No. 33

Trans-Australia Airlines, Viscount 720 aircraft, crashed after take-off at Mangalore Aerodrome, Victoria, Australia, on 31 October 1954. Accident Investigation Summary. Aviation Safety Digest No. 4, April 1955 (Commonwealth of Australia, Department of Civil Aviation)

Circumstances

The aircraft crashed after take-off just outside the boundary of Mangalore Aerodrome, Victoria, at 1507 hours on 31 October 1954. At the time of the accident the aircraft, engaged on routine conversion training, was making a three-engine take-off. The two pilots and one other supernumerary pilot were killed, three other occupants received serious injuries, and the remaining two occupants escaped without injury. The aircraft broke up on impact and was destroyed by fire.

Investigation and Evidence

The aircraft employed at the time on pilot conversion training was operating at Mangalore Aerodrome, alternate to Melbourne Airport. Just prior to the take-off in which the accident occurred the aircraft had landed into the northeast on three engines after having completed a circuit during which No. 4 engine was deliberately stopped in the take-off just after V_1 speed, to simulate engine failure. On completion of the landing run the aircraft was lined up for take-off in the reverse direction with No. 4 engine stopped and the propeller feathered. The pilot-in-command, was occupying the right-hand seat and the pilot under training was occupying the left-hand seat. Two supernumerary pilots and an engineer were standing as observers at the rear of the cockpit, and the remainder of the occupants were seated in the cabin.

After a pre-take-off cockpit check had been carried out Nos. 2 and 3 engines were opened up to take-off power, the brakes released, and, as the aircraft moved forward, the pilot under training gradually advanced No. 1 throttle. When the aircraft had travelled some distance a swing to starboard developed but this was corrected by the use of nosewheel steering. However, this was followed almost immediately by another more severe swing to starboard in which the aircraft left the runway and became airborne at a speed below the minimum control speed.

As the aircraft left the ground it continued turning and whilst climbing slightly the starboard wing went down. This turn steadily steepened and the aircraft, which had not climbed above 100 feet, steadily lost height until the starboard wing tip struck the ground. As the aircraft was about to crash one of the supernumerary pilots moved back into the cabin.

Mangalore Aerodrome, is 450 feet above mean sea level. Runway 22 is a sealed gravel pavement 150 feet wide and 5 880 feet long.

The weather on the afternoon of 31 October was fine, warm and cloudless, with unlimited visibility. The wind was light and variable.

Tyre marks left on the runway during the take-off reveal that a swing to starboard occurred approximately 1 100 feet from the start of the take-off run and, as indicated by the marks on the runway, nosewheel steering was used to correct it. Marks of a second swing were in evidence 1 800 feet along the runway and it was during this swing that the aircraft left the runway at a point some 2 000 feet from the commencement of the take-off, and became airborne, 240 feet further on. There were no nosewheel steering marks during this swing. The path of the aircraft is shown in the attached plans. (Figures 31 and 32).

Evidence could not be found of the aircraft having struck the ground, or any tree or object, between the runway and the wreckage site. The aircraft was demolished on impact, the wreckage being spread along a distance of 450 feet. Both wings were torn off, the fuselage was broken in half and the four engines were separated from the main wreckage. The front portion of the fuselage came to rest on its port side with the rear portion, inverted and facing in the opposite direction, lying alongside it. A fire which occurred on impact spread throughout the wreckage but, although the area ultimately affected was extensive, it did not spread rapidly and large portions of the fuselage were not affected by the fire until at least ten minutes after impact.

All the occupants of the cabin survived and reported only moderate deceleration on impact. One of the two supernumerary occupants of the flight deck at impact was killed, and the other escaped through a hole in the fuselage, after receiving serious injuries. Both pilots, who were wearing lap strap type safety belts, but not the shoulder harnesses available to them, received fatal head injuries from contact with cockpit fittings. One pilot had no injuries below his head and the other, apart from head injuries, had a broken thigh. After an examination of all the circumstances it is concluded that had the pilots been wearing the shoulder harnesses available to them they may have survived the accident.

An examination of the engines and propellers established that Nos. 1 and 2 engines were at full power on impact and No. 3 engine was under substantial power, probably full power. No. 4 propeller was fully feathered and there was no indication that any attempt had been made to unfeather it. All the evidence, including calculations of the aircraft's performance in such a take-off, indicates that the three engines were delivering full take-off power.

