AUSTRALIA

AIRCRAFT ACCIDENT INVESTIGATION

Report 831-1053

Beech 200 Super King Air
VH-KTE
Adavale, Queensland

28 August 1983

BUREAU OF AIR SAFETY INVESTIGATION

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R. R. Moore and Co. Pty Ltd
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VH-KTE
Adavale, Queensland
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The Secretary to the Department of Aviation 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 the Bureau of Air Safety Investigation
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Note : All times are Australian Eastern Standard Time (Greenwich Mean Time plus 10 hours) and are based on the 24-hour clock....

A Beech 200 Super King Air

Accident Investigation Report

BEECH 200 SUPER KING AIR VH-KTE OPERATED BY R. R. MOORE AND COMPANY PTY LTD AT ADAVALE, QUEENSLAND ON 28 AUGUST 1983.

Synopsis

At approximately 2145 hours on 28 August 1983, in the course of a planned charter, Instrument Flight Rules night flight from Windorah to Toowoomba, Beech 200 Super King Air aircraft VH-KTE broke up in flight and crashed to the ground 3.5 kilometres south of Adavale, 201 km from Windorah, and on the aircraft's planned track.

The pilot-in-command and the 11 passengers were killed when the aircraft fuselage, devoid of wings and empennage, impacted the ground, inverted.

The Adavale police officer reported the accident to the duty officer of the Department of Aviation, Queensland Region. An investigation team from the Bureau of Air Safety Investigation assembled at Adavale on the morning of 29 August 1983.

1. Factual Information

1.1 HISTORY OF THE FLIGHT

On 26 August 1983 Hawker Pacific Pty Ltd at Archerfield Airport completed a routine check No. 1 of Beech 200 Super King Air aircraft VH-KTE. After that check the following flights were carried out prior to the accident:

Date	*Pilot*	*Route*	*Flight time*
28.8.83	A. Van Dongen	Toowoomba–Dysart	1.12
"	"	Dysart–Kooralbyn	1.48
"	"	Kooralbyn–Archerfield	.13
"	"	Archerfield–Brisbane	.05
"	"	Brisbane–Dysart	1.54
"	"	Dysart–Kooralbyn	1.45
"	"	Kooralbyn–Toowoomba	.18
"	K. Moore	Toowoomba–Windorah	2.49
		Total flight time	10 hrs 4 mins

No serious defects were reported or documented at the conclusion of the above flights.

At Toowoomba, company manager and chief pilot Mr K. Moore took command of VH-KTE from company pilot Mr Van Dongen at about 1730 hours on 28 August1983.

The purpose of the charter was to return personnel from a drilling rig near Windorah to Toowoomba. Charters of this type were routine for the changeover of drilling rig field crew and had been carried out for the charterer by R.R. Moore and Company for some months.

The only passengers on the outbound flight were Mr C.K. Cox, a visitor from the U.S.A. and guest of the drilling company, and Mr R. Strate, the drilling company General

Manager, who occupied the co-pilot's seat. Mr Cox stated that the flight was conducted at 18 900 ft, airspeed 240 kts and groundspeed 180 kts. There was no turbulence during the flight. Mr Moore appeared to operate the controls smoothly throughout the flight although the auto-pilot was engaged during cruise. Mr Cox said that the pilot did not seem fatigued and did not cough or blow his nose. On completion of the apparently incident-free outbound flight Mr Cox remained at Windorah but Mr Strate joined the return flight.

The passengers for the return flight (see Appendix A) had travelled by road from the drilling rig, some 64 km from Windorah. While they were awaiting the arrival of VH-KTE a Flying Doctor aircraft from Charleville landed to evacuate an injured man from Windorah. The pilot of the Flying Doctor aircraft reported no weather or other problems during his flights to or from Windorah.

The pilot and 11 passengers boarded VH-KTE at about 2115 hours. The co-pilot's seat was again occupied by Mr Strate. The seating position of the other 10 passengers is uncertain.

At 2122 hours the pilot advised Brisbane Flight Service Centre,'Taxiing Windorah for Toowoomba'. Brisbane acknowledged this call. The pilot departed Windorah at 2127 hours, advised Brisbane and, at 2130 hours, was instructed to 'remain outside controlled airspace'. This instruction referred to Airway B72, the vertical limits of which were Flight Level 250- 450 (i.e. 25 000 - 45 000 ft above sea level on standard altimeter setting of 1013.2 mb. See transcript of Airways Communications, section 1.9).

At 2134 hours the pilot was given an airways clearance to climb to, and cruise at, Flight Level 270 (27 000 ft). The pilot acknowledged this clearance. No further radio transmissions were received from the aircraft.

At Adavale (elevation 800 ft), a small town on the direct track between Windorah and Charleville, an evening tennis tournament, under electric lights powered by a portable generator, had concluded and the participants were attending a barbecue. At about 2144 hours a noise resembling thunder was heard. The night was clear and there was immediate speculation concerning the noise. The power generator was turned off to assist hearing and a few seconds later another unusual sound was heard, as of a heavy vehicle crash towards the south, in the direction of the Adavale–Quilpie gravel road. A ground fire was then seen in the same area. The Adavale police officer was called out and a number of persons in several vehicles departed to investigate the fire. The fire was brief but, after searching the area for some time, the fuselage of VH-KTE was seen in the light of a newly risen moon.

Having identified the aircraft by its registration letters and determined that there were no survivors, the policeman advised his headquarters and the Department of Aviation authorities of the accident.

The Brisbane Airways Operations Centre had instituted routine communication checks at 2152 hours as the pilot had not made his scheduled position report at 2149 hours. On receipt of the police report at 2305 hours Brisbane Airways Operations declared the 'Distress' phase of Search and Rescue Procedures.

A rescue team of Queensland police officers from Quilpie and Charleville, accompanied by an ambulance team, arrived at the accident site before daylight. The police rescue team rolled the fuselage upright and removed the bodies of the 12 occupants, all contained within the fuselage occupiable area.

The advance party of the BASI investigation team arrived at 1000 hours on 29 August.

The wings, engines and empennage had separated from the fuselage at a height calculated to be between 5000 ft and 8400 ft. The fuselage impacted the ground 3.6 km south of Adavale and as the lighter items of wreckage fell they were spread towards Adavale by the wind, on an average bearing of 336 degrees magnetic.

1.2 INJURIES TO PERSONS

Injuries	*Crew*	*Passengers*	*Other*
Fatal	1	11	Nil
Serious	Nil	Nil	Nil
Minor/None	Nil	Nil	

1.3 DAMAGE TO AIRCRAFT

The aircraft was destroyed by an inflight breakup, subsequent ground impact, and post ground-impact fire to the right hand wing.

1.4 OTHER DAMAGE

The aircraft fell into unimproved, slightly undulating, scrubland and caused no property damage.

