72-3

Air Safety Investigation Branch

Department of Civil Aviation

Australia

ACCIDENT INVESTIGATION REPORT

Piper PA 31–310 Navajo Aircraft VH–CIZ at Golden Grove on 13 July, 1972

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Ansett General Aviation, Piper PA 31–310 Navajo aircraft VH–CIZ at Golden Grove on 13 July, 1972

The investigation of this aircraft accident was authorised by the Director-General of Civil Aviation pursuant to the powers conferred by Air Navigation Regulation 278.

Prepared by:
Air Safety Investigation Branch Melbourne

May, 1973

CONTENTS

THE ACCIDENT

At approximately 0748 hours Central Standard Time on 13 July 1972 a Piper PA31-310 Navajo aircraft, registered VH-CIZ, struck the ground in a shallow dive at Golden Grove in the foothills of the Mount Lofty Ranges some 13 miles north-east of Adelaide Airport, South Australia. The aircraft was engaged in operating a charter flight for the carriage of passengers and freight from Adelaide to Moomba. The aircraft was destroyed by impact forces and the pilot and seven passengers were killed.

1 — Investigation

1.1 HISTORY OF THE FLIGHT

On 13 July 1972 the Piper PA31-310 Navajo aircraft, VH-CIZ, was engaged to operate a charter flight for Santos Ltd. The aircraft was owned and operated by Ansett Transport Industries (Operations) Pty. Ltd. trading as Ansett General Aviaion, who hold an appropriate charter licence issued by the Director-General of Civil Aviation. It was one of the three aircraft, of similar type, belonging to this company which were, on this morning, carrying out flights for the purpose of conveying passengers, baggage and freight from Adelaide to the Moomba oil field in the Cooper Basin, 431 miles north of Adelaide. The aircraft was under the command of Mr. J.D. Crouch who was the sole crew member on board.

Before departing from Adelaide the pilot attended the Adelaide Operational Control Centre and compiled an instrument flight rules (IFR) flight plan covering the proposed flight to Moomba and return to Adelaide with an estimated time of departure from Adelaide of 0800 hours. The flight plan indicated that the initial route from Adelaide would be outbound on the Adelaide localiser, on a track of 044 degrees magnetic to the Stonefield non-directional beacon (NDB) which is 53 miles from Adelaide Airport.

The estimated flight time to Stonefield was shown as 19 minutes and the total flight time to Moomba was estimated as 141 minutes. The total fuel endurance was shown as 238 minutes which was some 30 minutes in excess of statutory requirements. The flight plan was approved by the senior operations controller on duty who endorsed it as valid for departure from Adelaide until 0830 hours.

Before the aircraft commenced to taxi the pilot informed Adelaide Tower that he had received the current automatic terminal information service broadcast (ATIS) designated CHARLIE. This broadcast specified that the runway in use was Runway 30, that it was wet, the wind velocity was 330 degrees at 10 to 20 knots, the altimeter setting (QNH) was 1010 millibars, the temperature was 12 degrees Celsius, the cloud base was 1,000 feet with lower patches at 700 feet and the visibility was reduced in showers.

The aircraft commenced to taxi at 0734 hours and whilst it was taxying towards the threshold of Runway 30 the pilot was advised by Adelaide Tower that Runway 05 was available. This runway, which is aligned with the planned initial departure track, offered the pilot a climb out on take-off heading and was immediately accepted by him.

The airways clearance issued to the pilot instructed him to track 044 degrees from the Adelaide localiser or NDB for a distance of 53 miles to the Stonefield NDB and then follow his flight planned route to destination. This clearance also required the pilot, when operating in instrument flight conditions, to reach an altitude of 3,000 feet by the Modbury locator which is on the localiser track, 11 miles from the airport.

At 0739 hours the pilot reported ready for departure and Adelaide Tower issued a take off clearance with the instruction to call Adelaide Radar on frequency 124.2 MHz when airborne. At 0741:26 hours the pilot reported on the radar control frequency that the aircraft was airborne on runway heading. The radar controller then advised that the aircraft was identified and the pilot acknowledged this transmission. No further communication was received from the aircraft. The radar controller continued to observe the progress of the aircraft radar return and it was seen to closely follow the Adelaide to Stonefield track - which is shown on the video map superimposed on the radar display - to a position approximately two miles beyond the Modbury locator. At this point the radar return of the aircraft appeared to deviate to the north and then to continue in a left turn in the direction of Parafield Airport. When the aircraft was indicated to be about 14 miles from Adelaide on a heading of approximately 270 degrees the radar return ceased to register on the display screen.

The radar controller called the aircraft three times before the radar return disappeared but no reply was received. The first of these calls made by the radar controller to the aircraft was recorded at 0747:15 hours and repeated at 0747:21 and again at 0747:35.

The radar controller then contacted Parafield Tower and requested advice of any sighting. During the next three minutes radio calls were directed to the aircraft by the radar controller, Adelaide Tower and another airborne aircraft. At 0750 hours advice was received at the Adelaide Operational Control Centre that an aircraft had crashed at Golden Grove.

At about 0748 hours, a number of witnesses in the Golden Grove area, some thirteen miles north-east of Adelaide, heard the sound of an approaching aircraft but could not initially see it due to low overcast cloud. Some of these witnesses saw the aircraft emerge from the base of the cloud or observed it on a descending flight path immediately before it struck the ground. In all cases, the eye witnesses saw the aircraft for only a very short period of time.

The witness evidence indicates that the aircraft emerged from the base of the low cloud in a shallow descent on a south-westerly heading and turning to the left. The aircraft continued in this descending turn for a distance of approximately 2,400 feet before striking the ground on a heading of 198 degrees magnetic. The aircraft disintegrated on impact and numerous pieces of wreckage were thrown high into the air.

1.2 INJURIES TO PERSONS

Injuries	Crew	Passengers	Others
Fatal	1	7	—
Non-Fatal	—	—	—
None	—	—	—

1.3 DAMAGE TO THE AIRCRAFT

The aircraft was totally destroyed by impact forces.

1.4 OTHER DAMAGE

The aircraft struck and damaged three large sections of structural steel framework which were lying on the ground near the impact point. Parts of the wreckage levelled 130 feet of light wire fencing at a distance of some 360 feet beyond the initial impact point.

1.5 CREW INFORMATION

The pilot-in-command of the aircraft Jack Denis CROUCH, was 48 years of age and held a valid commercial pilot licence endorsed for PA31-310 aircraft and a class one instrument rating. His total flying experience amounted to 2,697 hours of which 987 hours had been gained in twin-engined aircraft. His total flying experience in PA31 type aircraft was 538 hours.