No evidence was found to suggest that the flying controls were other than serviceable and the trim positions were consistent with a three-engine take-off configuration. From the flap selector lever position and the condition of the flaps it is concluded that flaps were extended 20°. Examination of the pilot system components revealed no defects or evidence of malfunctioning. On impact the undercarriage was down and locked but it had been selected "up" approximately 2 seconds prior to impact, which time is insufficient for the selector valve to expose the undercarriage retract mechanism to system pressure. The port wheels, tyres and brakes were found to be in good condition but no assessment could be made of the starboard wheel assembly because of the extensive fire damage it sustained. The nature of the tyre marks on the runway indicates that there was no malfunctioning of these assemblies, including the brakes, and that the brakes were not misapplied.

The nosewheel assembly sustained relatively little external damage except for fractures of the lower lugs on the ram-foot to which the lower steering link is attached, but the centering helix inside this strut was found broken into a number of fragments. After extensive examination and analysis of this damage it was concluded that it had all occurred on impact.

The nosewheel steering hydraulic circuit was found to be intact and serviceable. The main hydraulic system sustained extensive damage and it was not possible to determine conclusively that this system was operative at the time of impact.

The pilot-in-command held a first class airline transport pilot licence and his total flying experience amounted to over 11 000 hours, of which 3 158 were in-command of DC-4 type, 1 846 CV. 240 type, and some 3 000 hours DC-3 type. He was regarded as a highly competent check and training captain. His experience on Viscount type totalled 21 hours 30 minutes at the time of the accident. After a conversion course, which included ground training in engineering, and flight training lasting 5 hours 30 minutes, his licence was endorsed for the type, on the certification of competence by the Chief Check and Training Captain of Trans-Australia Airlines. During his conversion he carried out several three-engine take-offs. He was rostered for duty as a training captain on Viscount aircraft, covering all aspects of this company's Viscount training syllabus, after a total experience of 10 hours 40 minutes on this type.

The pilot under training held a first class airline transport pilot licence and his experience amounted to just over 12 000 hours, of which 6 715 hours had been as captain on DC-4

type. Prior to this flight he had completed 4 hours conversion training on Viscount aircraft in which he had twice taken-off on three-engines.

Analysis

The take-off from which the accident resulted was being attempted in the most critical three-engine configuration, i.e. with No. 4 engine (starboard outer) inoperative. In this configuration, with flaps extended 20° and the three engines on full power, a minimum speed of 96 knots is necessary in order to ensure that, using both rudder and aileron, a constant heading can be maintained. When flying under these conditions at speeds below 96 knots it is not possible to keep the aircraft from turning.

The take-off safety speed for the conditions existing at the time of this accident is given in the flight manual for Viscount VH-TVA as 106 knots and it has been the practice of Trans-Australia Airlines to teach its pilots not to lift the aircraft off the ground at speeds below 110 knots in a three-engine take-off.

It follows that in a three-engine take-off whilst the aircraft is still on the ground and at speeds below 96 knots directional control depends on the use of some nosewheel steering to supplement any rudder that may be applied. In order to ensure full effect from steering, the nosewheels must be held firmly on the ground by keeping the control wheel fully forward.

It is appropriate to mention here that an important characteristic of turbo-propeller aircraft, by comparison with piston-engine aircraft, is the marked difference in response to throttles. The proportionate increase in power obtained in the final stage of throttle opening is much greater with the turbo-engine than with the piston-engine. Also, the response to throttle opening in the turbo-engine is slower than in the piston-engine.

The tyre marks show that the aircraft was running 15 feet to the right of the runway centre line, when the first swing to starboard commenced at a point some 1 100 feet from the start of the take-off. It is estimated that the speed of the aircraft at this point would be of the order of 65 knots. Marks on the runway indicate that this swing was corrected by nosewheel steering and as the swing was controlled these marks became lighter until they disappeared when the aircraft was running straight again. Although running straight, it was still heading slightly to the right away from the runway centre line. After approximately 200 feet in this condition, which would have taken about 1-1/2 seconds, the aircraft again swung to starboard, left the runway and a short distance later became airborne. This swing was severe.

The surviving supernumerary pilot, who at this time was standing between the pilots, states that as the aircraft left the runway, the pilot-in-command pushed the throttles fully open and pulled the aircraft into the air at an airspeed between 85 and 90 knots - definitely not higher than 90 knots. It has been calculated that with normal acceleration in a three-engine take-off the speed of the aircraft where it left the runway would have been 85 to 90 knots. From what is known of the characteristics of the aircraft near the minimum control speed, it is clear that it could not be controlled directionally after it left the ground, and its fate was inevitable so long as full power was drawn at speeds below 96 knots. In deciding to lift VH-TVA into the air at this time, rather than abandon the take-off, an error of judgment was committed by the captain and the accident resulted.