1.5 PERSONNEL INFORMATION

1.5.1 Flight crew

The pilot-in-command and sole flight crew member was Kenneth Robert Raby Moore, age 45, the holder of Commercial Pilot Licence number 045356 valid to 30 September 1983 endorsed for Beech 200 Super King Air aircraft. The licence contained an endorsement limitation that 'The pilot shall not exercise the privileges of this licence unless he wears a suitable correcting optical lens or suitable correcting optical lenses and carries on his person for emergencies a second such lens or set of lenses'. Broken glasses found in the cockpit indicated that the pilot had complied with this limitation.

The pilot held a valid Class One instrument rating and had passed a renewal test on 12 August 1983. He also held a Flight Radiotelephone Operator Licence. His last flight crew medical examination renewal was on 14 September 1982.

Pilot experience:

Total flying all types	4203 hours (fixed wing)	
In command	3865 hours	
Night flying	294 hours	
Actual instrument flight time	433 hours	
Beech 90) included in	Day 426 hours	Night 48 hours
Beech 200) above figures	Day 195 hours	Night 8 hours

The pilot's flying activities for the seven days preceding the accident were as follows:

VH-KTE	23.8.83	1 hour 40 minutes
VH-KTE	25.8.83	5 hours 10 minutes
VH-DYN	28.8.83	3 hours 50 minutes (as co-pilot)
VH-KTE	28.8.83	3 hours 15 minutes Toowoomba - Windorah crash site

1.5.2 Passengers

Occupancy of particular cabin seats is not known apart from those passengers still strapped in their seats at impact. Passengers' positions at impact are shown in Appendix B. Those passengers not held in by seat belts would have been thrown about the aircraft cabin when the mainplanes and empennage separated from the fuselage.

Mr Ronald Allen Strate, a Canadian citizen, occupied the right hand pilot seat. Department of Transport Canada records produced the following information:

1 On June 27 1978 Ronald Allen Strate met the minimum requirements for issue of a Private Pilot Licence and was subsequently issued licence XDP-250487, valid for single engine land aeroplanes of a maximum gross weight of 4 000 lbs. No instrument or night flying.
2 His Private Pilot Licence was medically valid until December 1981.
3 There were no medical or other licence restrictions.

No record of Mr R. A. Strate's flying experience has been found. He did not hold an Australian pilot licence.

1.6 AIRCRAFT INFORMATION

1.6.1 History

Beech 200 Super King Air aircraft, serial number BB-320, built in the United States of America in 1978, was first registered in Australia, as VH-KTE, a new aircraft, on 19 May 1978 in the name of Katies Limited. A certificate of airworthiness in the 'Normal' category was issued on 24 May 1978.

On 6 July 1979 the aircraft was acquired by Norfolk Island Airlines Limited.

On 28 July 1981 the aircraft was acquired by Aviation Developments Pty Ltd, trading as Avdev Airlines of Australia, and registered in the 'Charter' category. On 28 August 1981 a new certificate of airworthiness was issued for VH-KTE in the 'Transport' category.

On 16 March 1982, in the course of a passenger-carrying flight from Norfolk Island to Sydney, one of the locking pins of the main passenger entry door released at 24 000 feet altitude and the cabin depressurised. Minor damage was caused to the door. A replacement door was installed. No further incidents concerning the passenger door are recorded.

On 28 March 1983 another change of ownership occurred and a certificate of registration was issued for VH-KTE in the name of R.R. Moore and Company Pty Ltd.

1.6.2 Engines and propellers

At the time of the accident the aircraft time in service was 7206 airframe hours. Details of the turbine engines and the propellers installed in the aircraft together with the airframe hours at which they would have been due for servicing are shown below:

Type	*Serial No.*	*Due for reconditioning*
LH engine PT6A-41	PCE 80904	7824 hours
RH engine PT6A-41	PCE 81378	7322 hours
LH propeller HC-B3TN-3G	BU6874	7698 hours
RH propeller HC-B3TN-3G	BU11442	7477 hours

Dismantling and specialist investigation of the engines and propellers revealed no defects which would have affected normal operation prior to inflight breakup of the aircraft.

1.6.3 Maintenance

Since first being registered in Australia VH-KTE had been maintained to Department of Aviation approved maintenance systems by the following organisations:

14.7.78–6.9.79 Hawker Pacific
7.9.79–25.9.81 Norfolk Island Airways
26.9.81–4.5.83 Avdev Airlines
5.5.83–Date of accident. Hawker Pacific.

The last periodic inspection was completed by Hawker Pacific Pty Ltd at Archerfield Airport on 26 August 1983.

1.6.4 Weight and balance

Assuming that the 11 passengers and one crew member occupied normal seating on departure from Windorah and that the baggage area in the rear of the cabin contained the passengers' personal luggage, the weight and balance of the aircraft would have been within approved limits.

Considering the passenger distribution to have been as found at the accident site, that is, with four of the passengers in the rear of the cabin, the aircraft balance would still have been maintained in flight.

1.7 METEOROLOGICAL INFORMATION

The following meteorological situation was applicable to the flight of VH-KTE from Toowomba to Windorah and return:

A 1022 millibars high pressure area centred over SW Queensland was moving east. A jet stream 260 degrees M, maximum speed 140 knots lay from Brisbane to Tibooburra at Flight Level 340 (34 000 ft).

1.7.1

A terminal forecast for Windorah had been issued to the pilot for this flight which indicated wind velocity, direction variable, speed 5 knots. No significant cloud. Aerodrome QNH 1021/1022 millibars. (Note definition-QNH altimeter setting is the atmospheric pressure corresponding to mean sea level pressure at a particular place. An altimeter with this QNH set on its [millibars] subscale will indicate its altitude. That is, on landing at Windorah it would read the height of the aerodrome above mean sea level.)

No Sigmets (significant en route weather phenomena which may affect the safety of aircraft operations) had been issued, or were applicable to the flight of VH-KTE. However, the significant weather prognosis by the Melbourne forecasting office included moderate turbulence between Flight Levels 200 and 500 (20 000 - 50 000 ft).

The pilot's intended cruising altitude was 27 000 ft. Had he encountered uncomfortable inflight turbulence he could have requested a turbulence free level. In the quiet traffic conditions obtaining such a request would probably have been granted by Air Traffic Control, but the pilot made no such request.

A meteorological post analysis of the Adavale area at the time of the accident indicated the following probable conditions:

Surface-Wind calm. Visibility 10+ kilometres, sky clear.
Temperature +10 degrees Celsius wet bulb 9 degrees Celsius.
QNH 1021 millibars.

