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Department of Transport
Australia

ACCIDENT INVESTIGATION REPORT

Air Safety Investigation Branch

Partenavia P68B Aircraft VH-PNW near Essendon Airport, Victoria, on 10 July 1978

Special Investigation Report 79-1

AIR SAFETY INVESTIGATION BRANCH

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The Secretary to the Department of Transport authorised the investigation of this accident and the publication of this report pursuant to the powers conferred by Air Navigation Regulations 278 and 283 respectively.

Prepared by Air Safety Investigation Branch

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Contents

Note 1: All times are Eastern Standard Time and are based on the 24-hour clock. Where applicable, seconds are shown using a six figure time group.

Note 2: Metric units are used except for airspeed and wind speed which are given in knots; and for elevation, height and altitude which are given in feet.

THE ACCIDENT

At approximately 1853:30 hours EST on 10 July, 1978, Partenavia P68B aircraft registered VH-PNW, with a crew of two and one passenger aboard, became airborne from Runway 26 at Essendon Airport, Victoria, and climbed to a height of 200 to 250 feet. Co-incident with the raising of the wing flaps from the take-off position and a simulated failure of one engine, the aircraft assumed a nosedown attitude and continued straight ahead on a descending flight path.

The aircraft crashed into houses 286 metres beyond the western end of the runway. Six persons on the ground were killed, and one person received minor injuries. The aircraft was destroyed and the three occupants were seriously injured.

1 FACTUAL INFORMATION

1.1 HISTORY OF THE FLIGHT

1.1.1 Nature of the Operation

Partenavia P68B aircraft, registered VH-PNW, was operating under a current certificate of registration, the holder of which was Tank Aviation Pty Ltd. At the time of the accident the aircraft was being operated by Speedair Pty Ltd. It was engaged on an aerial work flight under the terms of a current charter, aerial work and flying school licence.

The aircraft had been hired by the holder of a private pilot licence for the purpose of maintaining recent experience required for him to continue to act as pilot-in-command of twin-engined aircraft in Visual Meteorological Conditions (VMC) at night. Additionally the pilot hired the services of a flying instructor employed by Speedair Pty Ltd to check his operating procedures and manipulative skill.

1.1.2 Description of the Flight

The pilot-under-supervision arrived at the offices of Speedair Pty Ltd, Essendon Airport, at about 1800 hours. The flight was duly recorded in accordance with the operator's procedures and, shortly afterwards, he commenced a pre-flight inspection of the aircraft, which included inspection of the stabilator for damage, freedom of movement and compatibility of the relative positions of the stabilator, its trim tab and the cockpit trim position indicator. Meanwhile, the flying instructor, who was the pilot-in-command, attended the Department of Transport Aircraft Movement Reporting (Operations) Office and submitted a flight plan which covered the proposed flight. This indicated that the flight duration would be 30 minutes with an estimated time of departure of 1835 hours EST to undertake three circuits and landings, and that the flight category was Instrument Flight Rules (IFR). This flight plan was approved by Air Traffic Control and endorsed as valid for departure from 1835 hours until 1905 hours. The pilot-in-command then proceeded to the aircraft, completed a walk-around inspection, established that a pre-flight inspection had been completed and boarded the aircraft.

The pilot-under-supervision occupied the lefthand pilot seat, and the pilot-in-command occupied the righthand pilot seat. One passenger, a personal friend of the pilot-under-supervision, occupied the passenger seat immediately behind the pilot-in-command.

Following receipt of the flight plan the Essendon Airport Air Traffic Control Unit carried out the liaison required with the Melbourne Area Approach Control Centre preparatory to the release of airspace to the Senior Tower Controller, Essendon Airport, to enable the flight of VH-PNW to be undertaken.

Prior to the commencement of the flight, the pilot-under-supervision requested that the pilot-in-command, if he was satisfied with the conduct of the first two circuits, simulate an engine failure of one engine after take-off on the third circuit.

VH-PNW first contacted Essendon Tower at 1821:18 hours with a request for a clearance to taxi for the purpose of undertaking the planned flight. At 1829:00 hours VH-PNW received airways clearance to operate from Runway 26 'lefthand circuits within three nautical miles of the aerodrome not above one five zero zero.' At 1830:40 hours VH-PNW was cleared to 'line-up' and clearance for take-off was transmitted at 1832:05 hours. The take-off and subsequent circuit were without incident.

It was decided to carry out a touch-and-go landing and the aircraft was cleared to do so at 1839:40 hours. This manoeuvre was completed without incident and at 1844:15 hours VH-PNW reported 'turning base for full stop'. The aircraft landed at about 1848 hours and was cleared to taxi, via the taxiways, for a third take-off from Runway 26. At 1850:50 hours the pilot-in-command advised 'ready' and was cleared to 'line up'. At 1852:20 hours VH-PNW was advised 'clear for take off make left circuit'. The acknowledgement of this transmission was the last recorded communication from the aircraft.

The pilot-under-supervision has reported that the standard pre-take-off cockpit checks were completed, in particular the stabilator trim indicator was set within the take-off range, the fuel boost pumps were selected ON, and the wing flaps were set at 15 degrees. Prior to release of the brakes, both engines were run to about 75 per cent power and take-off with full engine power was then initiated. The aircraft was rotated at 80 knots and climb was established at 110 knots.

At a height of 200 to 250 feet the pilot-under-supervision selected the wing flaps UP and, at about this time, the pilot-in-command simulated an engine failure of one engine by closing a mixture control—believed to have been the starboard engine. The pilot-under-supervision identified the 'failed' engine, exercised the appropriate engine throttle to signify this identification and indicated the essential actions which would be taken in the event of an actual engine failure. The relevant controls were not operated. Following the completion of these actions full engine power was restored by the pilot-in-command.

During the course of the simulated engine failure the aircraft assumed a nosedown attitude. It then descended straight ahead with full engine power, passed through electric power cables outside the airport boundary at a height of 4.15 metres above terrain, and crashed into houses 286 metres beyond the western end of the runway.

The accident occurred at night at about 1853:30 hours, civil twilight having ended at 1745 hours.