Mr. Crouch carried out his last proficiency check in a PA31 type aircraft on 6 June 1972 when the senior pilot of the company assessed his overall performance as being good. He successfully completed a test for initial issue of a Class One instrument rating on 18 January 1972 and at that time he had accumulated a total of 40 hours instrument flight experience. The rating was renewed on 9 June 1972 following a flight test with an Examiner of Airmen. His instrument flight experience since the issue of his class one rating amounted to 15 hours.

1.6 AIRCRAFT INFORMATION

History The aircraft involved in this accident was a Piper PA31-310 Navajo aircraft, Serial No. 31-682, constructed in 1970 by Piper Aircraft Corporation of Lock Haven, Pennsylvania, U.S.A. The aircraft was first entered on the Australian register as a new aircraft and allotted the registration letters VH-CIZ on 26 February 1971. The aircraft was owned and operated by Ansett Transport Industries (Operations) Pty. Ltd., trading as Ansett General Aviation, throughout its operating life.

The Piper PA31-310 Navajo is a twin-engine low wing monoplane and it is approved for single pilot IFR operation in Australia. The aircraft's usable fuel capacity is 156.3 imperial gallons carried in four wing tanks. VH-CIZ was fitted with fully functional dual controls and was equipped to carry 7 persons in addition to the pilot. A nose locker and rear stowage area were provided for baggage and freight.

At the time of this accident VH-CIZ was properly registered and had a current Certificate of Airworthiness which was valid until 10 December 1973 when a major inspection was due. It had flown a total of 857 hours since new and the engines had 143 hours of flight time remaining before being due for complete overhaul.

Following a 100 hourly inspection which was carried out on 5 July 1972 a new maintenance release was issued and this was valid for a period of 100 hours in service or one year whichever occurred first.

Loading The aircraft involved in this accident was engaged almost solely in providing flights between Adelaide and Moomba for the charterer, Santos Ltd. For the purpose of load planning, the operator had informed the charterer that a maximum available load of 1,500 lb would apply except when special circumstances, such as the carriage of additional fuel, required some reduction to this figure. In addition, the charterer was informed by the operator that a standard weight of 200 lb per passenger, comprising 170 lb personal weight and 30 lb baggage allowance, was to be used in calculating the load.

The maximum permissible take-off weight for this type of aircraft is 6,500 lb. The weight of VH-CIZ including the pilot and the standard usable fuel load of 105 imperial gallons, less three gallons for taxying, was 5,186 lb. It can thus be seen that the maximum payload availability was 1314 lb. The charterer allocated seven passengers, their baggage and 75 lb of freight to VH-CIZ on this morning and, as a result, the take-off gross weight using standard weights is calculated to have been 6,661 lb, which is 161 lb in excess of the maximum permitted.

The foregoing standard weight calculations provide for a baggage component of 210 lb. There is evidence from the dispatcher that all of the passenger baggage was loaded, under the pilot's supervision, in the nose locker of the aircraft which has a weight restriction of 150 lb. As the baggage consisted of only three small suitcases and a number of light overnight bags, the limitation was certainly not exceeded.

It had not been possible to establish the actual centre-of-gravity position, but calculations using a very light nose locker load, which is the most critical situation when all seats are occupied, indicate that the centre-of-gravity would have been within allowable limits throughout the flight.

1.7 METEOROLOGICAL INFORMATION

Before he compiled his flight plan, the pilot of the aircraft obtained flight and terminal forecasts covering the proposed flight.

The forecast prepared by the Adelaide Meteorological office indicated that instrument meteorological conditions would prevail at Adelaide and over that section of the route encompassing the accident site. It indicated that there would be 4/8 of stratus cloud at 1,000 feet in rain showers, 4/8 of cumulus cloud at 5000 feet and 3/8 of strato cumulus cloud at 3,000 feet. The tops of the cumulus cloud were predicted to extend from 8,000 to 12,000 feet. The general surface visibility of 20 miles was expected to reduce to 4 miles in rain showers. Drizzle and rain showers were forecast over this area. The freezing level was shown as 8,000 feet and moderate clear icing was expected in the cumulus cloud with intermittent slight to moderate turbulence below 8,000 feet about the ranges and in the vicinity of the cumulus cloud. The wind at the aircraft's cruising level was forecast to be from 275 degrees at 35 knots. It is apparent that, in general terms, the weather existing at the time of the accident was as forecast.

At the time the aircraft departed Adelaide Airport, a layer of stratus cloud at 1,000 feet covered the airport and extended into the hills to the north-east. Some lower patches at 700 feet, with drizzle and rain, were also present. The wind velocity at the airport was 330 degrees at 11 knots but muchstronger north-westerly winds were reported at about 4,000 feet level in the vicinity of the accident site and this is consistent with the forecast.

Witness evidence, together with a post-accident anaysis carried out the Bureau of Meteorology, indicate that, in the vicinity of the accident site, there was 8/8 cover of stratiform cloud with a ragged base ranging between 300 to 500 feet above the height of the terrain at the initial impact point. The wind was from the north-west at 10 to 20 knots.

1.8 AIDS TO NAVIGATION

The aircraft was equipped to utilise instrument landing system (ILS), automatic direction finding (ADF), visual omni range (VOR), distance measuring equipment (DME) and visual aural range (VAR) navigation aids. However, the pilot's Class One Instrument Rating was valid only for ILS and ADF.

The terms of the airways clearance issued to the aircraft, prior to its departure from Adelaide Airport, required the pilot to track 044 degrees by reference to the Adelaide ILS localser or the Adelaide NDB for a distance of 53 nautical miles to the Stonefield NDB.

The wreckage examination showed that at the time of the accident, the aircraft's VHF navigation system was selected to the Adelaide localiser frequency, 109.0 MHz. The aircraft's single ADF was equipped with two controllers. The Number One controller was tuned to the Adelaide NDB frequency 362 KHz and the Number Two cotroller was tuned to the Stonefield NDB frequency 257 KHz. The controller selection switching indicated that the ADF receiver was selected to the Number Two controller. The aircraft's DME was selected to the Adelaide DME channel, Channel 9.

The localiser unit of the Adelaide ILS is aligned with Runway 05/23 on a bearing of 044 degrees magnetic from the airport. Two non-directional radio navigation aids are positioned on the localiser alignment. The Modbury locator is positioned some 11 miles from the airport and the Stonefield NDB is a further 42 miles beyond Modbury. The Adelaide NDB and DME are located on the airport. The rated coverages of these aids are such that the aircraft would have been able to effectively receive any one of them throughout the duration of the flight.

At the time of the accident all of these navigation aids were operating normally and there were no failures or malfunctions reported or recorded.

There was no evidence that the navigation aids used by the aircraft contributed in any way to the accident.

1.9 COMMUNICATIONS

Very High Frequency (VHF) communication channels were used between the Adelaide air traffic control units providing air traffic services and the aircraft involved in this accident.