Upper conditions—

Altitude (ft)	*Wind direction/speed*	*Temperature (degrees C)*
1 000	150/5	+11
2 000	150/10	+ 9
3 000	160/10	+ 6
4 000	170/10	+ 7
5 000	200/15	+ 7
6 000	170/15	+ 6
7 000	170/18	+ 5

Altitude (ft)	*Wind direction/speed*	*Temperature (degrees C)*
8 000	190/18	+ 4
9 000	210/18	+ 3
10 000	210/25	+ 2
11 000	220/25	+ 1
12 000	220/25	0
13 000	230/25	− 2
14 000	230/30	− 3
15 000	230/30	− 4
16 000	240/40	− 5
17 000	240/45	− 7
18 000	240/50	− 9
19 000	240/50	−10
20 000	240/55	−13
21 000	240/60	−15
22 000	250/65	−18
23 000	250/65	−20
24 000	260/65	−22
25 000	260/70	−24
26 000	260/80	−27
27 000	260/80	−30

The surface conditions at Adavale were confirmed by ground witnesses.
Moonrise at Adavale was 2205 hours.

1.8 AIDS TO NAVIGATION (copy of RNC at Appendix C)

The following radio navigation aids were installed in VH-KTE:

Instrument Landing System
Automatic Direction Finding
VHF Omni Range
Distance Measuring Equipment

- all the above equipment was designated on the flight plan as serviceable for flight.

So far as could be ascertained during the detailed investigation, all on-board navaids were serviceable. Weather radar had been removed from the aircraft for servicing and was so annotated in the aircraft maintenance records. Weather radar was an optional aid and was not mandatory for this class of operation.

As the forecast and observed weather conditions for the flight of VH-KTE from Toowoomba to Windorah and return were fine, the lack of weather radar in the aircraft had no bearing on the accident.

1.9 COMMUNICATIONS

The aircraft was equipped with very high frequency (VHF) and high frequency (HF) radio fitted with all communications frequencies applicable to this route. A radar transponder was also installed.

There appears to have been no problem with communications between the aircraft and ground stations on the outbound flight from Toowoomba to Windorah. Transcripts of communication between Brisbane Flight Service Centre and VH-KTE, before and after departure Windorah are as follows:

Time EST	*From*	*To*	*Text*
2122	KTE	FS3	BRISBANE KILO TANGO ECHO taxiing Windorah for Toowoomba
	FS3	KTE	KILO TANGO ECHO
2127	KTE	FS3	BRISBANE KILO TANGO ECHO departed Windorah time two seven tracking zero niner niner on climb to flight level two seven zero
	FS3	KTE	KILO TANGO ECHO roger BRISBANE standby for clearance
	KTE	FS3	KILO TANGO ECHO
2130	FS3	KTE	KILO TANGO ECHO BRISBANE remain outside controlled airspace will advise clearance
	KTE	FS3	KILO TANGO ECHO
2134	KTE	FS3	BRISBANE KILO TANGO ECHO when are we cleared to cruise two seven zero
	FS3	KTE	KILO TANGO ECHO BRISBANE clearance enter and leave and re-enter controlled airspace on track Windorah Charleville cruise flight level two seven zero
2135	KTE	FS3	KILO TANGO ECHO flight level two seven zero (Note: This was KTE response to the clearance from FS 3)
			NO FURTHER TRANSMISSIONS WERE RECEIVED FROM VH-KTE
2152	FS3	KTE	KILO TANGO ECHO BRISBANE
	FS3	KTE	KILO TANGO ECHO BRISBANE

1.10 AERODROME INFORMATION

The aerodromes applicable to this flight were the departure aerodrome Windorah and intended destination Toowoomba. The aerodromes were not a factor in the accident.

1.11 FLIGHT RECORDERS

The aircraft was not fitted with either a Cockpit Voice Recorder or a Flight Data Recorder. There was no requirement for Australian-registered aircraft of this category to be so equipped.

1.12 WRECKAGE AND IMPACT INFORMATION

A diagram of the wreckage, as found, is at Appendix D. Distribution of the wreckage on a basic line of 336 degrees M from the fuselage for 3.6 km was mainly due to wind effect. A trajectory analysis of items of wreckage was carried out to determine the height of breakup. The analysis depends on the bulk and mass of the item and the distance it would have been carried by the wind i.e. rate of fall versus wind speed and direction. Calculations determined that the aircraft broke up at 5000–8400 ft altitude. The intended track from Windorah to Charleville was 099 M and Adavale was on that track.

1.13 MEDICAL AND PATHOLOGICAL INFORMATION

The pilot's last flight crew medical examination on 14 September 1982 revealed no deficiencies other than the continuing requirement to wear glasses.

Mr Moore died as a result of his injuries. Witness evidence indicated that four or five days before 28 August Mr Moore is believed to have 'self medicated' with aspirin and a cough mixture to treat an upper respiratory tract infection. Histology reports indicated the presence of an inflammatory process in the trachea and bronchi which could have resulted from this infection. However, witnesses have indicated that Mr Moore appeared to be healthy and in good spirits on 28 August 1983.

The Government Analyst's report indicated no trace of either carbon monoxide or alcohol.

Mr Moore's heart was destroyed at ground impact, and no heart tissue was recovered for analysis.

Mr Ronald Allen Strate occupied the right hand pilot seat. Autopsy did not reveal evidence of any pre-existing disease or indicate any sudden incapacitation. There was no alcohol present in the urine. Mr Strate died from multiple injuries received in the accident.

Autopsy reports indicate that the other ten passengers also died from injuries sustained at impact.

1.14 FIRE

The only section of the aircraft subjected to fire damage was the right wing. The aircraft battery was contained in a special compartment in the right wing. After inflight breakup, when the right wing containing the battery and fuel cell impacted the ground, the fuel cell burst and the battery short circuited across its pole pieces, igniting the fuel vapours. Some of the vapours exploded within the wing and flap structure causing 'balloon' distortion. There was no evidence of any other fire in the aircraft or its components.

1.15 SURVIVAL ASPECTS

The accident was non-survivable because of the extremely high ground impact forces.

1.16 TESTS AND RESEARCH

1.16.1 Engines

The engines were shipped to Canada and dismantled by the manufacturer, Pratt and Whitney Ltd, under the supervision of the Airworthiness Branch, Transport Canada. The airworthiness report concluded as follows: 'From analysis of the teardown the engines and accessories were capable of functioning prior to impact. However, the indented pressure turbine blades and vane ring on engine PCE-50904, bent pressure turbine blades and compressor airseal stator indentations on engine PCE-80378, indicate both engines were completely rundown (stopped) at (ground) impact'.

1.16.2 Propellers

The engines separated from the mainplanes at inflight breakup and the propellers auto-feathered. This is the normal reaction when the propellers are deprived of engine power as, for example, when the engines are shut down on completion of a flight.

1.16.3 Aircraft structure

The aircraft had separated into a number of major components. These components covered a wide area consistent with an inflight breakup. Both wings had separated from the fuselage and the engines had separated from the wings. A three metre section of the right outer wing had also broken off in flight. The complete empennage and fuselage tail cone had separated from the fuselage, and the right horizontal stabiliser had broken away approximately one metre outboard of the aircraft centre line. The inboard section of the right wing which contained a fuel tank plus the aircraft battery burnt following ground impact. No other components were fire damaged.

