BASI

Bureau of Air Safety Investigation

Air Safety Report

Mid-Air Collision Between Cessna 172-N VH-HIZ and Piper PA 38-112 VH-MHQ

Near Tweed Heads, NSW

20 May 1988

BASI Report 881/1042

COMMONWEALTH DEPARTMENT OF
TRANSPORT AND REGIONAL DEVELOPMENT

Department of Transport and Regional Development

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Note:

(1) All times shown are Australian Eastern Standard Time and are based on the 24-hour clock.

(2) The accuracy of the illustrations provided in appendices 7 and 8 is determined by the degree of validity of the raw data described in section 1.16 of this report, and by the processes to which that data was subjected.

LIST OF ABBREVIATIONS

AACC	Area Approach Control Centre.
ADC/APP	Air Traffic Controller performing Aerodrome/Approach Control functions.
AFIZ	Aerodrome Flight Information Zone.
ARR/R	Arrivals Sector, Radar.
AVR	Automatic Voice Recording.
BN SEC 1R	Brisbane Control Sector One, Radar.
BN SEC 1P	Brisbane Control Sector One, Procedural.
COORD	Air Traffic Controller performing Coordination functions.
FISS	Flight Information Service Supervisor.
FIS 4	Flight Service Flight Information Sector 4.
FIS 4 CDTR	Flight Service Flight Information Sector 4 Coordinator.
FPS	Flight Progress Strip/s.
FSC	Flight Service Centre.
FSFD	Flight Service Flight Data.
FSO	Flight Service Officer.
IFR	Instrument Flight Rules.
KM	Kilometres.
OMC	Operations Monitoring and Control.
QNH	Altimeter sub-scale setting to obtain elevation or altitude.
SMC	Air Traffic Controller performing Surface Movement Control functions.
VFR	Visual Flight Rules.
VMC	Visual Meteorological Conditions.

SYNOPSIS

At approximately 1609 hours on 20 May 1988, Cessna 172-N registered VH-HIZ and Piper PA38-112 Tomahawk registered VH-MHQ collided on the downwind leg of the right hand circuit for Runway 14 at Coolangatta, Queensland. The aircraft had been engaged in training flights in the Coolangatta circuit area. Both broke up after the collision and fell into swampland. A flying instructor and a pilot under instruction in each aircraft received fatal injuries.

The Piper VH-MHQ had been instructed to make a left orbit while on the downwind leg to permit an inbound commuter aircraft, Cessna C404 VH-SON, to overtake, descend and become the number one aircraft in a landing sequence. The Cessna VH-HIZ had been requested to make an early right turn on becoming airborne from a touch-and-go landing. This request was made to clear VH-HIZ from the runway centreline so that a landing clearance could be issued to a Fokker Friendship FK27 VH-FNO, then following on short final.

Both VH-MHQ and VH-HIZ complied with their respective instructions and requests and were observed commencing the appropriate manoeuvres. Air traffic control personnel did not maintain continuous visual surveillance of these two aircraft involved in the accident throughout their respective manoeuvres. During these manoeuvres Cessna 210 VH-MDG contacted Coolangatta tower and advised that it was 41 nautical miles (76 km) to the south of the aerodrome.

For a significant period, activity had been normal for a Friday but had increased substantially in the 10 minutes prior to the accident. At the time of the accident there were five other aircraft on tower frequency - the leader of a formation flight of Tiger Moth aircraft operating to the north, clear of the Coolangatta control zone, a Piper PA28 VH-MCS in the Burleigh Heads area, a Cessna C172 VH-KZG in the Springbrook area inbound to Coolangatta, a Cessna 404 VH-BUY landing on Runway 14 and a Beechcraft BE36 VH-TYZ at the Runway 14 holding point.

(Refer to Appendix 1 - Relevant Maps and Charts)

1. FACTUAL INFORMATION

1.1 History of the Flights. Cessna 172 VH-HIZ was being operated by a training organisation based at Coolangatta. The flight was for the purpose of refamiliarisation for the pilot under instruction, who had been undertaking training to fulfil the recent experience requirements of his licence. He had not flown since 1982. The aircraft was carrying out right hand circuits and landings on Runway 14 at Coolangatta at the time of the accident.

Piper PA38 VH-MHQ was being operated by another local training organisation. The particular flight was being conducted as part of a program of refresher training for the pilot under instruction, who had not flown for some years. This aircraft was also carrying out right hand circuits on Runway 14.

VH-HIZ was initially cleared for takeoff at 1529 hours and at the time of the accident had completed five circuits and touch-and-go landings. Both right and left hand circuits had been flown during this sequence. At 1607 hours the aerodrome/approach controller (ADC/APP) cleared VH-HIZ for a further touch-and-go landing and requested the aircraft to make an early right turn after becoming airborne.

VH-MHQ was cleared for takeoff at 1558 hours and had completed one right hand circuit with a touch-and-go landing. During the second circuit the ADC/APP instructed the aircraft to make a left hand orbit. At that time it was on downwind at a position a few degrees north of a bearing of 230 degrees magnetic from the control tower. In the latter stages of this orbit the two aircraft collided.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	4	-	-
Serious	-	-	-
Minor/None	-	-	-
Total	4	-	-

1.3 Damage to Aircraft. Both aircraft were destroyed by the collision and the subsequent ground impact forces.

1.4 Other Damage. No other property was damaged during the accident sequence.

1.5 Personnel Information

1.5.1 Pilots. The pilot in command of Cessna 172 VH-HIZ was aged 28 years. He held a Commercial Pilot Licence which was current to 31 August 1988, together with a Grade One Flight Instructor rating. His licence was appropriately endorsed to allow him to act as pilot in command and instruct on Cessna 172 aircraft. His total flying experience at the time of the accident was 1548 hours, of which 646 hours had been gained on Cessna 172 aircraft. His most recent proficiency check had been completed on 21 April 1988 when he successfully completed a flight test, conducted by an Examiner of Airmen, for upgrading to a Grade One Flight Instructor. His most recent pilot medical examination had been conducted on 2 July 1987.

The pilot under instruction in VH-HIZ was aged 64 years. He was the holder of a valid Private Pilot Licence which was current to 30 April 1990. He had not recorded any flying time since 1982 but had recently decided to regain his proficiency. Since 7 April 1988 he had completed seven dual instructional flights and was carrying out a further dual flight when the accident occurred. He had 361 hours total flying experience, of which 10 hours were on Cessna 172 aircraft. His most recent pilot medical examination had been conducted on 18 April 1988.

The pilot in command of Piper PA38 VH-MHQ was aged 23 years. He held a Commercial Pilot Licence valid until 31 October 1988, together with a Grade Three Flight Instructor rating. His licence was appropriately endorsed to permit him to act as pilot in command and instruct on the PA38-112 aircraft. His total flying experience was 790 hours, of which 200 hours were on the Piper PA38 type. On the day prior to the accident he successfully completed an Instructor Renewal test conducted by an Examiner of Airmen. His most recent pilot medical examination was on 28 August 1987.

The pilot under instruction in VH-MHQ was aged 43 years. He was the holder of a Private Pilot Licence current until 28 February 1989. He had not exercised the privileges of his licence for some years and was undergoing refresher training to regain his proficiency. At the time of the accident he had approximately 72 hours flying experience, of which two hours were on PA38 aircraft. His most recent pilot medical examination was on 19 February 1987.

1.5.2 Air Traffic Services Personnel

1.5.2.1 Coolangatta Control Tower. There were three air traffic controllers rostered for duty in the Coolangatta control tower on the afternoon of the accident. This was the normal staffing level for a Friday afternoon/evening shift. The positions occupied from left to right, facing the runway complex, and the duties performed were:

(a) Surface Movement Control (SMC). The occupant of this position is responsible for issuing instructions, clearances and information to all traffic operating on the manoeuvring area of the aerodrome, excluding the duty runway(s).

