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AVIATION SAFETY DIGEST

No. 29 MARCH, 1962

DEPARTMENT OF CIVIL AVIATION

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No. 29 MARCH, 1962

Prepared in the Division of Air Safety Investigation,

Department of Civil Aviation.

Contents

Commonwealth of Australia

Accident to DC. 4 at Brisbane

(All times are expressed in Eastern Standard Time based on the 24 hour clock)

At 0229 hours on 24th May, 1961, Douglas DC.4 aircraft VH-TAA under the command of Captain P. J. Norriss with First Officer N. K. Adams and with 12,309 lbs. of freight and mail aboard, departed Sydney for Brisbane on the final stage of a regular freight service from Melbourne to Brisbane. The route flown was via West Maitland, Point Lookout and Casino at cruising flight level 90. At 0425 hours when the aircraft reported 30 miles south of Brisbane Airport it was given landing information by Brisbane Tower. Nine minutes later, when the captain reported that he had the field in sight, the aircraft was observed by the airport controller. At 0441 hours when the aircraft had not landed, it was found that communication with it had been lost. The wreckage of the aircraft was located 2 hours 15 minutes later on Bulwer Island in a position 2.5 miles north-east of Brisbane Airport. The impact had occurred in a tidal mangrove covered mud flat, both crew members had lost their lives and the aircraft had been destroyed by impact forces.

THE AIRCRAFT

Douglas DC.4 aircraft VH-TAA was owned by the Australian National Airlines Commission and operated by Trans Australia Airlines, Melbourne, Victoria. At the time of the accident the aircraft was engaged on a regular public transport freight service, designated by the operator as Flight 1902, which was scheduled to commence at Melbourne at 2230 hours on 23rd May and to arrive in Brisbane at 0500 hours on 24th May.

The aircraft was manufactured by the Douglas Aircraft Co., U.S.A., in 1946 and had been operated and maintained by Trans Australia Airlines throughout the whole of its life of 46,006 flying hours. During the last 2½ years of its life the aircraft had been used almost exclusively for the carriage of freight between major airports in Australia. Apart from the removal of the passenger seats and buffet equipment and the installation of plywood panels to protect the interior of the structure, no major modifications were made to the aircraft in its conversion for freight - carrying operations. It was powered by four Pratt and Whitney R2000-D5 engines each developing 1450 b.h.p. and driving three-bladed Hamilton standard hydromatic propellers. No unserviceabilities in the aircraft were reported by the crew at Sydney and there was no evidence of any unserviceabilities developing subsequently in flight. All the required maintenance inspections had been carried out and were correctly certified.

The aircraft had operated for 4,576 hours since the last complete overhaul. With two minor exceptions all mandatory modifications for Douglas DC.4 aircraft had been carried out and all the installed components of the aircraft were operating within their approved periods of service. It was determined that the two minor irregularities did not in any way contribute to the accident.

HISTORY OF THE FLIGHT

VH-TAA departed Melbourne at 2254 hours on 23rd May. The flight to Sydney was conducted on the prescribed route via Canberra at cruising flight level 90 and the aircraft landed at Sydney at 0048 hours on 24th May. The aircraft was on the ground in Sydney for 99 minutes in which time it was refuelled, the load was revised, the crew had a meal and completed the pre-flight requirements for the flight to Brisbane.

The aircraft was flown in fine, clear weather conditions between Melbourne and Sydney, and before departing for Brisbane, Captain Norriss obtained a meteorological briefing at the Sydney Avmet Office. The forecast indicated that en route weather conditions would again be fine with no cloud or turbulence at the planned cruising flight level 90. In the Brisbane terminal area smoke haze was expected with a visibility of eight miles and a ground wind of 6 knots from the south-west.

Only a slight trace of cloud at 5,000 feet was forecast. The actual weather encountered at Brisbane was not significantly different from that forecast for the area.

The flight plan submitted and approved at Sydney prior to the aircraft's departure indicated that the aircraft would take 129 minutes to reach Brisbane following the prescribed track via West Maitland, Point Lookout and Casino. The fuel computations indicated that the aircraft's endurance capacity would be sufficient to provide for the flight to Brisbane and a further 3½ hours cruising flight or 4½ hours of holding before fuel exhaustion would occur.

At 0227 hours the aircraft took-off on runway 16 at Sydney and set course at 0229 hours climbing to flight level 90. Position reports were received as the aircraft reached West Maitland, 80 DME West Maitland, Point Lookout and Casino. None of these reports contained any hint of unusual circumstance which might have affected the operation of the aircraft. The aircraft, still at flight level 90, reported reaching Casino at 0406 hours and gave its estimated time of arrival at Brisbane as 0435 hours. At this point a clearance for the descent from cruising level was issued by Brisbane area control but since there was no conflicting traffic, the terms of the clearance only embraced the tracking and terrain clearance requirements.

At 0425 hours VH-TAA called Brisbane tower on a frequency of 118.1 mc and reported its position as being 30 miles from Brisbane by reference to Distance Measuring Equipment (DME). The airport controller on duty authorised continuance of the descent, nominated runaway 22 for the landing and provided the information that the wind was 5 knots from the south and the altimeter setting (QNH) was 1023 mbs. A further report when the airport was in sight from the aircraft, was requested. At 0434 hours, when the airport controller received a report from the aircraft "field in sight" he observed its navigation lights, aparently in the normal position for such a report, and cleared the aircraft to make a visual approach to the runway reporting again when on base leg of the circuit. The acknowledgement of this clearance was the last transmission heard from the aircraft.

The airport controller expected the aircraft to land at approximately 0440 hours and, when no report had been received by this time he began to search visually for the aircraft. Being unable to see the navigation lights in the circuit area or on the ground he called the aircraft on 118.1 mc at 0441 There was no response and the distress phase of search and rescue procedures was instituted at 0443 hours. At 0656 hours the wreckage of the aircraft was located by a searching aircraft on Bulwer Island which is situated in the Brisbane River. The accident had occurred at a point 1.65 miles on a bearing of 081 degrees magnetic from the threshold of runway 22 at Brisbane Airport (see Fig. 1).

INVESTIGATION

The Accident Locale

Brisbane Airport is situated four miles north-east of the city of Brisbane on a flat plain two miles from the coast and its southern boundary is skirted by the Brisbane River, within which Bulwer Island is situated. The island is uninhabited and the aircraft had crashed onto a tidal mud flat densely covered with mangrove trees (see Fig. 2). The airport is seven feet above mean sea level and its density altitude at the time of the accident was minus 360 feet.

Both runways at Brisbane airport are equipped with low intensity, omni-directional lighting. The radio-navigation aids available at Brisbane consist of a visual-aural range (V.A.R.) transmitting on a frequency of 110.9 mcs., distance measuring equipment (D.M.E.) on a frequency of 206/224 mcs., an approach localiser serving runway 22 transmitting on a frequency of 109.9 mcs. and a non-directional beacon (N.D.B.) transmitting on 216 kcs. All of these radio navigation aids are located on the airport and were functioning correctly at the time of the accident.

Wreckage Examination

Attempts to operate vehicles into the accident site for the removal of components were unsuccessful because of the nature of the surface. The early activity was, therefore, concentrated on acurately establishing the configuration of the wreckage and raising the movable components above the level of the peak tides which were expected to cover the area three days after the accident. All of the components required for testing or for workshop examination were ultimately extricated by manhandling or, in the case of heavier items, by winching the components on specially constructed sleds across mud areas cleared of mangrove vegetation. Although the extremely difficult condition of soft mud and dense mangroves at the accident site (see Fig. 3) was accentuated by tidal action and by heavy rain the early precautionary action taken was successful in that the engineering conclusions were unhampered by salt water corrosion, by weathering or by an unpremeditated disturbance of the wreckage.

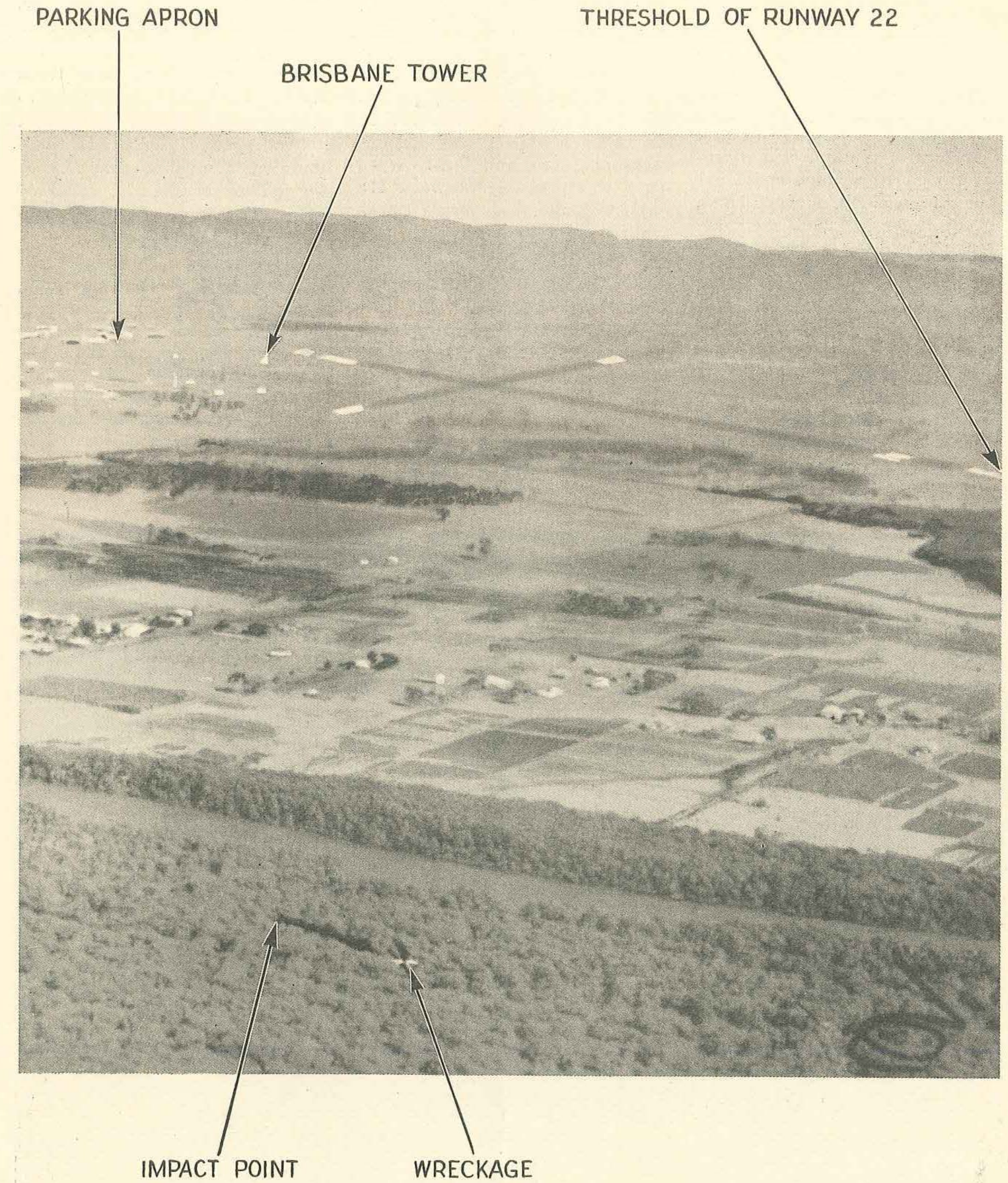


FIG. 1.