1.1.3 Reconstruction of the Flight Path

At Appendices B and C two graphical representations of the flight path are shown. These graphs, which are based on time from start of take-off and distance from start of take-off respectively, have been derived from computer integration of known performance of the aircraft, flight test information and the following parameter values applicable to this flight:

Aircraft weight	:	1803 kg
Headwind component	:	10 knots
Temperature	:	+5 C
Runway pressure height	:	0 ft
Lift-off speed	:	80 kn CAS
Simulated engine failure speed	:	106 kn CAS (110 kn IAS)
Acceleration after power restoration	:	6.3 ft/sec^2

The pilot-in-command has no recall of the circumstances of the accident. The pilot-under-supervision states that when the engine failure was simulated he aimed to maintain the existing climb attitude as it was intended to be a brief exercise to be completed before it would become necessary to establish the aircraft in a single-engined climb. He further reported that when full engine power was restored the airspeed was 110 knots and the aircraft then of its own accord changed from a climb attitude to a level attitude. Initially he felt this change, then confirmed the change by visual reference outside the aircraft. The aircraft attitude continued to change further nosedown and the airspeed increased. He was unable to move the control column rearwards, or move it sufficiently to change the aircraft attitude. He has no recollection of operating the electric trim switch at any time. The pilot-in-command instructed him to 'pull back', then attempted to do so himself, also checking that the throttles were in the full power position.

The three air traffic controllers on duty in Essendon Tower observed the take-off of VH-PNW. Nothing unusual was observed until such time as the aircraft was abeam of the control tower, apparently in a normal climb, at a height of 200 to 250 feet. The aircraft attitude then changed quite positively to slightly nosedown and the aircraft entered a 'gentle descent' compatible with some previously observed flight paths associated with a simulated engine failure. The descent continued with the speed higher than expected and the descent path possibly steepening. When the aircraft was in the vicinity of the western end of the runway the controllers became apprehensive for the safety of the aircraft and alerted the emergency services. Almost immediately thereafter, the aircraft crashed. Due to the control tower being sound proofed, the controllers were unable to hear any changes of engine noise which could be associated with the flight path of the aircraft.

A number of witnesses were located in the northwestern sector of the airport and environs and they described the flight path in similar terms to the air traffic controllers. Some witnesses were in locations where engine noise could be heard. The consensus of these witnesses was that the engine noise originally sounded normal for a twin engined aircraft; there was then a marked reduction in engine noise followed a few seconds later by a very rapid increase to a level consistent with normal two engine operation. At this time the aircraft appeared to be descending along a flight path similar in slope to a landing aircraft.

Witnesses travelling in vehicles along the roadway and the tramway adjacent to the western boundary of the airport observed the aircraft but generally only for a few seconds as it crossed their lines of vision at a height of some 40 feet. Those who noticed engine noise referred to it as being loud.

At a late stage of the descent, the pilots banked the aircraft to the right in an attempt to pass between houses directly ahead. A number of witnesses to the west of, and therefore ahead of the aircraft describe the engine noise about this time as being at less than full power, possibly backfiring. The starboard wing of the aircraft passed through electric power cables then, when banked to the right some 25 degrees, impacted the front of a house. The final angle of descent was 6.3 degrees.

1.2 INJURIES TO PERSONS

Injuries	*Crew*	*Passengers*	*Others*
Fatal	—	—	6
Non-Fatal	2	1	1
None	—	—	—

1.3 DAMAGE TO AIRCRAFT

The aircraft was destroyed by impact forces and by fire which occurred after the ground impact.

1.4 OTHER DAMAGE

One house was destroyed by the combined effects of an explosion and subsequent fire caused by the ignition of fuel from the righthand wing. A neighbouring house suffered minor damage from the wing, propeller and lefthand main landing gear. The fuselage struck the rear of a third house, causing serious structural damage and some minor fire damage. The fuselage also demolished a small building at the rear of the house which was destroyed. Panels of fencing were destroyed or damaged and minor damage was inflicted upon other outbuildings near the accident site. Two electric power cables and the associated obstruction markers were brought down by the righthand wing.

1.5 PERSONNEL INFORMATION

1.5.1 Flight Crew

The pilot-in-command was Alan Clement Baskett, aged 40 years. He held a commercial pilot licence which was valid until 31 October 1978. His licence endorsements included Partenavia P68B aircraft and he held a Class 1 instrument rating endorsed for ADF, VOR, DME, ILS and LQCALISER radio navigation aids. He held an A Grade flight instructor rating and he was an approved pilot to conduct endorsement training and testing of private or higher categories of pilot licence holders, on multi-engined aircraft. His total aeronautical experience at the time of the accident was 3512 hours of which 2942 hours had been flown as a flight instructor, and 100 hours at night. He had flown a total of 282 hours in multi-engined aircraft, 86 of these hours as a flight instructor. In respect of Partenavia P68B aircraft he had flown 2 hours 30 minutes under dual instruction, and 229 hours 15 minutes as pilot-in-command; 15 hours 40 minutes of this time having been flown at night.

His most recent proficiency check was successfully completed on 23 June 1978 in a Partenavia P68B aircraft. His most recent flight crew medical examination was passed on 16 September 1977. During the day preceding the accident he had flown about 2 hours 30 minutes. He had retired at a normal hour arising at about 0900 hours EST on the day of the accident. He then flew for about 2 hours 30 minutes during that afternoon.

The pilot-under-supervision was Geoffrey Walker, aged 33 years. He held a private pilot licence which was valid until 31 December 1978. His licence endorsements authorised him to fly Partenavia P68B aircraft and he held a Class 4 (Night VMC) instrument rating applicable to single and multi-engined aircraft. These ratings were obtained in February 1977 and January 1978 respectively.

His total flying experience at the time of the accident was 288 hours of which 28 hours had been flown at night. He had flown 30 hours 25 minutes by day and 3 hours 50 minutes by night in Partenavia P68B aircraft.

His most recent proficiency check was successfully completed on 18 January 1978 and it had been undertaken in a Partenavia P68B aircraft. His most recent flight crew medical examination was passed on 9 December 1976. During the day preceding the accident he had flown a single engined aircraft for 1 hour 30 minutes. He had retired at a normal hour arising to commence work at 0730 hours EST on the day of the accident. He finished work at 1600 hours and, after an evening meal, arrived at Essendon Airport at about 1800 hours EST.