(b) Coordination (COORD). The occupant of this position relays messages to and from other airways units, and has various operational and weather information liaison tasks.

(c) Aerodrome/Approach Control (ADC/APP). The occupant of this position is responsible for maintaining separation and an orderly traffic flow in the circuit area, and also carries out the function of approach/departures procedural control.

(Refer to Appendix 2 - Coolangatta Air Traffic Control Duties)

The controller occupying the SMC position was aged 37 years. He held ratings for the SMC and COORD positions. In addition to conducting his SMC duties, he had been temporarily performing the duties of the COORD for a period of approximately 10 minutes immediately prior to the accident. His last proficiency check was in April 1988 and he completed an aviation medical examination in February 1988. He had 14 years experience as an air traffic controller and had served in the Townsville Area Approach Control Centre before recommencing duty at Coolangatta in December 1985.

The controller rostered for duty at the COORD position was aged 39 years. He held valid ratings for COORD, ADC/APP and SMC. His last proficiency check was in May 1988 and he had completed an aviation medical examination in August 1987. He had 15 years experience as an air traffic controller and served at the Darwin, Adelaide and Brisbane Area Approach Control Centres, and the control towers at Adelaide and Alice Springs before commencing duty at Coolangatta in February 1985.

The controller occupying the ADC/APP position was aged 42 years. He also held valid ratings for SMC and COORD. His last proficiency check was in October 1987 and he was due to be rechecked in May 1988. He had completed an aviation medical examination in August 1987. He had 17 years experience as an air traffic controller and served in the Brisbane Area Approach Control Centre and the control towers at Brisbane, Archerfield, Cairns, Coolangatta and Brisbane before recommencing duty at Coolangatta in March 1987.

1.5.2.2 Brisbane Area Approach Control Centre (AACC). The airspace above the Coolangatta control zone is controlled from the Brisbane AACC under the jurisdiction of Brisbane Control Sector 1 Radar (BN SEC 1R) and Sector 1 Procedural (BN SEC 1P). Aircraft entering the Coolangatta zone from controlled airspace are procedurally separated and sequenced by the BN SEC 1P controller before hand-off to Coolangatta tower. The ADC/APP at Coolangatta then applies procedural approach and separation standards and integrates arriving aircraft into an orderly landing sequence.

The controller occupying the BN SEC 1P position was aged 32 years. He held a valid rating for Brisbane Arrivals Radar control (ARR/R) which is a requirement for BN SEC 1P duty. His last proficiency check was conducted in May 1988. He had been an air traffic controller for six years, all of which had been spent in the Brisbane AACC.

1.5.2.3 Brisbane Flight Service Centre (FSC). The airspace to the south of the Coolangatta control zone and below the control area steps is non-controlled, under the administration of Brisbane Flight Service, Flight Information Sector 4 (FIS 4). Because the FIS 4 operator had a high workload during the period leading up to the accident, he was being assisted by a Coordinator (FIS 4 CDTR).

The Flight Service Officer (FSO) occupying the FIS 4 position was aged 50 years. He held valid ratings for this position and also for Flight Data (FSFD), Aerodrome Flight Information Zone (AFIZ) and Flight Information Supervisor (FISS). His last proficiency check was in March 1988. He had been an FSO for 19 years and had served in the Brisbane Flight Service Centre since mid 1984.

The FSO occupying the FIS 4 CDTR position was aged 33 years. He held valid ratings for this position and also for FSFD, AFIZ and Operations Monitoring and Control (OMC). His last proficiency check was in March 1988. He had been an FSO for seven years and had served in the Brisbane Flight Service Centre since 1985.

1.6 Aircraft Information

1.6.1 Cessna 172-N VH-HIZ. The aircraft was manufactured by the Cessna Aircraft Company in 1979. It was a high-wing four seat piston engined aircraft with a maximum takeoff weight of 1043 kilograms.

1.6.2 Piper PA38-112 VH-MHQ. The aircraft was manufactured by the Piper Aircraft Corporation in 1979. It was a low-wing two seat piston engined aircraft with a maximum takeoff weight of 759 kilograms.

1.6.3 Loading. The weight and centre of gravity for each aircraft were within the specified limits, and there was adequate fuel on board for the proposed flights.

1.6.4 Maintenance and Serviceability. Both aircraft had a current certificate of airworthiness and a valid maintenance release. No maintenance was outstanding at the time of the accident. Examination of the wreckage did not reveal any defect that may have contributed to the accident.

1.7 Meteorological Information. At the time of the accident the surface wind was a light easterly, the altimeter setting (QNH) was 1007 hectopascals, and the temperature was 21 degrees Celsius. There were 2 octas of cloud at 3000 feet, and the visibility was greater than 18 kilometres with no smoke or haze. A high overcast towards the north-west was associated with thunderstorms west of Brisbane. This high dark overcast partly obscured the sun and pilots subsequently advised that the sighting of other airborne aircraft was made difficult because of a lack of definition and contrast. This difficulty was most noticeable when looking towards the north-west. No problems were experienced by any of the controllers with ground-to-air visibility, conditions being regarded as excellent.

1.8 Aids to Navigation. Both aircraft involved in the accident were operating in the circuit area under the Visual Flight Rules (VFR) and the status of the navigation aids at the time of the accident was not relevant to their operation. There were other aircraft conducting navigation aid training and Instrument Flight Rules (IFR) descents and arrivals during the same period. None of these aircraft advised of any unserviceability of the navigation aid facilities.

1.9 Communications. There were no problems identified or noted with the aeromobile communications facilities at Coolangatta tower prior to, at the time of, or after the accident during the aerodrome emergency. Examination of the automatic voice recording (AVR) tapes indicated that all transmissions by the ADC/APP, COORD and SMC were clear, with no over-transmissions or interference. The COORD and SMC used the one set of communications facilities.

(Refer to Appendix 3 - Transcript of Recorded Communications)

1.10 Aerodrome Information

1.10.1 General. The administration of Coolangatta Airport was vested in the Federal Airports Corporation. The complex includes two sealed Runways, 14/32 and 17/35, these being 2042 and 552 metres in length respectively. At the time of the accident, operations were being conducted from Runway 14. Radar facilities were not installed at Coolangatta.

Coolangatta is designated as a primary control zone with defined boundaries. The ADC/APP is normally responsible for traffic separation tasks in airspace extending from sea level to 6000 feet, and to 30 nautical miles (56 km) from Coolangatta. The area of responsibility which is contained within the control zone may be extended for communications and separation purposes with the concurrence of those sectors responsible for adjoining airspace. This arrangement permits an inbound aircraft to communicate with the ADC/APP prior to the aircraft reaching the control zone boundary. To help maintain a record and mental picture of the activity for which he has jurisdiction the ADC/APP is required to maintain flight progress strips (FPS) on which he records pertinent aircraft data. This is particularly important in the case of Coolangatta, where the ADC/APP also exercises an approach/departures procedural function for aircraft beyond the circuit area and the control zone.

The FPS is the controller's working record, which indicates aircraft flight plan details, communications, pilot intentions, clearances, restrictions and frequency transfer times. The controller makes notations on these strips as he conducts communications. This process interrupts the controller's visual surveillance of external events and traffic situations.

1.10.2 Control Tower. The Coolangatta control tower is located 200 metres east of the intersection of the 14/32 and 17/35 runways and between the runway complex and light aircraft apron. The tower cabin floor line stands 10.36 metres above ground level.

The cabin window sill is 1.19 metres above the floor and the roof line is a further 1.98 metres above the sill height. The cabin is octagonal with double glazed windows. The glazing is splayed outwards at an angle of 18 degrees from the vertical. Each glazed panel measures 2.08 metres at the sill level and 2.57 metres at the roof line.