Although the whole of the aircraft was accounted for at the accident site, a most thorough examination of the wreckage, functional testing of as many components as lent themselves to this process and exploration of a wide range of possible system or structural faults failed to reveal any matter which could explain this accident. Nevertheless, a great number of facts were established which, in the overall pattern of the investigation either served to exclude or to lend support to the possible explanations of this accident.

The functional state of the aircraft immediately prior to the impact was established with a reasonable degree of certainty. The undercarriage and wing flaps were in their fully retracted positions whilst the landing lights were extended but not switched on. All four propellers were rotating but none of the engines were delivering power. The heading of the aircraft at the time of impact was 358 degrees magnetic and the forward speed was probably between 115 and 125 knots. The aircraft was banked some 10 degrees to port and the flight path angle was approximately seven degrees below the horizontal. This evidence carries no suggestion that there was a complete loss of control in the aerodynamic sense prior to this accident.

All major components were located in the area of the principal impact and there is no evidence of any structural failure, fire, explosion or of any other event which would have affected the integrity of the aircraft in flight. There is no evidence to suggest that any of the flight control systems were not functioning correctly or that any of the hydraulic, electric, radio or other systems required for safe flight were not capable of normal operation. The most significant feature in this area, perhaps, was the evidence that all electrical and radio systems had been disconnected from the aircraft's electrical power sources prior to the impact by movement of the emergency disconnect switch, which is located in the cockpit overhead panel.

FIG. 2.

A most careful examination of the engines and propellers together with their associated control systems and the ignition, fuel and lubrication services has failed to reveal any circumstances which might have prevented the crew from utilizing up to full power on all four engines. Uncontaminated fuel of the correct grade was found in the fuel lines leading to the fuel feed valve where fuel enters the induction section of the engine and it is apparent that, with the propellers windmilling, some fuel must have been circulating through all four engines. It was concluded, however, that all four of the engine ignition switches were probably in the OFF position at the time of impact.

The aircraft's flight deck was very severely damaged in the impact (see Fig. 4), so that practically no significant information was obtained from the cockpit dial indicators and only corroborated evidence can be accepted in respect of the positions of most cockpit controls. Both crew seats were also severely damaged and had separated from the floor. First Officer Adams' body when found was still strapped into the right hand seat which had been adjusted prior to the accident to the lowest available position and fully forward. Captain Norriss' body was found some 5 feet from his seat, the belt of which was in the unfastened condition. The chair had been adjusted prior to the impact to the second lowest avaliable position and, although the fore-and-aft adjustment could not be reliably determined, it is probable that it was positioned against the aft stop at the time of impact.

The Aircraft Load

The cargo consisted of 11,151 lb. of mixed freight comprising some 400 items and 1,158 lb. of mail in 51 bags. Relatively little damage occurred to the cargo in the impact although in the sudden deceleration it shifted forward in bulk breaking the tie-down ropes and displacing the forward cabin bulkhead.

At the time of the accident it was estimated that the all-up-weight of the aircraft was 58,771 lb. which is 4,729 lb. less than the maximum permissible landing weight for Brisbane.

A load distribution sheet was compiled at Sydney prior to the aircraft's departure and the aircraft's centre of gravity was established as being within permissible limits. Because of the major disturbance of the load in the impact it was not possible to confirm the accuracy of the load distribution sheet other than for arithmetic correctness.

Crew History

Captain Patrick James Norriss was 45 years of age and his total flying experience amounted to 13,019 hours of which 11,367 hours had been gained in command including 378 hours in command of DC.4 type aircraft. In September, 1960, having satisfactorily completed all the necessary training requirements, he was promoted to Captain on DC.4 aircraft. On 19th March, 1961, Captain Norriss satisfactorily completed a flight proficiency check on a DC.4 aircraft and this was his last check prior to the accident. He held a current First Class Airline Transport Pilot Licence and a First Class Instrument Rating.

First Officer Noel Keith Adams was 25½ years of age and his flying experience totalled 3,132 hours which included 821 hours of command experience gained on DC.3 and Convair 440 aircraft and 406 hours as first officer on DC.4 aircraft. He was employed by Trans Australia Airlines in June, 1960, and two months later, on completion of the necessary engineering and flying training, he was issued with a Second Class Airline Transport Pilot Licence endorsed for DC.4 type aircraft. First Officer Adam's last flight proficiency check on a DC.4 aircraft was in January, 1961, and this was completed to a satisfactory standard. At the time of the accident his Second Class Airline Transport Pilot Licence was current and he also held a Second Class Instrument Rating.

The Flight Path

VH-TAA arrived over Brisbane 1½ hours before the beginning of daylight with a clear sky and no moon. There was no evidence of any circumstance existing in the Brisbane area at this time which might have presented any abnormal hazard to the safe operation of the aircraft.

Evidence was obtained from 17 witnesses who saw the aircraft during the last six miles of its flight. A further 28 people who heard the aircraft in the Brisbane area shortly before the accident also gave evidence. A series of simulation flights were conducted in Brisbane in order to test the reliability of the observations made by the significant witnesses and to crystalise the conclusions which might be drawn from this evidence. It is apparent that the track followed by the aircraft in the vicinity of Brisbane Airport involved no significant departure from the track normally followed by aircraft arriving from the south and carrying out a visual left-hand circuit for a landing on runway 22 (see Fig 5).

From the evidence of the eye-witnesses and the results of the simulation flights it was also posible to deduce some facts as to the profile of the aircraft's flight path in this area. It seems that although the aircraft entered the circuit area and turned on to the down-wing leg at the normal height of 1,000-1,200 feet, the impact occurred only three miles beyond this point. The aircraft came under the notice of a number of eyewitnesses during the last 1½ miles of its flight primarily because it was abnormally low and continuing to descend with little engine noise apparent. Although the precise point at which the descent below normal circuit height commenced has not been established from the witness evidence, the range was narrowed to a small segment of flight path 1½ miles in length. Special test descents at idling engine power were conducted in a DC.4 aircraft similarly loaded and the results of these tests point to the probability that the descent of VH-TAA commenced 1.8 miles short of the impact point assuming this was the power condition which pertained. All possible commencing points within the established range succeed the point at which the last transmission was made from the aircraft.

Although no evidence was available from the aircraft clock or from the crew watches it was deduced from the witness evidence that the impact probably occurred between 0436 and 0437 hours. This proposition implies that the aircraft was four miles south of the airport and five miles from the impact point when the "field-in-sight" report was given to the airport controller. It was determined beyond reasonable doubt that this transmission, which seems to have been quite normal in every respect, was made by Captain Norriss as were all the previous transmissions from the aircraft during the flight from Sydney. Having regard to the normal division of cockpit duties on this flight it is most probable, therefore, that the aircraft was being flown by First Officer Adams during the approach to Brisbane Airport.

The general picture of the final flight path which can be drawn from the evidence therefore is one of an aircraft entering the Brisbane circuit area in a perfectly normal manner. To all external appearances the height, entry point, speed, engine power and lights displayed were consistent with normal operating practices. The aircraft was under control and was steered into the circuit pattern without any hint of an imminent disaster. However, from a position on the down-wind leg approximately opposite the mid-point of runway 22, the aircraft commenced a steady but high-rate descent with little or no engine power being delivered. The descent path was quite similar to the expected power-off glide path for this type of aircraft but it apparently remained under adequate aerodynamic control right up to the point of impact. In the final stages of flight there is some evidence that the aircraft was banked to port and turned left some 40 degrees from the down-wind heading. There are several possible explanations of this circumstance but it occurred at such a low height that it can only be regarded as incidental to the acident.

Medical Evidence

There is no evidence in the medical history or in the post-mortem examination of First Officer Adams to suggest that he was or was likely to have been incapacitated by any pathological condition or that his physical and mental responses were affected by any circumstance occurring in this flight. His death was due to an injury sustained in the impact. With one exception it may also be said that the medical history of Captain Norriss contains no evidence which might be significant in the consideration of this accidet. It was found, however, in the post-mortem examination that his death was due to a cardiac failure arising from a condition of myocarditis or inflammation of the heart muscle. The injuries sustained by Captain Norriss in the impact were not such that immediate death would be expected from these injuries alone.

No obvious cause for the myocarditis was found in this instance but it was of relatively recent onset and would have been virtually impossible to detect during life.

The cardiac failure arising from this condition may have occurred before or after impact and the premonitory symptoms of the attack may range from none at all to a vague feeling of discomfort for any period up to 30 minutes before the attack followed by breathlessness or coughing for a short period of minutes prior to the cardiac failure. In the circumstances of this accident it is perhaps most significant that the attack can occur at any time without warning and can involve an almost immediate loss of consciousness. It is also significant that, if there was any period of time between the onset of the attack and the loss of consciousness, one of the measures adopted for relief might be the undoing of the safety belt or the pushing back of the seat or both these actions as well as an attempt to stand up.

There is some evidence that only two months prior to this accident. Captain Norriss was observed to become distressed by minor exertion. The medical evidence is insufficient to establish whether this was symptomatic of the condition which ultimately caused his death. The last electrocardiogram examination undertaken by Captain Norriss was in September, 1960 and it was quite normal but the condition of myocarditis cannot be detected in this form of examination. Captain Norriss is not known to have suffered any ailment likely to have generated or accelerated the condition. There is no evidence that the crew's performance was affected by fatigue and the medical opinion is that fatigue cannot be associated with Captain Norriss' heart condition or with the time at which the heart failure occurred.

Although the medical evidence was insufficient to establish conclusively whether Captain Norriss died before or after the impact it was the opinion of medical specialists that the relatively minor degree of haemorrhage was very slightly suggestive of cardiac failure before the impact. The medical evidence left no doubt however that the captain suffered a cardiac failure and it pointed strongly to the conclusion that this was the cause of his death.

ANALYSIS

In considering the cause of this accident there are three fundamental conclusions arising from the evidence on which to focus —

(a) Although the aircraft was fully airworthy and, in the engineering sense, capable of being operated normally, it struck the ground with no engine power being delivered and with some crash/fire precautions having been taken.