Detailed examination of the aircraft structure revealed that:

(a) All fracture surfaces were indicative of overload failures. There was no evidence of fatigue or corrosion or other loss of strength of any structural component.

(b) All eight (four per side) outer wing attach bolts and their respective fittings were intact and, other than post impact fire damage to the right wing, showed no signs of distress.

(c) The wings failed in a positive symmetric pitch-up manoeuvre, positive gust load, or both.

(d) The following evidence indicates that the right wing separated first:

(i) The right engine was still developing power when it tore free.

(ii) Cables which had pulled out from the right wing flicked across the fuselage and struck the left engine nacelle which was therefore still in place at that time.

(e) Separation of the right wing tore out part of the belly of the aircraft including the engine controls, which then shut off power to the left engine.

(f) Both engines separated from the nacelles at the firewall mountings due to excessive loads as the wings rotated rapidly following structural failure of the wing spars.

(g) Following failure of the right wing the unbalanced airloads on the left wing caused rapid rotation of the fuselage to the right. Airloads on the empennage opposed the rolling action resulting in:

(i) buckling and collapse of the rear fuselage aft of the pressure bulkhead and

(ii) an upward bending failure of the down-going right horizontal stabiliser.

(h) Following separation of the right stabiliser the unbalanced airloads on the tail, possibly assisted by the clockwise rotation and tumbling action of the fuselage, caused a torsional separation of the weakened rear fuselage.

(i) The outboard section of the right wing failed in upwards bending as the wing separated due to down aileron being applied as the control cables were strained and broke sequentially.

(j) As the right wing separated, the battery and engine control cables were pulled from the wing flicking across and striking the left engine nacelle and the windscreen. Either the wing trailing edge, or flailing cables, struck and broke the right side cockpit windows.

The fuselage was grossly damaged as follows:

(a) Wing separation had torn out a section of the lower fuselage and floor structure leaving a hole approximately two metres by one metre.

(b) The fuselage impacted the ground inverted and was extensively crushed along the line of the windows.

(c) To remove the occupants the fuselage had been rolled over and cut open using rudimentary implements.

(d) All window glass had been fragmented and parts of the windscreen frame torn out.

Examination clearly established that the cabin entry door was in position, latched and locked at impact, as was the emergency exit. A previous repair adjacent to the cabin entry door was intact. The front and rear pressure bulkheads were crushed and the front bulkhead had split. All structural damage was attributed to the inflight breakup or ground impact. No evidence could be found of any pre-existing damage.

All windows and windscreens were fragmented. The majority of the fragments were scattered around the fuselage impact site, but some pieces of the cockpit side windows and windscreen were found on the wind-drift wreckage trail. Several of the fragments found on the wreckage trail contained paint smears or scratches consistent with having been struck by other components during the inflight breakup. The upper windscreen surround bore heavy cable marks consistent with having been struck by flailing control and electrical cables. All available sections of window acrylic and windscreen glass were collected for identification and analysis.

1.16.4 Flight control systems

Both the primary flight control surfaces and the trim surfaces were operated via conventional closed cable and bellcrank systems. The systems had been extensively damaged by the inflight breakup and subsequent ground impact and the position of the controls at breakup could not be determined. The control runs were traced from the cockpit to the control surfaces. There was no evidence of pre-existing defects.

All primary and secondary control surfaces, their hinges, attachments, actuators and mass balances were closely examined for defects which could have given rise to control problems. All fractures and failures were consistent with overloads induced at breakup of the aircraft structure and by the airloads resulting from breakup. There was no evidence of control binding, corrosion, fatigue cracking or aerodynamic flutter.

The elevator trim screw jacks were in the full nose-down position. This was not consistent with the breakup mode of the aircraft which had resulted from a nose-up pitch. Both trim cables had failed in overload. It is considered that one cable failed before the other, and that the remaining cable wound the jacks to their full nose-down travel position.

1.16.5 Automatic Flight Control System

The aircraft was fitted with the King KFC 300 Automatic Flight Control System (AFCS) which incorporated a flight director and three axis autopilot. The yaw axis could be engaged independently of the roll and pitch axis for use as a yaw damper.

The impact had extensively damaged the AFCS. Strip examination showed that the rotors from the reference gyros (pitch, roll and yaw) were all rotating at impact. The selector switches for both the autopilot and yaw damper were of the type that unlatch when power is removed and therefore their position prior to inflight breakup could not be established.

The autopilot mode controller, the elevator, aileron and rudder servos together with the elevator trim servo were examined by appropriate specialists.

The autopilot mode controller was mounted at the aft end of the centre pedestal and had the following selector switches and warning lights:

(a) yaw damper engage switch
(b) autopilot engage switch
(c) a number of autopilot mode selector switches
(d) manual pitch and roll controls
(e) a fault light for the pitch, roll and yaw servo systems

An annunciator panel was located on the instrument panel immediately in front of the pilot.

When recovered, the mode controller had extensive impact damage and could not be functionally tested. Both the autopilot and yaw damper switch knobs had broken off and, as both switches were electrically latched, they were found in the off position. The roll, pitch and yaw fault lights had been smashed and had fallen out of their sockets.

The mode selector switches were push on/push off type and impact damage across the face of the switches cast doubt on the significance of the existing switch positions which indicated all modes disengaged. The fuselage impact in the inverted position could also induce sufficient inertia loads on the switches to move them to the disengage position.

Both the elevator trim and the elevator servo motors were bench tested and found to function correctly.

The aileron servo motor was extensively damaged and could not be functionally tested. However, there was no evidence of an electrical failure of any of the components.

The rudder servo motor had received superficial damage to the casing but the electrical components were undamaged.

1.16.6 Oxygen system

The aircraft was equipped with a Puritan-Zep oxygen system with a 76 litre capacity oxygen bottle. The aircraft flight manual quotes oxygen duration for 12 people and a full bottle (1800psi) under normal usage as 43 minutes. If both crew members use 100 per cent oxygen the duration is reduced to 37 minutes. At a daily inspection made by Hawker Pacific in conjunction with the inspection on 26 August 1983 the oxygen pressure was required to be checked and in excess of 1000 psi. This check was certified as having been carried out but no record was found of the actual oxygen pressure. If the pressure had been 1000 psi the bottle would have been at 55 per cent capacity and the duration would have been:

- normal usage 23.6 minutes
- crew on 100% oxygen 20.3 minutes

The oxygen system included automatic deployment passenger masks controlled by a barometric switch. The oxygen masks installed were:

(a) two quick donning diluter demand masks in the two pilot positions;

(b) 13 constant flow auto-deployment masks in the passenger cabin contained in four dispensers of three masks each and one single mask dispenser; and

(c) one manual deployment constant flow mask (medical or first aid oxygen mask).