Surface Movement Control Service, Aerodrome Control Service and Departure Control Service were in communication with the aircraft at various stages of the flight. All communications originating from these air traffic control facilities and from aircraft under their control are recorded on the ground.

As instructed, the aircraft, after departure, had established communications with Departure Control on the radar control frequency and the last communication from the aircraft was received on that frequency. The investigation established that the radar control frequency and the aerodrome control frequency were selected on the aircraft's dual VHF communication equipment at the time of the accident. Although the aircraft failed to respond to calls made on the radar control frequency immediately before the accident occurred, there is no evidence to suggest that the communication equipment at any of the air traffic control facilities or in the aircraft was subject to any fault which could have had a bearing on the accident.

1.10 AERODROME AND GROUND FACILITIES

The accident occurred some thirteen miles from Adelaide Airport, the aircraft's last point of departure. The aerodrome and ground facilities were not a factor in this accident.

1.11 FLIGHT RECORDERS

No flight recorders were carried in this aircraft nor was there any requirement for it to be so equipped.

1.12 MEDICAL AND PATHOLOGICAL INFORMATION

Post-mortem examinations of the pilot and the passengers were conducted but were limited by the extreme fragmentation of the bodies caused by the severity of the impact.

Mr. Crouch was last medically examined for the renewal of his pilot licence on 8 February 1972 when he met the requirements at commercial licence standard. He had electrocardiograms taken in 1959 and on 2 May 1972 and both of these were within normal limits. There is no evidence that he was other than in good health and spirits immediately before departure on the flight on which the accident occurred. The limited post mortem examination revealed no evidence of any pre-existing disease. Tests indicated that there was no carbon monoxide present.

The passenger, Mr. C.G.H. Saunders, who occupied the right-hand control seat was the holder of a current private pilot licence. He was last medically examined for the renewal of this licence on 27 October 1971, when he met the requirements at commercial licence standards. There is no evidence from his previous medical history or the post mortem examination that there was any pre-existing disease.

1.13 WRECKAGE

The aircraft was extensively fragmented as a result of its high-speed impact with the ground. The wreckage trail extended to a distance of some 770 feet beyond the initial ground impact point and the distribution of principal items indicated that the aircraft was on a heading of approximately 198 degrees magnetic when it struck the ground. The only large pieces of wreckage were the port outer wing panel and the empennage, which came to rest 270 and 530 feet respectively beyond the main impact point.

The extreme degree of fragmentation which occurred and which can be seen in Fig. 1, is consistent with high forward speed at impact. Several portions of a structural steel framework, which had been lying on the ground in the impact area, contributed to the extreme nature of the structural break-up. The steel sections themselves sustained severe damage and one of them, an "A" frame about 15 feet long and built up of tubing and channel sections, was broken into three pieces which were distributed along the wreckage trail at varying distances up to 250 feet from the main impact point, where it had originally lain.

The disintegration of the fuselage structure was particularly severe in the forward section of the aircraft. It was only after re-assembly of the fuselage fragments that an assessment could be made of the aircraft's attitude at impact. It was then apparent that it had struck the ground in a fairly level longitudinal attitude, with a moderate rate of descent.

The starboard wing was broken into a large number of pieces which, with one exception, had sustained damage consistent with their failure having occurred due to high-speed ground impact. The exception was that the wing showed evidence of failure in upward bending at a point about 7 feet from the tip, this outer section falling to the ground some 35 feet prior to the main impact point.

The port wing was extensively fragmented from the wing root to the nacelle area but, outboard of the nacelle, the wing had separated as one piece with the aileron remaining attached. The inboard fragments of the wing structure and the inner end of the separated outer wing panel showed evidence of severe ground impact loads in a rearward and outboard direction. Three sections of spar cap were found embedded vertically in the ground at the main impact point. They were identified as two adjacent sections of upper spar cap and one section of lower spar cap from the left wing just outboard of the fuselage. The nature of the wing damage was consistent with the aircraft striking the ground while banked fairly steeply to the right.

Both wing flaps were broken into a number of pieces. The directions of failure, together with the positions of the actuators, showed that the flaps were in the retracted position at impact.

The empennage, which had separated as a unit following the failure of the rear fuselage at the fin front spar bulkhead, had sustained severe rearward impact damage as the cabin collapsed rearwards onto it. The fin and rudder were extensively crushed and folded rearwards and to the left. Prior to receiving this damage the port tailplane had folded upward and rearward at the elevator centre hinge point and had struck the left side of the fin and rudder. The starboard tailplane had also collapsed in upward bending at the centre hinge and at some stage had folded upwards to almost the same extent as the port tailplane. The elevators had each separated into three pieces by upward bending failures. The sections inboard of the centre hinges remained attached to the tailplane, but the two outer sections of each elevator were located in a large area of scattered wreckage to the left of and prior to the main impact point. The most distant piece was the outer portion of the starboard