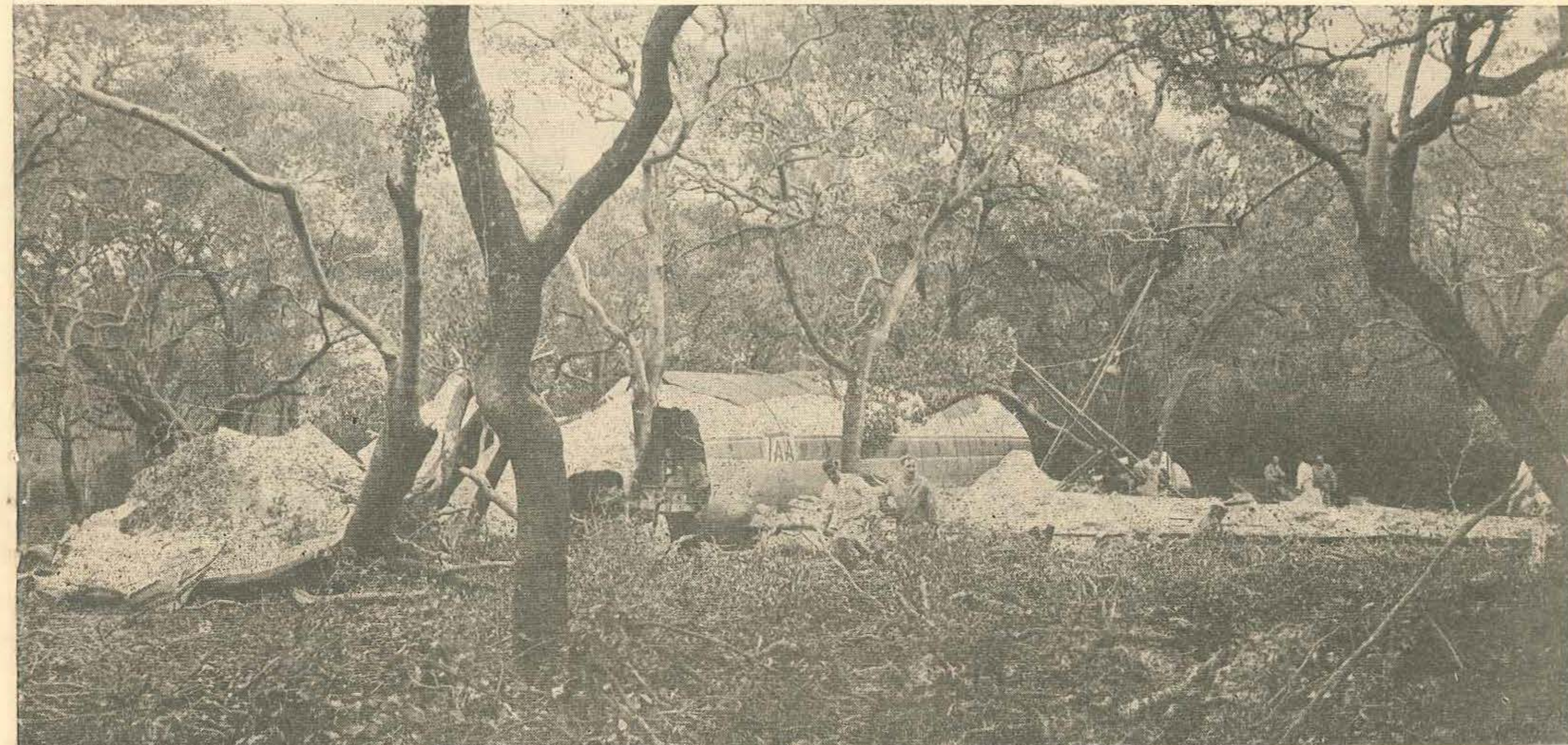
(b) The aircraft was operating normally until it reached the mid-position of the down wind leg where a rapid power-off descent was commenced and continued without loss of aerodynamic control until the accident occurred.

(c) The captain's safety belt was not fastened at the time of the impact and he had suffered a cardiac failure.

Although the fundamental engineering conclusion contains no complete explanation of this accident, it does contain two very significant points. It is clear that no power was being delivered by any engine at the time of impact although there was no engineering reason why full power on all four engines could not have been utilised by the crew right up to this point. This fact has added significance because it supports the witness evidence of a descent with no audible engine noise. It is also clear that the aircraft was prepared for the impact at least to the extent that all electrical power and ignition were switched off. This is significant because it dispels any view that neither member of the crew were aware of the seriousness of the situation which the aircraft had reached. Furthermore, it shows that, although there was no means in the time available of overcoming the emergency situation which had arisen, at least one member of the crew was still capable of rational action. The proposition that the aircraft remained under control in the aerodynamic sense during this descent is also consistent with this view.

A wide range of hypotheses was examined in an endeavour to advance an operational reason to explain why an aircraft would

FIG. 3.



suddenly enter a rapid but apparently controlled descent on the downwind leg of a visual circuit and strike the ground without there being any evidence of recovery action. There is no support for the proposition that this was a landing approach on to an illusory runway since there were no lights in the immediate area of the impact and the undercarriage and flaps were not extended. It is also highly improbable that any reference to inadequate visual cues or any misreading or malfunction of the altimeter deceived the crew as to the real height of the aircraft since it passed over a large and brightly illuminated oil storage depot at a height of some 300 feet only ¾ mile before impact. A simulation of the flight path in similar circumstances showed clearly that this was a dominant and unambiguous point of reference. The evidence of preparations in the cockpit for the impact supports the view that the crew were well aware of the dangerously low height which had been reached.

FIG. 4.

A wide range of emergency situations which might have induced loss of control, errors of judgment or serious distractions sufficient to cause this accident was examined and, in each hypothetical situation, it was found that the proposition either ran contrary to the evidence or was unsupported in any way. It is most difficult to envisage any emergency situation arising at this point in the preparation for landing which would induce the crew to avoid using engine power, either in the recovery action itself, or, in the last resort, to avoid an accident, unless that emergency itself involved the complete loss of power on all four engines.

Consideration of the fundamental medical conclusion alone also afforded no ready explanation of this accident. Accepting the probability that the captain's death occurred suddenly in flight, the presence of a competent and experienced first officer should have been an adequate safeguard against an accident of this nature. There is no suggestion that the first officer was also incapacitated but there is little doubt that a sudden collapse by the captain would have induced a major distraction of his attention for some period. The evidence that aerodynamic control of the aircraft was retained and that it was prepared for the impact indicates that this distraction did not persist for sufficiently long to cause the accident.

In the light of all the evidence it is entirely reasonable to believe that this accident was associated with events arising from the heart attack suffered by Captain Norriss. The evidence that his seat belt was unfastened and that a premonitory symptom of the attack might be a desire to stand up for some relief led to a consideration of the ways in which collapse of the captain could deprive the first officer of the ability to utilise engine power. After discussion and experiment a quite feasible mode of collapse which would have just this effect became clear. It envisages the captain moving his seat to the rear, unfastening his seat belt, standing and turning half-right in the normal actions to leave the seat and then collapsing across the engine control console with his body falling so as to bring all throttles to the fully closed position and moving all pitch control levers towards the full fine position. The experiments also confirmed that, with a body in this position, it would be impossible for the first officer to remove the obstruction so as to regain engine power control without leaving his seat and abandoning control of the aircraft for an intolerable period of time. There would also be some forward pressure on the control column from the captain's legs which could be overridden without difficulty by the first officer but, nevertheless, would be sufficient to cause nose down pitching if counteracting pressure was not continuously applied.

It seems that the period within which the collapse of Captain Norriss must have occurred can be narrowed to the half minute or 1¼ miles of flight path between the turn on to the down-wind leg and the mid-position of this leg where the abnormal descent commenced. The fact that Captain Norriss himself gave the field in sight report only four miles south of the airport indicates that there was little or no warning of his collapse. This is completely consistent with the range of possibilities described in the medical evidence. The proposition of a collapse in this segment of the flight path also introduces a logical explanation of the undercarriage and flaps being in their retracted positions at impact. The evidence indicates that the emergency situation arose at or prior to the aircraft reaching the mid-downwind position. In the known circumstances of this aircraft's approach to the airport it could not be expected that the undercarriage would be extended until after this position had been passed.

Although the first stage of flap extension is often taken prior to this point it is by no means unusual for this action to be delayed until a later point in the flight path is reached when there is no excess height or speed to be lost. It is entirely reasonable to assume, therefore, that the emergency arose before the extension of either flaps or undercarriage had been caried out and, in view of the nature of the emergency which is postulated, it could not be expected that the first officer would take these actions subsequently.

The mode of collapse envisaged offers a complete explanation of the otherwise inexplicable evidence, that this descent occurred without engine power being applied at any time. It is compatible with the evidence that, in the engineering sense, this power was available at all times. It explains why no feathering action was taken despite the apparent lack of power and it clarifies the apparent resignation of the first officer to the inevitability of an accident as is reflected in the actions to switch off the electrical power and engine ignition before the impact. It is compatible with the evidence that the aircraft remained under control throughout the descent and it gives a ready explanation of the fact that no emergency call was made on the radio. If both crew members had been competent to jointly deal with the emergency which arose, the first officer, during the 55 seconds which the descent would occupy, would have had time to give some indication to the airport controller that an emergency existed although it is by no means certain that he would do so. If the first officer was obliged to cope with this emergency alone, however, he could not be expected to make any transmission in the time available.

Another feature of the evidence which puzzled the investigators until this proposition had been developed was the fact that the landing lights were in the extended position at impact and yet even the closest eyewitnesses denied that they were illuminated at any time during the descent. It is most difficult to conceive of any pilot attempting a crash landing at night on unknown terrain without, at some point in the descent, using the landing lights to gain some appreciation of the terrain or to select the most favourable terrain within the usable area. The landing light extension and illumination switches for this aircraft are situated in the ceiling panel immediately above the captain's position and they cannot be reached by the first officer whilst he is in his seat with the belt snugly fastened. It is entirely feasible that the lights were extended by Captain Norris when he was capable of doing so earlier in the approach so that they would be ready for immediate use when required for the normal landing. The fact that they were not subsequently used despite a pressing need can only be attributed to the fact that the captain was then incapable of actuating the switches and the first officer was unable to take the steps necessary to reach them.

