to have caused the aircraft to stall.

The circuit of the 21-degree pitch lock solenoid contains four microswitches, two connected in parallel on the positive side and two connected in parallel on the negative side. This necessitates that one switch on each side of the circuit be electrically conductive before the solenoid is energized, thus completing one of the steps toward withdrawal of the 21-degree pitch stops. This circuit is designed expressly as a safety measure in that malfunctioning of two switches is required to establish an unwanted circuit. However, this double failure feature of the circuit was compromised in that a failure of one switch could go undetected for an indeterminable period of time. No specific inspection period had been established for these switches.

Examination of these microswitches showed three were capable of having malfunctioned by either freezing or sticking. In the light of the first officer's statement that he saw the 17-degree pitch warning lights on before touchdown, it is concluded that at least two of these switches malfunctioned in flight.

The first officer stated that simultaneously with the execution of the captain's command for full flaps he saw three of the 17-degree pitch warning lights come on. The airspeed at that time was approximately 105 knots. Seeing these lights, he rapidly advanced all four throttles approximately two-thirds of their travel.

Power control of the Viscount aircraft consists of four throttles which simultaneously schedule r.p.m. and fuel flow for each of the four engines. The propeller response to the signal for higher r.p.m. is more rapid than the engine response to increase power to maintain this r.p.m. This is a normal turbine propeller characteristic and the lag of the Rolls Royce Dart engine is considered to be acceptable. A number of variables, such as airspeed and rate and extent of throttle movement would affect the duration of this lag. In this instance, it is believed the lag was approximately 2.5 seconds. During a major portion of this period, the propeller blades would be at four degrees attempting to maintain the higher called for r.p.m. through windmilling action with resultant greatly increased drag.

Under these circumstances, two deleterious effects on aircraft performance are produced. These two effects are the increased propeller drag and the loss of wing lift due to the reduced local air velocity over the wing in the area aft of the propellers. In this instance, the loss of lift effect was more significant since the effect was immediate, whereas the drag effect requires a longer time interval to be fully effective. Since the aircraft was only 25 to 50 feet above the ground when the drop occurred, and the time interval from the beginning of the difficulty to ground impact was so short, it is thought that loss of lift was mainly responsible. Subsequent flight tests, conducted by the manufacturer, confirmed this belief. These tests also showed that under similar conditions, if the throttles were advanced slowly, drag detrimental to flight and deterioration of lift does not develop.

It is apparent that at least two of the microswitches malfunctioned when the aircraft became airborne at Detroit and continued to do so throughout the flight. The failure of these switches permitted the energizing of the 21-degree pitch lock solenoid, making it possible for the stops to be withdrawn during the approach. The crew did not observe the 21-degree pitch lock solenoid warning light and consequently the emergency switch which was provided to prevent the propellers going into the ground fine pitch range while in flight was not actuated. As the aircraft neared the ground at Chicago, the first officer did see the 17-degree pitch lights come on. No instructions having been provided to the crew of the consequence, he quickly advanced the throttles, causing the propellers to immediately seek the lowest possible blade angle. The ensuing loss of lift dropped the aircraft to the ground.

PROBABLE CAUSE

The Board determined that the probable cause of this accident was a malfunctioning of the propeller control switches which culminated in an abrupt loss of lift.

RESULTANT ACTION

As a result of the investigation of this accident, immediate corrective action was taken:

1. A dual, 21-degree pitch lock solenoid warning light was installed on all company Viscount aircraft. This second light is a safety factor in the event of a broken or burned-out bulb.
2. A 300-hour periodic check of all microswitches was implemented. This requires their removal and installation of newly overhauled microswitches.
3. A hole was drilled in each microswitch case to allow excess moisture to drain from the switch.
4. Prior to installing any new switch received from the manufacturer, an inspection of the switch will be made.

Following the public hearing of this accident, the company decided to take this additional immediate corrective action:—

(a) A test circuit was installed in all Company Viscount aircraft consisting of a dual light and single pole double throw switch which provides a means to check, while in flight, the positive and negative sides of the 21-degree pitch solenoid circuits to determine if the microswitches are malfunctioning. This test circuit will also indicate an inadvertent positive or negative feed which might have been introduced directly to the wiring of the circuit.

(b) The 21-degree pitch lock warning lights were duplicated on the fire control panel in front of the co-pilot.

(c) Hermetically sealed landing gear actuated microswitches were ordered and are to be installed upon delivery.

The following action has been taken in respect of Viscount Models 720B, 747 and 756 operating in Australia—

(a) All oleo switches are checked at 600 hours for presence of moisture or corrosion, and they are now sealed with a waterproofing compound.

(b) The ground fine pitch warning light has been duplicated and the original "press to test" feature has been isolated to prevent an inadvertent positive supply to fine pitch lock solenoids.

(c) A duplicate warning light and test switch have been installed so that a pre-landing check may be made to ensure that ground fine pitch will not be available prior to the aircraft touching down.

(d) The circuit has been revised to prevent asymmetric braking due to a fractured ground fine pitch solenoid lead.

Bonanza Out of Control, Burbank, California

(This summary is based on the report of the Civil Aeronautics Board, U.S.A.) (18/27/94)

EIGHT residents of an apartment building were fatally injured and another seriously injured when a Beech Bonanza aircraft crashed into the building at night. The pilot was killed, the aircraft destroyed by impact and fire, and the building extensively damaged.

THE FLIGHT

The flight was planned from Burbank, California, to Las Vegas, Nevada. The accident occurred little more than four miles from the aerodrome of departure. The weather in this area for about two hours from the time of flight planning was: ceiling 700 feet overcast; visibility 2 miles smoke and haze: top of the overcast reported variable 1,800 to 2,300 feet above the ground. The tower controller cleared the flight at 2208 hours as follows: "Your climb out after take-off, make right turn, climb on magnetic heading of 260 degrees to on top, report on top." The pilot acknowledged this clearance. The take-off appeared normal to the tower personnel and they noted the navigation and two anti-collision lights (Grimes lights) on the Bonanza were on throughout this time. The aircraft was last observed from the tower turning right and climbing towards the overcast. At 2214 it crashed into an apartment building 4.3 miles south-west of the airport.

The accompanying diagram shows the probable flight path of the aircraft reconstructed from the testimony of the numerous ground witnesses who saw or heard the aircraft in flight.

INVESTIGATION AND ANALYSIS

The aircraft structure available for examination was greatly limited, major portions of the fuselage, left wing and cockpit having either been consumed by fire or burned nearly beyond recognition. However, major portions of the right wing, right flap and aileron, together with the empennage, were found at varying distances up to several hundred yards north-east of the main wreckage site. This was confirmation that the aircraft had sustained an in-flight failure of its basic structure.

The findings of the investigators are given below together with comments on related evidence.

1. The pilot held a valid commercial pilot certificate and medical certificate but did not hold an instrument rating.

At his last application for a medical certificate the pilot listed his total flying hours as 3,800, including 800 actual instrument, 45 hours hooded instrument, and 45 hours simulated instrument flight. After purchasing the Bonanza four months prior to the accident, the only instruction sought was about two hours, when the owner insisted that it be confined to take-off and landing practice. The instructor later testified that the pilot/owner's flying was "very rusty" and showed little evidence that he had accumulated 3,000 hours or that 800 hours were instrument flight. No records substantiating such flying experience could be found, nor had personal logs been kept.

2. Violation charges were pending against him for entering the overcast without clearance and without an instrument rating.

Three such incidents had occurred during the ten days prior to the accident. They were readily admitted by the pilot who stated that he held no instrument rating but showed that he was familiar with the regulations applicable to the flights concerned. He was advised to terminate such instrument flights until he demonstrated his capability and was certified for them.

3. The pilot was fully aware of the charges and that his flights were contrary to safe practice and the intent of Civil Air Regulations.

Evidence suggested that some pilots believed that a clearance to "take-off" from or "enter" a control zone automatically released the pilot from adherence to regulations pertaining to pilot qualification or certification. Subsequent action was initiated to have included in regulations a specific statement of those minimum weather conditions below which VFR flight could not be conducted within a control zone even though a traffic clearance was obtained. However, existing requirements had been amplified during discussions concerning his previous incidents with the pilot involved in this accident.