The captain may have been influenced in this decision by his considerable experience on other aircraft recently flown by him, the minimum control speeds of which are lower than that of the Viscount. It is felt that in an emergency such as faced the captain he would be inclined to react automatically under the influence of his predominant experience in the DC-4, overlooking the particular characteristics of the Viscount of which he was comparatively inexperienced. It is also possible that he may have been led into error by a natural urge to make the utmost endeavour to avoid damage to this aircraft, which was destined to play an important part in his company's operations. It would have been obvious to him once the aircraft had left the runway, that to abandon the take-off would almost certainly have resulted

in some damage to the aircraft by collision with flight strip boundary markers or other features of the aerodrome outside the prepared flight strip.

It is considered that in these circumstances a training captain fully familiar with the characteristics of the Viscount type would not have taken the aircraft into the air. The fact that the captain attempted to do so at a speed below the minimum control speed, indicates that he was not sufficiently familiar with this type of aircraft for the duties on which he was engaged. It is concluded, therefore, that his limited experience materially affected his judgment at this time.

Whilst the accident is considered to have been caused by the decision to take the aircraft into the air, this decision was precipitated by loss of directional control during the final stages of the ground run. There are a number of circumstances which could have caused the final swing. Some possibilities, such as power plant failure and propeller malfunctioning, have been discarded after investigation, but it has not been possible to eliminate or confirm others.

A puzzling feature of the last swing is the absence of any nosewheel steering marks, which would be expected particularly as marks of this sort indicate that nosewheel steering had been used a few seconds earlier to correct the previous swing. Having regard to the surviving supernumerary pilot's evidence that he was not aware of any difficulty being experienced in the cockpit it is apparent that either the nosewheel steering mechanism failed, unbeknown to the pilots, or that the pilots failed or were unable to use it effectively, at a stage in the take-off when its use was essential for directional control. Although the nosewheel and associated steering mechanism are considered to have been in a serviceable condition at the time of the accident, owing to the destruction of some of the hydraulic system plumbing, it was not possible to determine this conclusively. Complete loss of hydraulic pressure through such a cause as a broken hydraulic line could have deprived the pilots of nosewheel steering. In assessing the likelihood of such an occurrence, the successful use of steering immediately prior to this last swing cannot be overlooked.

On the other hand, if the steering mechanism was serviceable it is obvious from the absence of runway marks that the pilots either failed or were unable to use it. Both were experienced pilots of DC-4 and/or CV.240 aircraft and accustomed to the use of nosewheel steering. It is considered that if either of the two pilots had been in complete and continuous control each would have applied steering instinctively to correct such a swing.

The supernumerary pilot has said that the pilot under training corrected the first swing with steering and the absence of steering marks on the runway in the last swing suggests that he was no longer flying the aircraft, or was flying it in such a manner as to be deprived of effective steering. At first it was thought that this latter possibility might apply if the pilot under training, who with his left hand on the tiller and his right on the control wheel, had released the control wheel in order to operate the throttles, thereby reducing the load on the nosewheels and rendering the steering ineffective.

In tests with another Viscount to explore this possibility, it was found that when the control wheel was released at 75 knots, during a normal four-engine take-off under the same loading conditions as prevailed in the aircraft, the nosewheel did not leave the ground despite a slight up movement of the nose after which the aircraft still responded to nosewheel steering. This suggests that if steering had been applied by the pilot under training, after releasing the control wheel, some steering marks would have been made on the runway in the final swing. In any case, the pilot-in-command might be expected to push the control wheel forward again, thereby restoring full steering effectiveness, if he saw the pilot under training release it. It is thought, therefore, that the likelihood of the pilot under training being deprived of effective steering is extremely remote.

The possibility of the pilot-in-command taking control of the aircraft, during or immediately prior to the last swing, remains. In considering this the absence of any nosewheel tracks in the gravel at the edge of the runway is significant as it indicates that the

nosewheels were off the ground before they crossed the edge of the runway. For this to have happened it is apparent that the control wheel was previously pulled back and, as the supernumerary pilot has said that the pilot-in-command did, in fact, pull it back on taking over control, this points to the pilot-in-command having assumed control before the aircraft left the runway. This deduction conflicts with the supernumerary pilot's evidence, but allowance must be made for the possibility of the sequence of events as recalled by him not being exactly correct in every detail, particularly when the rapidity with which this sequence occurred is appreciated.