1.5.2 Air Traffic Control

An Air Traffic Control Unit is established in the Essendon Tower with provision for three operating positions. At the time of the accident it was manned by a Senior Tower Controller, a Surface Movement Controller, and a Co-ordinator.

All three air traffic controllers held valid air traffic controller licences containing endorsements appropriate to the services they were providing.

1.6 AIRCRAFT INFORMATION

1.6.1 History

VH-PNW was a Partenavia P68B aircraft which was manufactured in 1976 by Partenavia Construzioni Aeronautiche S.p.A. in Italy and allotted Serial No. 65. At the time of the accident, VH-PNW had flown a total of 819 hours since new.

The aircraft had been maintained in accordance with Air Navigation Orders 100.5.0 and 100.5.1. The aircraft was operating under a current maintenance release and had flown 54.1 hours since the inspection for issue of that document on 30 May 1978. However, certifications made for the electrical and instrument category inspections performed prior to the issue of the maintenance release had been made by an LAME who was not licensed in these categories. This constituted a technical breach of the regulations but had no bearing on the accident.

There was a daily inspection certification recorded in the maintenance release for 10 July 1978 and at the time the aircraft commenced flying that evening there were no known defects in the aircraft or its equipment.

1.6.2 Equipment

The P68B aircraft is fitted with an all-moving tailplane. Aerodynamic 'feel' is provided by a trailing edge anti-balance tab which is also controllable from the cockpit to provide longitudinal trim.

The stabilator trim control consists of a manually operated trim wheel, with integrated position indicator, located on the pedestal below the engine controls. Movement of the trim wheel is transmitted to the trim tab actuator, mounted adjacent to the trim tab, by a single steel cable forming a closed circuit. The cable passes over two 'Vee' pulleys, one adjacent to the trim wheel and the other on the actuator.

In addition to the manual system, the aircraft is fitted with an electric pitch trim system and the trim cable described previously passes around the capstan of the pitch trim servo. The system has two operating modes, command trim and auto-trim. The command trim mode operates independently of the autopilot system and provides the pilot with the facility of actuating the stabilator trim system by means of a rocker switch. The auto-trim mode operates when the pitch section of the autopilot is engaged, and provides automatic aircraft longitudinal trim. The system is designed to withstand any type of single malfunction without uncontrolled operation resulting. A detailed pre-flight check procedure is specified to detect any malfunction. When the top bar of the command switch, which is located on the top of the left horn of the left control yoke only, is depressed it disconnects the autopilot, if it should be selected on, and arms the command mode. If the top bar is held depressed and the switch is moved forward, a nose-down trim change will occur. If the top bar is held depressed and the switch is moved rearward, a nose-up trim change will occur. Forward or rearward movement of the switch is not effective unless the top bar is held depressed (see Appendix D).

In addition the system includes a master disconnect/interrupt switch which is also located on the top of the lefthand control yoke, forward of the command switch. When depressed and released it disconnects the auto pilot, if it should be selected on. When depressed and held it interrupts all electrical operations of the trim system. Subsequent action, if required, is to then turn off the autopilot and the trim master switch which is located on a panel on the left side of the cockpit.

In the event of a 'runaway' of the electric trim system it can also be overriden by holding the manual trim wheel.

1.6.3 Loading

The maximum permissible weight, for this type, for take-off is 1960 kgs and for landing 1860 kgs. It has been calculated that at the time of the last take-off the gross weight of the aircraft was 1803 kgs. The allowable centre-of-gravity range for the aircraft at a weight of 1803 kgs is from 306 to 526 mm aft of datum which is the wing leading edge. It has been calculated that at the time of the last take-off the centre-of-gravity position was 319 mm aft of datum.

1.7 METEOROLOGICAL INFORMATION

The terminal area forecast for Essendon Airport which was current at the time of the accident covered the period 1800 hours EST on 10 July 1978 to 0600 hours EST on 11 July 1978. The conditions forecast were:

Wind	:	230 degrees (True) at 10 knots
Visibility	:	In excess of 10 kilometres
Cloud	:	4/8 Cumulus, 3000 feet
Temperature	:	7, 5, 3, 2 degrees Celsius
QNH	:	1006, 1007, 1008, 1008 millibars

The aerodrome terminal information service (ATIS) which was current at the time of the accident was designated 'golf'. It was first broadcast at 1817 hours and was current until 1902 hours when a change of runway was made. It contained the following information:

. . . wind two eight zero degrees one zero, QNH one zero zero six, temperature six, cloud three octas at three thousand . . .

The recording of the airport anemometer indicates that at the time of the accident the wind direction as 290–310 degrees (Magnetic) at 10–12 knots.

The moon, which was in its first quarter, was setting on a true bearing of 307 degrees from the airport at an elevation of 30 degrees 22 minutes.

A pilot who landed on runway 26 some five minutes before the accident described the flying conditions as excellent. He stated that the visibility was excellent, there was no turbulence and he was not aware of any cloud below 3000 feet.

1.8 AIDS TO NAVIGATION

The availability and use of navigation aids were not relevant to the accident.

1.9 COMMUNICATIONS

With the exception of an omission to obtain a clearance to start the aircraft engines, the communications with VH-PNW were normal in all respects. VHF communication facilities were used between VH-PNW and Essendon Tower and were recorded on continuously running magnetic tape. Aural examination of this recording indicates that the communications from VH-PNW were made by the pilot-in-command.

1.10 AERODROME AND GROUND FACILITIES

Essendon Airport, elevation 260 feet a.m.s.l., contains two sealed runways designated 17/35 and 08/26. Runway 26 bears 259 degrees magnetic and was in use at the time of the accident. The runway surface is 1920 metres long and 60 metres wide, surrounded by an unsealed strip 2040 metres long and 180 metres wide.

Runway 26 is served by a low intensity omni-directional and high intensity uni-directional side lighting system. The total system has available six stages of brilliance, the intensities of which are matched with an approach lighting system. At the time of the take-off preceding the accident the runway and approach lighting were selected to Stage 2. The taxiways are marked by green centreline lighting and appropriate sections of the two runways, when used as taxiways, are marked by sideline blue lighting. All appropriate taxiway lighting was operating, probably selected to Stage 1.