4. Despite this knowledge he knowingly attempted another flight through the overcast.

The pilot's apparent willingness to climb through the overcast without clearance, proper certification, or regard for other possible traffic was considered to be the result of his general disregard and disrespect for safe instrument flying practices and procedures. The Board reluctantly associated his flying habits with his driving record, which included 90 arrests for highway traffic violations, 36 of which were for speeding, and the loss of driving privileges in certain States. While the fact that he did not hold an instrument rating does not necessarily mean that he was incapable of instrument flight the Board felt that it may have indicated that he was unsure of his ability and proficiency to the extent that he was unwilling to attempt to qualify for the rating.

5. The take-off and climb out appeared normal until the aircraft entered the overcast.
6. After entering the overcast, control was lost and the aircraft began a left descending spiral.

The first witness was an aircraft mechanic interested in the anti-collision lights which he stated positively were on while he could see the aircraft. He first saw it as it turned right to an approximate heading of 260 degrees and continued to climb and entered the overcast. Shortly after, the engine sound became louder and the aircraft emerged from the overcast at very high speed diving steeply and turning left. The nose jerked up sharply while the turn continued through 360 degrees from the first observed direction. The aircraft again disappeared into the overcast, climbing steeply.

7. Several circular patterns were flown during which the flight climbed into and emerged below the overcast several times in a manner indicating partial control accompanied by panic and desperation on the part of the pilot.

The second witness, a pilot, observed the aircraft pass closely over his position three times while it flew a circular path, approximately half a mile in diameter, climbing into and diving out of the overcast several times. He stated that these erratic movements seemed to indicate the pilot was having difficulty with lateral and longitudinal control. The engine sounded as though it was operating with an appreciably high power setting and with its propeller in fairly low pitch. The engine sound was uninterrupted and did not indicate any malfunction. Neither this witness nor subsequent witnesses observed the anti-collision lights to be on.

8. Without regaining full control the pilot re-entered the overcast at a steep angle but failed to reach the clear area on top before entering another descending spiral.

The third group of witnesses also described the rising and falling engine and propeller noise and some saw the aircraft go in and out of the overcast, completing at least one circular path. One witness with dive bomber experience said the sound was unmistakably that of an aircraft diving and pulling up.

9. During the attempted recovery the aircraft was subjected to forces beyond its design structural strength.

Just prior to the crash the aircraft dived out of the overcast at an estimated 65-75 degree angle. Turning rapidly to its right through about 90 degrees, it pulled up sharply, when major portions of the right wing, right flap and aileron, together with the empennage, separated from the main aircraft structure. Rolling violently to the right the major structure plunged into the apartment roof. An explosion and intense fuel fire followed.

Primary failure of the right wing occurred just outboard of the wing-to-centre section attachment in upward or positive bending as a result of loads in excess of the strength of the structure. Chord-wise compression buckles were evident on the upper wing surface outboard of the primary fractures. Numerous diagonal wrinkles were found on both the upper and lower surfaces. The type and direction indicated a high nose down torsional load on the wing box structure.

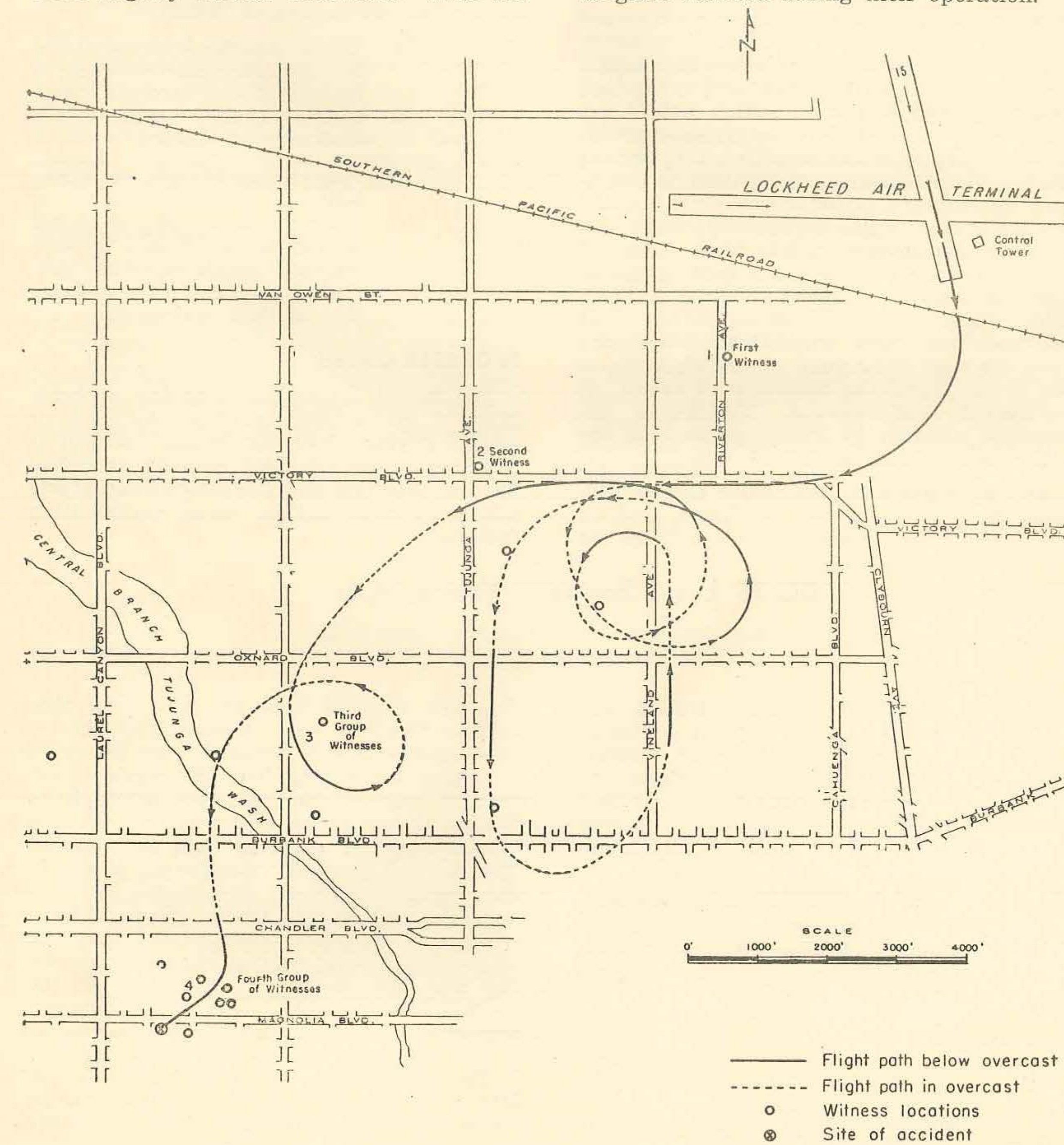
The right aileron and portion of the flap were torn from the wing by forces in excess of their strength. The twin inboard flap hinge ribs were jammed in the flap's retracted position. Before separation the aileron had been positioned well past its normal down travel.

The left and right tail section failures both occurred at the spar-to-fuselage attachment —the right section failure upward under positive loads and the left downward under negative force, indicating violent right rotation of the aircraft along its longitudinal axis following wing separation.

Metallurgical examination showed the material to be within the specification limits, and there was no evidence of fatigue failure. A review of the design data of the Beech model C-35 showed that the structural design met, and in many cases exceeded, the minimum design strength requirements. The adequacy of the design was thoroughly verified by extensive laboratory testing. The wing design incorporated strength for an ultimate load factor of from 5.25 to 5.80 g's as compared with required minimum strength of 4.4 g's.

10. The installation and relocation of the rotating beacons were not in accordance with required procedures.

The pilot, dissatisfied with the original installation of the Grimes lights, insisted that they be repositioned: one above and just behind the pilot seat on the top of the fuselage, the other on the bottom of the aircraft slightly farther rearward. With the top one mounted upward and the other inverted the resultant rotating flashes moved in opposite directions. The aircraft logs were not in the aircraft so no new computation of the aircraft's centre-of-gravity was made. Neither was an electrical analysis made following the light installation nor a flight test performed to determine how the lights functioned in flight or if any reflection or glare resulted during their operation.



11. Flight tests with similarly located lights induced immediate serious pilot vertigo which was an element contributing to the initial loss of control in the accident.