Several other possible ways in which the operation of the aircraft might have been affected by the captain under the influence of a disordered cardiac function were also examined. It is concluded that the evidence did not admit any possibility that a physical collapse by Captain Norriss could have affected any other engine controls such as the mixture levers or the fuel tank selector levers so as to produce the known circumstances of the final flight path. It has been shown by experiment to be extremely unlikely that any mode of collapse in or from a seated position, even with the safety belt unfastened, would affect control of the aircraft or of the engine power in a manner consistent with the evidence in this accident. The investigators have also considered the possibility of irrational behaviour in the premonitory stages of his cardiac failure, being a causal factor in the accident. This hypothesis was not supported by any evidence and it is difficult to believe that any irrational act affecting the operation of the engines could go unnoticed or could remain long undetected by the first officer. There was no evidence of any confliction between the captain and the first officer in the control of the aircraft and it is considered that the possibility of irrational behaviour by Captain Norriss cannot be supported

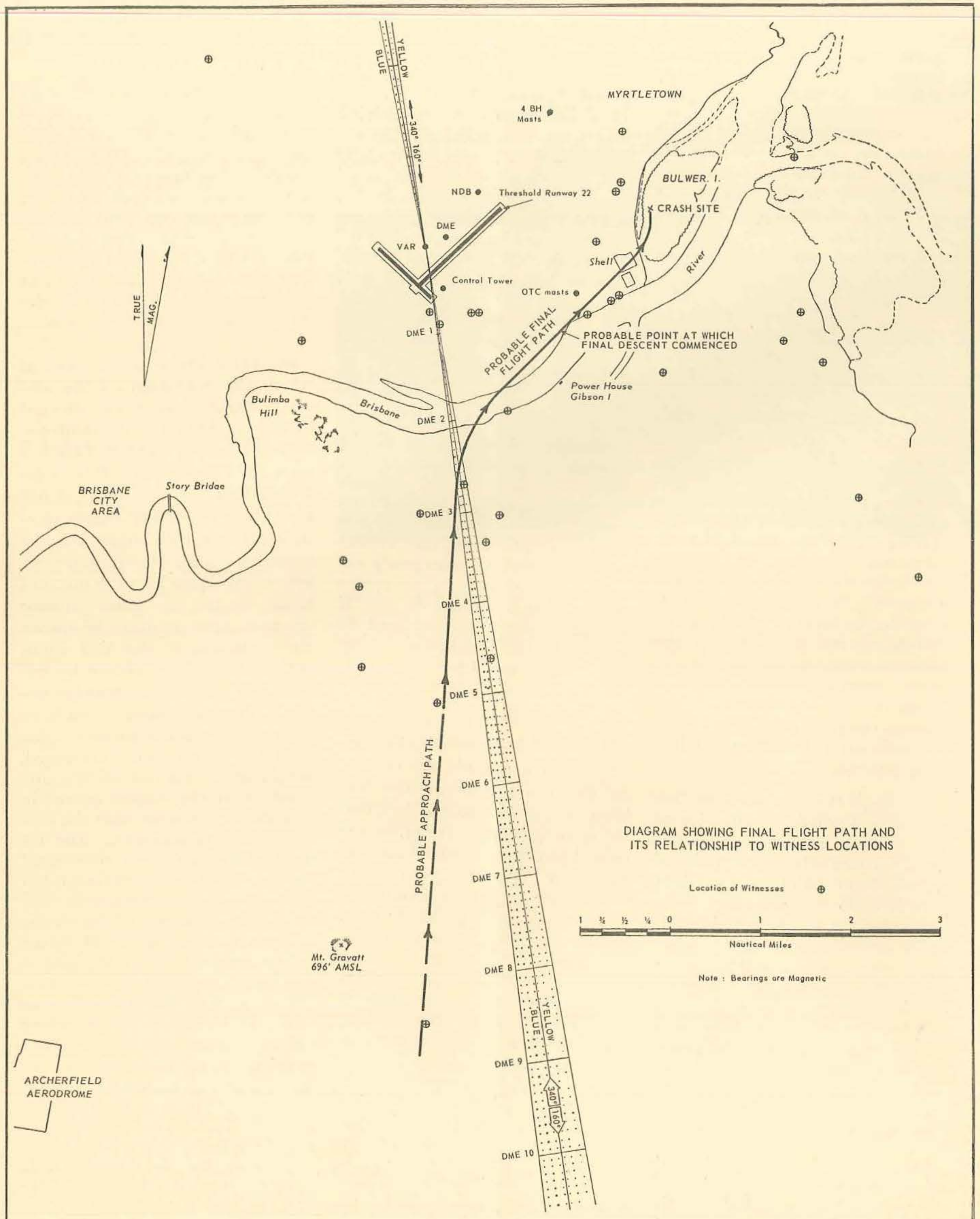


Fig. 5.

as a significant factor in this accident.

The opinion formed as to the cause of this accident was only reached after careful examination of a wide range of hypotheses. None of the alternative explanations were acceptable in the light of the firmly established evidence and none of them were supported so strongly by circumstantial evidence as was the view that Captain Norriss' heart failure occurred on the down-wind leg of the circuit and that his collapse deprived the first officer of all engine power. This proposition in turn provided a reasonable explanation of some items of evidence which could not be explained in any other way. Some minor variations of the accepted mode of collapse are equally feasible but they all involve closing of the engine power levers and the forming of a complete obstruction to their further movement. There was no suggestion in the evidence that Captain Norriss, whilst in normal health, undertook any action likely to endanger his aircraft and it is probable that First Officer Adams, without warning, was presented with an emergency situation which was beyond the capacity of one person alone to rectify under the circumstances. The evidence points to the fact that he took action to minimise the dangers of the imminent impact.

CONCLUSION

The available evidence points to the probability that this accident was caused during the pre-landing circuit when Captain Norriss endeavoured to leave his seat under the influence of a disordered cardiac function and, in the course of so doing, collapsed across the engine control console in such a way as to bring all four throttle levers to the closed position depriving First Officer Adams of the throttle movement necessary to avoid a crash-landing off the airport.

Can You Handle It?

Last winter the pilot of a Beaver aircraft attempted a "go-round" from an approach to a strip situated at an elevation of 2,900 feet. The engine did not develop full power when the throttle was opened and the aircraft struck sloping ground beyond the strip. The pilot and his passenger were not injured but the aircraft was substantially damaged.

Having completed a day of agricultural operations at a country property, the aircraft was flown to a field near a town at which the pilot intended to spend the night. An into wind approach was commenced towards the west but this was abandoned because of glare from the sun and a second approach was commenced into the east. When over the threshold the pilot decided that he was too high and elected to "go round". The throttle was opened and the flaps pumped to the take-off position and it was then realised that the engine was not developing full power. The aircraft flew just above the ground but could not be climbed away and when it had flown beyond the strip, it passed through two wire fences. The pilot then cut the engine and with the wheels on the ground the aircraft ran through three more fences, crossed a road, at which point the undercarriage was broken off. Yet another fence was breached and the starboard wing struck a telegraph pole whilst the aircraft was sliding 350 feet before coming to rest in a shallow swamp.

The investigation revealed that the pilot had obtained his Beaver endorsement only some seventeen days prior to the accident and his experience on the type was very limited. He was not aware of the recommended mixture temperature range for the engine and immediately prior to the accident the mixture was approximately 9 degrees Centigrade below the minimum recommended temperature. An inspection of the engine failed to reveal any defect which may have resulted in a power loss but as weather conditions at the time were conducive to carburettor icing it was concluded that this was the probable reason for the loss of engine power.

From the evidence available it appears that the Beaver endorsement training had been inadequate in that the engine operating limitations were not sufficiently stressed. Apart from this it would seem reasonable to expect a pilot with aeronautical experience in excess of 4,000 hours to have made it a personal responsibility to familiarise himself with the engine characteristics. Apparently this was not done.

When training for endorsement on a new type of aircraft, remember that it is not sufficient to be able to perform smooth take-offs and landings. Engine handling is of equal importance and if ignored power may not be available when most needed.

Boeing 707 Wheels-Up Touchdown

NEW YORK, U. S. A.

At 2049 hours on 9th May, 1960, a Boeing 707 crashed "wheels up" at New York International Airport. Eight of the 100 passengers received mild injuries during evacuation and the aircraft sustained major damage as a result of contact with the runway and ensuing fire.

Summary based on the Report of the Civil Aeronautics Board, U.S.A.

The aircraft which was engaged in a regular flight departed from Los Angeles at 1606 hours. The flight was routine and approaching the New York area the aircraft was descended in preparation for an instrument approach to runway 22L at Idlewild. Approach control established radar contact with the flight and vectored it to intercept the localizer course of the I.L.S. about three miles north-east of the outer marker. The flight was given the latest wind and altimeter setting and advised that the glide slope was inoperative. The weather at the time was given by the tower as ceiling measured 400 feet variable broken, 700 feet overcast; visibility four miles in fog; wind from the south at 15K; altimeter setting 29.49.

The captain testified that the trip from Los Angeles had been routine. Descent was made on instruments in the New York area in accordance with instructions from New York centre and Idlewild approach control. He said that they had been cleared to make a localizer approach, that they intercepted the localizer about two miles outside of the outer marker at an altitude of 1,500 feet, and that the aircraft was being operated in accordance with all prescribed instructions. He testified that the ILS approach was completely normal; airspeed was maintained constant at reference plus 10 knots (141K); rate of sink was maintained between 500 and 700 feet per minute; and that the aircraft was on the localizer from the outer marker almost all the way down. The captain testified that he identified the outer marker by the ADF's and the flashing marker beacon light on the instrument panel but that the audible signal for the marker beacon had been turned off. He said the aircraft was being flown on autopilot; that it was on the "localizer feature" of the "automatic coupler", and that he was controlling the altitude by use of throttle. The captain said that he did not recall "hitting" the middle marker and "did not note anything that was other than the normal."

The captain further testified that the autopilot was operating properly and that there were no heading changes made during the approach but that approximately two-thirds of the distance from the outer marker to the runway, while the aircraft was on the localizer, the autopilot, for unknown reasons, disengaged.

The captain further testified that he established visual contact with the runway shortly after the autopilot disengaged. At that time, he said the aircraft was about 100 feet to the right of the runway and between 500 and 1,000 feet from the threshold at an altitude of approximately 400 feet. After dropping full flaps he had to "S" the aircraft to line up with the runway. Approximately half way down the runway and at an altitude of "about 50 feet or perhaps less" he said he decided to abandon the landing and go around. He advanced the power to approximately 2.0/2.30 EPR and gave the command for 30 degrees of flaps and for the gear to be raised. He also said that at the time the command was given to raise the gear the aircraft was to the best of his knowledge in a climbing attitude. When asked if the aircraft was climbing he replied, "We were on the runway."