The workstation is aligned so that the air traffic control personnel sit, or stand, at the workstation and look directly ahead at the Runway 14/32 and 17/35 complex. The workstation and front glass panel of the tower are parallel to Runway 14/32 so that the operators are facing 230 degrees magnetic.

(Refer to Appendix 4 - Coolangatta Control Tower Cabin Floor Layout).

There are obstructions to visibility caused by the eight roof pillars and eight glazing joint strips, on the external panels only, which reduce the all round vision by a total of 14.62%. Any obstructions to vision, created by the tower pillars or glazing joint panels, can be overcome by the controller moving sideways in the required direction.

The external glazing has suffered the ravages of continual exposure to salt air and pitting caused by airborne sand particles which degrades vision under certain ambient light conditions.

The workstation was originally designed for two-man operation. When the COORD position was incorporated the workstation console was modified to accommodate this position. However, a discrete set of communications facilities was not provided for the COORD operating position.

1.10.3 Aircraft Movements. During the previous 10 years the number of aircraft movements at Coolangatta had substantially increased. In 1977 there were 50058 aerodrome movements (departures and arrivals), and 7480 through movements (aircraft transiting the Coolangatta control zone). In 1987 these movements had increased to 72567 and

18507 respectively. During this period, the functions of aerodrome control and approach/departures procedural control continued to be performed by one operator for each shift.

(Refer to Appendix 5 - Coolangatta Air Traffic Movements).

1.10.4 Special Aerodrome Procedures. Special procedures applicable to training flights for aircraft above 5700kg maximum all up weight were in force. These procedures required the FK27 VH-FNO to operate on left hand circuits.

1.11 Flight Recorders. Neither aircraft involved in the collision was equipped, nor required to be equipped, with any flight recording device.

1.12 Wreckage and Impact Information

1.12.1 Wreckage Disposition. The wreckage of both aircraft was located in swampland at a position 2.7 kilometres west of Coolangatta control tower and about 7 kilometre west-north-west of the town of Tweed Heads, New South Wales. The impact site was on the New South Wales side of the state border.

The wreckage of Cessna 172 VH-HIZ was in three major portions - the engine and forward fuselage including the instrument panel; the wings; and the rear fuselage including the rear cabin and seat. This high mass wreckage was aligned in a north-westerly direction. Smaller portions of the wreckage were spread over an area with a radius of approximately 200 metres.

The wreckage of Piper PA38 VH-MHQ was aligned in a north-north-westerly direction and was also contained within a radius of 200 metres. The engine had separated from the aircraft soon after mid-air impact and was embedded 1.8 metres in the ground. It was horizontally displaced 300 metres from the estimated mid-air collision point.

1.12.2 Nature of Collision. The nature of the collision sequence was determined from a detailed examination of impact marks on the wreckage. The initial contact was between the left mainwheel of VH-HIZ and the inboard leading edge of the right wing of VH-MHQ. The wheel then entered the cockpit of VH-MHQ through the right hand cabin door, tearing the cabin roof, doors, and windscreen from that aircraft. At the same instant, the propeller of VH-MHQ entered the left side of the forward fuselage of VH-HIZ at the engine firewall and cut through the cabin floor, leading to major structural failure in this area.

The failure of the cabin floor of VH-HIZ allowed the engine and forward cabin to depart upwards and to the left, and led to the left wing being almost completely severed near the wing strut attachment point. Simultaneously, the entire wing centre section separated from the fuselage and the three sections fell independently to the ground.

The main wreckage portions of VH-MHQ were in close proximity, except for the engine and propeller. The initial impact had caused the right wing to fail at near mid-span and the failed outboard section, prevented from falling free by the aileron cables, trailed behind the remainder of the wing as the aircraft spun to the right before ground impact. It then bounced and came to rest inverted. The rear fuselage was detached as a result of the final impact.

1.12.3 Determination of Impact Angle. The impact marks of the collision were close to 45 degrees to the longitudinal axis of each aircraft, in the horizontal plane. A detailed study of the marks indicated that VH-MHQ was banked to the left at an angle of approximately 25 degrees, and that VH-HIZ was flying straight and level at the time of impact. The angle of separation of the cabin floor of VH-HIZ was closely aligned to the direction of the other impact marks. It was evident that the aircraft had collided at an angle of close to 90 degrees while travelling at about the same speed. The angle of impact was further confirmed by the initial cut made by the propeller of VH-MHQ into the cabin wall of VH-HIZ.

(Refer to Appendix 6 - Probable Attitudes at Impact)

1.13 Medical and Pathological Information

1.13.1 Medical Reports. There were no medical aspects that may have contributed to the accident. The controllers stated that they were in good health, and were not suffering from any physiological conditions or job related stress. Each controller had taken the normal number of rostered days off during the 14 days preceding the accident. The ADC/APP and SMC were subsequently examined by a Designated Medical Examiner - Opthalmology and no defect of vision was detected.

There was no evidence of any pre-existing medical or physiological problems that may have affected the ability of the pilots to safely control their respective aircraft.

1.13.2 Psychological Reports. No evidence was found of any psychological factors that may have affected the performance of the controllers or of the pilots on the day of the accident.

1.13.3 Pathological Reports. There was no evidence of pre-impact incapacitation of any of the four pilots involved, and toxicological analyses did not reveal any abnormality.

1.14 Fire. There was no fire resulting from either the collision or the subsequent ground impact.

1.15 Survival Aspects. The accident was not survivable.

1.16 Tests and Research

1.16.1 Computer Graphics. The determination of the final flight paths was difficult because neither aircraft was equipped with flight recording devices, there were no known witnesses of the collision and there were no radar or video recordings of the circuit activity. However, by using the relevant data which was available, an animated three dimensional computer model was constructed. This model was used to analyse the likely aircraft movements, together with cockpit and control tower visibility aspects, and the probable eye movements of the ADC/APP.

The flexible characteristics of the computer graphics model facilitated the determination of the most probable final flight paths. The computer animation was synchronised with a recording of the radio transmissions.

(Refer to Appendix 7 - Presentation of Probable Flight Paths)

1.16.2 Cockpit Visibility. Binocular photographs supplied by the United States Federal Aviation Administration showing each pilot's field of view from the different aircraft types were superimposed on the three dimensional computer graphic image. Where necessary, these views were adjusted for the stature of the pilot and his position in either the left or right seat of the aircraft.

(Refer to Appendix 8 - Cockpit Visibility Diagrams)

1.16.3 Visual Surveillance by the ADC/APP. Data obtained from a survey of the control tower were related to radio transmissions made by the ADC/APP. His likely head movement at particular times during the sequence was superimposed on the computer model. This gave an appreciation of the limitations imposed on visual surveillance of the circuit area when the ADC/APP was also required to carry out the approach function and annotate flight progress strips.

1.16.4 Communications Workload. To quantify the variations in the number of radio transmissions prior to the accident, the durations of transmissions from aircraft and from the ADC/APP were measured. Fifteen minutes before the accident the percentage of each minute taken by radio transmissions was 15.8. This comprised 7.5% originated by the ADC/APP and 8.3% originated by aircraft. Radio transmissions occupied 78.5% of the minute immediately prior to the collision. This comprised 41% originated by the ADC/APP and 37.5% originated by aircraft.

The communications workload was further examined to determine which exchanges were directly related to the aerodrome control function and those which were related to the approach/departures function.

(Refer to Appendix 9 - Analysis of Tower Communications)

1.16.5 Voice Analysis. Spectrograms of the recorded voice of the ADC/APP were made from the AVR tape. The samples were taken from transmissions made during the 15 minutes immediately prior to the collision.