The tests flown in a Beech Bonanza with nearly identically mounted lights showed that an immediate and seriously distracting effect was caused by the lights. The opposite rotation and brilliance of the forward mounted lights caused clouds to appear to move in, out, up and down when the flashes struck the aircraft wings and propeller, reflecting into and around the cockpit. A pilot was immediately confronted with serious vertigo which required the highest degree of skill and concentration to maintain instrument control of the aircraft while being affected by the distracting conditions. Pilot vertigo involves a loss of the sense of the true vertical as well as a turning sensation. A Flight Safety Foundation Bulletin adds: "Vertigo doesn't mean merely that one does not know which way is up; one feels strongly that some wrong direction is the proper one. The feeling isn't vague. It is almost overpowering. Vertigo is apparently affected by vision as well as the other cues to balance."

On the night two days prior to the accident the pilot slept for 13½ hours, and on the eve of the accident he slept from six to eleven o'clock, after which he attended a party celebrating his 41st birthday. He was driven from there to the airport early in the morning of the day of the accident, and had little further sleep, spending the day overseeing the light relocation. His resultant fatigued condition was believed to have made him even more susceptible to vertigo and also to have delayed corrective action during the initial loss of control and thereafter while attempting to regain it.

12. There was no evidence found to indicate malfunction or failure of the aircraft structure or controls prior to the load-induced failure.

13. Ascertainment of the possibility of electrical failure or determination of electrical equipment being used through physical evidence was precluded by a complete destruction of that equipment.

PROBABLE CAUSE

The Board determined that the probable cause of the accident was the pilot's loss of control during which the design strength of the aircraft was exceeded, causing structural failure. Vertigo, and the pilot's inability to take corrective action, were contributing factors.

DC.7B Loses Engine— Venice, Italy

(*This summary is based on the report of the Civil Aeronautics Board, U.S.A.*) (18/27/103)

A U.S. operated Douglas DC.7B lost its Number 3 power-plant following engine fire in flight near Venice, Italy. The aircraft returned to Rome, its last point of departure, and landed without further difficulty and without injury to any of its occupants. The C.A.B. investigators stated:

"It is very apparent that a serious accident was barely averted . . . Alertness and good judgment, under extreme emergency, are strongly reflected in the crew's conduct."

THE FLIGHT

Fifty-four minutes after departure the No. 3 engine and propeller oversped, carrying the tachometer needle to full deflection. The fire warning light for zone 1 of that engine flickered only momentarily, but a crew member came forward from the cabin to report the engine fire. Emergency procedures were carried out, but attempts to feather the propeller were unsuccessful, and it continued to windmill at a high speed. The firewall shut-off valves were closed in an attempt to "freeze" the engine by shutting off its oil supply. Discharge of one bank of CO_2 extinguishers reduced the intensity of the fire without extinguishing it, and the fire was not checked by discharge of the second bank of CO_2 after fire warnings appeared for zones 2 and 3 of the engine.

The aircraft was descended from 5,000 to 500 feet with the intention of making an emergency landing on the flat shores of the Adriatic Sea which were clearly visible in the moonlight. At 500 feet, after a series of bright flashes and severe vibration, the burning engine fell free of the aircraft. At a height lower than 500 feet severe buffeting occurred with the airspeed dropping abruptly to about 90 knots. Power was applied to the remaining three engines, and an airspeed of 140 knots and climb of 150 feet per minute were soon established.

When visual inspection revealed the fire to be extinguished with no apparent damage to the wing, and the use of 10 to 15 degrees of wing flap reduced the buffeting, a further check was made which indicated that the aircraft was capable of continuing flight, and the flight proceeded back to Rome.

INVESTIGATION

After recovery of the power plant dismantling of the propeller governor revealed a fatigue type failure of the governor drive shaft, total time on which was 407 hours. Initial failure extended through the web between two of the high pitch oil ports with resulting failure occurring to the drive shaft through the remaining webs; the fracture line passed through one or more quench cracks at the port webs. Broken parts of the shaft had blocked oil ports which effectively prevented feathering of the propeller.

As a result of overspeeding the engine impeller assembly failed centrifugally and damaged the rear engine case to the extent that the fuel injection lines in the case were broken. This allowed fuel to escape, resulting in severe fire. The cause of malfunctioning of the fire warning system could not be determined because of the damage sustained.

In the three months prior to this accident, four governor drive shafts of the same type had failed similarly, total times for these shafts being between 375 and 592 hours. The propeller manufacturer subsequently designed and produced a governor drive shaft which has four oval ports at the high and low pitch positions, thereby increasing the web size between the ports, and eliminating stress concentrations which formerly occurred in the corners of rectangular ports.

PROBABLE CAUSE

The Board determined that the probable cause of this accident was failure of No. 3 propeller governor drive shaft which resulted in overspeeding, inability to feather the propeller, an engine failure, fire, and inflight loss of the No. 3 power plant.

CORRECTION

In the last issue, Aviation Safety Digest No. 8, in an account of the accident to an Avro Anson on an aerial ambulance flight in Western Australia on 4th February, 1956, it was stated that the aircraft was equipped with "fluorescent instrument lighting". This is incorrect. The only illumination available to the pilot was the effect of the self-luminous compound which had been applied to a few instrument dial markings.

PART III

AUSTRALIAN ACCIDENTS

Elevator Defect Causes Fatal Glider Accident

(6/256/186)

AT about 1715 hours on 28th April, 1956, a primary glider, type UT/1, crashed into an open grassed field close to the western end of the 112°-292° runway at Gunnedah aerodrome, New South Wales. The pilot was severely injured and died later in hospital; the glider was substantially damaged by impact with the ground.

During the afternoon a party of aero club members assembled to fly the glider, which had been recently acquired by this club. The wind was from the west, below 5 knots in strength, and launching was by tow from a private car along the 292° airstrip. The glider became airborne and then fell heavily back to the ground, but became airborne again and climbed to an estimated height of 800 feet over the western boundary of the aerodrome. At this point the tow-cable was released from the glider and it began to turn right and commence a continuous series of stalls and dives progressively losing height. After four or five stalls the glider dived into the ground at a steep angle from a height of approximately 100 feet having flown in almost a complete circle to the right. The impact point was approximately 800 feet north of the western end of the runway. The eye-witnesses rendered immediate aid to the seriously injured pilot, who, although apparently conscious, made no audible comment about the accident before his death.

The pilot held a current private pilot licence. His flying experience on powered aircraft amounted to 146 hours, including 13 hours in the three months preceding the accident. His experience on gliders comprised six flights of a few minutes duration each.

An examination of the wreckage revealed that the whole structure was intact until the moment of impact. All control cables and control surfaces were intact and functioning correctly. The control column was securely fastened and it was apparent that in the cockpit area there had been no impedence to the use of the controls. The only damage of significance was found in the aft end of the fuselage where it was noticed that the arm of the elevator mass balance had broken just below the weld to the elevator horn and the mass balance was found lying in the bottom of the fuselage. The surface of most of the fracture was bright and in the same area it was noticed that a transverse piece of steel channel, providing a rear mounting for the tailplane, had noticeable wear at a point where it could only have been caused by repeated striking of the mass balance arm, probably over a long period of time. A hole in the fabric of the tailplane undersurface was also noticed and its position and shape strongly suggested that it had been made by the lead mass and arm flying free on impact.

In view of the pilot's experience and the conditions of the flight there is no reason to believe that the apparent lack of control arose from any personal inability to handle the aircraft, nor was there any evidence of physical disability or condition which might have affected his faculties. The only explanation of the accident which is supported by evidence is that a structural failure deprived the pilot of effective elevator control.

The installation of the elevator mass balance was carried out after original construction of the glider and it was attached in such a way that its arc of travel intersected that of the elevator crank; interference was avoided by the timing of their relative movements. During many years of operation the mass balance arm was subject to heavy and repeated downward bending loads arising from contact with the transverse channel piece and from inertia forces on the mass balance (e.g. during heavy landings). The effect of this bending was to shift the datum of the mass balance arm closer to that of the elevator crank and also to impose a tension load on the upper circumference of the tube.

The distortion would probably increase slowly but at an increasing rate and it seems that some final shock (probably the ground impact during take-off) either bent the tube further so that it interfered with the elevator crank, or, cracked the upper circumference of the tube causing it to droop and thereby destroy the timing clearance from the elevator crank.