The captain said he did not see the approach lights during the approach. Then, in answer to a question of what possible factors could have contributed to his "overshoot", he said, "one, no approach lights. Two, no glide path. Three, the automatic pilot became disengaged prior to the threshold of the runway." It might be noted here that the runway lights, narrow-gauge lights, centreline lights, and the high-speed taxi lights are operated from a panel in the control tower cab. Included in the control panel is a monitoring system which indicates by a warning light and buzzer if any one of the lanes is not operating properly. Testimony of the tower personnel indicated that all the systems were in operation and no outages or failures in the systems were indicated.

The captain stated that immediately after touchdown he heard the landing gear unsafe warning horn and immediately closed the throttles. The aircraft settled to the runway and slid to a stop with all three landing gears retracted. He said there was a fire warning signal for engines Nos. 2 and 3 and that he cut off the start levers with the exception of No. 3 which was jammed. He saw that the first officer had started to activate the fire bottles in Nos. 2 and 3 engines but he did not observe whether the bottles were actuated.

The first officer testified substantially the same as the captain that the flight approach into the New York area was completely normal.

He stated that the approach speed of the aircraft was constant from the outer marker inbound at reference plus 10K. Also that the rate of descent was normal; approximately 500 feet/min.

He testified that he noted passage of the outer marker by the ADF needles but could not see the flashing marker beacon because it is located on the other side of the cockpit. He also testified that he did not identify the middle marker because they were contact before reaching it. He said, "I say we were contact better . . . half a mile from the end of the runway or a little better and this is purely judgment." He then stated that the middle marker was located five-tenths of a mile from the end of the runway. (The location of the middle marker for runway 22L is actually six-tenths nautical miles from the runway threshold.)

He also said that just before becoming contact he "sensed" the aircraft had started a slight right turn and out of the corner of his eye he could see the automatic pilot disengage warning light flashing. This warning light is located on the lower left side of the centre instrument panel. It is below and slightly to the right of the airways marker beacon light.

Visual contact was established two or three seconds later and, according to the first officer, the aircraft was about 150 feet to the right of the runway centre-line and at an altitude of 450 feet. He said Captain Campbell lined the aircraft up with the runway and continued the approach. He could not estimate the altitude of the aircraft as it crossed the threshold but did say it was approximately 50 to 75 feet in the air and halfway down the runway when the captain initiated a "go-around". He said the captain told him they were going around, applied power, and ordered 30 degrees of flaps and gear up. He further stated that upon the captain's order he raised the flap handle to the 30 degree position, noted that the indicator began to move, and then raised the landing gear handle to the up position. He said he did not know whether the aircraft was still descending when he raised the gear because he was occupied with checking the flap and gear indications and was not looking out of the cockpit.

He stated that the landing gear warning horn did not sound until the aircraft contacted the runway. As the aircraft slid to a halt the fire warning sounded for engines Nos. 2 and 3. He stated that he armed the fire selectors for these engines but that as he was about to actuate the extinguisher all electrical power went off the aircraft.

After the aircraft came to rest, evacuation of the passengers was accomplished quickly but with some difficulty. The left front passenger loading door was opened by the captain and first officer and the emergency chute was lowered. It would not inflate so the captain, first officer, and two male passengers descended to the ground and held the chute secure. About 25 or 30 persons left the aircraft by this exit.

Firefighting equipment arrived at the aircraft promptly and immediately extinguished fires which had developed on engines Nos. 2 and 3.

INVESTIGATION

All structural damage to the aircraft resulted from the aircraft sliding along the runway on its fuselage belly. Examination also revealed that the damage sustained by the Nos. 2 and 3 powerplants was the result of this contact with the runway and the ensuing fire. Powerplants Nos. 1 and 4 were undamaged. As a result of crew testimony and examination of the engines, all four were determined to have been capable of normal operation prior to the accident.

All the aircraft systems were checked and found to be operating normally. In addition, no evidence could be found to indicate a malfunction in the autopilot.

The aircraft was equipped with a flight recorder which was operating properly during the accident. The tape covering the last portion of the flight was read and found to contain rather significant information. Airspeed was found to have been about

All times herein are GMT.

165K at the outer marker inbound. It then increased to about 170K, for a period of about one minute. It then began to decrease to approximately 141K at the middle marker; then to about 128K at the first point of touchdown.

The acceleration trace indicated slight turbulence throughout the approach and a series of heavy accelerations at runway contact with several indicated peak loads of 3.2 and 4.2 gs.

The heading trace from the outer marker inbound was extremely erratic. The aircraft heading varied almost 30 degrees during the approach.

The altitude recording and rates of descent calculated from it were also very significant. The aircraft crossed the outer marker at an altitude of about 1,200 feet. Its rate of descent during the next minute was approximately 100 feet per minute. The rate of descent then increased to about 1,200 feet/min. and the aircraft descended to about 650 feet. The descent continued at a much lesser rate for a short period and the aircraft then began a gentle climb as it reached the vicinity of the middle marker. Shortly after this the aircraft was again dived at a rate of at least 1,000 feet/min. until it contacted the runway.

The captain had logged flying time in excess of 27,000 hours of which approximately 750 hours were in the Boeing 707. The first officer had accumulated a total of 15,765 hours with 867 hours in the Boeing 707.

ANALYSIS

Nothing was found during the investigation of this accident which would indicate a failure or malfunction of the aircraft, its powerplants, or systems. In addition, the crew members stated that the flight had been routine and that no discrepancies or malfunctions had been encountered. The flight recorder was also found to operate normally subsequent to the accident. It was also recalibrated and found to be accurate within tolerances prescribed by civil air regulations.

No substantiating evidence was found to indicate a malfunction in the autopilot or to account for its disengagement as reported by the captain. Even so, the alleged malfunction should not have affected the captain's ability to continue his approach successfully. By the captain's own testimony the aircraft was on the localizer centreline when the disengagement occurred. The copilot stated that he sensed a slight right turn and this is the only indication of any deviation for the flightpath as a result of the reported disengagement. The Board cannot therefore attach any significance to a malfunction such as was reported.

As for the captain's testimony concerning the three factors cited to account for his overshooting the runway, the Board cannot agree that these should have had any serious adverse effects on the completion of a properly executed instrument approach. The malfunction of the autopilot has been discussed above. In addition company regulations prohibit use of the automatic pilot for a coupled instrument approach when no glide slope is available.

The captain's allegation that the approach lights were not in operation appears to be unfounded. No outage was recorded and numerous aircraft had made similar aproaches immediately preceding this flight. Also, although the Board does not downgrade the importance or usefulness of approach lighting systems it does believe that this approach should have been completed successfully even without such assistance. Even though the sky was overcast it was daylight and there was adequate light; visibility was about four miles. Further, the crew stated the runway was visible immediately upon breaking out of the clouds.

The captain was well aware that no glide slope was available on this runway and should have set up a constant rate of descent which would have brought the aircraft down its approach so as to break out of the overcast at the proper point. If the captain had felt that executing an instrument approach without a glide slope was not completely safe, then his only action should have been to proceed to his alternate where a safe approach could be made.

The flightpath of this aircraft from the outer marker inbound was extremely erratic. It is difficult to believe that the autopilot was ever even engaged unless it was malfunctioning all the way down the localizer. Heading changes of more than 20 degrees and rapid altitude changes such as are evidenced from the flight recorder readout could not have occurred unless this were true. However, the crew was unanimous in stating that no malfunction occurred prior to the disengagement two-thirds of the way down the approach. Further, these extreme readings were not a result of a malfunction of the flight recorder as it operated normally after the accident. From this evidence it appears that the aircraft was flown by hand or that it was on autopilot but being controlled by the pilot by means of the autopilot turn and pitch controllers. All the evidence indicates a lack of competency in the equipment and a lack of instrument proficiency.

With a properly executed approach, this aircraft should have broken out of the overcast at an altitude of approximately 400 feet (about 20 seconds), or almost eight-tenths of a mile, before reaching the middle marker. At this point the runway would have been visible and the landing could have been made successfully. It is obvious to the Board that the approach was not executed in this manner.

Immediately upon breaking contact it should have been obvious to the crew that the aircraft was too high and too close to the runway and that the approach should have been abandoned. From the position described by the captain, a flightpath of 21 degrees from the horizontal would have been required to land at the beginning of the runway. From the position described by the copilot, a flightpath of about nine degrees would have been required. A normal approach would result in a glidepath of around 2-4 degrees.

It is also evident that the captain continued his approach despite the fact that he was at an altitude of about 275 feet over the threshold. If it was not obvious to the crew that a go-around would be necessary when they first became contact, it most certainly should have been evident when they crossed the threshold at this extreme height.

In spite of this the captain continued his approach until approximately one-half of the runway was behind him. Then at an altitude of about 50 feet he initiated a go-around. Again the technique employed by the captain indicated a complete lack of proficiency with the equipment. The captain advanced the power levers, called for 30 degrees of flaps, and gear up. Instead of applying takeoff thrust, as called for in the go-around procedure, he advanced the throttles to approximately 2.0/2.3 EPR. At 125K this would result in about 12,450 pounds of thrust per engine. Under the conditions existing on that day the take-off power setting of 2.55 EPR would have been available, which would produce 14,730 pounds of thrust. Actually the aircraft's performance at 2.30 EPR would be good and a go-around possible; however at 2.55 EPR it is probable that less altitude would have been lost during rotation to climb attitude and before a positive climb would have been effected.

It is also apparent that the captain did not make certain that a positive rate of climb had been established before ordering the landing gear retracted. This is a specific requirement in the go-around procedure and is spelled out in the operations manual. In addition, it is just good common sense to make certain the aircraft is not going to touch down before retracting the landing gear.

Inasmuch as a normal go-around is not an emergency, the normal procedures set out in the aircraft manuals should be followed. The co-pilot who actually performs the duty should make certain the aircraft is climbing and will not touch down before he moves the gear handle. He has a responsibility in the safe operation of the aircraft and should at least call to the attention of the captain any dangerous situation of which he is aware. It appears to the Board that the co-pilot, as well as the captain, should have been aware that the aircraft was not climbing out when the gear was retracted. The duties the co-pilot was performing were not so arduous as to prevent him from ensuring that a positive rate of climb had been established.

PROBABLE CAUSE

The Board determines that the probable cause of this accident was a poorly conducted instrument approach necessitating a go-around which was initiated too late and improperly executed.

OBSCURED VISION

Before taking off on a private flight in a DH.82 the pilot made sure that his passenger's goggles were in position. He failed to ensure that his own were securely positioned and as the aircraft gathered speed during take-off, they slipped down obscuring his vision. Result—One overturned DH.82. It's as simple as that—**but avoidable.**

Stopping Under Adverse Conditions

(Extract from Pilots Safety Exchange Bulletin)

(The article "Stopping Under Adverse Conditions" originally appeared in the Boeing Airliner, a publication of the Boeing Co. While it and the accompanying charts apply specifically to 707 and 720 airplanes, the information is generally applicable to all jet transport aircraft. Even though jet operations in Australia are confined to one operator the article has been included in the Digest because many of the points made are of equal validity to other operations.)