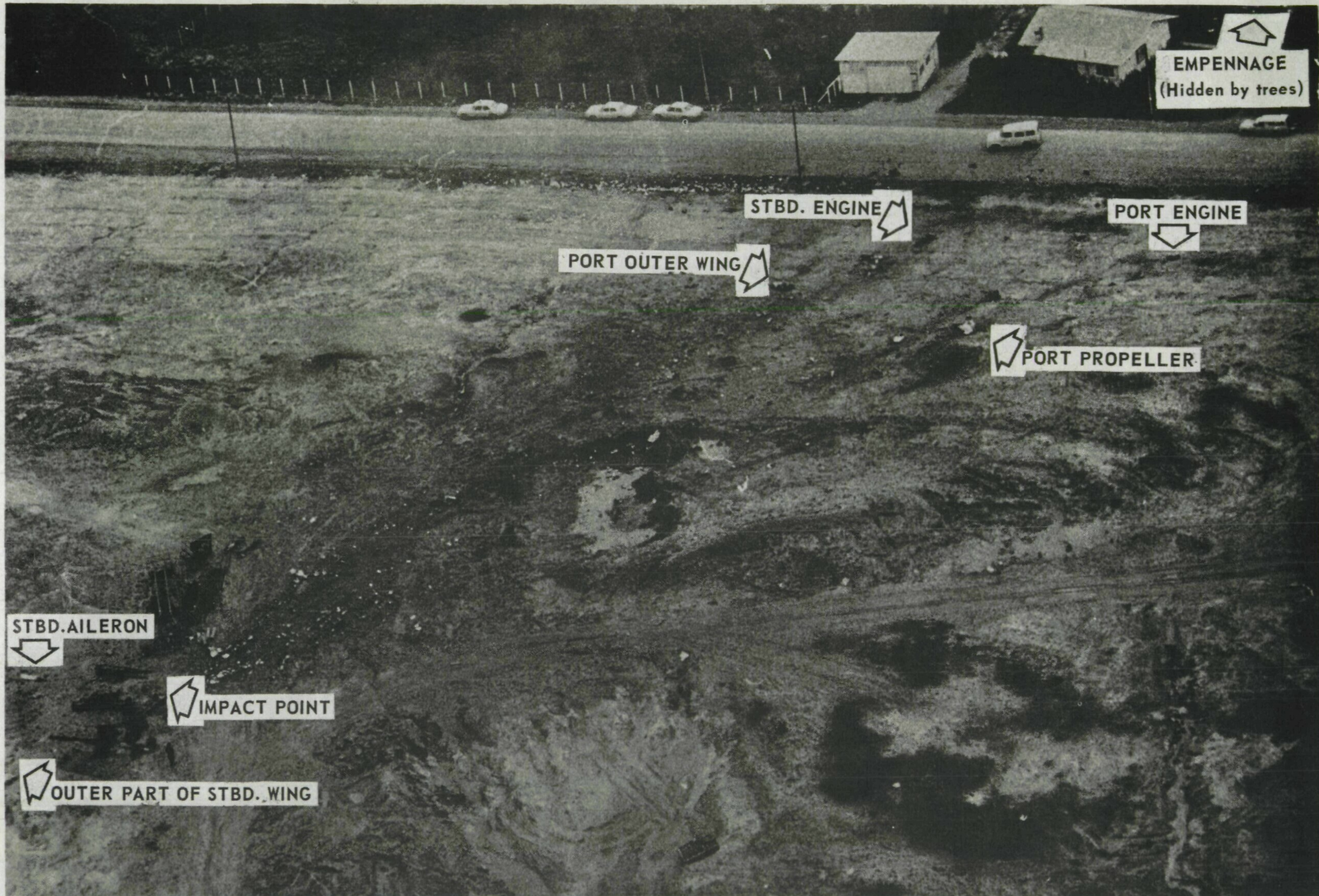


FIG. 1

Adelaide Advertiser Photograph

elevator which was about 250 feet prior to and 450 feet to the left of the impact area. The locations of these items, and that of the outer section of the starboard wing, indicated that these structural failures occurred in-flight probably about 1½ seconds prior to ground impact.

The landing gear was severely damaged by impact forces, and was in the fully retracted position prior to impact with the ground.

The engines fitted to the aircraft were Avco Lycoming Model TIO-540-A2B and the propellers were Hartzell Model HC-E3YR-2A. Both engines were detached from the airframe and severley damaged by ground impact. In each case the crankcase had disintegrated and all engine-mounted accessories had broken away from the accessory housing. The largest portion of each engine comprised the crankshaft with the connecting rods, and some cylinders attached, and these items came to rest some 330 feet after impact. The remaining pieces of the engines and their accessories were widely scattered throughout the wreckage trail beyond the main impact point.

A detailed examination of the remains of the engines and their accessories disclosed no evidence of any pre-existing defect. A small quantity of fuel was found in each of the injector systems and there was evidence that a substantial quantity of oil had been present in each engine at the time of impact. All bearings were in good condition, with no signs of loss of lubrication or metal contamination. The engine controls appeared to have been in a satisfactory condition prior to impact but, because of the degree of fragmentation, no reliable pre-impact control positions could be established.

Both propellers had sustained very severe damage on impact. The port propeller had broken away from the crankshaft mounting flange, and all three blades were severely damaged by multiple impacts. The starboard propeller hub remained bolted to the crankshaft flange but the remainder of the propeller was shattered, with all three blades detached and severely damaged. In both cases there was evidence of rotation at impact, but it was not possible to reliably determine the blade angles.

All of the fuel system components were found and identified, with the exception of the finger screen of the left-hand inboard fuel cell. The fuel cells and fuel pipes were extensively broken up and widely dispersed throughout the wreckage trail. There was no evidence of fuel leakage or contamination of the fuel system and, although no fuel sample was recoverable, there were signs of a substantial quantity of fuel having seeped into the ground around the main impact area.

The flight control system showed no evidence of any defect or failure having existed prior to impact with the ground. All of the component failures and cable breaks were examined and found to be consistent with the break-up of the aircraft at impact. It was not possible from this examination to establish trim settings prior to impact or primary control positions at impact. Damage to the automatic flight system was so extensive as to preclude any opinion being formed as to its serviceability or operating status prior to the accident but examination of the remains of the servo units, which had sustained severe impact damage, revealed no evidence of any pre-existing defects.

Some sections of electrical wiring showed evidence of burning, but this was found to be of external origin and associated with small post-impact ground fires. None of the broken or abraded sections of the wiring showed any evidence of electrical arcing. The aircraft batteries had disintegrated on impact and their examination did not reveal any indication of abnormality or malfunction.

The Janitrol 39D59 combustion cabin heater was severely distorted and broken into several sections. There was no evidence of external fire having been present in the heater area prior to impact. The heater fuel valve was found in the ON position, and the evidence suggests that the heater was operating at the time of impact. There was no fire as the result of the disintegration of the heater, and all damage observed was consistent with ground impact.

All hydraulic system components were severely damaged, but there was no evidence of chafing or deterioration of any lines or hoses and all damage was considered to have been caused by impact. Slight metal contamination of the filters was noted but this did not appear to be excessive or indicative of any pre-impact malfunction.

The extreme fragmentation of the instrument panel areas precluded any useful information being obtained from the instruments. It was not possible to completely establish the integrity of the various flight instrument systems, but the examination was carried as far as practicable and no defects were evident. The port pressure pump was completely shattered and provided no useful evidence. The starboard pump, although severely damaged by impact, appeared to have been capable of normal operation prior to the accident. All identifiable instrument panel lights were examined in an attempt to establish their operating condition at impact. It was possible to determine that a number of panel lights had been illuminated. In addition, it was established that the navigation lights were illuminated at the time of impact, the port wing tip lamp filament showing a pronounced degree of stretching. The rotating beacon globes were completely destroyed and neither of their filaments was recovered.

1.14 FIRE

There was no evidence that VH-CIZ was subject to any in-flight fire. The aircraft carried approximately 100 gallons of 100/130 grade aviation gasoline and 5 gallons of oil at the time of impact and although the rubber fuel cells in both wings ruptured and the fuel was forcibly ejected into the air in the form of a visible cloud, no large scale fire occurred. Several very small ground fires occurred in and around isolated pieces of wreckage.

1.15 SURVIVAL ASPECTS

This was not a survivable accident. In the circumstances, no search and rescue ation was necessary.

1.16 TESTS AND RESEARCH

Spiral Stability Tests In connection with the examination of the flight path, several flight tests were carried out in an aircraft of the same type. For these tests the aircraft was loaded to maximum gross weight and the centre of gravity was at its aft limit.