All oxygen masks in the passenger cabin, apart from the medical mask, were part of the automatic deployment system. These masks were controlled by a barometric switch which opened a valve and released oxygen pressure to the dispensers. The pressure to the masks then operated a plunger which opened the dispenser door allowing the masks to drop out a short distance. With this system, as the passenger pulls the mask to his face a lanyard attached to the mask pulls a pin to release the oxygen flow. One strapped-in passenger was wearing his mask with the elastic band around his head, two others were holding their masks.

The barometric switch would deploy the masks automatically in the event that the cabin pressure altitude exceeded the switch setting (nominal 12 500 feet). The system could also be activated by the pilot via a manual override. Before oxygen can be drawn from the system the control cock at the oxygen bottle must be in the 'on' position. This cock was operated by an on/off control in the cockpit.

The oxygen system control positions, as found during the examination were:

- oxygen bottle cock—on
- cockpit on/off control—on
- passenger system manual override—off
- pilot's mask control—midway between normal and 100%

The pilot's oxygen mask was found in the pilot's position in the wreckage and there was evidence that it was being worn at impact. The co-pilot's mask was not located, but the retaining straps, outlet hose and outlet fittings were found in the cockpit, indicating that the mask had been present at impact. Of the 13 auto-deployment passenger masks 12 had been deployed. The mask in the single dispenser had not deployed and no reason could be found which would have prevented it deploying. The medical oxygen mask, stored in a manually operated container, was found in the wreckage out of its container. Whether it was deployed prior to impact or disturbed during impact or rescue operations could not be established.

The oxygen bottle was empty. However, the gauge and fittings had been sheared off at breakup and any oxygen in the bottle would have discharged at that time.

The position of the oxygen controls indicate that the manual override was not used to deploy the masks. The other two possibilities which would release the dispenser door and deploy the cabin oxygen masks were:

(a) operation of the barometric switch due to a drop in the cabin pressure; and
(b) inertia loads due to inflight turbulence.

1.16.7 Pressurisation system

Detailed examination of the pressure hull (fuselage) did not reveal any defects likely to have existed prior to the inflight breakup.

The fuselage was pressurised by bleed air from the engines. That is, clean air, under pressure taken from the compressor stage of the turbine engines. The cabin pressure was regulated by a controller unit in the cockpit, which operated outflow valves situated in the fuselage rear pressure bulkhead, to maintain the selected cabin pressure.

The pressurisation controls were found as follows:

cabin pressure switch—'normal' position
pressurisation controller—set to 9000 ft cabin altitude
bleed air switches—both damaged, position not determined.

The cabin pressure switch was 'gated' to prevent inadvertent operation. It had three positions: spring loaded into the 'test' position, gated to 'normal' and to 'dump'. The dump position is to rapidly relieve cabin pressure to ambient pressure.

The pressurisation controller was set to the normally accepted cabin altitude of 9000 feet for flight at 27 000 feet. That is, the pressurisation system would maintain a cabin pressure equal to 9000 feet altitude when the aircraft was operated at 27 000 feet.

No evidence was found of any pre-impact disruption or contamination of the bleed air pipes between the engines and the fuselage outlets.

1.16.8 Air conditioning system

All components were examined including the condenser, evaporator and vent blower motor. There was no evidence of pre-breakup defects or damage.

1.16.9 Fire protection system

Both engines were protected by a fire warning and extinguisher system. There was no evidence of any fire damage or extinguishant discharge on either engine prior to inflight breakup. The cylinders containing the extinguishant were mounted in the wing behind each engine. The left engine cylinder was fully charged. The right cylinder had discharged due to operation of the thermal relief as the right wing burnt following ground impact.

1.16.10 Electrical system

Electrical power was provided by one starter/generator on each engine and one nickel-cadmium battery mounted within the leading edge of the right wing.

With the exception of the burnt-out right wing, all electrical components and wiring were examined and revealed no evidence of arcing or burning.

Most of the electrical switches and circuit breakers located in the cockpit and cabin were damaged. Their positions may have been moved at ground impact or during subsequent rescue operations. However, the filament of the right wing navigation light was stretched, indicating that this light was illuminated, therefore, electrical power was available when inflight breakup occurred.

1.16.11 Vacuum and pitot static systems

Examination of the vacuum and pitot static systems revealed no pre-existing defects and no blockages. The alternate static source control lever was in the 'normal' position.

The left altimeter subscale was set to 1012.5 millibars and the right (co-pilot's) to 1013 millibars.

As previously mentioned, the QNH altimeter setting for Windorah, the departure aerodrome, was 1021 millibars. The settings as found on the altimeters would tend to indicate that the pilot had climbed above the transition altitude of 10 000 feet, and had set (close to) the standard cruising subscale of 1013.2 millibars, in preparation for his climb to cruise at Flight Level 270 (27 000 ft.)

1.16.12 Communications equipment

The nose section of the fuselage which housed the avionics equipment was severely crushed, but the following evidence was derived:

The high frequency radio was selected to channel 10, 6610 megaHertz, the frequency which had been used to communicate with Brisbane Flight Service Centre.

The pilot's microphone function selector switch was set to 'cabin', indicating that the cabin public address system had probably been used at some time between the pilot's acknowledgement of his airways clearance and the inflight breakup.

1.16.13 Fuel system

Each engine was fed from a nacelle tank which in turn received fuel via gravity feed from its main fuel tank. Each main fuel tank consisted of a number of interconnected fuel cells in each outer wing. An auxiliary tank was situated in each inner wing between the engine and fuselage and was equipped with an automatic fuel transfer system to pump the fuel to the nacelle tank. For single engine operation a cross feed system was incorporated to supply fuel to the operating engine from the other wing. Evidence was found that both main fuel systems still contained fuel at ground impact. The fuel control panel mounted in the cockpit was extensively damaged at impact and may have been further disturbed during rescue operations. The switch positions were:

<table>
<tr><th>Switch</th><th>Left</th><th>Right</th></tr>
<tr><td>Fuel firewall shut-off</td><td>Open</td><td>Open</td></tr>
<tr><td>Crossfeed</td><td colspan="2">Off</td></tr>
<tr><td>Standby fuel boost pump</td><td>On</td><td>Off</td></tr>
<tr><td>Auxiliary fuel transfer</td><td>Override</td><td>Auto</td></tr>
</table>

The engine driven fuel pump on the left engine was in a serviceable condition and there was no reason found for the standby fuel boost pump switch to have been in the 'on' position.

In normal operations the auxiliary tanks are the first to be used and should have been emptied early in the flight to Windorah. As only the main tanks were refuelled at Windorah the auxiliary tanks should have been empty and there should have been no requirement to transfer fuel from the auxiliary tanks on the flight from Windorah.

The switches for the standby boost pump and the auxiliary fuel transfer were adjacent. It is probable that they were both disturbed during rescue operations.

1.16.14 Fuel supplies

The fuel installation from which VH-KTE had been refuelled at Windorah was inspected and fuel (Avtur) samples from the installation were subjected to specialist laboratory tests. The fuel samples were close to specification. Furthermore, other aircraft had been refuelled on 28 August 1983 from the same installation and had operated normally.