Adverse weather conditions at a destination airport have contributed to several landing incidents in which a jet transport has either partially lost directional control and veered to the side of the runway or has gone beyond the end of the runway. Since adverse weather can affect a number of factors during a landing, it is important to the safe and efficient operation of jet aircraft for pilots to know how to —

1. Operate the airplane during the approach in a way that will minimize stopping requirements after touchdown without running the risk of landing "Short". These are "in-the-air" factors.

2. Stop the airplane in the shortest distance when the runway is wet, short (runway remaining from point of touchdown), or icy. These are 'on-the-ground" factors.

Obviously it is more difficult to stop an airplane within the available runway if it touches down 20 knots over the recommended touchdown speed. A number of other factors, such as excessive height over the threshold, glide path angle, drag and lift configuration, and gross weight also affect stopping requirements. Many of these factors are within the control of the pilot. Once on the ground, stopping distance varies with the co-efficient of friction between tyres and runway surface, timing and technique of braking action, operation of thrust reversers, and control surface handling technique. An analysis of these air and ground factors will enable operating personnel to fully utilize the maximum stopping ability of the airplane under whatever conditions may be existing during a landing. In the accompanying charts, total landing distance is defined as the measured distance from the point at which the airplane is at a height of 50 feet with an airspeed of 1.3 Vs (Vs = stall speed) to the point where the airplane is stopped (Fig. 1). The total landing distance should not be confused with the handbook landing field length which is greater and is used for planning.

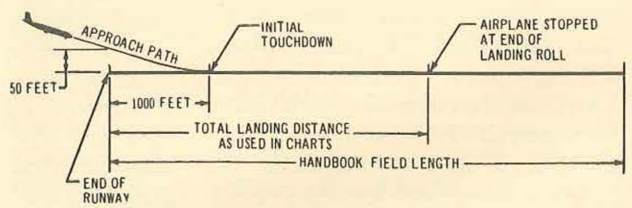


FIG. 1 — Defined distances and nomenclature used in the text. Total landing distance is based on a reference condition where the airplane is 50 feet over the end of the runway and touches down 1000 feet from the end. The term, total landing distance, should not be confused with handbook field length which is used for planning.

With so many factors affecting total landing distance a meaningful analysis can only be made by holding all other factors constant while varying the one factor. This method of analysis will not achieve any absolute values, but it will show trends. Once these trends are understood, they can be compared to determine which of the factors are most important and which are negligible.

(Trends for the factors which affect landing are shown in Figs. 2 through 6. Although these curves where drawn specifically for 720 aeroplanes they also apply to 707 aeroplanes when allowances for gross weight differences are applied.)

IN-THE-AIR FACTORS

Aeroplane handling by the pilot during the final approach can affect the total stopping distance, but pilots should be warned against trying to touch down near the end of the runway. Aiming at a touchdown point 1,000 feet from the end of the runway will still provide sufficient distance to bring the aeroplane to a stop. Landing short of the runway can have even more serious consequences than overrunning the end at low speed. Floating just off the runway surface for several thousand feet before touchdown must be avoided, as this procedure uses up a large portion of the available runway. If the aeroplane should be over the recommended speed at the point of intended touchdown, deceleration on the runway is about three times greater than in the air. Therefore, in such a case, the aeroplane should be set on to the runway as near the 1,000 foot point as possible rather than allow the aeroplane to float in the air to bleed of speed.

Approach velocity differences affect total landing distance in accordance with the trends in Fig. 2. Consider an aeroplane that would normally approach at 130 knots and require a

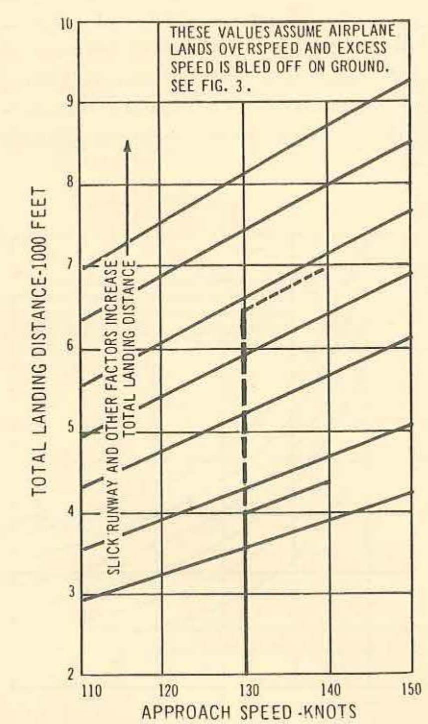


FIG. 2 — Trend lines for effect of varying approach speeds on landing distance. Example lines show how to use different trend lines when other conditions, such as slick runway, high approach, or other variables change landing distance from 4000 feet to 6500 feet.

normal landing distance at 4,000 feet. With other conditions constant, flying over the threshold with 10 knots excess speed at 140 and touching down 10 knots over-speed would increase total landing distance only 350 feet. If this 10 knots excess speed is bled off in the air before touchdown, landing distance will be increased by about 1,200 to 1,500 feet. See Fig 3. Under slick runway conditions, if 6,500 feet total landing distance would be required at an approach speed of 130 KIAS, coming in at 140 knots and touch down 10 knots overspeed would increase distance by 500 feet in accordance with the dotted lines shown in Fig. 2.

Height of the airplane over the end of the runway also has a very significant effect on total landing distance. The relatively steep trend lines of Fig. 4 show this effect for a range of glide slope paths. This chart indicates a change in total landing distance directly. For example, flying over the end of the runway at 100 feet altitude rather than 50 feet could increase the total landing distance by 950 feet on a 3-degree glide path. This change in total landing distance results primarily because of the length of runway used up before the aeroplane actually touches down. Glide path angle also affects total landing distance as shown in Fig. 4. Even while maintaining the 50 foot height over the end of the runway, total landing distance

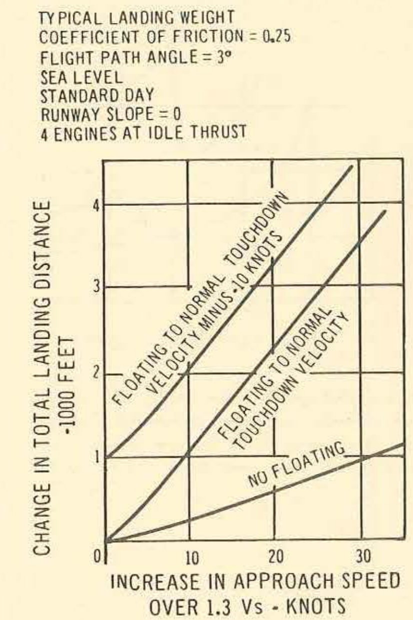


FIG. 3 — Floating before touchdown penalises landing distance. Bleeding 10 knots below correct speed in air before touchdown increases landing distance by 1000 feet. If approach is 10 knots overspeed, floating and touching down on speed uses 1100 feet compared to 350 feet if deceleration is on runway rather than in air.

is increased as the approach path becomes flatter. A combination of excess height over the end of the runway and a flat approach uses up runway in a hurry. Glide path angle is a function of pilot technique and best results will be obtained at a normal ILS glide slope angle.

Usually a wet or slick runway condition is accompanied by adverse weather conditions. Under these conditions an unsatisfactory approach may cause the aeroplane to run off the runway. If weather should contribute to a poor approach, pilots should be prepared to make an early decision to go around rather than touch down far beyond the 1,000 foot aim point and run the chance of overrunning the end of the runway.

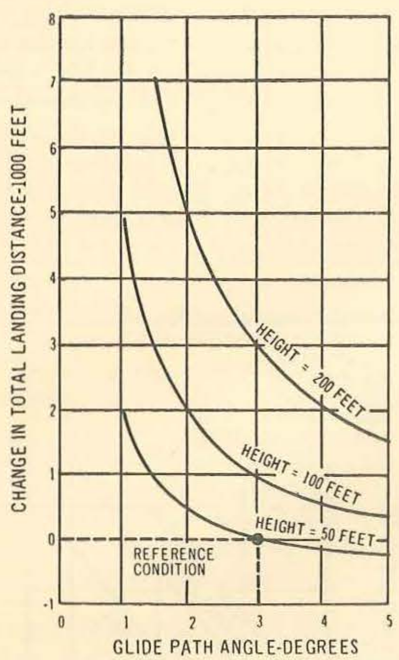


FIG. 4 — Flat glide slope path and excessive height over end of runway combine to extend landing distance required due to runway used before touchdown. Reference conditions call for 50 feet over threshold while on 3 degree glide slope path.

ON-THE-GROUND EFFECTS

Regardless of a pilot's technique in the air, the aeroplane must still be brought to a stop on the ground. Here again, pilot technique and the conditions existing at the airport affect the total landing distance.

Probably the most important factor that affects total landing distance is the coefficient of friction between tyres and runway surface. This coefficient is a result of many variables, such as tyre tread design, runway material, water or ice cover on the runway, air temperature, and rolling speed of tyres. A normal effective coefficient of friction on dry concrete may be expected to vary between .25 and .30. On icy runways at temperatures near 32 deg. F., tyre friction may drop as low as .05. The range can be considerable, and the effects of these variations are shown in Fig. 5. It can be seen from this chart that landing distance can be significantly increased when a runway is covered with water and/or ice with other conditions constant.

Two related factors, coefficient of lift (CL) and coefficient of drag (CD), during the braking roll also affect landing distance even though the aeroplane is on the ground. Basically, the CL is constant for any specific aeroplane at the same configuration. However, aeroplane attitude and speed brake deflection affect CL. Keeping the nose wheel off the ground, for example, produces a higher angle of attack for the wing than if the nose gear is rolling on the runway. This higher angle of attack develops lift and prevents the brakes from working to their full capacity, regardless of the condition of the runway. Therefore, immediately after touchdown, the nose wheels should be lowered to the runway and held there positively until taxi speed is reached. Speed brakes increase drag and lessen or "spoil" wing lift and, therefore, affect CL during landing. Aeroplane drag is not increased by keeping a nose-high attitude on the ground during landing roll.

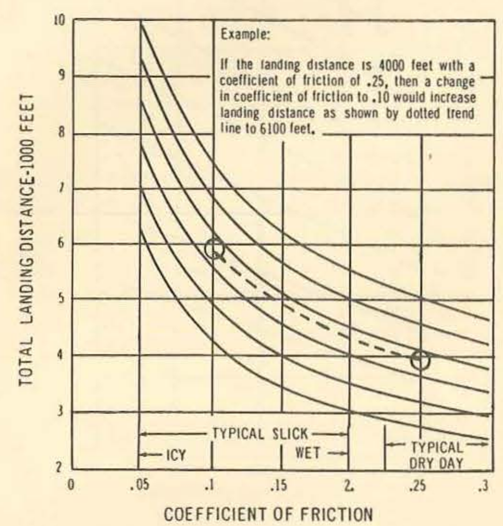


FIG. 5 — Trend lines for coefficient of friction show increase in stopping distance on wet or icy runway surfaces. Trend lines show only effect of friction. Which trend line used must be determined from length of runway required by variation of all other factors that affect distance.