The effect of this interference would probably not be noticed in the cockpit during the take-off whilst the control column was kept forward of the half rearward position. However, as soon as the control column was moved behind this position, the toe of the mass balance would come behind the elevator crank and prevent the control column being returned beyond the half rearward position. The application of heavy stick forces would have little effect since the elevator crank would only apply an end load to the mass balance and its arm. There was a heavy indentation on the toe of the mass balance which mated very accurately with a weld ledge on the crank. This indicated that heavy forward stick forces were applied by the pilot. Correlating the mechanical evidence with the operational probabilities, it seems likely that the pilot would not apply any substantial back stick until approaching the limit of ground tow and then, having obtained a final lift, he endeavoured unsuccessfully to push the stick forward as he released the cable. This could explain the normal behaviour of the glider whilst being towed and the onset of the longitudinal oscillations immediately upon release of the cable.

The fabric puncture on the undersurface of the tailplane was apparently due to partial penetration by the detached mass balance. It is most likely that the mass balance was still attached to the elevator horn immediately prior to impact, and it seems that its own inertia caused the final fracture during the impact deceleration. There seems to be no significance in the fact that the glider circled to the right during the sequence of stalls and dives. It is most probable that the pilot, devoting all his attention to freezing the elevator controls, paid little attention to directional control after the cable had been released.

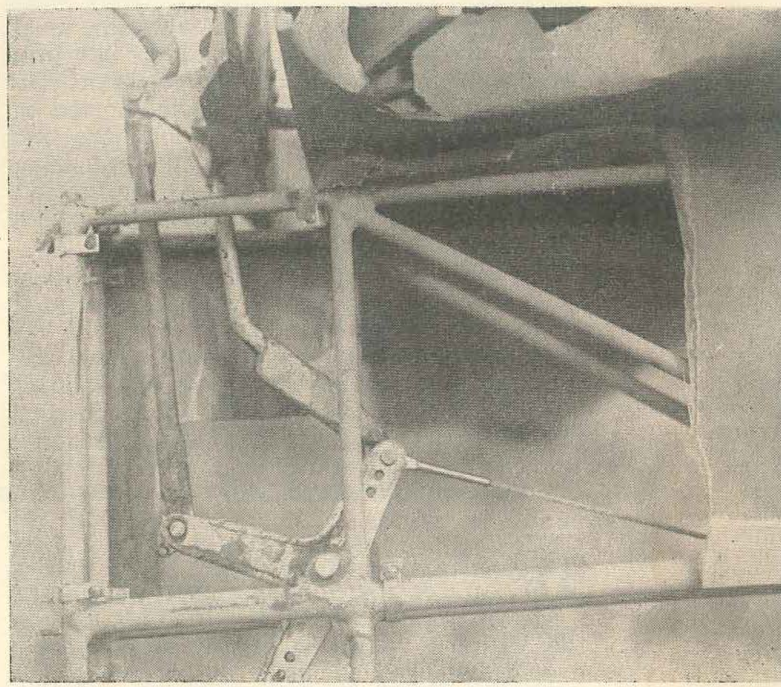


Illustration of the way in which the mass balance restricted the rotation of the elevator bell-crank.

It was concluded that:—

The cause of the accident was that the pilot was deprived of elevator control when the bending of the mass balance arm allowed the mass balance to interfere with the rotation of the elevator bell-crank.

DH.82 on Spreading Operations Collides with Power Lines

(6/256/293)

WHILST engaged in fertilizer spreading a DH-82 crashed immediately after colliding with electricity transmission wires spanning a small gully on a pastoral property near Boorowa, New South Wales. The accident occurred at approximately 1135 hours on the 20th July, 1956, while the aircraft was returning to the landing ground to re-load with fertilizer. The pilot was seriously injured and the aircraft damaged beyond repair.

The aircraft was one of four which had been operating for three days spreading fertilizer on this property. Prior to commencement of operations an inspection of the area was carried out and the presence of the power line was noted.

The top dressing site was about one mile north-west of the landing ground. The power line crossed the track between these two places at approximately a right angle and about one fourth of a mile from the landing ground. The area traversed by the power line and over which the aircraft were shuttling consisted of a series of low hills, averaging about 50 feet in height, carrying scattered trees from 20 to 60 feet high. The power line of two cables was supported on poles 29 feet high and located on the tops of two low hills. Due to the inherent droop the wires were 50-60 feet above the ground at the point of impact and over the centre of the small gully.

The pilot had spread a load of fertilizer and was returning to the landing ground to re-load. The pilot stated that because he had not sighted one of the aircraft which was top-dressing another area near the landing ground, close to the track he was following, he deviated to the left to provide clearance should this aircraft still be in the area. On passing over the crest of a low hill he sighted the power line immediately in front of him but it was too late to take avoiding action. The propeller was shattered on contact with the wires and the starboard interplane struts were torn out permitting the starboard mainplanes to collapse. The aircraft continued a further 200 feet and then struck the ground with the port wing tips and nose almost simultaneously, and cartwheeled to its final position.

An investigation revealed no evidence of defect or malfunctioning which could have caused or contributed to the accident. Weather conditions were fine with 4/8ths cloud, visibility unlimited.

The pilot stated during the investigation: "I cannot understand how I came to hit the wires because I had pointed them out to the other pilots." It is apparent that the accident was caused by the pilot forgetting the existence of the wires rather than misjudging their location. The deviation from his accustomed track may well have contributed to such an oversight.

Auster Strikes Tree after Missed Approach at Bankstown, N.S.W.

(6/256/1)

WHILST climbing away on a missed approach following a poor landing, an Auster J5 struck the top of a tree on the western boundary of Bankstown aerodrome and crashed on to the adjacent golf links. The pilot and three passengers suffered minor injuries and the aircraft was damaged beyond repair.

As the aircraft approached for a landing into the north-west the surface wind was 10-12 knots with direction varying between west and north-east. The landing path selected was on the left side of the aerodrome and although not the longest available run it was of ample length and in conformity with aerodrome traffic rules.

During the approach, the wind shifted to the north-east, i.e. 90° to the right of the approach path. The pilot failed to observe the wind change and continued the approach with port drift. The aircraft touched down half-way along the landing path, dropped heavily and bounced back into the air in a steep nose up attitude. The pilot decided that he could not land off the bounce safely and proceeded to carry out a missed approach. In the bounce he allowed the aircraft to veer to the left without correction, and this, together with the port drift, brought the aircraft much closer to a line of trees over which it could have climbed comfortably on the original approach path. The aircraft struck the top of a tree about 30 feet above the ground and approximately 1,080 feet beyond the point of touchdown.

The pilot's total aeronautical experience amounted to 124 hours of which approximately eight hours were flown on Auster J5 aircraft.

The cause of the accident was that the pilot, after abandoning a landing, allowed the aircraft to climb away on an obstructed flight path when a clear path was available.

Fatal "Beat-Up" in DH.82

(6/256/245)

SHORTLY before mid-day on the 19th June, 1956, a DH-82 departed from a field 3¾ miles south-east of Wollum, N.S.W., on a fertilizer spreading flight over a nearby field. On completion of the spreading the aircraft was climbed to a height of

about 2,000 feet above the terrain and two loops carried out. It was then dived low over the loading bay on the landing field and a steep climbing turn to the left commenced. When at a height of about 200 feet, and whilst over the field, the aircraft "flicked" to the left and dived almost vertically into the ground. The pilot who was the sole occupant was killed instantly on impact with the ground.

Eye-witness reports indicated that the aerobatic manoeuvres were carried out below a height of 3,000 feet above the terrain, contrary to Air Navigation Regulation 131 (3) (a). Furthermore, the certificate of airworthiness did not permit aerobatic flight and consequently by flying the aircraft in this manner the pilot also disregarded Air Navigation Regulation 131 (2) (b).

During the steep turn to the left, the aircraft was seen to suddenly roll further to the left, quickly regain a laterally level attitude and then "flick" to the left as the nose dropped suddenly. It then entered a relatively steep dive rolling to the left and continued in this manner until it struck the ground. This behaviour is consistent with a stall and the commencement of a spin.