The primary purpose of the tests was to examine the spiral stability of the aircraft and to determine the flight path that would occur if all control inputs were removed when the aircraft was trimmed in a climb configuration. During the tests the flight instrument readings were recorded on magnetic tape and by cinephotography.

The tests revealed that the aircraft is long-term spirally unstable. The divergence may occur in either direction as a result of some very small factor such as a minor degree of aileron or rudder mis-trim, random turbulence, or a small amount of lateral imbalance. In order to ensure that a left divergence occurred, as in the accident, a very small degree of aileron mis-trim was introduced. The flight path plots resulting from several tests in which the controls were released with the aircraft in trimmed climbing flight at 120 knots IAS, correlated closely with the radar plot of the early part of the final flight path.

The results of the tests may be summarised as follows:

1. There was a slow and almost linear increase in bank angle and rate of turn until a bank angle of 35 to 40 degrees was attained. At this point the rate of change of both parameters increased markedly and the tests were discontinued when the bank angle reached 60 degrees.
2. There was a gain in height of 400 to 500 feet during the early part of the turn but at 35 to 40 degrees bank angle the aircraft was established in a descent at a steadily increasing rate. At the time the tests were discontinued, height was being lost at a very rapid and still increasing rate.
3. The aircraft's pitch angle varied somewhat during the early part of the turn but at 35 to 40 degrees bank angle a positive nose-down pitch angle was established and this was increasing rapidly when the test was terminated.
4. The airspeed varied somewhat during the early part of the turn with an overall increase of about 20 knots as the bank angle increased to 40 degrees. Beyond this point the rate at which the speed increased was very rapid
5. The aircraft remained in balanced flight throughout the tests and the background engine and air noises did not vary appreciably. There were no noticeable physical sensations until the bank angle exceeded 45 degrees at which time the g loading first became apparent.

6. The tests established that, if all control inputs are removed, the aircraft will ultimately enter a steep spiral dive. The elapsed time for this to occur will depend upon the state of lateral and directional trim of the aircraft and the occurrence of any external disturbance.

The tests were carried through to the point where the aircraft was established, in each case, in a steep and tightening spiral dive. The rapidly increasing g loading dictated that they be discontinued at that time.

Radar Coverage Test A flight test was also carried out to determine the radar coverage in the vicinity of the accident site. A PA31 aircraft was used in this test, which was performed in fine cloudless conditions.

A race-track pattern was flown consisting of one-minute legs, with rate 1½ turns at each end, disposed about the accident impact point on headings of 314°M and 134°M (i.e. at right angles to the 224 degree localiser track).

The pattern was entered from the east at a height of 3,500 feet AMSL and a complete circuit was flown at each 500 feet interval down to 1,150 feet AMSL. Continuous communications were maintained with the radar controller and the following results were obtained:

3,500 feet — Radar contact was lost at the commencement of the turn at the western end of the pattern and regained at the completion of the turn.

3,000feet — Radar contact was lost at the commencement of the turn at the eastern end of the pattern and regained at the completion of the turn.

2,500 feet — Radar contact was maintained throughout.

2,000 feet — Radar contact was maintained throughout.

1,500 feet — Radar contact was lost throughout the whole of the eastern half of the pattern.

1,150 feet — Radar contact was lost throughout the whole of the eastern half of the pattern.

2 - Analysis

The evidence indicates that from an established normal flight condition, control of the aircraft was lost and recovery was not effected, but there was no indication of any readily discernible causal area.

Operational and Meteorological Aspects With the exception of the possibility of minor overloading, which has been referred to in Section 1.6, there was nothing to indicate that the pre-flight preparation was other than routine. The extent of possible over-loading would not have affected the aircraft's performance to any marked degree and this is confirmed by the tower controller's observation of a normal take-off and initial climb. It is apparent, however, that the standard of load control exercised by the operator, the pilot and the charterer did not provide an adequate safeguard against possible over-loading.

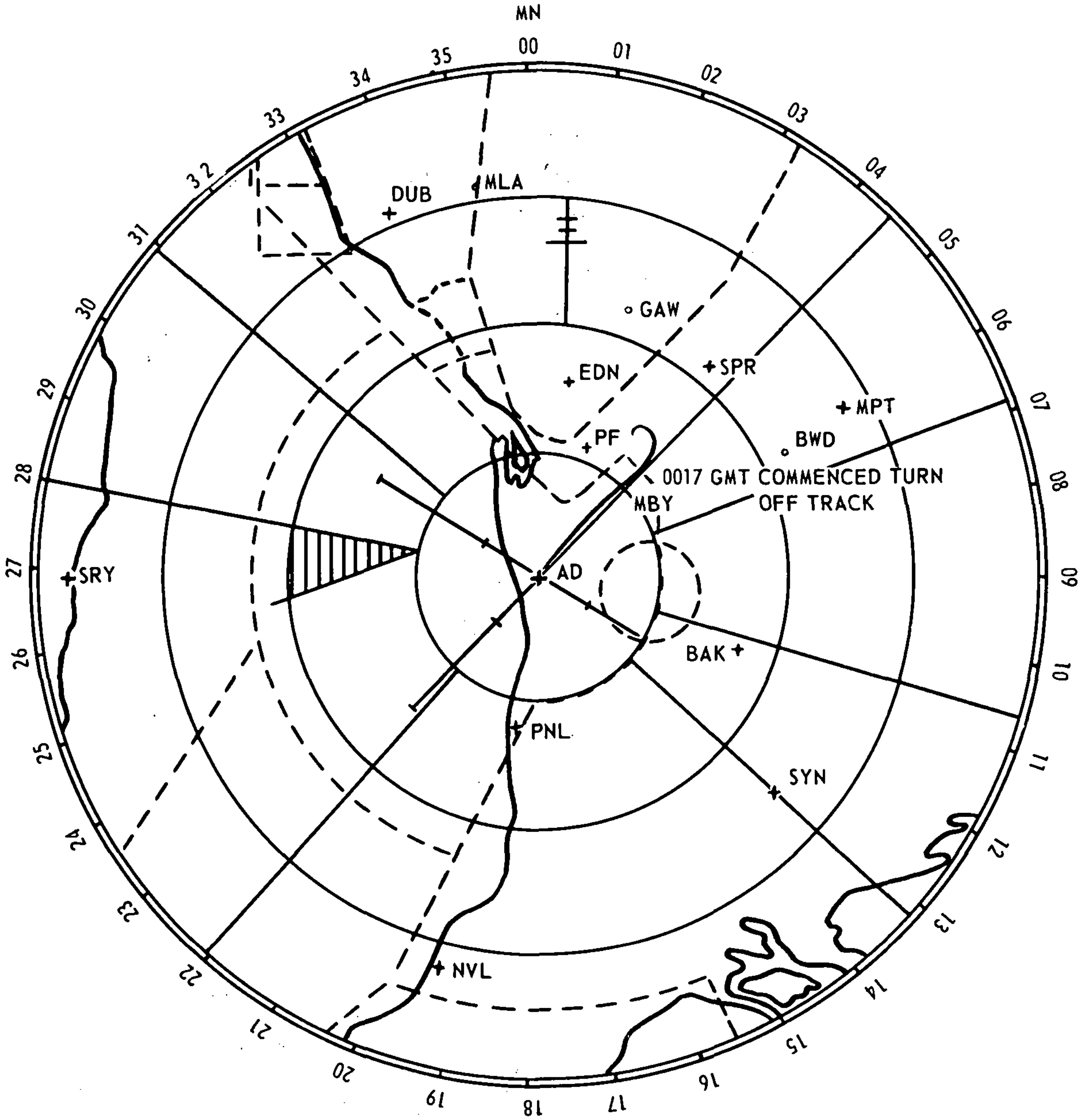
It has been established that, depending upon wind effects and aircraft weight, a PA31 aircraft will normally reach an altitude of 3,500 to 4,000 feet at the Modbury locator following a take-off on Runway 04 at Adelaide. It therefore seems likely that, when VH-CIZ first diverged from the localiser track, some two miles beyond Modbury, it would have been at an altitude of about 4,000 to 4,500 feet. The impact point was 675 feet above mean sea level and thus there was a probable height loss of about 3,500 feet before the aircraft struck the ground.