1.17 Additional Information

1.17.1 Air Traffic Disposition. Between 1530 hours and 1554 hours there was only one aircraft in the circuit, VH-HIZ. From 1554 hours the traffic flow progressively increased. At 1554.31 VH-MHQ reported ready for circuits, and at 1556 hours Fokker FK27 VH-FNO reported inbound to Coolangatta for a practice instrument approach. The traffic disposition after this time was as follows:-

1557:56	VH-MHQ	-	cleared for takeoff for a right circuit Runway 14.
1558:02	VH-BUY	-	initial call inbound at 26 miles (48 km) north.
1559:04	VH-MCS	-	initial call inbound at 20 miles (37 km) north.
1600:13	VH-HIZ	-	cleared for touch-and-go Runway 14.
1600:22	VH-SON	-	initial call inbound 22 miles (41 km) south.
1602:35	VH-HIZ	-	instructed to make a right circuit Runway 14.
1602:53	VH-MHQ	-	cleared touch-and-go Runway 14 right circuit.
1603:17	VH-KZG	-	initial call inbound requesting clearance.
1604:26	VH-MCS	-	instructed not to proceed south of Burleigh Heads
1604:54	VH-FNO	-	reported inbound on the final leg of the instrument approach and requested two touch-and-go landings.
1605:28	VH-KZG	-	further call requesting clearance.
1606:01	VH-HIZ	-	instructed to turn base and keep speed up.
1606:09	VH-SON	-	instructed to descend to 1500 feet (6 miles [11 km] south-west).
1606:15	VH-BUY	-	requested to sight VH-FNO.
1606:23	VH-BUY	-	instructed to make visual approach and follow VH-FNO.
1607:06	VH-FNO	-	advised number two for landing following VH-HIZ.
1607:15	VH-HIZ	-	cleared for touch-and-go Runway 14, requested to make an early right turn after takeoff.
1607:25	VH-TYZ	-	reported ready for takeoff Runway 14, was told to hold position.
1607:44	VH-MHQ	-	instructed to make a left hand orbit (VH-MHQ was on mid right downwind).
1607:58	VH-BUY	-	reported turning left base for Runway 14
1608:01	VH-SON	-	requested to sight VH-MHQ (pilot advised that he did not have that aircraft in sight).

1608:37	VH-BUY	- cleared to land.
1608:49	VH-SON	- was observed to pass abeam VH-MHQ by the ADC/APP and was cleared for a visual approach Runway 14.
1609:05	VH-MDG	- initial call inbound at 41 miles (76 km)south.(ADC/APP spent next 25 seconds processing this aircraft).
1609:32	VH-MCS	- ADC/APP began to request VH-MCS to sight VH-MHQ and observed falling debris.

1.17.2 Circuit Area Traffic. At 1609:30 hours, the approximate time of the accident, there were ten aircraft known to be on the tower frequency. Of these, six were operating in the circuit area; their registrations and positions relative to Runway 14 were:-

(a) VH-HIZ - right downwind.

(b) VH-MHQ - orbiting to the left on right downwind.

(c) VH-FNO - crosswind for a left circuit.

(d) VH-BUY - final approach from a left circuit.

(e) VH-SON - approaching right base.

(f) VH-TYZ - awaiting takeoff clearance.

1.17.3 Air Traffic Service Procedures. Cessna 210 VH-MDG was the first aircraft in a sequence of three aircraft inbound to Coolangatta from the south. The pilot contacted Brisbane FIS 4 and advised passing TUCKI at 1607, 7000 feet and estimating Coolangatta at 1624. TUCKI is a position reporting point 45 nautical miles (83 km) bearing 177 degrees magnetic from Coolangatta. To expedite the flow of traffic, BN SEC 1P elected to adopt the procedure whereby VH-MDG would be transferred from BN FIS 4 frequency direct to Coolangatta ADC/APP frequency. This procedure required BN SEC 1P to advise Coolangatta tower that the aircraft would be transferred before reaching 35 nautical miles (64 km) south of Coolangatta; however this advice was not provided to Coolangatta tower. Because this information had not been passed, the Coolangatta ADC/APP expected the transfer of VH-MDG to occur at 30 nautical miles (56 km) from Coolangatta at 1616 hours. The pilot contacted Coolangatta tower at 1609:05 hours, and reported at 41 nautical miles (76 km) south of Coolangatta at 7000 feet. At 1609.25 hours ADC/APP issued a descent instruction to VH-MDG.

1.17.4 Control Tower Manning. At 1556 hours a Civil Aviation Authority clerk telephoned the control tower to advise that he was positioning a vehicle at the tower and to request that he be driven back to his office. This positioning of the vehicle was normal practice to allow the duty controllers to have ready access to a vehicle outside normal working hours. By mutual arrangement with the other controllers, the COORD left his position for approximately 10 minutes to carry out this task. He returned to the tower cabin only seconds before the collision occurred.

1.17.5 Visual Surveillance

1.17.5.1 Controllers. The ADC/APP is required to maintain, as far as practicable, a continuous watch to determine the position of all aircraft under his jurisdiction. To achieve this the controller must scan the circuit area, inbound check points and particular tracks. The SMC and the COORD are not required to maintain visual surveillance of the airborne traffic. However, they may be requested to sight specific aircraft or assist with circuit area surveillance if the ADC/APP considers it necessary.

The SMC had assisted in the sighting of Cessna 404 VH-SON, inbound from Lismore at 2000 feet. He realised that it would be on a right base at about the same time as VH-MHQ. He then heard the ADC/APP instruct VH-MHQ to make a left hand orbit, and saw the aircraft commence the turn. He had intended to observe the whole of the orbit. However, he became occupied with the completion of a prior intercommunications exchange with BN SEC 1P to verify the position of Cessna 172 VH-KZG.

The last sighting of VH-MHQ by the SMC occurred as the ADC/APP instructed the Cessna 404 VH-SON to make a visual approach. At that time, 1609 hours, he observed VH-MHQ to be on a mid right downwind position for Runway 14, in the latter part of the orbit, and banked left at about 20 degrees.

The ADC/APP last observed VH-HIZ in a shallow right turn, passing the upwind threshold as it cleared Runway 14 prior to the touch-and-go landing of the Fokker FK27 VH-FNO. Neither the ADC/APP nor the SMC saw VH-HIZ during the time that the Cessna 404 VH-SON entered the circuit and passed VH-MHQ. After this sequence was resolved the ADC/APP processed the Cessna 210 VH-MDG and then turned his attention to VH-MCS, which was in the Burleigh Heads area.

1.17.5.2 Pilots. The flights involving VH-HIZ and VH-MHQ were being conducted under the Visual Flight Rules. These rules provide, inter alia, for the prevention of collisions between aircraft. It is a requirement that "when two aircraft are on converging headings at approximately the same heights, the aircraft which has the other on its right shall give way".

Although the aircraft were operating in a controlled aerodrome environment, the pilots were required to ensure that compliance with any instructions would not result in a loss of separation from other traffic. This required visual surveillance of other aircraft together with a continuous listening watch to be maintained on the tower frequency.

1.17.6 Aircraft Anti-Collision Beacons. Both aircraft were fitted with red, strobe-type, anti-collision beacons. It was normal procedure for these lights to be turned on when the aircraft were in flight. It could not be ascertained whether the beacons were operating at the time of the accident. Examination of these systems found no defect that might have caused them to be unserviceable prior to the accident.

1.18 Useful or Effective Investigating Techniques. The use of computer graphics in the determination of the most probable final flight paths of the respective aircraft, was found to be a most useful tool in the investigation. The technique permitted a methodology to be employed which was efficient in isolating the set of flight paths which best matched all of the available information. The method and results are outlined in Section 1.16, 2.9 and 2.10 of this report.

2. ANALYSIS

2.1 General.. The aircraft involved in the collision, VH-HIZ and VH-MHQ, were both engaged in similar training exercises when the accident occurred. The pilots of VH-HIZ had been operating in the circuit area for some 40 minutes and had completed 5 touch-and-go landings, while the crew of VH-MHQ were performing their second circuit, 11 minutes after receiving an initial takeoff clearance. Since VH-MHQ commenced operations the number of aircraft in the circuit area had increased, and the ADC/APP was attempting to sequence these additional aircraft into the traffic pattern.