1.17 ADDITIONAL INFORMATION

1.17.1 Aircraft certification

The Beech 200 Super King Air aircraft was certificated in the United States of America by the Federal Aviation Administration (FAA) on 14 December 1973. The basis of the certification was Federal Aviation Regulation (FAR) Part 23 to amendment 23.23. Australian certification followed in 1974.

VH-KTE, manufactured in USA in 1978, was allotted serial number BB-320. It was certificated as above and entered in the Australian Register of Aircraft on 19 May 1978.

1.17.2 Main spar material

The structural examination found that the right wing separated first and that the main spar lower cap was the first component of that wing to fail. A section of the main spar lower cap adjacent to the fracture was analysed at the Department of Aviation Materials Evaluation Facility to determine the spar material, its hardness and therefore strength level.

The X-ray spectrum of the spar material indicated the presence of aluminium, copper, silicon, magnesium and iron at levels typical of a 2014 series aluminium alloy. The hardness of the spar material was found to be consistent with a normal T6 temper. Aluminium alloy 2014 is widely used in both civil and military aircraft structures because of its high strength and good resistance to corrosion and fatigue.

The manufacturer requires the lower spar cap material to be 2014 with a T4511 temper. This temper results in a lower hardness and strength but improved fatigue and corrosion properties compared with the T6 temper. The reason for the hardness of the spar lower cap from VH-KTE being similar to a T6 temper is considered to be strain hardening of the material as it was overstressed at failure.

The spar cap is therefore considered to be satisfactory with regard to material quality and strength level.

Measurements indicated that the lower spar cap bent upwards at least 28 degrees before it failed.

1.17.3 Flight conditions to overload the wing spar

At the estimated aircraft weight at the time of the accident the manufacturer has calculated the minimum load factor to cause the spar lower cap to fail as 8.36g. Further, the minimum airspeed at which the wings could produce sufficient lift to reach this load factor was 292 knots equivalent air speed (EAS). This equates to a calibrated airspeed (CAS) of approximately 295 knots at the calculated breakup altitude. This speed is in excess of the maximum operating speed of 260 knots (CAS).

The manufacturer also provided estimates of the force necessary on the control column (pilot effort) to attain this load factor, considering a symmetric pull up and the trim set for 1g flight. Three centre of gravity (CofG) positions were used in the calculations to cover the range of load distributions possible at the time of the accident. The estimates are:

Condition	*CofG position*	*Pilot effort*
Most aft C of G	195.1 inches	265 lbs
Most likely C of G	192.1 inches	305 lbs
Most forward C of G	191.8 inches	307 lbs

These forces are unlikely to have been within the capability of the pilot alone. The basic design requirement limits pilot effort necessary for transient conditions to a maximum of 75 lbs and the structural design requirements consider maximum pilot effort loads under emergency conditions to be 236 lbs. Thus, if the calculated loads had been applied, the pilot would probably have required some form of assistance.

1.17.4 Effect of elevator trim

A given elevator trim position results in an approximately constant aircraft angle of attack and wing lift coefficient. Therefore, as the aircraft speed increases the lift coefficient remains constant but the aerodynamic lift will increase because it is proportional to both the lift coefficient and the square of the aircraft speed. At the planned cruise level of 27 000 feet the flight manual indicates a cruise speed of 260 knots true (TAS) or approximately 170 knots equivalent airspeed (EAS). If the aircraft had remained trimmed for this speed the following load factors would apply at higher airspeeds:

Airspeed EAS knots	*Load factor g*
170	1.0
200	1.4
250	2.2
292	3.0
300	3.1
350	4.2
400	5.5

The estimated minimum airspeed at breakup was 292 knots EAS and at this speed enough force could be applied to the control column to increase the load factor further and exceed the wing ultimate strength. Due to the increasing load factor at higher speeds, as the table indicates, less pilot control input would be required to exceed the wing ultimate strength.

1.17.5 Aircraft windows

Parts of the windscreen and the right side cockpit windows were located on the wind-drift wreckage trail indicating that they had been broken during the inflight breakup. All remaining windows had been shattered at ground impact and the fragments further disturbed during rescue attempts, making it impossible to associate fragments with particular windows.

All fragments of glass from the windscreen and acrylic from the windows were collected, separated into window types - windscreen, sidescreens, cabin windows - analysed and weighed.

The following results were obtained:

Windscreen glass	92% recovered
Sidescreen acrylic	68% recovered
Cabin windows	98.5% recovered.

The windscreen glass was destroyed during inflight breakup. There was no evidence of bird impact material on the glass. The right sidescreens bore marks indicating that they had been broken during inflight breakup.

The cabin windows all broke at ground impact when the fuselage impacted inverted. The cabin roof had been crushed along the cabin window lines.

1.17.6 Icing of aircraft controls

There have been occurrences of water pooling in the bottom of the fuselage of Beech 200 Super King Air aircraft, immediately aft of the pressure bulkhead and freezing on to the elevator cables, restricting or completely immobilising the elevator controls. However, this condition is not known to have caused accidents since descent to warmer temperature levels resulted in the ice melting and freeing the cables.

On advice from the manufacturer the drain hole in the fuselage outer skin in this area was required to be enlarged. This requirement appears to have solved the problem.

The drain hole in VH-KTE had been enlarged and the aircraft is not known to have encountered inflight rain, rain when parked, or to have been washed down in the 48 hours preceding the accident.

1.17.7 Birds in the cabin

Three dead birds, Cockatiels Nymphicus hollandicus, were found in the cabin of VH-KTE. Also found was the cardboard carton in which the birds had been carried.

The Department of Aviation ornithologist determined that the birds were probably not capable of flight, other than fluttering for short distances.

To determine more precisely the probable reaction of the birds to the varying conditions of flight in VH-KTE, several birds of the same type and age were subjected to a test program in a decompression chamber. The program included climbs, rapid depressurisation, rapid descents from 27 000ft to 10 000 ft, then to sea level, following depressurisation at 27 000 ft.These experiments had virtually no effect on the birds. They remained in their positions in the cage, or perched, throughout.

The birds would not have been capable of forcing their way out of the cardboard carton in which they were carried. They were either deliberately released from the carton during flight or freed from the carton by other forces during the inflight breakup.

1.17.8 Descent in the event of depressurisation

In the event of depressurisation, the recommended procedure is for the pilot to don his oxygen mask, deploy passenger oxygen masks, reduce power, extend landing gear and partial flap and descend at 182 kts to 10 000 feet or below as appropriate.

Evidence established that the landing gear and the flaps were in the fully retracted position prior to inflight breakup, and that the pilot and some passengers were using oxygen masks.