Obstruction and hazard lighting at Essendon Airport is automatically selected in conjunction with the selection of runway lighting. With the exception of the two most northern obstruction lights marking poles carrying overhead power lines and which were not in a position significant to the intended or final flight path of VH-PNW, all the airport obstruction lighting was operating.

A double-sided white rotating beacon, which rotates eight times per minute, is situated on the top of the air traffic control tower. This beacon was operating at the time of the accident. The control tower is located approximately in the middle of the airport 675 metres north-north-west of the intersection of the runways.

No evidence was found of any deficiency, defect or malfunction in the airport facilities which could have affected the operation of the aircraft at the time of the accident.

1.11 FLIGHT RECORDERS

The aircraft was not equipped with either cockpit voice or flight data recorders and there was no requirement for it to be so equipped.

1.12 WRECKAGE AND IMPACT INFORMATION

The wreckage trail commenced 255 metres from the threshold of Runway 08 on a bearing of 272 (T) where the righthand wing tip struck electric power cables 4.15 metres above the terrain. The trail extended some 130 metres and the large majority of items were contained within a swath 10 metres wide.

The first major impact occurred when both wings almost simultaneously struck the front of two houses facing the airport. At that point the aircraft was banked 25 degrees to the right, descending at an angle of 6.3 degrees and travelling at a ground speed of 133 knots. The righthand wing, outboard of the engine, was torn off immediately and entered the house which it had struck, through a front window. That part of the wing contained the righhand fuel tank, and fuel spilling from the ruptured tank inside the house ignited causing an explosion and fire in the building. Because of the angle of bank the lower spar cap of the lefthand wing just outboard of the engine nacelle struck the edge of a roof line of the neighbouring house. The reduced structural strength was insufficient to resist the applied aerodynamic loads, and the outer wing failed upward and rearward as the wing passed across the roof. The wing was found at the rear of the house which had been destroyed. It had been burnt in a local post-impact fire originating from the fuel in the fuel tank.

The fuselage, with wing centre section and engines attached, passed between the two houses, along the top of the dividing fence. During that time the stabilator was torn off. It was later found, in pieces, behind the houses. The fuselage continued on, cartwheeled through 180 degrees, demolished a small outbuilding and slid tail first into the rear of a third house, causing extensive damage to the fin and rear fuselage. A small fire then broke out around the lefthand engine, which was extinguished before it caused serious damage. The righthand engine separated from the wing during the final part of the ground slide, and came to rest inverted in the rear wall of the third house, below the engine mounts on the wing.

The aircraft was virtually destroyed by the impact. No pieces of the aircraft were found outside of the wreckage trail, and all significant items and components which could possibly have caused control difficulties were located. All of the wreckage was removed to a hangar at Essendon Airport and laid out to establish the status of the aircraft at impact. This examination revealed that the flaps were up; the propeller blade angles were within the constant speeding range; both engines were capable of normal operation and the evidence overall indicates that they had been operating at substantial power at impact. The cockpit overhead light, the landing light, tail position light and two instrument panel lights were on at impact. No other bulbs or switches were recovered in a condition which enabled a determination of their operating status.

There was no evidence of any pre-existing defects or malfunctions which could have affected the operation of the aircraft at the time of the accident.

The actuator for the stabilator trim tab was found in a position corresponding to a tab setting of about six degrees up, which is close to full nose-down trim. The actuator was of the cable-actuated screw jack type and, being an irreversible mechanism, could not have been displaced from its pre-impact setting by loads applied to the push rod during the break-up of the aircraft. It could, however, have been moved in one direction or the other if loads had been applied to the cable during the breakup.

All components and wiring of the electric trim system, and those sections of the autopilot system associated with pitch trim functions, were examined for evidence of any defect which could have resulted in a malfunction of the electric trim, or in an inability to disconnect or interrupt the trim function if a runaway trim condition had occurred.

The trim master switch, the master disconnect/interrupt switch, and the command trim switch had been only slightly damaged by impact and were all found to function correctly. No evidence was found of any electrical or mechanical defect in these switches.

The pitch trim amplifier had sustained minor impact damage to the case. On testing it was found to meet all of the manufacturer's minimum performance specifications.

The pitch trim servo had been substantially damaged during the course of the aircraft break-up. Examination showed that the unit had been capable of functioning normally prior to being impact-damaged. The clutch setting was checked and found to be within the specified limits.

The pitch trim relay box had been slightly distorted by impact, but when this distortion was corrected it was found to operate correctly. The function of this relay box is to disconnect the autopilot and connect power to the command trim switch whenever the control bar in that switch is pressed.

The automatic pilot console was severely damaged by impact and was heavily contaminated with dirt, but its internal condition was such that tests could be carried out on those circuit elements associated with the automatic pitch trim and the disconnection of the autopilot. These tests showed that the console controls were serviceable prior to the impact and that the controls would immediately return to the OFF condition upon actuation of either the control bar of the command trim switch or the master disconnect/interrupt switch.

The automatic pilot amplifier had been severely damaged by impact but the pitch motor driver and output stages were found to be intact. It was established by test that these stages operated normally, that there was no imbalance of these stages, and that no inadvertent output would have occurred even if the autopilot had been switched ON.

In addition to the functional testing described above, all components, switches and wiring were examined for evidence of any pre-existing defect or signs of electrical or mechanical malfunction. No such evidence was found, and all damage was consistent with the effects of impact.

1.13 MEDICAL AND PATHOLOGICAL INFORMATION

Both pilots suffered serious injuries in the accident, and the pilot-in-command sustained head injuries which resulted in a loss of memory of events preceding and during the flight. There is no evidence that any form of pilot incapacitation contributed to the accident.

1.14 FIRE

There is no evidence that fire occurred in flight.

The righthand wing, outboard of the engine, was almost totally consumed in the very intense fire which occurred in the house after initial impact. The lefthand wing, outboard of the engine, was burnt when fuel ignited after it hit a neighbouring house and separated from the aircraft. The fire destroyed the fibreglass leading edge and wing tip, but was not severe enough to melt the structure. A small fire broke out around the lefthand engine after the fuselage came to rest. This was extinguished before it caused any significant damage, by local residents who were first on the scene.