The pilot held a commercial pilot licence with a total aeronautical experience of 3,100 hours; approximately 800 hours had been flown on DH-82 aircraft with some 500 hours on aerial agricultural operations.

The examination of the wreckage did not reveal any pre-crash defects or evidence of malfunctioning which could have contributed to the accident.

It was concluded that the probable cause of the accident was a lack of care by the pilot in the execution of a steep turn whilst engaged in a "beat-up" at a low height above the terrain.

Cessna 180 Strikes Tree at Low Altitude in Poor Light

(6/256/324)

THE long wet winter of 1956 in New South Wales brought flood conditions to huge areas in the west of the State. Forced by these conditions to suspend agricultural operations an operator took the hoppers out of two of his Cessna 180 aircraft and flew them west in search of charter work in the flooded areas. Soon both aircraft were engaged in dropping fodder to groups of stranded sheep in the flooded Bogan River near Bourke, New South Wales.

In one of these aircraft a station manager acted as dropping assistant so that he could observe the location and condition of his sheep and also regulate the quantities of loose oats dropped. The rear cabin seat and right-hand pilot's seat had been removed from this aircraft to provide sufficient space for five bags of oats and the assistant but no seat, safety harness or static line were provided for his use.

The aircraft was operating from the Bourke aerodrome and the last trip for the day was commenced at 1730 hours E.S.T. (i.e. 16 minutes before sunset) to drop fodder over three flood bound islands at a point some 18 miles east of the aerodrome. To ensure minimum spread of the lightweight grain the runs were flown at a low altitude and speed was reduced to a minimum by applying full flap. The aircraft did a left-hand circuit and came back to drop again on one of the islands, but this time it flew through the top of a tree growing on the island's perimeter and crashed to the ground. The weather was fine and clear at the time of the accident which occurred 2 minutes before sunset. The aircraft was substantially damaged and the station manager seriously injured whilst the pilot received only slight injuries. They had to spend the night on the island and were rescued the following day.

The pilot involved in this accident had considerable experience of low level flying in agricultural operations. It is apparent that, in his endeavour to fly as low and slow as possible, he extended full flap and then reduced speed and height to such a point that he had no margin of performance for emergencies. When the tree appeared in the path of the aircraft, the pilot could not manoeuvre around it and the aircraft did not respond quickly enough to fly over it.

Another important factor in this accident was the condition of natural light. At two minutes before sunset the direct sunlight was striking across the tree tops at a very acute angle, throwing long shadows and making clear definition of tree tops and accurate depth perception most difficult. This was confirmed by re-flying the flight path with the sun in a similar position relative to the horizon. This situation may explain why such an experienced pilot did not appreciate the possibility of collision until it was too late to be avoided even in a lively aircraft such as the Cessna 180. It is considered that the action of the pilot in adopting such a flight configuration at a low altitude in these conditions of light, caused the accident, since he could not then be sure of seeing obstructions to the flight path of the aircraft in sufficient time to avoid them.

DH.82 Overturns in Hillside Take-Off

(6/156/352)

FOR many weeks the weather had prevented superphosphate spreading operations in the Gippsland area of Victoria but on 27th June it dawned bright and clear and a local agricultural operator seized the opportunity to complete an unfinished contract while the weather was suitable. He left Morwell at 0830 hours in a DH.82 aircraft and soon was top-dressing a field near Dumbalk North operating from an adjacent strip. The strip was quite exposed to the elements and after two hours work the wind strength began to rise and some storm clouds appeared in the west.

The wind was blowing across the strip and the pilot ceased operations for a time in the hope that it might abate a little. This it did not do and, as the weather looked more threatening an hour later, the pilot decided to take-off at a suitable moment and return to Morwell, abandoning further operations for that day.

The strip from which the pilot was operating was far from suitable for DH.82 aircraft even under the most favourable conditions. It ran along the top of a ridge of high land but was only 1,170 feet in length or 480 feet short of the minimum length prescribed in A.I.P.'s for a DH.82 at 1,000 feet above mean sea level. The full width of this strip did not exceed 61 feet at any point and, at about mid-length, it narrowed to 38 feet (i.e. less than 4½ feet beyond each wing-tip of a DH.82). The average longitudinal grade between strip ends was 1:16 i.e. 3 times steeper than the maximum grade specified in A.I.P.'s.*

Despite the strip's unsuitability under favourable conditions it was not beyond the capacity of a DH.82 as is proved by the fact that the pilot had carried out some 200 landing and take-off operations on it; in doing so the margin of safety is considered to have been quite unacceptable. However, add to this a cross-wind gusting up to 25 knots and never below 10 knots (maximum permissible cross-wind component is 7 knots for a DH.82) and the pilot was faced with an awkward decision if he was to avoid pegging his aircraft down at such an exposed place in the face of deteriorating weather.

He decided to take-off during what appeared to be a lull in the wind, but could not hold the aircraft on the narrow strip. It swung down the steep slope falling away from the side of the strip and eventually overturned. The aircraft was severely damaged but the pilot escaped unhurt.

In the circumstances the pilot should have abandoned the operations much earlier. His eventual decision to fly the aircraft out was obviously made without an objective assessment of the risks involved. The physical features of the field, the wind and lack of wheel brakes precluded the take-off being abandoned safely once the aircraft began to move. As it was, the wind strength increased sharply during the take-off and being unable to stop, the pilot had to try and keep the aircraft on the narrow strip and endeavour to get it airborne. In the severe crosswind conditions the pilot lost control and the aircraft veered down the steep slope with the pilot still trying to get into the air right up until the time the aircraft overturned. He was fortunate to escape from this accident without injury.

From the evidence it was concluded that—

(a) The landing strip in use did not permit take-off and landing with a reasonable standard of safety.

(b) At the time of the take-off leading to the accident, the wind component at right angles to the take-off path was in excess of 7 knots. The pilot contravened Air Navigation Order 20.1 in attempting to take-off in these conditions.

(c) The strip was so narrow that the pilot had to maintain a most precise take-off track and its downslope was such that, once a take-off was commenced in an aircraft without wheel brakes, it could not be safely abandoned.

CAUSE: The cause of the accident was that the pilot attempted to take-off on this narrow sloping strip in cross-wind conditions which affected controllability of the aircraft beyond safe limits.

* A.I.P.'s—A.G.A.1-4 specify minimum requirements for authorised landing grounds for normal operations. These standards are at present being reviewed in their application to agricultural operations with a view to adapting them to the special nature of these operations.

DH.82 Collides with Wires during Crop-Dusting at Mulgowie, Queensland

(6/356/367)

ON 1st September, 1956, at Mulgowie, Queensland, a DH-82 aircraft was extensively damaged by impact with a tree stump and fallen logs in the course of a forced landing following a collision with electricity transmission wires bordering a field on which crop dusting was being carried out. The pilot, who was the only occupant, was not injured.

The field being dusted on this flight was rectangular in shape, measuring 300 feet by 360 feet and was located on the western side of the Mulgowie road with the minor dimension bordering the road. The road, running north-south, was lined on its western side, i.e. field side, by three electricity transmission wires carried on poles 29 feet high spaced about 300 feet apart, and on its eastern side, by a multiple wire telephone line supported on poles 15-20 feet high. The pilot reported that he had made a ground inspection of the field two days prior to the accident and noted the presence of the wires.

The major part of the dusting operation was carried out in runs north and south, i.e. parallel to the road and wires, leaving two headlands to be covered, one along the north and one along the south boundaries of the field. The pilot commenced to dust the north headland first, making the run from west to east. He stated that he lost sight of the wires ahead of him because of glare from the sun just rising above the surrounding hills. At the end of the run he pulled up believing the aircraft would clear the wires, but it flew through them.

The aircraft structure suffered little damage by contact with the wires but the engine began to vibrate severely apparently due to damage to the propeller. A climb ahead was continued but when rising ground could not be cleared the pilot elected to land up the slope. A three point touchdown was effected without further damage about 500 yards beyond the point of impact with the wires but after running 43 feet the aircraft struck an isolated tree stump which wrecked the starboard lower mainplane. The aircraft then ran into some small fallen tree limbs and came to rest on its nose.

The pilot was the holder of a commercial pilot licence and had flown 1085 hours of which 120 hours were in DH-82 aircraft. His experience as pilot on agricultural operations amounted to five hours fifty minutes.