If the pilot-in-command assumed control after the first swing had been substantially corrected, and he could easily have felt this to be necessary because the aircraft was still heading so as to run off the runway just before it would have become airborne, the pilot under training would probably take both hands off the controls. The supernumerary pilot says that when the pilot-in-command took over he held the control column with his right hand while he "slapped" the throttles forward with his left. It would not have been possible for him to use the tiller at the same time and this, together with the application of full asymmetric power, could have resulted in the aircraft turning so quickly towards nearby obstructions, such as elevated runway lights and flight strip boundary markers that, influenced by his predominant experience of the handling of aircraft other than the Viscount, he instinctively pulled the control wheel back, in an endeavour to fly the aircraft out of this trouble. It has been suggested that with a comparable configuration a DC-4 could have been taken into the air at 85 knots without loss of control. It seems probable, then, that the pilot-in-command took over after the first swing and in his doing so nosewheel steering was released at a stage in the take-off when its use was essential.

Therefore, whilst failure of nosewheel steering through loss of hydraulic pressure cannot be positively eliminated, its likelihood is considered remote, and it is thought that the development unchecked of the last swing arose through nosewheel steering being released when the captain took over control from the pilot under instruction; this constitutes a probable contributory cause of the ultimate accident.

Probable Cause

The cause of the accident was an error of judgment on the part of the pilot-in-command in that he took the aircraft into the air at a speed below the minimum control speed, following loss of directional control during the ground run.

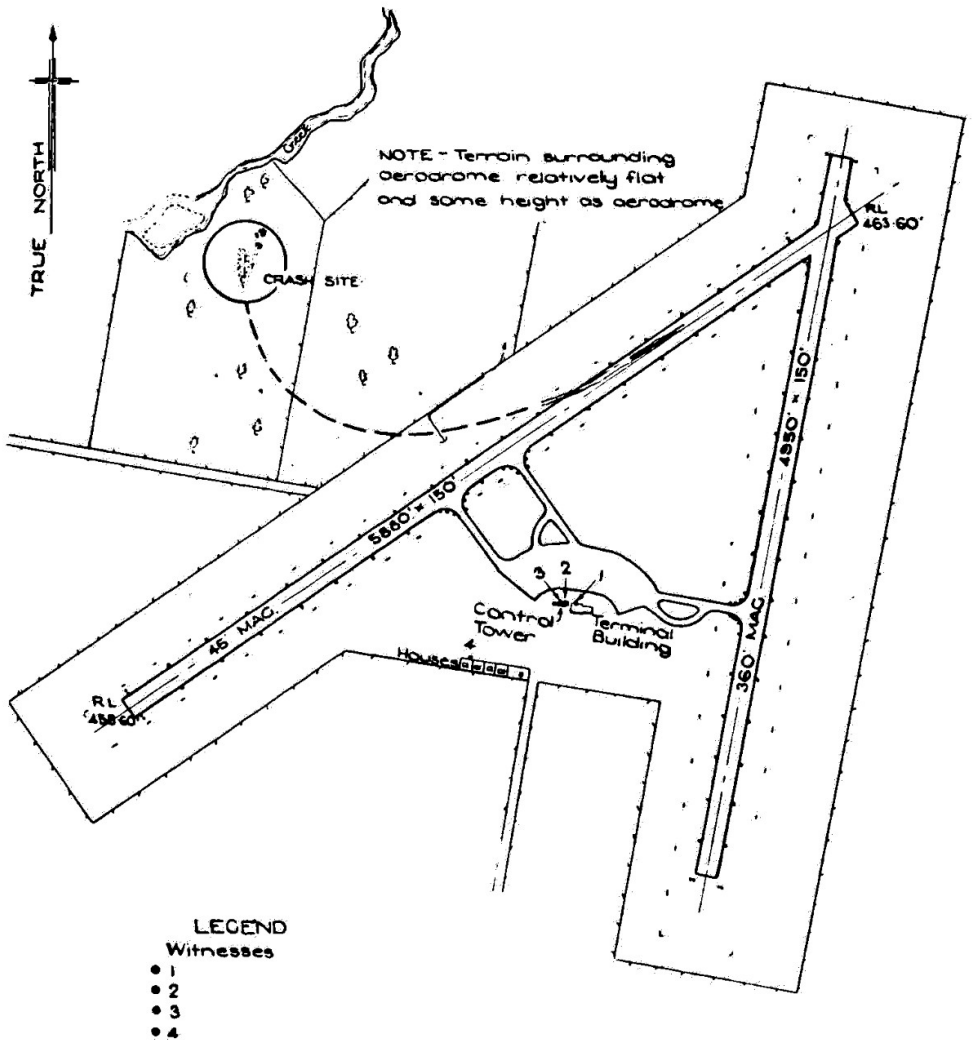
Some difficulty in maintaining directional control had been experienced during the take-off run but the final loss probably occurred through nosewheel steering being relinquished as the pilot-in-command took over the controls.