One house was destroyed by the combined effects of explosion and fire and another at the rear sustained minor scorching.

1.15 SURVIVAL ASPECTS

1.15.1 Services

As the aircraft approached the boundary of the airport, the air traffic control staff considered that an accident was imminent and activated both the airport crash alarm and a 'common call' facility to various emergency services, which responded without delay. The Essendon Airport Rescue and Fire Fighting Unit initially proceeded south along an adjacent road, intending to traverse the tramway via a crash access gate. Roadworks in progress precluded such access and two firemen with portable cutting equipment and extinguishers proceeded on foot over the remaining 200 metres to the accident site where they found local residents playing hoses on small fires in the aircraft wreckage and commencing the removal of the occupants. It is estimated the firemen arrived some four minutes after the accident and the associated tender, which was obliged to take another route, arrived some four minutes later.

1.15.2 Aircraft

When the aircraft first struck the houses it did so almost simultaneously with both wings. The fuselage was clear of the ground above the dividing fence and there were no large obstructions between the houses. Thus, initially, the integrity of the cabin space was preserved. Both wings separated virtually at the same time, preserving a degree of symmetrical loading which allowed the fuselage to pass between the houses without developing significant yaw.

Having passed between the houses the fuselage cartwheeled to the right through

180 degrees, probably due to the right wing low attitude at initial impact, and the drag of the righthand engine nacelle on the side wall of the house. The fuselage then travelled backwards through a small, lightly constructed building and impacted tail first into the rear of a third house. The distance from the first point of contact with the houses to the rear of the third house was 72 metres and the small building was at the midpoint.

At no time during the accident did the front of the fuselage receive a large head-on impact. The largest decelerating loads occurred when the fuselage slid tail first into the rear of the third house. Thus the rear half of the fuselage absorbed most of the energy by crushing and deforming. The three occupants, who were now in essentially rearward facing seats, were protected by both the rear fuselage and the seats themselves.

The pilot-under-supervision, who remained conscious throughout the accident sequence, and subsequently the rescuers, could not release his seat belt because the buckle had jammed. The webbing had to be cut to remove him from the wreckage. Tests were carried out to establish if the buckles from both pilot harnesses conformed to the 'release under load' requirements. The tests showed that both buckles failed to comply with the requirements. The force required to release the buckle for the lefthand harness (pilot-under-supervision) was $33\frac{1}{2}$ per cent more than the requirement and for the righthand harness was 7 per cent higher. Examination of the lefthand buckle showed that the catch was worn and the tongue had a ridge of metal along the latching surface which the catch had to ride up when being released. The ridge was chrome plated and had been present since manufacture.

1.16 TESTS AND RESEARCH

In order to examine the trim characteristics of the Partenavia P68B a series of flight tests was conducted. The areas of primary interest were the effect of flap retraction and simulated engine failure after take-off on longitudinal trim, and the control wheel loads at various stabilator trim settings.

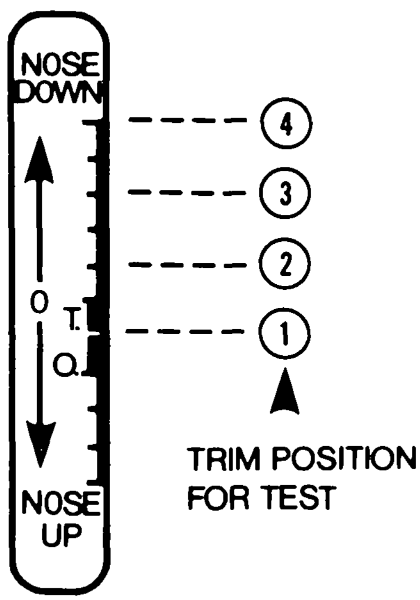


Figure 1

Figure 1 is a representation of the cockpit trim indicator. The thicker shaded area shows the trim range for take-off. The full nose-down trim stop in the test aircraft coincided with indicator position 3.5. Trim settings used in the tests are indicated.

With the trim set at position 1, 110 knots IAS and take-off power on both engines, the flaps were retracted from 15 degrees to 0 degrees. The aircraft exhibited a nose down trim change which required a PULL force of 10 kg to overcome.

With the aircraft trimmed at 110 knots IAS, the flaps set at 0 degrees and take-off power on both engines, failure of the starboard engine was simulated. The aircraft exhibited a nosedown trim change which required a PULL force of 6 kg to overcome.

The measurements of longitudinal control wheel forces at various trim settings were made with take-off power on both engines and the flaps at 0 degrees. The trim settings tested are labelled 1 to 3 at Figure 1 and the results of the tests are shown at Figure 2.

Position	80 KIAS	100 KIAS	120 KIAS	140 KIAS	160 KIAS
1	10 Pull	6 Pull	1 Push	10 Push	17 Push
2	←	29 Pull	26 Pull	24 Pull	22 Pull
3	←	All greater than 30 kg Pull →			
3.5	←	Not Tested →			

Figure 2

Precise PULL loads with the trim at setting 3 could not be measured because the test equipment was limited to loads of 30 kg.

Setting 3.5 was not tested as the test pilot considered the control forces to be unacceptably high.

1.17 ADDITIONAL INFORMATION

Not applicable.

1.18 NEW INVESTIGATION TECHNIQUES

Not applicable.

2 ANALYSIS

There is ample evidence that the two circuits which preceded the take-off on which the accident occurred were normal in all respects and there was no significant change in the weather conditions during the period that the operation took place.

The pilots concerned were appropriately licensed, endorsed for the aircraft type, rated to operate at night and had adequate total and recent experience. There is no evidence that any form of pilot incapacitation occurred prior to the accident.

There is no evidence of any pre-existing defect or malfunction of the aircraft which may have contributed to the accident and it was properly equipped for the flight.

There is no evidence that procedures and checks carried out by the crew prior to the last take-off were other than correct or that the take-off roll, lift-off and climb to a height of about 200 feet, which was reached in the vicinity of the intersection of the runways, were other than normal.