2.2 The Aircraft. Both aircraft were operating under current certificates of airworthiness and maintenance releases. Records showed compliance with all maintenance requirements. The weight and centre of gravity positions were within the specified limits.

Detailed examination of the wreckage of both aircraft did not reveal any defect or malfunction which might have contributed to the accident. Both aircraft were considered to be in a serviceable condition immediately prior to the collision.

2.3 The Pilots. The pilot in command of each aircraft was a qualified flying instructor, employed by separate organisations based at Coolangatta airport. Both pilots were experienced in operations in the local area. On the day of the accident there were no indications that either pilot was affected by any physiological or psychological difficulty which might have affected his performance. Post mortem examinations did not reveal any evidence of sudden illness or incapacity which might have affected the ability of either pilot to control or monitor the progress of his aircraft.

The pilots undergoing instruction in each aircraft were holders of valid private pilot licences. There was no evidence to suggest that either pilot was affected by any illness prior to the flights. The nature of the flights was such that it was likely that these pilots were handling the controls of their respective aircraft at or close to the time of the collision. Post mortem examinations revealed no evidence of any sudden illness or incapacity which might have affected their ability to exercise adequate control of the aircraft.

2.4 Air Traffic Services Personnel. The relevant air traffic controllers and flight service officers on duty at Coolangatta tower, Brisbane FSC and Brisbane AACC were suitably qualified and licensed for the tasks they were performing. There was no evidence that any of them were suffering any illness, or any physiological or psychological problems which might have affected their ability to carry out the duties and responsibilities of their respective positions.

2.5 Air Traffic Services Facilities. All relevant air traffic control and flight service facilities were serviceable at the time of the accident. No difficulties with these facilities were experienced by any officer.

2.6 Control Tower Manning. There were three controllers rostered for duty in the Coolangatta tower. However, for about 10 minutes immediately prior to the accident, the officer rostered for the COORD position had been absent. This officer, by mutual arrangement, was performing a non-operational task. At the time he left the tower the traffic activity was light and his presence was not considered to be essential. When the traffic density increased, the ADC/APP did not have access to the COORD, who was also rated for ADC/APP, at a critical stage in the development of the accident. The SMC was conducting a coordination exchange, and was not immediately available to assist with surveillance tasks.

2.7 Meteorological Conditions. The weather at the time was fine, with light wind and scattered cloud. The sun was partially obscured by a high overcast and the light was diffused, giving poor contrast. Other pilots experienced difficulty in sighting traffic in the area. These conditions may have had a significant effect on the ability of the pilots of VH-HIZ and VH-MHQ to sight each other's aircraft.

2.8 Operating Environment. The Coolangatta control zone is designated as primary controlled airspace. Within this zone, air traffic control officers are responsible for the separation of aircraft and the safe and orderly flow of traffic. Radar facilities were not provided. Controllers employed procedural control separation standards to ensure that aircraft entering the circuit area were correctly separated. Aircraft operating within the circuit area were separated by the ADC/APP, who applied visual surveillance techniques to maintain an appropriate traffic flow.

Because the ADC/APP was also required to perform approach and departures functions, he was prevented from giving his full attention to one specific task. In periods of moderate traffic density, this division of attention increased the potential for errors by the ADC/APP. Had a separate controller, with discrete communications facilities, been responsible for the approach and departures function, the likelihood of a collision in the circuit area would have been reduced.

The fact that the airspace around Coolangatta was under the jurisdiction of air traffic control did not absolve pilots operating within that airspace from the requirement to maintain their own visual surveillance and separation from other traffic. Pilots were responsible for advising controllers if instructions or clearances issued placed their aircraft in a potentially unsafe situation. However, when under positive control in the circuit area, it is probable that many pilots subconscously delegate responsibility for separation from other traffic to air traffic control.

Despite the prevailing light conditions, visual meteorological conditions (VMC) existed at Coolangatta. There was no evidence that the normal procedures required for the see and be seen concept for flight in visual conditions were not able to be applied by the respective pilots in command.

2.9 The Accident Sequence. Both VH-HIZ and VH-MHQ were conducting right hand circuits for Runway 14. They were spaced in the circuit such that VH-MHQ was on downwind as VH-HIZ was making a touch-and-go landing. Three additional aircraft had arrived in the circuit, Fokker FK27 VH-FNO and Cessna 404s VH-BUY and VH-SON. VH-FNO and VH-BUY were positioned for left circuits. The ADC/APP requested VH-HIZ to make an early right turn after takeoff, to facilitate a touch-and-go landing by VH-FNO. The latter aircraft was then to conduct a left hand circuit, as required by local procedures. Shortly after this exchange the ADC/APP instructed VH-MHQ to carry out a left hand orbit to expedite the descent and landing of VH-SON, which was on a right hand circuit. The ADC/APP intended the landing sequence to be VH-FNO, VH-BUY, VH-SON, VH-MHQ, VH-MCS, VH-HIZ, and VH-FNO again.

The ADC/APP expected that the orbit carried out by VH-MHQ would be symmetrical. Based on witness reports, times, aircraft performance, the position of the accident site and the relative positions of all the aircraft in the circuit area, the computer reconstruction of the most probable flight paths indicated that this was not the case. It was likely that after completing the first half of the orbit, VH-MHQ flew straight and level until VH-SON was observed to be well clear, and then continued the orbit. This resulted in VH-MHQ being further upwind than anticipated by the ADC/APP.

When the ADC/APP received the inbound report from VH-MDG he transferred his attention inside the tower to the relevant FPS and discussion with the SMC. He did not expect the call from VH-MDG at 41 nautical miles (76 km) because he had not been advised by BN SEC 1P of the early transfer. Verification of the position of VH-MDG and the issue of a descent instruction occupied some 25 seconds. The ADC/APP then turned his attention to VH-MCS, an aircraft holding outside the circuit area, intending the pilot of that aircraft to sight VH-MHQ. This was to allow the ADC/APP to establish the next landing and takeoff sequence, including the aircraft holding outside the circuit area and on the ground. By intending the holding aircraft to sight VH-MHQ, it appears that the ADC/APP had either forgotten the presence of VH-HIZ, or had not recognised that the effect of his previous instructions to these aircraft was to reduce the separation between them.

The pilots of VH-HIZ and VH-MHQ appeared to have lost an awareness of the relative positions of each aircraft. Monitoring of the various radio transmissions could have alerted them to the fact that the separation between them was decreasing, and it would be expected that their level of visual surveillance would be raised. There was no evidence that any avoiding action was taken by either aircraft.

2.10 Flight Path and Visibility Considerations. Analysis of the various flight path and visibility aspects using the computer graphics animation indicated that during the period that the ADC/APP was communicating with the pilot of VH-SON regarding the sighting of VH-MHQ, these aircraft and VH-HIZ became approximately aligned (Refer to Appendix 7, figures 5 and 6). VH-SON flew above and between the other aircraft, while VH-MHQ was turning left and VH-HIZ was turning to the right. The pilots of VH-MHQ and VH-HIZ were probably watching the progress of VH-SON. However, the alignment and headings of the three aircraft at this point would also have placed VH-MHQ in the line of sight of the pilot in the right hand seat of VH-HIZ, and VH-HIZ in the line of sight of the pilot in the left hand seat of VH-MHQ.

The pilots of VH-HIZ and VH-MHQ most probably continued to direct their attention to the progress of VH-SON after this point. As the three aircraft were never similarly aligned again, a further sighting opportunity of this kind did not recur. Although the point at which the three aircraft were aligned presented a possible opportunity for the pilots of VH-MHQ and VH-HIZ to see each other's aircraft even though they were directing their primary visual attention to VH-SON, there were factors which may well have prevented any such sighting being made.