The accident was assessed as being caused by the pilot misjudging the point at which to commence a pull-up to clear the obstructing wires; a contributing factor was the impairment of his vision by glare from the rising sun, towards which he was flying.

Agricultural DH.82 Trapped in Valley at Timor, N.S.W.

(6/256/141)

A DH-82 engaged in fertilised spreading operations crashed into a hillside whilst turning to fly out of a narrow valley which had been entered at a height that did not permit the aircraft to climb over the surrounding ridges. The pilot, the sole occupant, suffered facial injuries and the aircraft was extensively damaged. The accident occurred at approximately 10.55 a.m. on 8th April, 1956, at Timor, located in the upper reaches of the Hunter River Valley, approximately ten miles east of Blandford, New South Wales.

The area to be top-dressed on this flight was a corner of a field which extended into a small valley formed by steep sided timber crowned ridges. The ridges converge, closing one end of the valley, and give rise to a gradual narrowing of its width and elevation of the floor. In order to ensure that the fertiliser would be deposited within the boundaries of the property being treated, the pilot approached the area at a low height and below the level of the ridge crests keeping close to the right hand side of the valley. Immediately after commencing to stream the load the pilot realized he was heading into a position from which it would be difficult to extricate the aircraft so he operated the dump lever and jettisoned the load. When he was then nearing the rising ground ahead he attempted to escape by turning 130 degrees left but as there was insufficient space to complete this manoeuvre he closed the throttle and the aircraft stalled on to the ground.

The pilot held a current commercial pilot licence. His total experience amounted to 1500 hours, 1459 hours of which were flown on DH-82 aircraft; his total experience in aerial agricultural operations was 1300 hours.

The pilot stated that he experienced a severe down draught during the turn. The existence of some vertical movement of the air is possible but as he described the atmospheric conditions as "wind light, 2-3 m.p.h., calm conditions and very little turbulence" it is most unlikely that a down draught of the magnitude suggested was encountered. In the final stages of the turn the aircraft was heading towards rapidly rising ground and this probably gave the impression that it was descending under the influence of a down draught.

It was concluded that the accident was due to the pilot's error of judgment resulting in flying into a valley at a height which did not afford sufficient lateral space to manoeuvre clear of terrain.

Proctor Collides with Tree during Fatal "Beat-Up"

(6/756/69)

FLOWN by its owner and carrying two passengers a Proctor Mark III collided with a tree while circling the home of some friends of the pilot at Delissaville, a settlement 18 miles south-west of Darwin, Northern Territory. The aircraft dived into the ground some 500 feet beyond the tree and was demolished. The pilot and one passenger were fatally injured and the other passenger seriously injured. The accident occurred at approximately 1725 hours on 24th June, 1956, a few minutes after the aircraft had taken-off from Delissaville to return to Darwin.

The pilot and passengers flew from Darwin during the latter part of the morning. In the late afternoon they returned to the airstrip approximately 1½ miles distant from the settlement. The aircraft took-off and climbed to approximately 150 feet then headed toward the settlement. It was next sighted at about 30 to 40 feet above tree top height in a steep left turn centered on the house visited earlier by the pilot and his friends. The house stands about 100 feet from the edge of a bank forming one side of a gully about 40 feet deep through which a creek flows. A complete turn about the house was made followed by a second turn during which height was dived off until, as the aircraft passed out over the gully, it was below the level of the tops of trees on the banks. Having descended into the gully it was then necessary to climb as the turn progressed to gain clearance over scattered trees in the vicinity of the house.

The aircraft adopted a climbing attitude but almost simultaneously struck the upper limbs of a tree standing on the edge of the bank. Large holes were torn in the port mainplane but the full extent of the damage sustained at this stage could not be determined as the port mainplane was destroyed on final impact with the ground. The aircraft emerged from the tree top in a climbing turn but shortly afterwards the nose dropped and about 500 feet from the tree the aircraft struck the ground with the port wing and nose and was demolished.

The tree struck by the aircraft was one of a loosely spaced group and it is considered unlikely that the pilot failed to see this tree but rather that he misjudged the commencement of the climbing turn.

Weather conditions existing at the time were — wind 4 knots 5/8th-6/8ths high level cloud and visibility 20 miles.

The pilot held a private licence; his total experience was 470 hours, approximately 62 hours of which were gained on Proctor aircraft.

The probable cause of the accident was that while engaged in unauthorised low flying the pilot misjudged his proximity to a tree on his flight path resulting in him commencing evasive action too late to avoid it.

The flight over the settlement of Delissaville being carried out below 1,500 feet above the terrain, was conducted in contravention of Air Navigation Regulation 133 (2) (a).

PART IV

INCIDENT REPORTS

Near Collisions at Cambridge, Tasmania

Twice in a short space of time, airline aircraft came into close proximity with light aircraft in the circuit area at Cambridge.

The following is an account of each incident, and the action taken to avoid a repetition.

INCIDENT 6/156/426 (6/156/426 & 287)

At approximately 0655 hours on the 2nd August, 1956, a DC.3 on short final approach for landing on runway 28 at Cambridge aerodrome, Tasmania, was required to take avoiding action to avoid a collision with a DH.82 which turned on to final approach for runway 28 about 100 yards ahead of and slightly above the DC.3.

The weather was fine and cloudless, visibility unlimited and the wind was light and variable. The DH.82 was the only light aircraft operating at the time and was being flown by a student pilot with a total flying experience of approximately 20 hours. The light aircraft was practising circuits and landings on runway 28 using a left hand circuit direction and at the time of the incident was making its fourth circuit for the period.

At this time the Cambridge controller was responsible for the DC.3 which was descending V.F.R. and making a wide right hand circuit for runway 28, a Viscount which was taxying at Hobart (Llanherne) airport prior to departure for Launceston, another DC.3 which was approaching Ross (the descent point for southbound aircraft) and the DH.82 on circuits and landings. The DC.3 in the circuit area was advised of the presence of the Viscount and the DH.82 and the captain acknowledged this message.

When the DC.3 was in the vicinity of Sorrell commencing a right hand curved approach for runway 28 the air traffic controller sighted the DH.82 turning on to left base for the same runway. A steady red light was directed at the DH.82 and the controller watched the aircraft turn to the right apparently clearing the circuit area in the vicinity of Single Hill. Shortly afterwards the DC.3 requested a clearance to land. The controller looked towards Single Hill but could not sight the DH.82, then in looking back to the DC.3 his field of vision covered what would be a normal left base for runway 28. As no conflicting traffic was sighted, and the approach path appeared to be clear, the DC.3 was cleared to land but was advised that the controller had lost sight of the DH.82. The attention of the controller was then diverted from the aircraft to telephone communications concerning the Viscount departure and to accepting control of a DC.3 over Ross en route to Cambridge. When he next observed the DC.3 on short final the aircraft was approximately three hundred feet above the terrain, and the DH.82 was slightly above and ahead of the DC.3, descending through its flight path. Coincidental with the controller advising the DC.3 of the situation, the captain of the DC.3 turned to the right in a fairly steep turn and carried out a baulked approach. The DH.82 continued the approach and landed.

The captain of the DC.3 stated that the first officer was flying the aircraft which was heading into the sun. When on short final he observed the DH.82 which was on a left base about 150-200 feet above and 20°-30° left of the heading of the DC.3; the distance between the aircraft was then a few hundred yards. The captain thought that the pilot of the DH.82 had the DC.3 in sight and intended to continue an extended base and carry out another circuit passing over the top of the DC.3 The light aircraft was kept in sight but it turned on to final about 100 yards in front of, and slightly above, the DC.3, which was then placed in a rate 1 to 2 turn to the right and a baulked approach carried out.

INCIDENT 6/156/287

At approximately 1345 on the 20th May, 1956, a DC.3 and a DH.82 were involved in a near collision when landing on intersecting runways at Cambridge. Weather conditions at the time were — wind 4 knots from 350°, visibility 30 miles.

The DC.3 was cleared to land from a right hand circuit on to runway 28. The captain had previously been advised of the presence of two light aircraft in the circuit area. During the landing roll, approaching the intersection of the 28/32 runways, the captain saw the DH.82 about to touch down on runway 32. He immediately applied full brakes and at this time was warned by the controller to turn right. The DH.82 passed across a few feet in front of the DC.3.