The stabilator trim tab actuator is a cable operated screwjack and was found in an almost full aircraft nose-down position. This type of actuator is irreversible under loads applied to its push rod and although it is possible, during the breakup of the aircraft after initial impact, for the actuator to have been wound by loads on its cable to a position different from that which existed immediately prior to impact, the manner in which the aircraft structure failed makes this unlikely.

The known flight path of the aircraft, the difficulty which the crew encountered in their attempts to apply rearward movement to the control columns, and the as-found position of the stabilator trim tab actuator, combine to present an overwhelming case for a gross longitudinal out-of-trim condition, in the nose-down sense, having arisen during flight.

If any such out-of-trim had been present either before the commencement of the take-off, during rotation for lift-off, or on the initial climb to flap retraction height, it would have been immediately apparent to the pilot-under-supervision by medium of unusual control column forces, and he has stated that they were quite normal during the whole of this period. It seems, therefore, that the nose-down trim input did not commence at least until flap retraction had been initiated. It was not possible, due to the magnitude of the out-of-trim control forces, to measure in subsequent flight tests the time for the trim to run electrically from the take-off position to the full nose-down position. However the time to reach position 3 (see Fig. 1) was 13 seconds and this position would approximate the position of the trim tab actuator as found.

There are two possible ways in which the nose-down trim could have been applied; either by some malfunction of the electric trim system or by the pilot-under-supervision inadvertently operating the command trim switch mounted on top of the left horn of his control yoke.

Despite detailed examination of the electric trim system and extensive testing, no malfunction was found. It is not, however, possible to say with certainty that no malfunction of the system existed prior to impact.

Although the pilot-under-supervision has no recollection of operating the command trim switch on his control yoke, the design of the hand grip and the position of the switch is such that inadvertent operation seems possible. Advice from experts in the fields of psychology and human movement has confirmed that, if the pilot's thumb was positioned in the vicinity of the switch at the time that he became involved with the flap retraction/engine failure sequence, it would be quite possible for him to operate the switch in the nose-down sense, for a period, without being aware of it. The factors which could lead to this situation were all associated with the flap retraction/engine failure sequence and include his pre-occupation with events requiring actions on his righthand side, involving the muscular and nervous systems of the right side of his body, together with the development of tension loads of some 16 kg in his left arm and, initially, a considerable compression load in his left leg.

Regardless of the cause of an unwanted electric trim operation, had it been recognised in sufficient time it could have been arrested by either pilot holding the manual trim wheel and after disconnection, if necessary, of the electric system, the aircraft could have been re-trimmed manually.

The accident occurred without either pilot having identified the nature of the problem and the only remedial action which was applied was to pull back on the control columns and manoeuvre the aircraft between the houses which lay in its path. An assessment has been made of the capability of the pilots, in the time scale available, to detect the change in aircraft attitude and identify and rectify its cause. The pilot-under-supervision first felt that change of attitude after the restoration of engine power and confirmed it visually. However, the body sensations associated with a nose-up climb at steady speed and a nose-down descent at steady acceleration can be identical. It seems probable that the change in attitude began during the engine failure sequence and was not detected by the crew until after power was restored, because of pre-occupation and workload within the cockpit.

The pilot-under-supervision has stated that he always uses electric trim on this type of aircraft, that he never retracts take-off flap below a height of 200 feet and that the pilot-in-command simulated the engine failure immediately after flap retraction. Although the pilot-in-command has no recollection of events, this sequence is compatible with his normal procedures and is consistent with the flight path observed by the eye-witnesses. On this basis, as indicated on the reconstruction of the flight path at Appendix B the earliest time at which the flap retraction/engine failure sequence could have commenced was some 34 seconds after the start of take-off. There was probably some overlap in the two sequences, and the period involved in carrying out the actions required is estimated to have been at least 10 to 12 seconds. During this period the attention of both pilots would have been focused primarily within the cockpit. It can thus be seen that from the completion of this sequence only some 8 to 10 seconds remained for the crew to appreciate the descending flight path of the aircraft, identify the cause, apply remedial action, and have the aircraft respond to such action.

By the time the pilot-under-supervision recognised that the aircraft was descending applied back pressure to the control column, and found it apparently jammed, the aircraft was well established in its descent. It was only at this time that the pilot-in-command realised that there was a problem, when he apparently told the other pilot to 'pull back' and was told 'I am pulling back'.

If the pilot-in-command noted the nose-down change of attitude after he restored engine power he would not have been concerned, for a nose-down change of trim occurs with both flap retraction and simulated engine failure, and it would not be unusual with a relatively inexperienced pilot at the controls, at night, for the nose of the aircraft to drop momentarily. In these circumstances he would probably allow a little time for the pilot-under-supervision to detect this and return the aircraft to a climbing attitude. When he became aware that the pilot-under-supervision was unable to raise the nose of the aircraft the pilot-in-command first appreciated that a serious problem existed and it was by then too late for any action he might take to materially change the course of events. His first action on becoming aware that there was a serious problem was to check that full power was applied; this is quite understandable because the aircraft was descending and the problem appeared immediately after the simulated engine failure. Both pilots then concentrated on applying back pressure to their control columns and it would be unrealistic to expect any crew in such a situation to start analysing alternative hypotheses about the nature of their problem.

The longitudinal control system of the aircraft is designed to withstand a limit load of 90 kg and anthropological testing has shown that the 50th percentile of male subjects can exert a two-handed static force of 89 kg on an aircraft control wheel. The wreckage examination revealed no evidence of control system failure having resulted from pilot input loads; however, the flight path angle from the point at which the aircraft struck the electric power cables to the point at which it first struck a house indicates that some flattening of the flight path had occurred. This was probably due to the combined control inputs of the two pilots and 'ground effect' could also have been a contributory factor.

It is apparent, therefore, that the accident became inevitable at the time that the aircraft became grossly out of trim and, although it is not possible to completely eliminate a malfunction of the electric trim system, it seems more likely that the out-of-trim condition resulted from inadvertent operation of the command trim switch by the pilot-under-supervision.