The reconstruction of the aircraft's final flight path involves the consideration of evidence from two sources, the radar plot and the observations of the ground witnesses.

The radar plot (Fig. 2) is the basis of definition of the first segment of the final flight path. The radar plot is a small scale drawing completed by the controller some minutes after the event and is a line joining the controller's recollection of the position of a series of transient pulses, at 12 second intervals, observed on the radar screen. The radar plot so obtained has been replotted on a large scale map of the accident area (see Fig. 3) and the resultant flight path falls well outside the impact area. This is quite understandable when the small scale of the original drawing is taken into consideration. However, the evidence from the radar plot is

ADELAIDE RADAR PLOT

RAN : SCALE 40 N.M.



DATE. 13 / 7 / 70 TIME. 0747 CST AIRCRAFT VH-CIZ

ROUTE ADELAIDE TO MOOMBA FLIGHT CONDITIONS IFR

REMARKS. AIRCRAFT OBSERVED ON RADAR TO DEVIATE OFF TRACK. AT 0748 RETURN DISAPPEARED AND COMMUNICATION WAS LOST

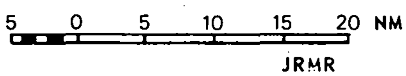


FIG. 2

considered to be valid to the extent of indicating that, at a point about two miles beyond the Modbury locator, the aircraft commenced to turn gradually to the left, that the rate of turn was gradually increasing, and that, when the last return was recorded, the aircraft was heading in approximately a westerly direction.

The second segment of the final flight path (see Fig. 3) has been obtained from a number of eye-witness observations of the aircraft's emergence from cloud and its subsequent flight to the ground impact point. This segment is quite short, some 2,400 feet, but can be accurately positioned.

Radio-communications provide a time base for the flight path segment covered by the radar plot but it was not possible to accurately determine the times of impact or emergence from cloud. Therefore the two defined segments of the final flight cannot be co-related in time.

It is possible to construct a final flight path in which the visually observed flight path is a direct continuation of a turn similar to that shown by the radar plot (see Fig. 3). Such a flight path would imply a smooth uninterrupted turn from the point of diversion from the localiser track to the ground impact point. The distance traversed in such a flight path is some 18,300 feet and during this time, if 3,500 feet of height had been lost, the average descent angle would have been about 11 degrees. Assuming an airspeed between 140 knots and 220 knots, the maximum angle of bank would have been between 30 and 45 degrees and a mean rate of descent of the order of 3,500 feet per minute would apply.

It is of course possible, using varying rates of descent, to construct any number of flight profiles which will terminate at the main impact point. Flight tests have shown however, that, to follow any of these flight paths, control inputs would be necessary to overcome the effect of nose-up trim and to prevent an excessive bank angle from developing.

An alternative flight path can be constructed in which a spiral dive involving a turn through about 360 degrees occurs between the termination of the flight segment illustrated by the radar plot and the commencement of the visual segment (see also Fig. 3.). Such a flight path would be consistent with the stick-free behaviour of the aircraft noted in the flight tests if it is assumed that recovery action was initiated in the course of the spiral dive and the recovery action was becoming effective as the aircraft emerged from cloud, but in a situation where there was insufficient terrain clearance to effect full recovery before the aircraft struck the ground.

The main objection to this second proposition arises from the fact that no steep spiral dive was detected by the radar controller. It will be noted, however, that the flight tests reported at Section 1:15 indicate a good deal of intermittency in the radar contacts in this area, particularly when the target is turning. The scan rate of the type of radar equipment in use is one turn each 12 seconds and, if one or two strikes had not been recorded on the screen when the aircraft was in the steep spiral dive phase of the suggested manoeuvre, it would probably have been below radar coverage by the time the recovery action was commencing to take effect.

There is evidence that the aircraft entered cloud at a height of about 700 feet shortly after take-off and there is little doubt that it remained continually in cloud until it emerged shortly before impact with the ground. The strong beam wind which was present would have produced an appreciable degree of drift and the aircraft would have been subjected to almost continuous moderate turbulence but there is no evidence that any hazardous meteorological condition existed. The early part of the final flight path is not indicative of a major upset occasioned by some meteorological phenomenon and, in addition, an aircraft of the same type flew over the same track some 15 minutes later and encountered no difficulties.

Engineering Aspects The on-site examination of the wreckage and the subsequent lay-out and re-assembly of the wreckage did not reveal evidence of any defect or malfunction. The integrity of the aircraft was established up to a point in time just before impact with the ground but the distribution of wreckage prior to the main impact point indicates that, at this time, structural failure of the starboard wing and the tailplane occurred as a result of excessive flight loads and the elevators became detached.