1.17.9 Cabin fire or smoke

The aircraft Flight Manual requires the pilot, in the event of an electrical fire or smoke in the cabin, to turn off electrical power from the generators and battery by use of the gang bar. All electrical power is thereby lost to instruments, lighting and the pressurisation system. In daylight visual conditions this would initially present no serious problem and descent as described in 1.17.8 would be accomplished. At night the pilot would be deprived of natural light and a visual horizon. He would need to use the (mandatory) hand held torch to illuminate the instrument panel and cockpit.

The pilot would then have to restore electrical power progressively to isolate the electrical, or smoke producing, problem. However, the Company Operations Manual specifies that instead of immediately turning off all electrical supplies, the pilot should turn off the least necessary circuits until the problem area is identified thus, at night, the cockpit lighting and instrument supplies would be the last to be turned off. Evidence from the other Company pilot indicated that pilot Moore would have adopted the latter procedure.

1.17.10 Passengers' baggage

Early in the field investigation witness evidence suggested the possibility of explosive or toxic material being carried in passengers' baggage.

A Queensland Police forensic squad was immediately despatched from Brisbane to Charleville. Their inspection of all baggage, then of the aircraft at Adavale, confirmed the absence of such material.

2. Analysis

2.1 Despite the detailed and extensive investigation there is no firm evidence to indicate the circumstances which led to the inflight breakup of the aircraft.

2.2 On climbout from Windorah the aircraft probably reached, or was close to, its approved Flight Level 270 (27 000 ft). Climb performance indicates that this level should have been achieved a few minutes prior to reaching Adavale. In the normal course of events the pilot should have advised Brisbane Flight Service if this had not been possible or if any other change of flight plan had been necessary.

2.3 The noise like thunder heard by Adavale witnesses on this clear night, was probably the noise of inflight breakup, calculated to have occurred at about 7000 ft altitude. The second noise, south of the town, was undoubtedly the ground impact of the major aircraft components.

2.4 Oxygen masks deployed and worn by the pilot and two passengers tend to indicate a problem with pressurisation, fire, fumes or smoke within the cabin. No evidence was found to support such a conclusion. The cockpit controls were not set to manually deploy the masks. Had the passenger masks deployed in turbulence, there would appear to have been no reasons for the pilot to deliberately don his own mask. Further, there was obviously time, and little enough turbulence, to permit the pilot and passengers to put their masks on properly before the aircraft became uncontrollable.

2.5 The pilot may well have executed an emergency descent, deploying landing gear and flaps and, on reaching a suitable altitude, retracted them prior to the inflight breakup. But there is no evidence to support this proposition.

2.6 No pre-existing defect was found in the engines, airframe or components likely to have led to the breakup.

2.7 The pilot's communication selector was switched to 'cabin'. He may have given brief warning of a problem to the passengers, sufficient only to allow one or two to fasten seat belts and don oxygen masks before the problem reached very serious proportions, but insufficient time to allow the other passengers to secure themselves. Those other passengers may have been thrown about during and after inflight breakup and deposited at the rear of the cabin.

2.8 All fractures in the aircraft structure were clearly the result of severe aerodynamic overload. The overload may or may not have been induced by the pilot or, should the pilot have been incapacitated, by the passenger in the co-pilot seat. However, there is no evidence to support such a conclusion.

2.9 There can be little doubt that the severe aerodynamic overload which induced the breakup was the consequence of a loss of control of the aircraft, for whatever reason, by the pilot. It is possible that the high aerodynamic loading was a result of the pilot or his front seat passenger, or both, attempting to recover control of the aircraft.

2.10 There is no requirement for aircraft in this category to carry either a cockpit voice recorder (CVR) or a flight data recorder (FDR). However, had the aircraft been equipped with, at least, a cockpit voice recorder with an 'area' microphone, the valuable information recorded would have considerably enhanced this investigation.

2.11 Many hypotheses can be proposed for the loss of control of the aircraft which, in turn, led to aerodynamic overloading and the resultant breakup of VH-KTE. There is no firm evidence to support any one in particular.

3. Conclusions

3.1 The pilot was properly licensed and qualified to conduct this flight.

3.2 There is no evidence that the pilot became incapacitated.

3.3 No deficiency could be found with the aircraft, its engines, components or materials likely to have contributed to the accident.

3.4 The weight and balance of the aircraft was within prescribed limits.

3.5 Airways Operations Services and Facilities were not factors in the accident.

3.6 There were no known meteorological phenomena which may have contributed to the accident.

3.7 This was an approved charter flight, conducted under the Instrument Flight Rules, at night.

3.8 Shortly before reaching Adavale the pilot lost control of the aircraft, for reasons unknown and, following a rapid descent to about 7000 feet, high aerodynamic loading occurred which resulted in failure of the wing spar and breakup of the airframe. However, the wing attachment bolts and their fittings did not fail.

4. Factors

There is insufficient evidence to determine the circumstances and factors which led to the inflight breakup of the aircraft.