The DH.82 engaged in local flying completed a left hand circuit and made a very low, powered approach and landed on the 32 runway. This runway was indicated by the direction of the "T" in the signal square. The pilot did not sight the DC.3 until he had actually passed in front of it.

The controller had warned the DC.3 captain of the presence of light aircraft when at the 10 miles north reporting point. Immediately prior to the incident he last saw the DH.82 on a southerly heading in a position to the south west of the airport. The aircraft was not sighted again until it was approaching the south east boundary fence on its final approach. The controller immediately alerted the DC.3 captain by radio.

CAUSE

The cause of these incidents was that the airport control failed to provide adequate separation of aircraft within the control zone.

A contributory cause was the failure of the pilots of the non-radio equipped DH.82 aircraft to maintain an adequate watch for other aircraft.

RESULTANT ACTION

As a result of these incidents the following action has been taken:—

(1) An additional controller has been placed in the tower so that it will now be manned continuously during daylight hours by two controllers. One will be solely responsible for aircraft movements while the other will be responsible for operation and co-ordination of the tower equipment.

(2) Launceston area control will control all aircraft outside a 20 mile radius of Hobart D.M.E.

(3) The control of aircraft by signal lights and the obligations of light aircraft pilots were discussed at length with the local aero club. With its active co-operation more rigid control was subsequently adopted.

(4) Consideration is being given to the painting in a distinctive colour of light aircraft based at Cambridge and other similar airports.

(5) Consideration is being given to equipping with radio the Chipmunk aircraft coming into operation with the local aero club.

(6) Problems associated with the joint operation of Cambridge and Hobart airports have been examined and controllers instructed in the procedures to be adopted.

(7) The general problems associated with the control of light aircraft at all other aerodromes with similar operational conditions to Hobart are currently under review.

An Aerial Agriculture Sulphur Dust Fire

(6/356/534)

Shortly before 0600 hours on the 4th December, 1956, a DH-82 departed from an airstrip near Forrest Hill, Queensland, on an aerial sulphur dusting operation over a nearby field of pumpkins. On departure the aircraft carried approximately 350 lbs. of sulphur dust.

As the second last dusting run was completed the pilot closed the hopper gate and commenced a climbing turn to port. On looking back to observe the result of the application, he saw a large ball of fire just behind the aircraft, at the end of the swath, and at the same time noticed a strong smell

of burning sulphur. The ball of fire vanished quickly and a thin trail of smoke extending from the beginning to the end of the swath was noticed.

Realising that the sulphur dust had exploded, and that the aircraft could be on fire, he immediately carried out a precautionary landing in a lucerne paddock. Examination of the aircraft revealed that sulphur in the spreader and under the deflector plate was smouldering. These parts were douched with water and when the smouldering had ceased the hopper, which still contained some sulphur, was opened and water poured in.

The cause of the dust fire has not been conclusively established. However, the aircraft was fitted with the conventional DH-82 exhaust pipe and thus there is a distinct possibility that the sulphur dust was ignited by the exhaust gases.

Following this incident the Department advised the operator that sulphur dusting operations in DH-82 aircraft should not be carried out unless the aircraft was fitted with a modified exhaust system.

Lightning Strike

(6/656/144)

The captain of an aircraft en route from Adelaide to Perth on the 5th November, 1956, submitted the following incident report:—

> "While descending at approximately 1,200 feet per minute in moderate build-up, the aircraft was struck by lightning. On investigation after landing it was found that the strike had severed the top of the aerial. If lightning has the capacity to achieve this, what would happen if it punctured the skin of a fully pressurized aircraft?"

It is possible for lightning to puncture the skin in pressurized areas of aircraft. However, in all known cases the size of the penetration has been very small, only slightly larger in diameter than a pin-head. From this, and other lightning strike characteristics, it appears most unlikely that a hole in a pressurized position of the fuselage, caused by a lightning strike, would be of serious proportions. Therefore, there appears to be no appreciable hazard in maintaining normal flight conditions provided the pilot is satisfied that there is no indication of an extensive pressure leak. Nevertheless, a wise precaution is to de-pressurize on all occasions and one operating company has issued such an instruction to its flight crews.

The question has also been posed whether or not an aircraft should be immediately de-pressurized following a lightning strike as a means of arresting any subsequent tearing of a lightning strike puncture hole, particularly should it occur in a highly stressed area. In this regard it is a fortunate characteristic of lightning strikes that they almost invariably enter or leave the aircraft via its extremities, i.e., at places that are not highly stressed.

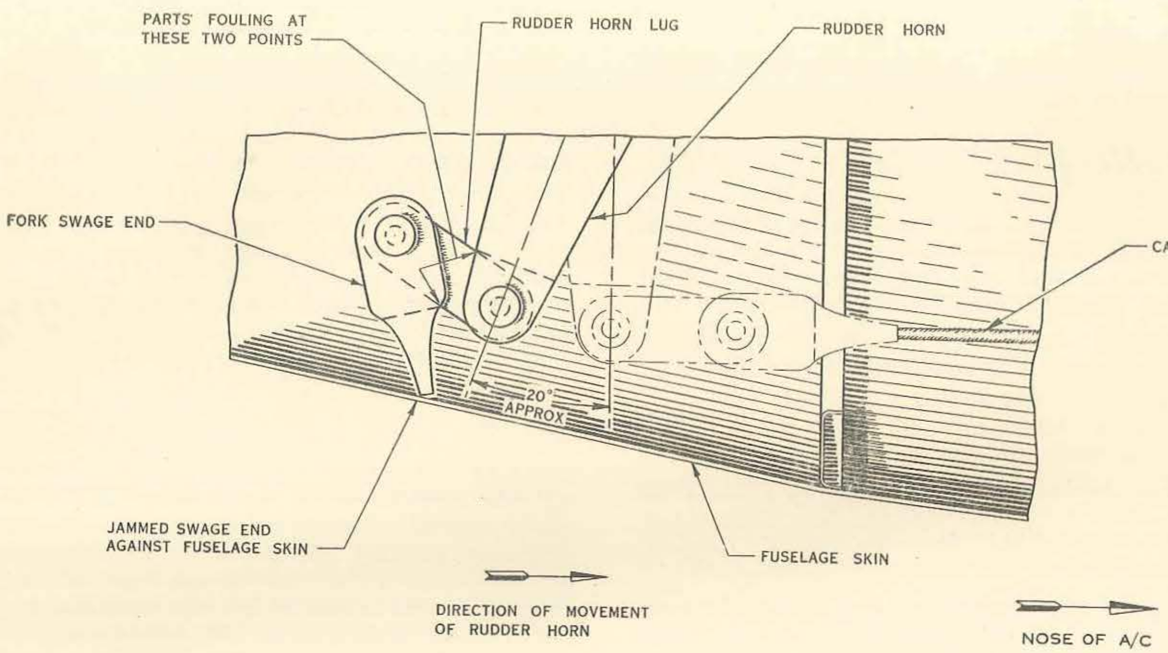
A constant watch is being kept on reported lightning strikes with particular emphasis on the structural damage caused. Never fail to report any significant lightning strike that you experience.

Jammed Rudder During Take-off in DC.3

(6/356/35)

The rudder of a DC.3 became jammed to port during a take-off from Coolangatta Aerodrome. The take-off was abandoned and the aircraft was brought to rest within the length of the runway.

Whilst on the ground at Rockhampton on the previous day, the aircraft had been subjected to severe buffeting during a storm, with winds up to 70 m.p.h. At this time the control surface chocks were out and the aircraft was occupied by the crew, who were awaiting the passing of the storm, before departure for Cairns. The crew report that they were unable to fully restrain the control surfaces. Despite the severe buffeting the crew did not check the control system before departing for Cairns. On arrival at Cairns the captain reported the buffeting to the company's engineer at that port, who carried out an inspection of the control system and found that the bottom rudder hinge attachment bolts and the rudder check cables were broken. This had evidently occurred whilst the aircraft was on the ground at Rockhampton. The company engineer, who is a licensed maintenance engineer, replaced the rudder



DIAGRAMMATIC SKETCH SHOWING RUDDER HORN LUG, AND FORK SWAGE END JAMMING BETWEEN RUDDER HORN AND FUSELAGE SKIN.

hinge attachment bolts but no check cables were available at Cairns. The company's chief maintenance inspector for Queensland, who is based at Brisbane, was then contacted and his approval was obtained for the aircraft to proceed to Brisbane without rudder check cables. Thereupon, the engineer at Cairns cut the broken cables off the fork swage ends but did not remove these ends or the rudder horn lugs, to which the fork ends are attached, from the rudder horn (see accompanying sketch). On the following day, the aircraft flew via several ports to Brisbane where the chief maintenance inspector cleared the aircraft to proceed without the cables to its home base at Melbourne. The jamming of the rudder occurred at the next port of call.