Coefficient of Drag (CD) affects landing distance in accordance with the chart in Fig. 5. The major change in CD over which a pilot has control is speed brake position. The effects of reduced lift and increased drag are additive in shortening landing distance.

Thrust reversers can be used to shorten the stopping distance once the aeroplane is on the ground and, thereby, shorten the total landing distance. By operating the thrust reversers at published limits during normal operation from touchdown to 60 knots indicated air speed, significant reduction in landing distance can be achieved. Fig 6 (based on 60 knots cutoff) indicates how much of a reduction in landing distance is possible under the stated conditions. Normally, ingestion of exhaust gases may cause engine surging if thrust reversers are continued in full use at speeds below 60 knots. Partial reverse thrust can be used until taxi speed without ingestion.

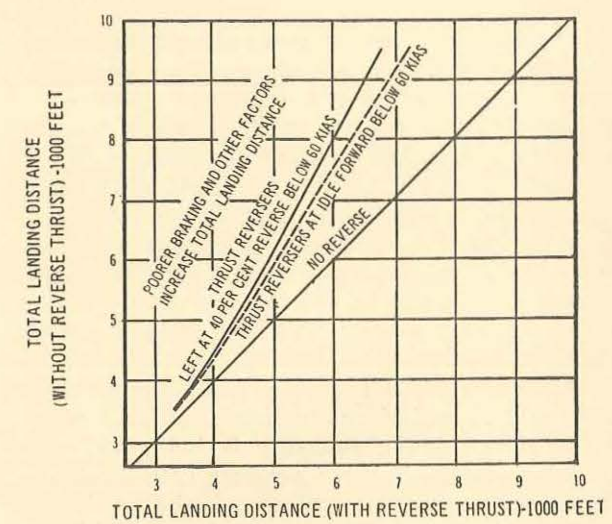


FIG. 6 — During normal landings, thrust reverses can reduce landing distance by differing amounts depending on whether thrust reverses are left in reverse or in idle when cut off below 60 knots. During emergency conditions, thrust reversers can be used below 60 knots, but effect on landing distance varies according to usage.

Transition time between touchdown and brake application affects total landing distance in accordance with the chart in Fig. 7.

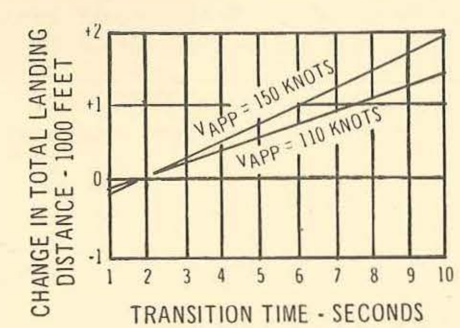


FIG. 7 — Delay in applying brakes increases landing distance as shown for different speeds at touchdown. Normal time between wheels rolling on runway and brake application is two seconds.

STOPPING TECHNIQUES

Actually, due to the many allowances applied in developing landing field lengths, a jet liner can normally be stopped with a good portion of the runway remaining. A number of factors which increase landing distance might combine to extend the normal distance required. Landing far beyond the 1,000 foot aim point may shorten the available distance to a critical length. If the runway is also slick, the combination of landing too far down the runway and the reduced braking effectiveness may require more runway distance than is available for normal stopping. Under emergency conditions, every available means for stopping should be exercised.

The importance of timing during the use of all means for stopping the aeroplane cannot be over-emphasised. As soon as it is definitely known that the main wheels are rolling on the runway, use elevators to bring the nose wheels on to the runway smoothly and hold them there. Immediately raise speed brakes to their full 60 degree deflection, apply wheel brakes, and actuate thrust reversers.

As noted earlier, raising speed brakes reduces wing lift and increases drag, both of which help to slow the aeroplane. Bringing the nose gear down to the runway also reduces wing lift and increases the effectiveness of the brakes. Throughout the landing roll, keep enough forward pressure on the control column to hold the nose wheels on the runway. Keeping the nose wheels on the runway noticeably improves directional stability, particularly in cross-winds.

Thrust reversers should be used symmetrically at high power as soon as possible during the landing roll. The brakes and thrust reversers should be applied together. Due to the 3 to 5 second delay before the build-up of full effective reverse thrust, brakes will normally be operating before reverse thrust. Braking thus counteracts any pitch-up tendency that may develop. Since thrust reversers are most active in reducing landing distance when applied during the highspeed portion of the landing roll, it is important that they be in operation early at maximum allowable power. Under emergency conditions, the normal thrust reverser engine and ground speed restrictions may be exceeded by using full throttle down to a complete stop. Normally, of course, thrust limitations for reverse thrust applicable to each aeroplane must be observed. Engine surging may begin to occur at around 60 knots due to cross ingestion of exhaust gases. When this happens, it may be desirable to back off on the inboard engine throttles to minimize surging. Actually, when a jet engine is surging, it is developing very little thrust; therefore, nothing is lost by reducing throttle position. Outboard engines are not sensitive to ingestion of exhaust gas when throttles are reduced on inboard engines. Should it be necessary to reduce inboard engine power, it is preferable to leave the inboard engines in reverse at about 40-45 per cent of N1 RPM rather than idle forward to eliminate the forward thrust which would be present. Fig. 6 shows the advantage of keeping the engines in reverse below 60 knots rather than idle forward. This is particularly applicable to turbofan engines that develop considerable thrust at idle.

Thrust reversers must be used symmetrically at high power and the application of differential reverse thrust should be avoided. During the application of reverse thrust, all levers should be rotated simultaneously. If one reverses should fail to move into reverse position immediately, its opposite should also be left at the interlock. The pair of engines that were originally left at interlock may be tried again in case a slow-acting rather than a malfunctioning reverser caused one reverser lever to stop at the interlock position.

Attempting to use asymmetrical thrust will not gain any stopping advantage, because brakes must be eased off on one side to keep the aeroplane headed straight. The reduction in braking offsets any benefit that might be derived from using asymmetrical thrust. Also, when runway conditions are slick, brakes may not be sufficient to prevent asymmetrical thrust from veering the aeroplane to one side (Fig. 8). Under certain conditions, reverse thrust and a strong cross-wind may drive the aeroplane off the centreline. Corrective action to straighten the aeroplane roll path is to return all engines to

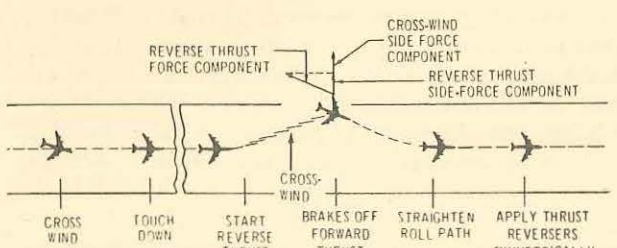


FIG. 8 — During cross-wind landing side thrust from thrust reversers, once aeroplane is canted to centreline, plus cross-wind can drive aeroplane off runway. To correct path, return all engines to forward thrust at low power to return to centre, use differential braking to straighten roll path then reverse thrust to stop.

forward thrust (to reduce the thrust element tending to drive the aeroplane to the side and to get the aeroplane back near the centre of the runway) and use differential wheel brakes and rudder to straighten the landing roll. Once the aeroplane is straight with the runway and near the centre, thrust reversers should again be set up symmetrically if needed.

Reverser lights in the cockpit are for the purposes of indicating when thrust reverser clam-shell doors are not in their cruise position. They should not be used as a guide to indicate when reverse levers may be lifted to apply reverse thrust. This can be determined by the release of the reverse lever interlock.

The 707 anti-skid system prevents excessive skidding or a locked wheel condition under all runway and operating conditions. During a landing, a sensor in each tandem pair of wheels senses a wheel skid and automatically relieves hydraulic pressure to those wheels until they begin rolling again. The rate of anti-skid cycling during a landing roll depends on how much brake pressure is being applied and the coefficient of friction between tyre and runway surface. During a portion of every skid cycle, a wheel is producing considerable less braking effort then when it is rolling but being braked to the point just before starting to skid. During cycling when brake pressure is being relieved and later reapplied, tyres produce little braking. Therefore, excessive cycling of the anti-skid system reduces total braking effort roughly in proportion to the cycling rate.

Maximum braking effort from wheels occurs when only enough brake pedals pressure is used to produce an occasional anti-skid brake release; that is, approximately one release every 2 to 3 seconds. A pilot can feel anti-skid cycling from a "kick" in the brake pedals. Large differences in cycling rates, due to the difference in brake pressure to left and right landing gear, a cross-wind, or runway conditions could cause an aeroplane to veer off to one side or the other.

Under wet or icy runway conditions relatively light pedal pressure can produce excessive cycling.

The pilot must realise that the pedal pressure which keeps him at a minimum cycling rate provides the best braking possible under the existing conditions.

To correct an aeroplane's veering course due to anti-skid cycling and cross-wind effects, let off on both brakes while keeping wings level.

Immediately apply differential braking on the side necessary to bring the aeroplane back toward the centre of the runway. When the aeroplane is again rolling parallel with the runway and near the centre, apply pedal pressure to develop maximum braking. This calls for adjusting pedal pressure such that an anti-skid release occurs about once every two to three seconds. An anti-skid release can be felt by a kick in the brake pedals. The rudder should also be used to maintain directional control. Under emergency conditions nose-wheel steering can be used for directional control rather than differential braking.

In summary, when a 707 (or any jet transport) is due to land on a runway that has become slick due to ice, snow, or excessive water, the pilots should be warned before making the approach. The aeroplane should then be handled before touchdown in a manner that will keep the total landing distance short and use as much as possible of the full-strength runway surface without risking a "short" landing. During the approach a pilot should:

1. Aim for a touchdown about 1,000 feet from the end of the hard-surface runway. On the recommended glide slope path (3 degrees), this calls for a 50 foot height over the end of the runway. While it is important not to land long, it is even more important not to land short of the runway.

2. Maintain a close control over approach speed to keep it at the speed recommended for existing conditions. Extreme care should be taken to keep speed high enough to avoid a partial stall due to gusts or to a decay in headwind velocity near the ground.

3. Control glide slope path to get the wheels on the runway at about 1,000 feet from the end of the runway. Probable the major cause of long landings is holding the aeroplane off the ground. The aeroplane should be touched down at the aim point even if speed is excessive.