3 CONCLUSIONS

1. Both pilots were appropriately qualified and licensed.

2. Weather conditions were not a factor in the accident.

3. The aircraft was loaded within safe limits.

4. There was no evidence of any aircraft defect or malfunction which may have contributed to the accident.

5. After a normal take-off and climb to a height of 200 to 250 feet the pilot-under-supervision retracted the flaps which had been set for take-off and about this time the pilot-in-command simulated an engine failure of the starboard engine. The pilot-under-supervision indicated the appropriate actions to be taken and full power was restored to the engine.

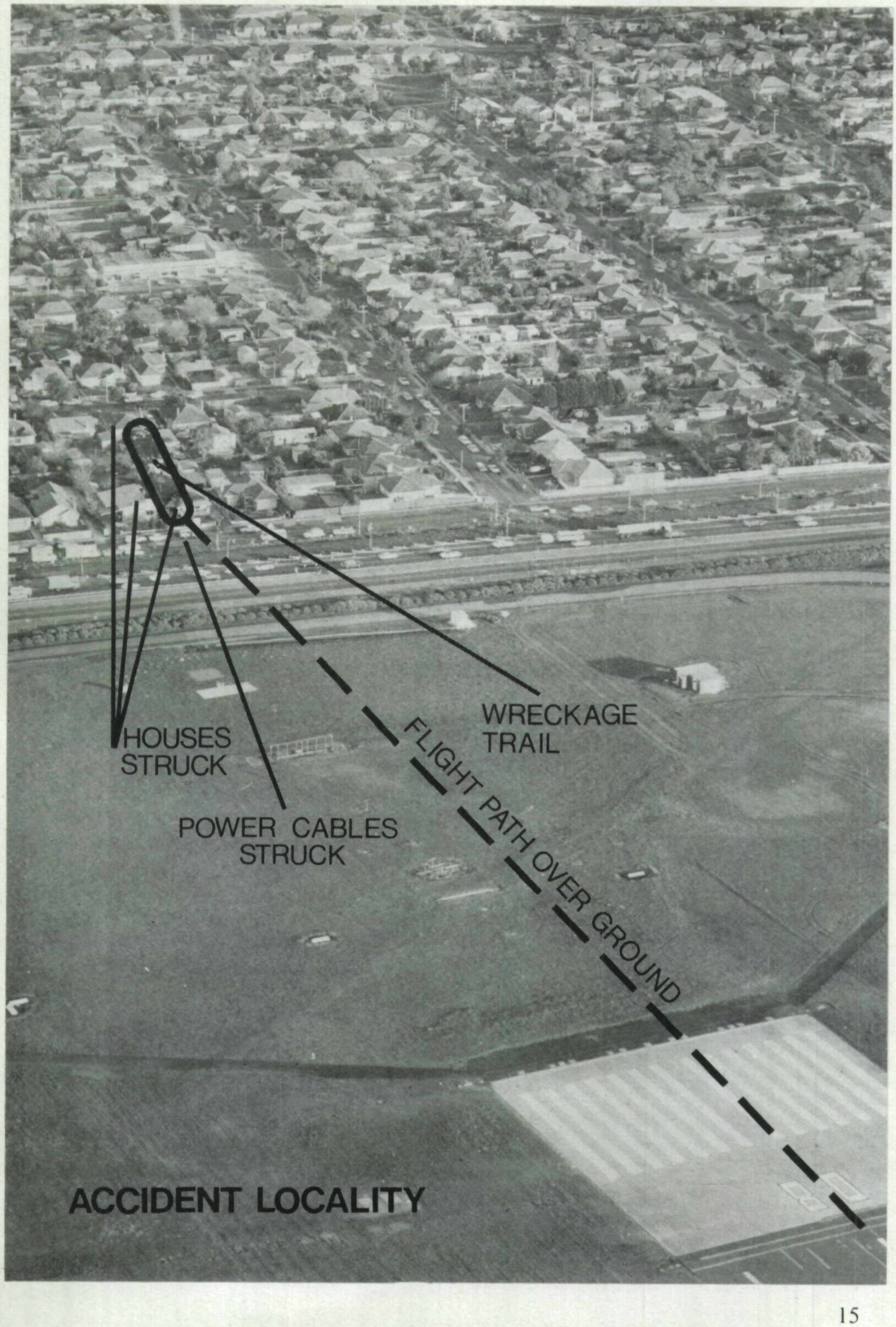
6. During the flap retraction/engine failure sequence the aircraft's longitudinal trim system operated electrically; it became grossly out of trim in a nose-down sense, and entered a shallow dive.

7. The pilots were unable to arrest the descent and the aircraft struck houses beyond the end of the runway.

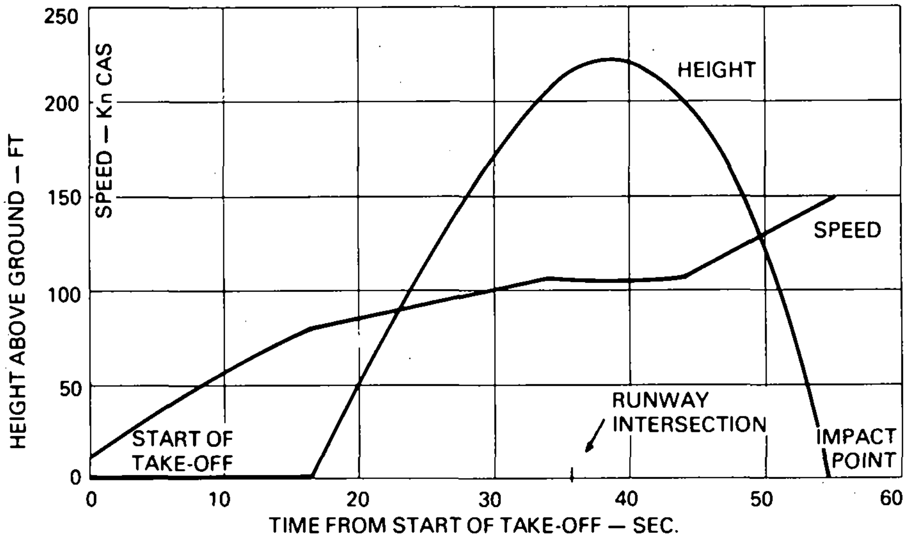
8. The stabilator trim tab actuator was found in the almost full nose-down position and it is probable that it was in this position prior to impact.