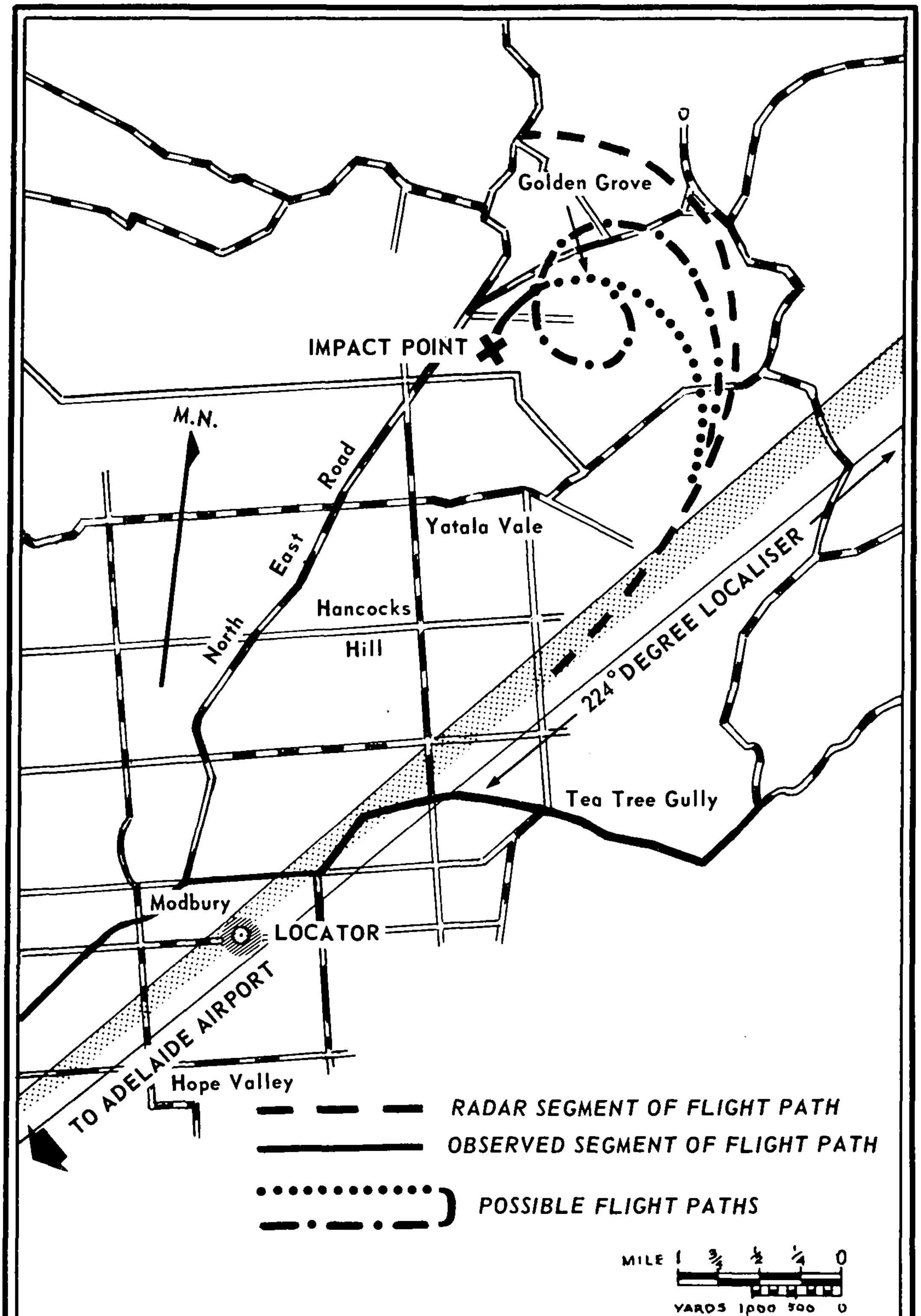

Golden Grove
IMPACT POINT
M.N.
North East Road
Yatala Vale
Hancocks Hill
224° DEGREE LOCALISER
Tea Tree Gully
Modbury
LOCATOR
TO ADELAIDE AIRPORT
Hope Valley
RADAR SEGMENT OF FLIGHT PATH
OBSERVED SEGMENT OF FLIGHT PATH
POSSIBLE FLIGHT PATHS
MILE 1 3/4 1/2 1/4 0
YARDS 1000 500 0

FIG. 3

The engineering areas which are of relevance to the initiation and development of the accident situation primarily concern the flight control system and flight instrmentation.

A detailed examination of the flight control system, including the trim system, revealed no evidence of any pre-existing defect and all cable and other failures were of an overload nature consistent with impact with the ground.

The flight instruments on this type of aircraft are variously operated by air pressure, pitot/static pressure or electrical power. The gyro instruments, with the exception of the turn and bank indicators are operated by air pressure derived from a pump on each engine. The output of the two pumps is manifolded and check valves are provided in the system so that, in the event of either pump failing, all pressure-driven gyro instruments will continue to operate normally. A pressure gauge on the instrument panel indicates system operating pressure and this gauge incorporates a pump failure warning system. The possibility of failure of both pumps and consequent loss of both directional gyros and gyro horizons is very low, but, as a safeguard against this, the turn and bank indicators are electrically operated should reversion to primary panel become necessary. The airspeed indicators, the altimeters, and the vertical speed indicators are normal pitot/static instruments provided with pitot head anti-icing and an alternate static source.

The possibility of simultaneous failure of all three or any two of the flight instrument systems has not been contemplated but the early part of the final flight path would not be incompatible with a failure of the pressure operated gyro instruments. It is most improbable, however, that such a failure would not have been quickly detected by the pilot during cross reference to the pitot/static instruments and confirmed by the pressure failure warning system.

The aircraft was equipped with a three axis auto-pilot which incorporates automatic elevator trimming, altitude and heading holds and a localiser tracking capability. The operator had not placed any limitations on the use of the auto-pilot and the senior pilot had instructed pilots to use it as much as possible. Evidence suggests that the normal procedure for the pilots employed by this company was to engage the auto-pilot, either partially or fully, on reaching a height of about 1,500 feet after take-off and to use it in the heading hold mode. It was also reported that the auto-pilot disconnect button on the control yoke of VH-CIZ was extremely sensitive and this feature was demonstrated on a similar type of aircraft when it was shown that disconnection would occur if the button was tapped gently with a single sheet of paper or brushed with a shirt sleeve.

Human Factors Aspects This accident was preceded by a loss of control from which recovery was not effected and, in these circumstances, the question of a pilot incapacitation warrants close consideration. The pilot's medical history and evidence as to his recent good health do not cast any doubts on his fitness, but as the post-mortem examination was necessarily limited, the possibility of in-flight incapacitation cannot be entirely eliminated.

Nevertheless, it seems unlikely that incapacitation of Mr. Crouch could offer an adequate explanation for the accident unless such an incapacitation resulted in interference with the flight controls. Mr. Saunders, who occupied the right hand control seat, had considerable flying experience and held a Class 4 Instrument Rating. Although qualifications for this class of instrument rating is directed primarily towards night operation under visual conditions, some capacity for attitude flight on instruments is required to be demonstrated. Crouch had arrange that Saunders, who was a close personal friend, should occupy the right-hand seat in his aircraft and he was accompanied by him to the pre-flight briefing.

Both pilot seats were fitted with shoulder harnesses and inertia reels. There was no evidence to indicate whether the shoulder harnesses were being used but in any case their use would not necessarily prevent interference with controls in the event of pilot incapacitation. Furthermore, the presence of a cabin divider behind each pilot seat could make removal of a collapsed occupant quite difficult.