APPENDIX A List of occupants of VH-KTE

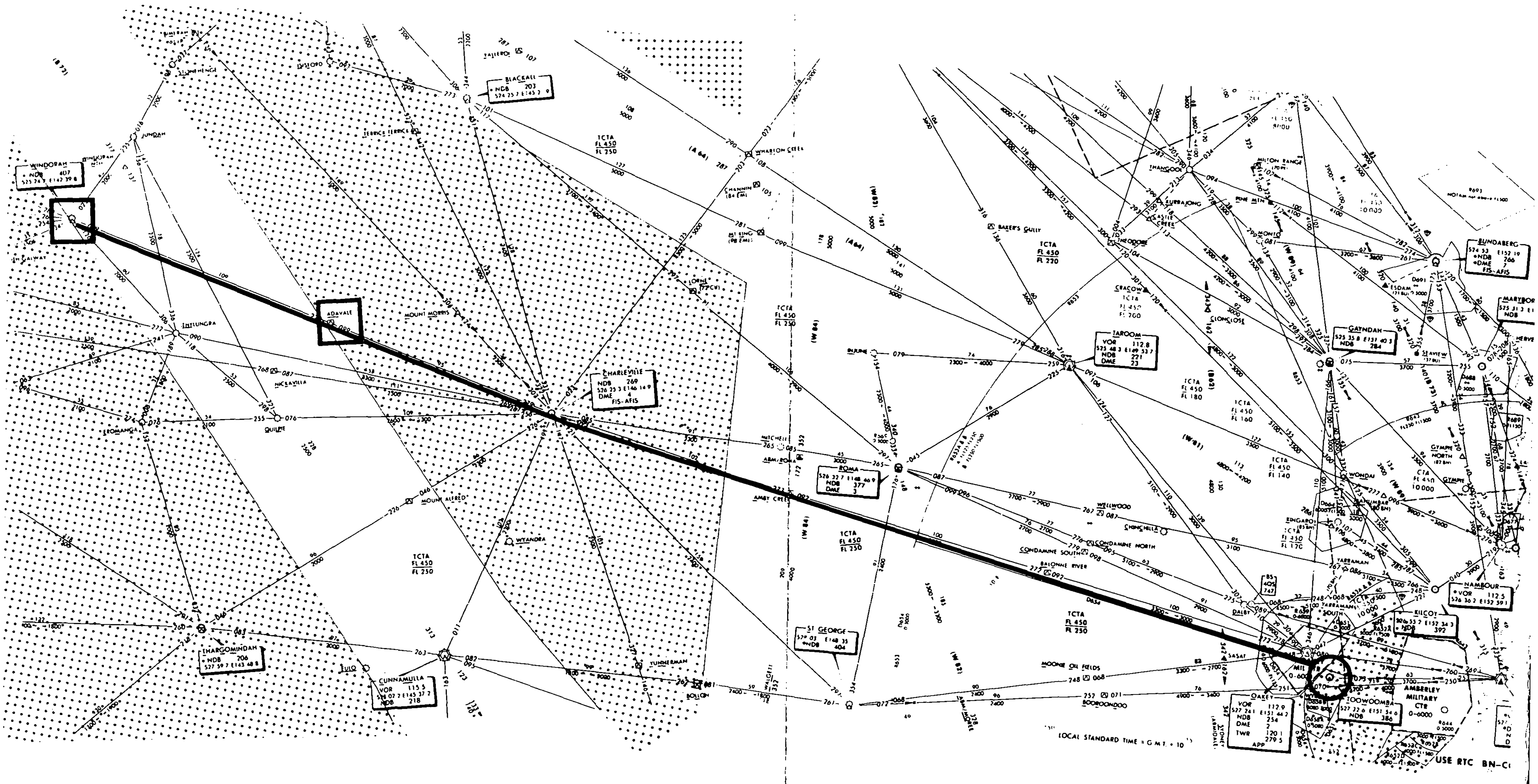
Kenneth Robert Raby MOORE	45 years	Pilot-in-command
Ronald Allen STRATE	35 years	Passenger
John William DUANE	21 years	Passenger
Allan Raymond VIDLER	29 years	Passenger
Rex DOWNMAN	32 years	Passenger
Stephen John KIRWAN	21 years	Passenger
Peter Frederick PECK	39 years	Passenger
Geoffrey James ANDERSON	22 years	Passenger
Mark Anthony SAMUELS	33 years	Passenger
Colin James O'BRIEN	50 years	Passenger
Kenneth Harry WETTER	41 years	Passenger
Stephen BUCHANAN	25 years	Passenger

APPENDIX B Occupants' positions at crash site

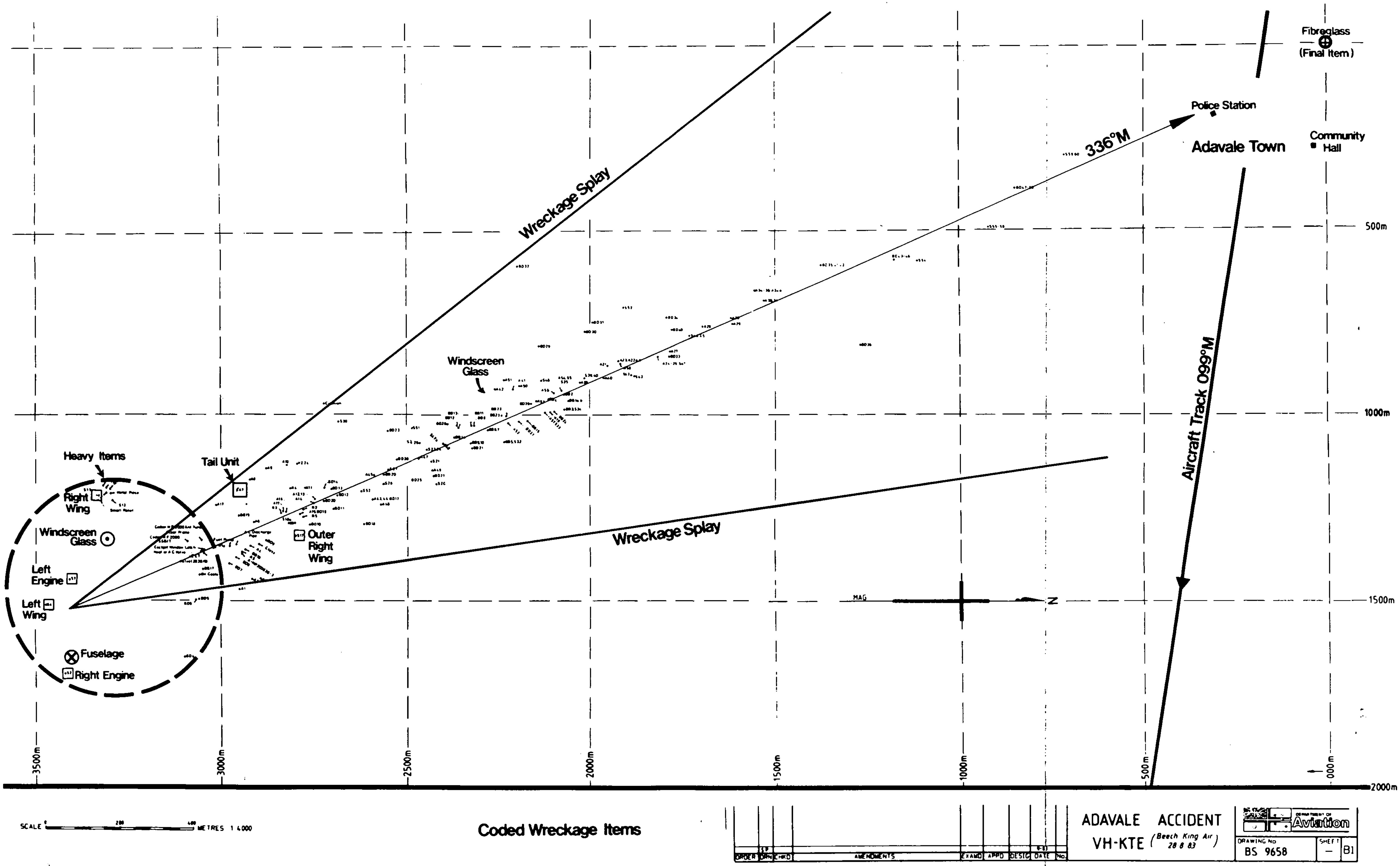
	Aircraft nose	
Pilot		
K. MOORE X0		R. STRATE X
	R DOWNMAN	
A. VIDLER		Vacant
C. O'BRIEN X		Vacant
Vacant		K. WETTER X
J. DUANE		S. BUCHANAN X0
Vacant		Vacant
Entrance Door	P. PECK	
	J. ANDERSON 0	Toilet
	M. SAMUELS	
	Luggage net	
	S KERWAN	

0 = oxygen mask worn
X = seat belt fastened

APPENDIX C **Copy of Radio Navigation Chart indicating planned route of VH-KTE from Windorah to Toowoomba.**



APPENDIX D **Wreckage distribution near Adavale**



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