CAUSE

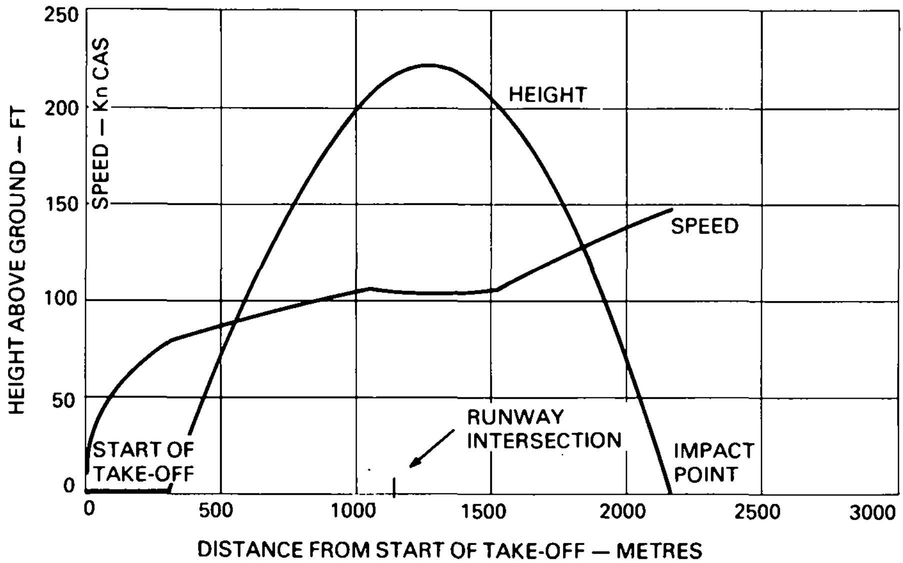
The cause of the accident was that the aircraft became grossly out of trim at a height which did not permit time for the crew to affect recovery. The manner in which the out-of-trim condition occurred has not been determined and the possibility of a trim system malfunction cannot be eliminated. However, the more likely explanation is that the command trim switch was activated unknowingly.

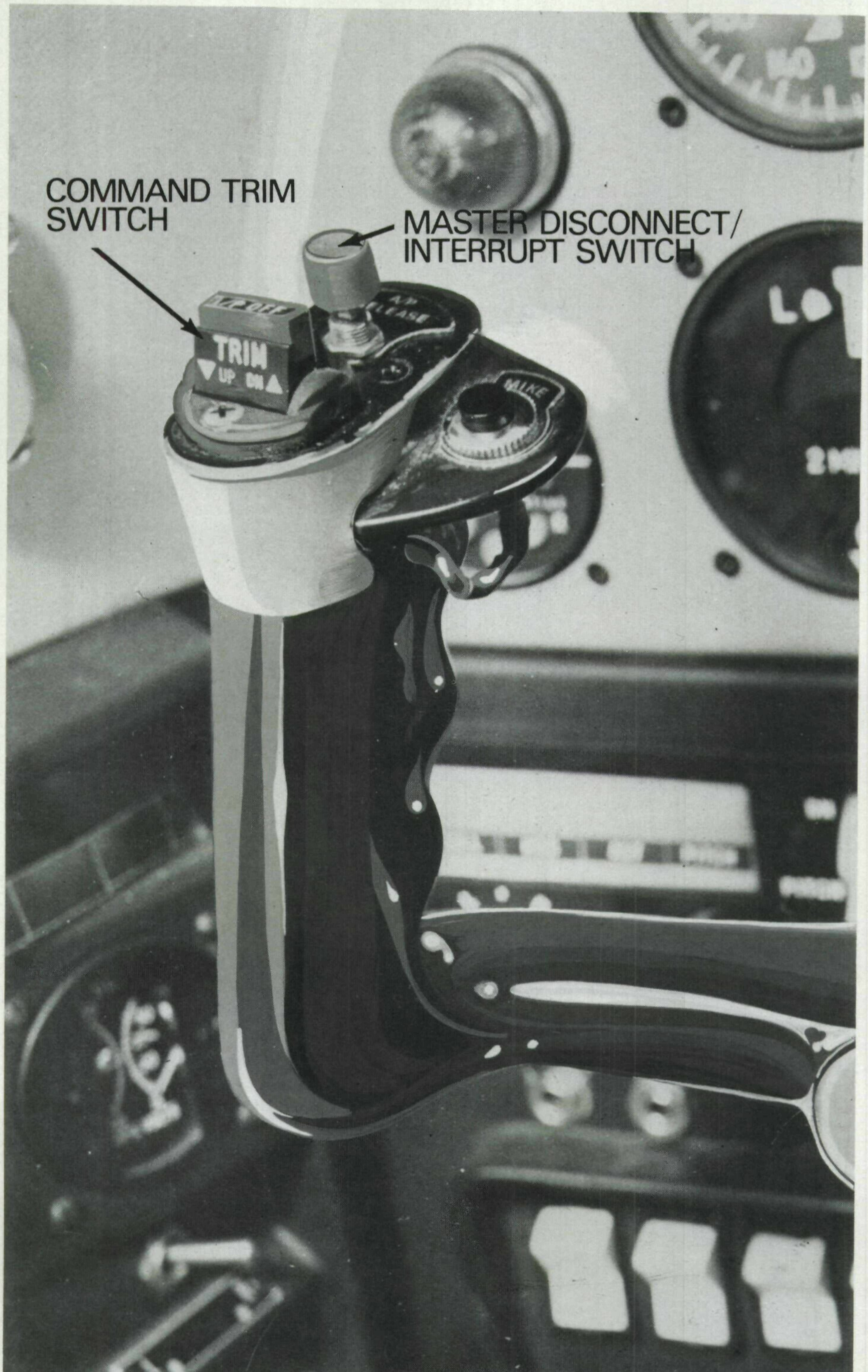

WRECKAGE
TRAIL
FLIGHT PATH OVER GROUND
HOUSES
STRUCK
POWER CABLES
STRUCK
ACCIDENT LOCALITY

APPENDIX B



APPENDIX C





Switches on left control yoke

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