In case an unsatisfactory approach is likely to cause a touchdown far down the runway, go around and make a second approach.

Once on the ground, the crew should strive for —

1. Best braking effectiveness and maximum reverse thrust consistent with existing runway conditions. This means keeping as much pedal pressure on brakes as possible without excessive cycling of the anti-skid release and using thrust reversers immediately after touchdown.

2. Minimum lift coefficient; that is, speed brakes 60 degrees and nose wheels on the runway.

3. Maximum drag; that is, flaps full down, speed brakes 60 degrees, and aeroplane in taxi position.

Keeping these factors in mind will permit stopping the aeroplane with the least landing roll.

Don't Wait To Learn The Hard Way

After taking off and climbing in the circuit to a height of 500 feet at the commencement of a private travel flight in a Piper PA22 aircraft, the pilot who holds a commercial licence decided to carry out a low run for the benefit of friends on the airfield.

The aircraft was dived to a height of 35 feet and after crossing the airfield it struck an overhead power line situated a short distance outside the boundary fence. Fortunately the wire broke, enabling the pilot to maintain control and continue the flight to a normal landing. A short length of wire was found wrapped around the nosewheel strut and damage to the propeller revealed that it had also struck the wire.

It was only good fortune that prevented this rather thoughtless display from becoming a tragedy and we have no reason to disbelieve the pilot when he says that this experience has cured him of the dangerous practice of taking unnecessary risks.

In aviation there is little room for those who cannot or will not plan their actions to achieve maximum safety and the weak and the recalcitrant are sooner or later rejected from the system by the painful process of accidents. A more pleasant way of overcoming the problem is to learn from the experience of others. Here is **your** chance.

Scheduled Error

During take-off the pilot of a light privately operated twin engined aircraft noticed that the wheel brakes were not functioning correctly. He abandoned the proposed flight and proceeded immediately to a maintenance base to have them checked. When examined, it was found that the port brake was completely unserviceable due to excessive wear.

The maintenance history of the aircraft showed that it had undergone a 100 hourly inspection only a short time prior to the incident. The manufacturer's Service Manual specifies that the wheel brakes be examined for wear and clearance at this inspection.

The work was done by a maintenance organisation which owned and operated a similar aircraft under a charter and aerial work licence. Under these circumstances their own aircraft was maintained in accordance with a maintenance system approved by the Department, under which the regular inspection schedules were slightly different from those in the manufacturer's Service Manual.

It so happened that, as a result of several years' experience and the nature of the operations involved, the maintenance organisation had been able to demonstrate to the Department that the wheel brakes on their own aircraft were capable of operating for periods in excess of 100 hours. For this reason the brake inspection had been deleted from the organisation's 100 hourly schedule and included at a higher hour inspection. Therein lay the trap which caught an experienced and conscientious maintenance engineer.

Overlooking the fact that the approved schedules applied only to their own aircraft and that the inspections set out in the Service Manual were required on the privately owned aircraft, the engineer completed only those inspections called up in their own schedules. The wheel brakes were not inspected and linings which were already worn beyond tolerance were allowed to remain in service.

In this case, the consequences of his oversight were not serious — due to the prompt action of the pilot but under less favourable circumstances it could easily have led to disaster.

The incident serves to illustrate very clearly that no matter how well you know an aircraft type and how familiar you are with a particular inspection schedule, it is always necessary to use and follow the schedule applicable to the aircraft concerned.

STEAM HEAT

According to the Directorate of Flight Safety, Air Ministry, London, there's a new hazard on the books. Recently a pair of tyres was removed from a military jet after landing on a wet runway, during which virtually no braking had been necessary. The tyres showed severe damage with several layers of rubber apparently scalded or scorched to some depth at a single spot on each tyre.

The tyres were returned to the manufacturer for examination, and the company's report confirmed the suspicion that superheated steam had been responsible for the damage.

When an aircraft lands on a wet runway, there is a thin layer of water between the tyre and the runway surface. This layer of water is subject to friction heat while the tyre is accelerating and also to a varying degree of pressure, depending on how firmly the aircraft is put down on the runway.

Under the right conditions of friction, pressure and quantity of water, sufficient superheated steam may be generated to cause a molecular breakdown of the rubber surface. While this happens to some extent on every landing on a wet surface, the depth is usually slight and traces are lost by subsequent scuffing.

The Directorate of Flight Safety further reported that in this incident there was some evidence that the pilot had floated the aircraft onto the runway in a particularly smooth manner. Satisfying though this type of landing may have been, it actually could have contributed to the tyre-scalding condition: the wheel does not start rotating immediately, thus leaving one contact point to bear the brunt of the scalding.

In discussing this incident, one official commented, "In talking about landing techniques, you hear, 'the aircraft should be lowered gently on to its main wheels', and then at other times you hear, 'the main wheels should be placed gently but deliberately on the ground.' On wet runways, it would seem the operative word is 'deliberately'."

—Extract from Flight Safety Foundation Bulletin.

Ditching Data

(Extract from Business Pilots Safety Bulletin)

Have you ever been faced with the possibility of having to ditch your aeroplane? Fortunately, in the operation of business aircraft, this has been an infrequent occurrence, but it has happened. The following account of a ditching of a fixed tricycle gear, high-wing, single-engine aircraft may provide a few how-to-do-it hints. In this instance the owner of the aeroplane was getting in some flying time in the left seat and the professional pilot was riding in the right seat. They were cruising at an altitude of 2,300 feet m.s.l. (about 1,300 feet above the surface) IFR, with an estimated ceiling of 800 feet. Here's the pilot's account:

"When engine failure occurred, I assumed command from the right seat and immediately established an approximately standard glide. I was without airspeed indication because of previous icing of the pitot tube. The wings were clear of ice. With a glide speed of about 100 m.p.h. on a straight descent, we broke out at a little under 1,400 m.s.l. or approximately 400 feet above the water. I continued the descent to about 40 feet, lowered full flaps, gradually slowing the aircraft, and concentrated on getting close to the water without actually touching. I held the aircraft off and increased pitch attitude, thus dissipating airspeed. At the exact moment of partial stall I rapidly increased elevator pressure, thus touching the tail and aft end of the fuselage into the water with the main gear wheels touching down shortly thereafter.

"The decrease in forward speed was rapid as the nose wheel made contact. The nose seemed to settle into the water about to the top of the engine cowling, with a heavy spray covering the windshield. The aircraft did not pitch violently at the sudden stoppage.

"It would be hard to estimate the distance covered from the moment of tail impact to the aircraft's coming to complete rest, but a guesstimate would be from 80 to 110 feet. The aircraft floated, with the water about 3 inches below the bottom of the door, from five to seven minutes, then finally sank some 30 feet to the bottom.

"On our way down to the landing, I had my passengers put their arms across face and chest areas, with those in the back seat leaning forward against the back of the front seats. I used both hands on the control wheel and held it full back until the spray started over the windshield. At that moment I leaned forward and crossed my arms in front of my face. My arms touched the dash, but very lightly, and no one was injured or bruised in the landing.

Comment

Our readers would be well advised to note carefully the flight circumstances under which the necessity for ditching arose. In Australia it would be unlawful to embark on such a flight.

We sincerely hope that you will never be confronted with the necessity to ditch your light single engine, fixed tricycle undercarriage, high wing aircraft. We also hope that your operating methods make it impossible for it to rise from a flight situation similar to that outlined in the above article.

Apart from this aspect we believe the experience of this ditching is well worth storing in the mind.

CONTROL CABLE INSPECTION

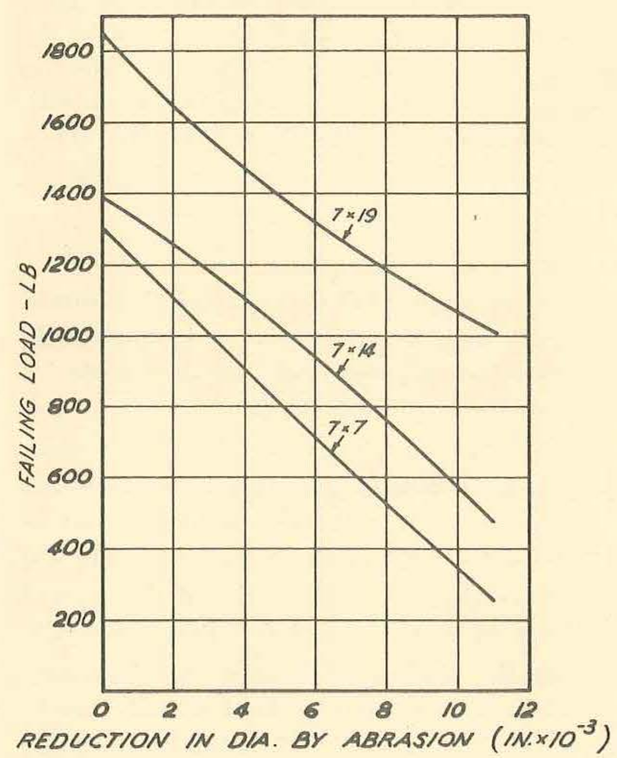
Quite recently an Auster rudder cable failed whilst the aircraft was taxying prior to take-off. This cable had been inspected and cleared only six flying hours previously. This happening highlights the necessity for extreme diligence and care when inspecting small diameter control cables in all aeroplanes.

When inspecting these cables care must be taken to ensure the core strand is undamaged. A number of cases have occurred in service of the core strand of small diameter cables breaking while the outer strands are sound. This is largely due to the fact that the core strand carries a higher load than the outer strands which are wound around it in a helix.

A minute reduction in diameter by abrasion produces a relatively large decrease in the strength of small stranded cables and the explanation of this important fact is that in fine wire cables, wear over a small area of the cable involves a large number of wires. Under these circumstances the reduction in the total cross sectional load-carrying metal is considerably greater than is suggested by the reduction in overall diameter of the cable. The accompanying graph shows this effect rather dramatically for cables of the type used for Auster rudder controls, gliders and other light types of aeroplane.

It is not possible to use this data to define absolute wear limits for cables in service because of work hardening effects, hammer and friction between wires, effects of lubrication, whip and other variables which influence the service problem. However, the Department is working on a research programme which will ultimately throw more light on the mechanism of failure in small diameter cables and may possibly lead to remedial action to minimise failures.

As a guide to the inspection of small cables any signs of corrosion, wear, broken wires or impaction between strands are grounds for immediate rejection. Cables in situ must be very carefully inspected where they pass over



pulleys, at terminal fittings and where they pass through fairleads. Run a "snag" cloth along the cables to detect broken wires and check that the cable diameter is uniform using a micrometer.

Let the motto be **"If in doubt, cast it out"**, when carrying out this very important function.