A factor probably contributing to this accident was the limited experience of the pilot-in-command on this type of aircraft.

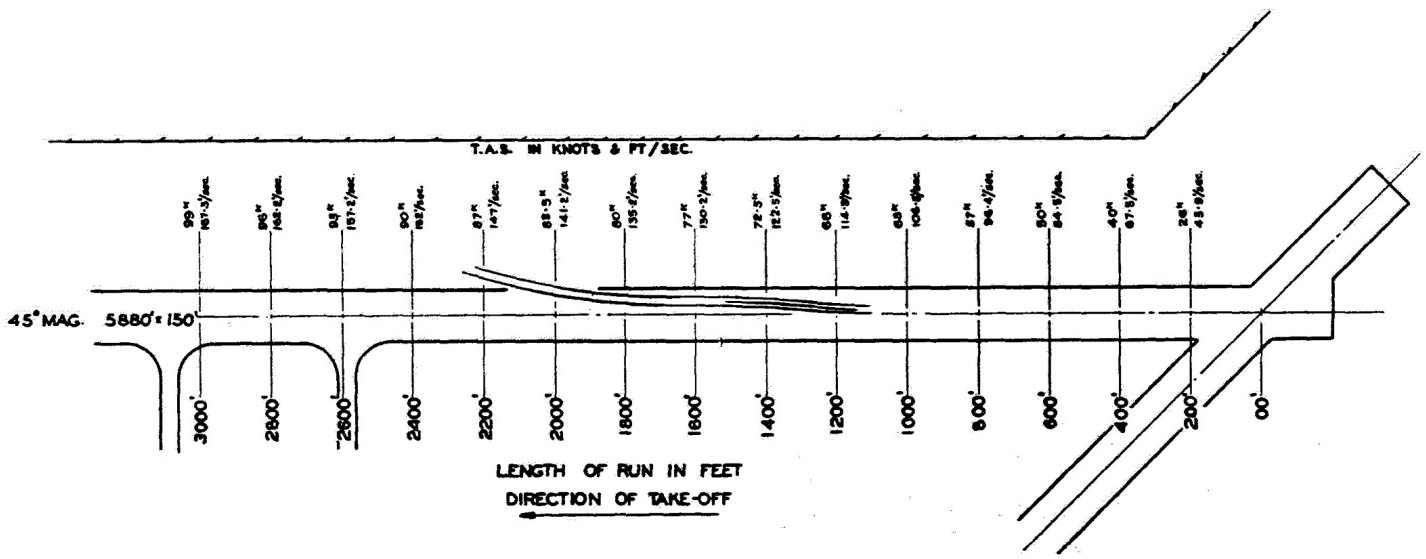
Note: The report included the conclusion that the injuries sustained by the operating crew indicate that they may have survived this accident if they had been wearing the full safety harness provided for their use in the aircraft.

ICAO Ref: AR/374

FIGURE 31



ACCIDENT TO VISCOUNT AIRCRAFT VH-TVA.
AT MANGALORE VICTORIA ON 31 OCT. 1954.
LOCALITY PLAN OF CRASH SITE SHOWING ESTIMATED FLIGHT PATH
Scale - 1" = 1000'



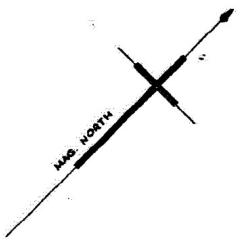


FIGURE 32

ACCIDENT TO VISCOUNT AIRCRAFT VH-TVA.
AT MANGALORE, VICTORIA ON 31 OCT. 1954.

RELATION OF TRUE AIR SPEED TO TAKE-OFF RUN.

Scale: 1" = 300'

CALCULATIONS BASED ON FOLLOWING ASSUMPTIONS.

1. THREE ENGINED TAKE-OFF WITH TWO ENGINES TO TAKE-OFF POWER ON BRAKES AND THIRD TO TAKE-OFF POWER WITHIN SIX SECONDS.
2. NO WIND. STANDARD I.C.A.N. SEA LEVEL CONDITIONS.