During flights conducted as part of the investigation, it was determined that the sighting of VH-HIZ as it climbed away from the runway would have been extremely difficult from the relative position of VH-MHQ. It was found that the visual target presented by a small aircraft could not be readily detected against the background of the terrain features and texture of the Coolangatta airport environment. It was therefore unlikely that the pilots of VH-MHQ would have seen VH-HIZ beyond VH-SON even when the aircraft were aligned.

A further factor probably affected the visual detection, and therefore their continuing mental expectation of the relative position of VH-MHQ by the pilots of VH-HIZ. The computer graphics animation showed that the nose up attitude of VH-HIZ during its climb and right turn away from Runway 14 would have caused VH-MHQ to be obscured from the view of the pilots of VH-HIZ for most of the period between that aircraft's final touch-and-go and the collision. Therefore, they would probably not have expected (Refer to Appendix 8, Figures 2 to 5) to see VH-MHQ beyond VH-SON at the time the aircraft were aligned. In addition, VH-MHQ would have been difficult to see because of the small size of the target, its position close to the horizon and the ambient light conditions (Refer to paragraph 1.7). All these factors would have lessened the probability of visual detection of VH-MHQ by the pilots of VH-HIZ.

The computer graphics animation verified that their orbit prevented the pilots of VH-MHQ from maintaining continuous visual surveillance of the circuit pattern - for example during the first part of the orbit as the aircraft turned left away from the downwind leg. This was due to the physical limitations on visibility imposed by the design of the cockpit and aircraft structure, together with the heading changes and bank angles involved in the orbit.

For these reasons, and because an orbit in the circuit area requires an aircraft to turn in a direction opposite to the normal traffic flow, the manoeuvre can significantly reduce the margin of safety.

2.11 Workload

2.11.1 Aerodrome/Approach Controller. The ADC/APP indicated that he did not consider that he was overloaded in terms of the number of aircraft on tower frequency. However, he believes with hindsight that the intricacies of the functions to be performed with those aircraft resulted in task overload. Analysis of the communications tape revealed that although more aircraft were coming onto the tower frequency, the only evidence of increasing workload for the ADC/APP was an increased rate of speech delivery. Nevertheless, in the few minutes immediately prior to the accident there were some aspects of the ADC/APP's performance which were open to question:

(a) He issued instructions to VH-MHQ and VH-HIZ, and made a request of VH-HIZ, which resulted in a substantial reduction in the separation between these two aircraft.

(b) He issued an inappropriate descent instruction to VH-MDG.

(c) He did not anticipate the potential confliction between VH-HIZ and VH-MHQ before beginning to process the next landing sequence.

The demands on the ADC/APP had risen rapidly in the 10 minutes preceding the accident. Apart from the increasing number of aircraft he was required to process, he was also operating without the assistance of the COORD. The overall demands of the developing traffic situation did not constitute a potential overloading of the ADC/APP given his qualifications and experience. However, the strategy, or "gameplan", he employed to accommodate the requirements of the various aircraft did not allow him sufficient time to mentally compute the outcome in time and space, particularly with respect to VH-MHQ and VH-HIZ.

2.11.2 Human Information Processing. Research on human information processing since World War II has shown that at the level of conscious decision making, man functions as a single channel processor of limited capacity. This fundamental characteristic places critical restrictions on man as a component of many complex man-machine-environment systems, such as aircraft and air traffic control operations. This topic was addressed in the 1987 Review of the Air Traffic Services System of Australia prepared by Ratner Associates Inc. for the Commonwealth Department of Aviation.

Unless air traffic service personnel are made fully aware of the nature and consequences of this basic limitation on their performance capabilities through appropriate training and awareness programs, they tend to assume that they can cope with high workload situations simply by trying harder.

Australian air traffic service personnel do not receive any specific training or awareness education on human information processing. The Ratner review proposed that this training deficiency should be rectified.

The ADC/APP's chosen game plan was not inappropriate in the light of his training and experience. He did not expect to become overloaded by the demands of the situation, and he had no reason to do so, given that he had received no training on human performance which might have influenced his chosen strategy.

(Refer to Appendix 10 - Specialist Report on Human Factors)

2.11.3 Voice Stress Analysis. Analysis of voice spectrograms confirmed that the ADC/APP's rate of issuing instructions increased considerably just before the accident; however other vocal characteristics did not change appreciably. The lack of major voice changes suggests that the ADC/APP did not experience any anxiety prior to the accident. This result supported the ADC/APP's belief that he was able to cope adequately with the demands of the situation at all times prior to the accident.

(Refer to Appendix 11 - Voice Stress Analysis)

2.11.4 Pilots. Both aircraft had been hired by pilots holding Private Pilot Licences. These pilots were undertaking refresher flying to fulfil the requirements for recent experience, necessary to exercise full privileges of the licences. They would have been expected to operate at skill levels above those of student pilots, and the instructors were more likely to have been monitoring the progress of the flights than imparting instruction. The workload levels inside the cockpits should therefore have been light for the respective pilots in command, allowing greater time for concentration on external aspects.

However, it was also possible that if the pilots under instruction were performing to suitable standards, the instructors may have been expecting them to be fully aware of the relative positions of other traffic in the circuit area. They may have subconsciously relaxed their normal vigilance.

2.12 Aircraft Anti-Collision Beacons. During the investigation it was found that the red strobe-type of anti-collision lighting systems did not assist in the early detection of aircraft from the air, or the ground, under conditions similar to those existing at the time of the accident.

3. CONCLUSIONS

3.1 Findings

1. The pilots were medically fit, correctly licensed and qualified to undertake the flights.

2. There was no evidence that any of the pilots were affected by any physiological or psychological factors which might have affected their ability to safely control the aircraft.

3. All air traffic services personnel were medically fit, correctly licensed, and held the required rating endorsements.

4. There was no evidence that any of the air traffic service personnel were affected by any physiological or psychological factors which might have affected their ability to perform their specified duties.

5. The aircraft had been maintained in accordance with approved procedures.

6. There was no evidence to suggest that either aircraft was not capable of normal operation at the time of the accident.

7. All relevant air traffic services facilities and equipment were serviceable.

8. Weather conditions were suitable for flight in accordance with the Visual Flight Rules.

9. The ambient light was such that conditions for pilots to detect airborne traffic were less than optimum.

10. The aircraft were operating in a procedural control environment.

11. Visual separation techniques were being employed to control aircraft in the circuit area.

12. The control tower was not manned to normal strength for about 10 minutes immediately prior to the accident because the COORD was absent performing a non-operational task.

13. VH-HIZ was requested to make an early right turn following a touch-and-go landing.

14. VH-MHQ was instructed to make a left hand orbit on mid downwind.

15. The orbit manoeuvre prevented the pilots of VH-MHQ maintaining visual surveillance of large segments of the circuit area.

16. VH-MDG contacted Coolangatta tower at 1609.05 hours instead of the expected 1616 hours. This distracted the attention of the ADC/APP away from maintaining visual surveillance of the circuit traffic because BN SEC 1P had not advised him of the early transfer.

17. The flight paths of VH-HIZ and VH-MHQ following the request (13) and the instruction (14) resulted in a collision between them.

18. The allocation of aerodrome and approach control functions at Coolangatta to one officer reduced the margin of safety in situations other than very light traffic.

19. The demands of the air traffic control tasks should not have overloaded the ADC/APP.

20. The strategy adopted by the ADC/APP in meeting the demands of the situation caused him to become temporarily overloaded at a critical time.

21. The ADC/APP had not received training in human information processing which might have assisted him to recognise and cope with information overload situations.

3.2 Relevant Events and Factors

1. Because the ADC/APP was also required to conduct an approach and departures control function, he was unable to devote his whole attention to visual surveillance and control of aircraft in the Coolangatta circuit area.