For the reasons already discussed, the radar plot would not necessarily indicate minor aberrations in the aircraft's flight path in the horizontal plane and there could well have been gross disturbance in the vertical plane without detection. The possibility exists, therefore, that, as a result of incapacitation, the pilot collapsed forward onto the controls and that, in the approximate one minute period available, although some measure of control was retained, Saunders was unable to effect recovery from the ensuing dive.

The evidence that an in-flight structural failure probably occurred very shortly before impact suggests that control inputs were being made at this time but does not resolve the possibility that pilot incapacitation may have been present. It could well have been that last-minute attempts to avoid collision with terrain, when visual flight conditions were re-established, resulted in the aircraft being over-stressed, but in any case the accident was inevitable at the time the structural failure occurred.

The likelihood of the pilot having been affected by vertigo or spatial disorientation has been considered but the flight paths which have occurred in documented cases of accidents occuring under these conditions involve a series of stalls and recoveries together with gross heading changes. This does not fit any flight path likely to have occurred in this accident. The presence of another pilot in the cockpit is also a barrier to acceptance of this proposal.

Summary The two possible flight paths which have been postulated are each indicative of a manner in which the accident could have developed. If the relatively shallow, descending turn is accepted it implies that the aircraft was subjected to some degree of control through the manoeuvre. If there were no control restrictions it is difficult to conceive any situation in which the balanced descending turn of this proposed flight plan would not have been disrupted by some attempt at what should have been a simple and straight-forward recovery manoeuvre. It is possible, however, that pilot incapacitation could result in a partial control restriction such that, although complete loss of control did not occur, there was insufficient control effectiveness to recover from the ensuing dive in the time available. There is no evidence upon which a finding of pilot incapacitation leading to an irretrievable loss of control can be advanced.

In the case of a flight path which includes a steep spiral dive, there would be no external reference or physical cues present during the early stage of divergence from the established flight path and monitoring of the flight instruments would provide the only indications to the pilot that this had occurred. If the attention of the pilot was briefly distracted during this period, the divergence could progress to a rapidly descending spiral dive, before physical sensations would redirect the pilot's attention to the flight instruments. In such a case, with the aircraft in an unusual attitude in cloud, there may have been insufficient time and height available for the pilot to asses his instrument indications, initiate recovery action and arrest the descent before the aircraft struck the ground. The situation as postulated could develop if the aircraft had previously been climbing under the control of the auto-pilot and inadvertent disconnection had occured. However, again there is no positive basis on which a finding in accordance with his hypothesis can be advanced.

It can be seen that a number of hypotheses can be advanced to explain why control of the aircraft might be lost but, since it has not been possible to establish, with certainty, the final flight path or the sequence of events which occurred during this period, the investigation has not been able to determine the reason for this loss of control.

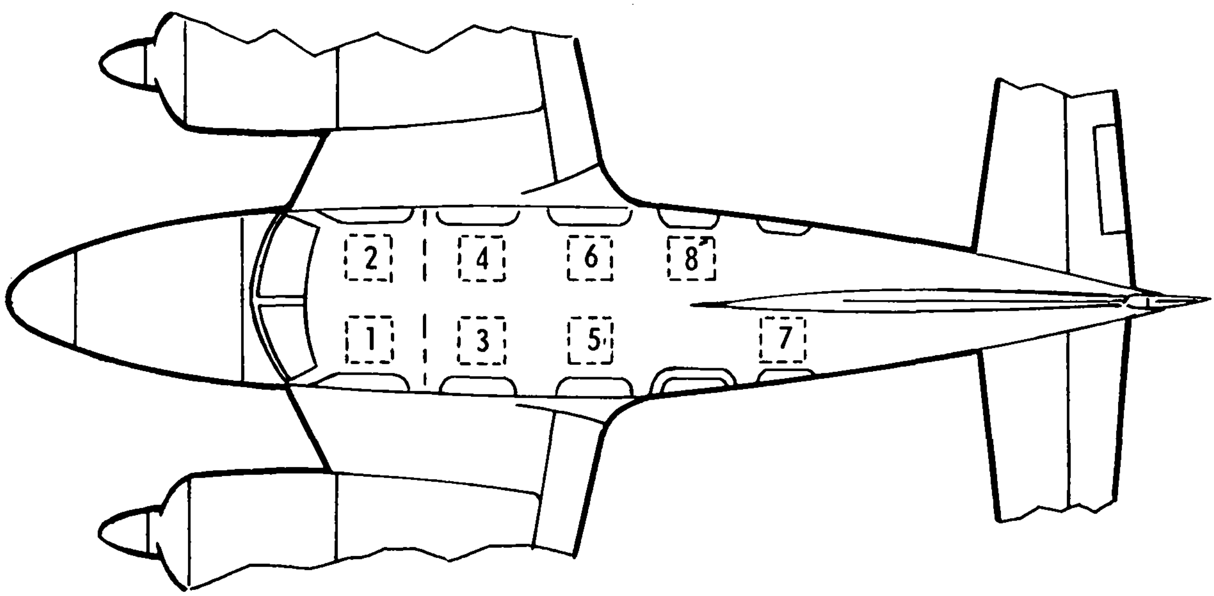
3 - Conclusions

1. The pilot of the aircraft was properly licensed, rated and experienced for the duties he was undertaking and he had no evident medical diability.
2. There was a current certificate of airworthiness for the aircraft and there was no evidence of any defect or malfunction which could have contributed to the accident.
3. Some seven minutes after a normal take-off and initial climb, control of the aircraft was lost and it subsequently struck the ground at high speed in a shallow dive.
4. Although the aircraft was operating in cloud from a height of about 700 feet after take-off until it emerged at a height of 300 to 500 feet above the terrain shortly before impact, there is no evidence of any meteorological condition which may have contributed directly to the accident.

Cause The cause of the accident was that control of the aircraft was lost and recovery was not effected before it struck the ground. The reason for the loss of control and the inability to take effective recovery action has not been determined.

LIST OF AIRCRAFT OCCUPANTS SHOWING

SHOWING SEATING ARRANGEMENTS



SEAT	OCCUPANT	AGE	ADDRESS
1	CROUCH,Jack Dennis	47	ADELAIDE S.A.
2	SAUNDERS, Clive Gordon Hardes	26	-- -- --
3	BARTLETT, Eward Arthur	34	-- -- --
4	McLEOD,Graham David	22	-- -- --
5	MINARELLI, Allen Lewis	31	-- -- --
6	COLLINGRIDGE. John Charles	33	-- -- --
7	LAWSON,Eward Douglas	43	-- -- --
8	GREENHALGH, Ellis Walter	48	-- -- --

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