In the absence of the cables, the rudder horn lug and the fork swage end were free to pivot around the end of the rudder horn. Examination of the aircraft after the incident revealed that they had moved in this fashion when the rudder was displaced to port, so that they jammed between the horn and the fuselage skin and prevented the rudder being returned to the central position (see sketch). That is, the jamming of the rudder was caused by the right hand rudder horn lug and fork swage end, from which the cable had been disconnected, jamming between the rudder horn and the fuselage skin.

This incident resulted directly from the failure of the engineer at Cairns to remove or secure the rudder horn lugs and fork swage ends after removing the check cables. He did not know from previous experience or training that where these components are disconnected from the cables they can jam the rudder, and he stated that at the time he carried out the work it was not apparent to him that this could occur. Whilst the configuration of lug, fork end and horn necessary to achieve jamming of the rudder is not readily apparent, as can be seen from the sketch, it is considered that, as a licensed maintenance engineer, he should have been able to appreciate the possibility of this jamming from a proper inspection. Apart from this aspect, his action in leaving the lugs and fork ends loose at the ends of the rudder horn was contrary to good engineering practice.

The company's chief maintenance inspector at Brisbane was not aware that the lugs and fork ends were not removed at Cairns

and no inspection of the system was carried out at Brisbane when the aircraft passed through that port. In regard to this latter aspect, in view of the buffeting the aircraft received and the work carried out at Cairns, it would have been prudent for him to inspect the control system when the aircraft arrived at Brisbane before clearing it to continue to Melbourne without check cables. It is considered, therefore, that he must share the responsibility for this incident.

At the time of the incident Air Navigation Order 105.1.0.2.5 (Issue 2) stated that, where an aircraft is subjected to winds exceeding 35 knots whilst on the ground when the gust locks are not engaged, and the control surfaces have not been effectively restrained by a person in the cockpit, the control system shall be inspected before further flight. This A.N.O. is not issued to pilots and its contents were not in any document with which the pilot is required to be familiar. Nevertheless, in view of his report to the engineer at Cairns, which indicates his concern over the buffeting the aircraft received, the pilot in command of the aircraft at Rockhampton, displayed poor airmanship in not checking the control system carefully before departing from Rockhampton. In this regard a thorough pre-flight check of rudder control movement will reveal broken check cables through the increased rudder bar travel and a different "feel" at the extremity of rudder bar movement.

Arising out of this incident the company's operations manual and maintenance procedures have been reviewed, and Air Navigation Order 105.1.0.2.5 has been amended to require the inspection of control surface attachments as well as control surfaces, when aircraft on the ground have been exposed to buffeting from high winds. Other action is in hand to include in all DC.3 operations manuals instructions regarding rudder check cable inspections.

Aircraft Overloading

EAGER BEAVER

During take-off from Wassi Kussa, Papua, New Guinea, the pilot of a Beaver floatplane decided that the aircraft was overloaded and discontinued the take-off after attaining a speed of 30 knots. On checking it was found that the aircraft was heavily overloaded.

The Beaver was operating a shuttle service between Wassi Kussa and Morehead carrying in oil drilling equipment which had been flown to Wassi Kussa by Catalina. A manifest of the cargo to be uplifted by the Beaver was not available, but as operations had already been delayed 24 hours he decided to accept verbal advice that the total weight of the load amounted to 705 lb. The cargo consisted of many small heavy pieces of metal equipment and it absorbed less than one quarter of the volumetric capacity of the freight compartment. However, it was subsequently discovered that the weight of the load was 1,405 lb. which resulted in the aircraft being overloaded by 587 lb.

Action was then taken to ensure that in the future all freight would be clearly labelled to show the correct weight of the particular item.

OLD FAITHFUL

A regular public transport DC.3 was scheduled for a flight from Lae to Garaina carrying a cargo consisting of lengths of iron girder to be used in the erection of a tea factory at Garaina. The pilot was assured by the company traffic officers that the load was within limits and that all the girders were numbered, their weight known to the pound, and each girder was mentioned on the manifest by its number. However, the take-off and climb performance of the aircraft indicated that the aircraft was definitely overloaded. The approach into Garaina was made at a speed of 10 knots higher than usual and the landing was completed without incident.

On checking off the load at Garaina it was found that it consisted of 42 items and not 40 as shown on the manifest. Also, the weight of only 11 of the 42 items coincided with the entries on the manifest. In addition the basic weight of the aircraft stated on the load sheet was incorrect as no allowance had been made for extra radio equipment which had been installed. It would appear that the all-up weight of the aircraft at the time of take-off was 29,092 lb. and not 26,200 lb. as indicated by the loadsheet.

This flight was one of a number of similar trips being undertaken by the company, the cargo consisting of many steel girders of various lengths, sizes and weights. In order to facilitate loading, and also to prevent overloading, numerous complete loads were weighed and stacked in separate heaps. When preparing these loads each piece of material was weighed separately and numbered.

It would appear that in this instance the traffic officer responsible for the loading was called away on other duties after 2,620 lb. had been loaded. The relief traffic officer then loaded a further 7,029 lb. without bothering to check the full load. He then handed the pilot a load manifest which bore little relation to the actual load being carried.

This incident resulted from poor supervision of the loading operations by the traffic officers and a lack of care in checking the load carried against the manifest and in compiling the load sheet. The company issued appropriate instructions to personnel concerned to ensure that there was no repetition of this incident.

The incorrect basic aircraft weight stated on the loadsheet was brought about by the use of various radio configurations in the company's fleet, the configuration depending on the type of service being conducted. In this incident, the loadsheet indicated that the radio configuration was as required for an internal flight but, in fact, the aircraft was fitted out for inter-island operation which resulted in the carriage of 47 lbs. of equipment additional to that normally carried on an internal flight.

Comment

Particular care on the part of persons engaged in the loading of aircraft — and this includes pilots — together with rigid adherence to specified loading procedures is the only effective way to prevent incidents of this nature.

Double Engine Failures

(6/756/78)

During the past three years there have been five reported cases of flights by Australian airline aircraft during which two engines were inoperative at the same time. Four of these incidents involved four engine aircraft and one a twin engine aircraft; in the latter case both engines were restarted after a short period.

The most recent incident involved a Super Constellation en route from San Francisco to Honolulu. On this flight No. 1 engine was shut down because of an extensive oil leak. Whilst returning to San Francisco, No. 3 engine was stopped following a fire warning. The first warning came on when a cylinder barrel lifted and fractured an exhaust manifold. The pilot decided not to restart No. 1 engine because of the risk of fire from oil which may have accumulated around the engine and cowlings. The descent into San Francisco was continued on two engines without further incident.

It is noteworthy that of the five reported cases the incident just described is the only one in which the need to stop two engines was confirmed by the subsequent investigation.

In two of the remaining four cases there was an actual engine failure, but for reasons primarily associated with crew technique, a second engine was also closed down although it was operating normally. Another incident involved the voluntary stoppage of two engines when the oil capacity had reached the minimum prescribed in company instructions for continuous operation. Subsequent investigation of this incident revealed that the in-flight minimum oil quantity prescribed was greatly in excess of that actually necessary for continued safe operation. At the time the engines were shut down, there was ample oil available for the flight to have been continued to the next stopping place without the engines being stopped. The publication of the incorrect oil minimum arose through an administrative error.

In the last case, which involved the twin engine aircraft, the engines cut completely because the crew failed to take proper action to keep the carburetters free from ice; before these engines returned to normal operation the aircraft lost 2,500 feet of altitude.

Comment

In three of the latter four incidents described, the circumstances in which they occurred gave the crews sufficient time to detect their errors and rectify them. In slightly different circumstances any one of these three incidents may well have resulted in an accident. Mistakes such as these have been the primary cause of many serious accidents throughout the world in scheduled operations.