2. The request and instructions given to VH-HIZ and VH-MHQ to expedite the arrival of other aircraft resulted in a collision between them.

3. The ADC/APP elected to process an inbound aircraft, which had called unexpectedly, at a critical stage in the intended landing sequence. His visual surveillance of the circuit area was interrupted by this decision.

4. The tower was not manned to normal strength at a time when assistance with the visual surveillance of the circuit area might have alerted the ADC/APP to the developing situation.

5. The crews of VH-HIZ and VH-MHQ either did not see each other's aircraft, or made the sighting too late to take effective avoiding action.

6. The red strobe-type anti-collision beacons fitted were not effective in enhancing the conspicuousness of the aircraft under the ambient light conditions at the time of the accident.

4. SAFETY RECOMMENDATIONS

As a result of this investigation, the Bureau of Air Safety Investigation recommends that the Civil Aviation Authority :-

1. Conducts a review of the air traffic services associated with primary control zones with the objective of :-

   a) reducing the complexity of the airspace management and functional control tasks for which the ADC/APP is responsible;

   b) reducing the amount of through traffic in these control zones;

   c) providing separation of the aerodrome control function from the approach/departure function, with discrete facilities for each;

   d) reducing the level of non-operational demands made on control tower staff.

2. Monitors traffic growth rates at controlled aerodromes to :-

a) provide timely planning and provision of appropriate facilities;

b) adjust staffing establishments commensurate with workload.

3. Provides training on human information processing to air traffic service personnel.

4. Considers the prohibition of orbits by aircraft in the circuit area and the use of alternative strategies to achieve adjustments in separation.

5. Considers a requirement for all registered general aviation aircraft to be fitted with multiple, rapid flashing omnidirectional white strobe lights.

6. Takes action to renew the external glazing in the Coolangatta control tower cabin.

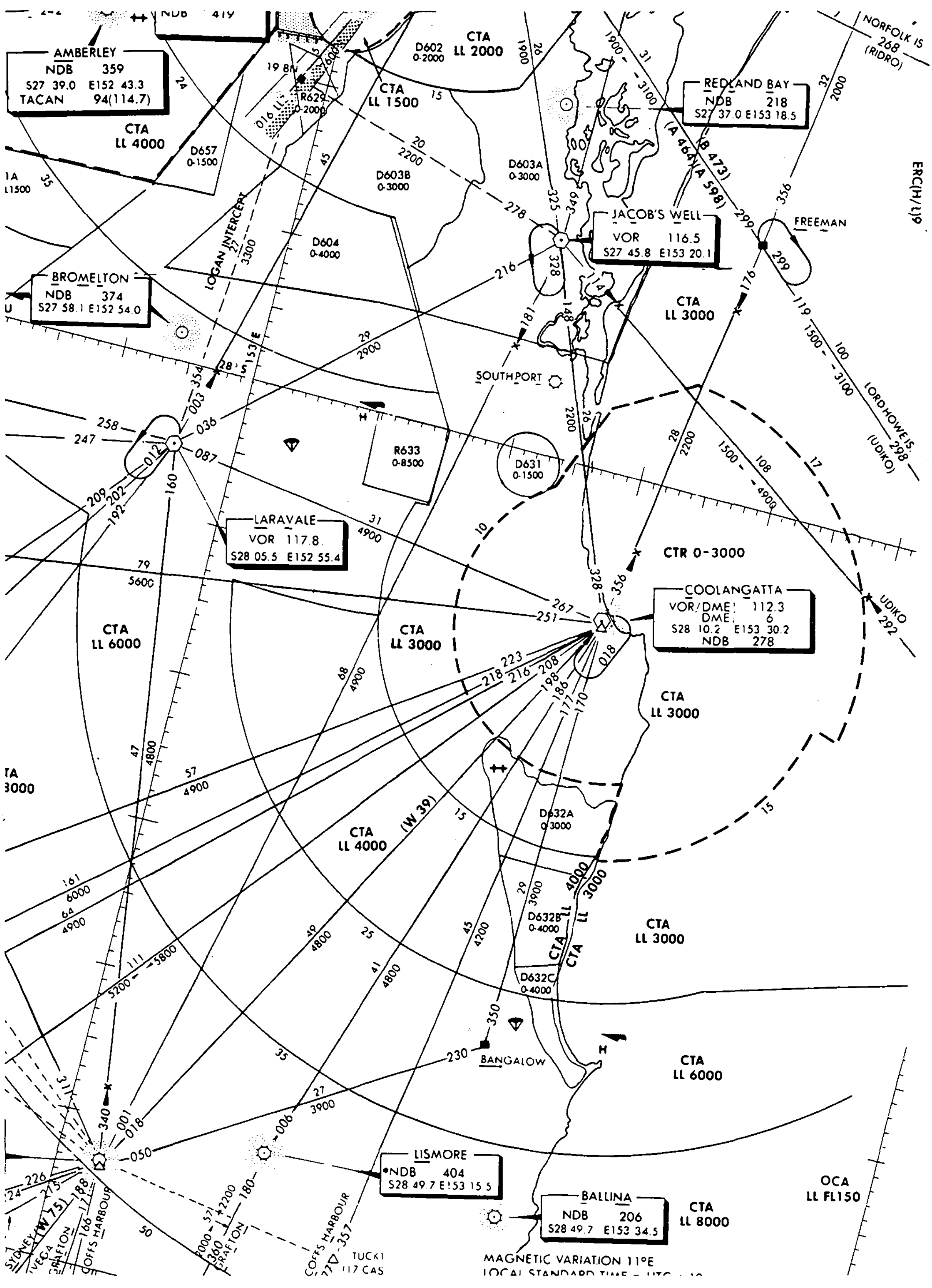
7. Explores the application of collision alerting systems which would be suitable for fitment to general aviation aircraft.

As a result of this accident, the Bureau of Air Safety Investigation has undertaken to conduct an evaluation and prepare a report on the practicability of the see and be seen principle in controlled and non-controlled airspace. This report will include a study of the general visibility from light aircraft, and will examine whether pilots operating in controlled airspace subconsciously delegate their responsibility for collision avoidance to air traffic controllers.

Appendix 1

RELEVANT MAPS AND CHARTS

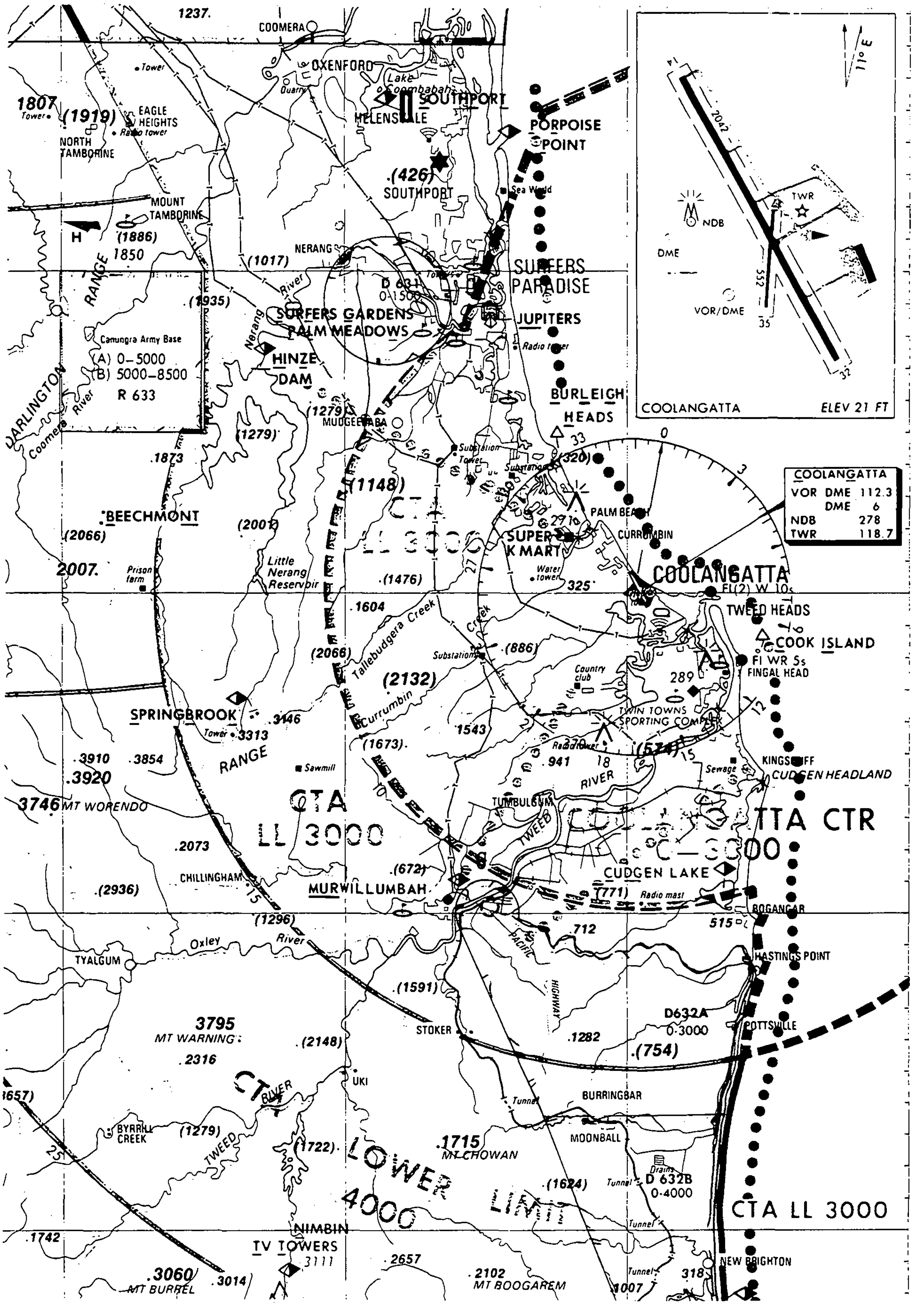
Figure 1



Appendix 1

RELEVANT MAPS AND CHARTS

Figure 2



Appendix 2

COOLANGATTA AIR TRAFFIC CONTROL DUTIES

1. Aerodrome/Approach Controller

Perform the more involved and responsible traffic separating tasks in accordance with Airways Operations Instructions and in particular:

(a) ensure the safe, orderly and expeditious flow of air traffic in aerodrome and terminal areas;
(b) maintain separation standards in respect of all aircraft operations within the designated areas of responsibility;
(c) integrate arriving aircraft into an orderly landing sequence;
(d) exercise judgement in the provision of landing and take-off clearances to aircraft;
(e) exercise control of aircraft making a missed approach;
(f) determine the release of airspace within the terminal area for general aviation training or military purposes;
(g) provide a thunderstorm and turbulence weather advisory service;
(h) close or re-open a runway, the airport or any specific approach or take-off path because of weather and the availability of landing aids;
(i) implement noise abatement procedures;
(j) initiate search and rescue or airport emergency action in accordance with prescribed procedures;
(k) determine the order in which minor aerodrome maintenance works may proceed with minimum interference to aircraft operations.

2. Tower Co-ordinator

Perform traffic co-ordination tasks at the first level of complexity in accordance with Airways Operations Instructions and in particular:

(a) co-ordinate airways clearances to departing aircraft and the sequence of arriving aircraft;
(b) maintain a continuous display of all aircraft movements in the designated area of responsibility;
(c) provide a hazardous weather advisory service;
(d) co-ordinate with control towers and other ATC and Flight Service Units, the traffic control, flight information and meteorological data necessary for the provision of traffic control services within the designated area of responsibility;
(e) co-ordinate the release of airspace for general aviation training or military purposes;
(f) co-ordinate the activities of the Aerodrome Approach Controller with military authorities, aerodrome works and technical maintenance authorities, Flight Service and emergency services;
(g) ensure the accuracy of the displayed information upon which the Aerodrome Approach Controller bases his control instructions;
(h) initiate search and rescue or aerodrome emergency action in accordance with prescribed procedures.

3. Surface Movement Controller

Perform traffic separating tasks at the first level of complexity in accordance with Airways Operations instructions, and in particular:

(a) issue instructions, clearances and information to all traffic operating on the manoeuvring area of the aerodrome, excluding the duty runway(s), for the purpose of preventing collision and minimising delay;
(b) direct departing aircraft to appropriate take-off points and arriving aircraft to parking areas, in accordance with the pattern established by the Senior Tower Controller;
(c) co-ordinate with the Aerodrome Controller regarding traffic crossing the runway(s) in use, the sequences of departing aircraft or any special taxying requirements;
(d) relay clearances to the pilot of a departing aircraft and ensure such clearances are correctly read back;
(e) relay to aircraft instructions and information as requested by other units and, using discretion, relay messages between aircraft and operating agencies;
(f) maintain a watch for aircraft and vehicles unable to communicate by radio and provide alternative means of control
(g) prepare flight strips from incoming flight plans and displays from operational information;
(h) initiate search and rescue or airport emergency action in accordance with prescribed procedures.

Appendix 3

TRANSCRIPT OF RECORDED COMMUNICATIONS

CONCERNING AIRCRAFT VH-MHQ AND VH-HIZ
DURING THE PERIOD
05201553 TO 05201610 EASTERN STANDARD TIME

LEGEND

ADC	AERODROME/APPROACH CONTROL (COOLANGATTA)
COORD	SMC/COORDINATOR (COOLANGATTA)
SEC1	SECTOR 1 (BRISBANE CONTROL SECTOR 1)
HIZ	CESSNA C172 AIRCRAFT: VH-HIZ
TCH	BELL B206-B HELICOPTER: VH-TCH
MHQ	PIPER PA38 AIRCRAFT: VH-MHQ
FNO	FOKKER FK27 AIRCRAFT: VH-FNO
FSU	CESSNA C206-F AIRCRAFT: VH-FSU
BUY	CESSNA C404 AIRCRAFT: VH-BUY
MCS	PIPER PA28 AIRCRAFT: VH-MCS
SON	CESSNA C404 AIRCRAFT: VH-SON
KZG	CESSNA C172 AIRCRAFT: VH-KZG
TYZ	BEECH BE36 AIRCRAFT: VH-TYZ
TIGERTEAM	FORMATION OF DE HAVILLAND DH82 AIRCRAFT: TIGER TEAM
MDG	CESSNA C210 AIRCRAFT: VH-MDG

SYMBOL DECODE

?	Unidentified Source Addressee
(–)	Unintelligible Word(s)
// //	Explanatory Note or Editorial Insertion
( )	Words open to other interpretation
*	Expletive Deletive
.....	Significant Pause (one dot per second)

TIME	FROM	TO	TEXT
1553.31	HIZ	ADC	HOTEL INDIA ZULU TURNING BASE FOR TOUCH AND GO
1553.40	ADC	HIZ	HOTEL INDIA ZULU CONTINUE APPROACH
1553.42	HIZ	ADC	HOTEL INDIA ZULU
1553.44	TCH	ADC	TANGO CHARLIE HOTEL SEAWORLD
1553.46	ADC	TCH	TANGO CHARLIE HOTEL SARWATCH TERMINATED
1553.47	TCH	ADC	TANGO CHARLIE HOTEL
1554.31	MHQ	ADC	MIKE HOTEL QUEBEC READY FOR CIRCUITS
1554.42	ADC	MHQ	MIKE HOTEL QUEBEC THERE IS A CESSNA ON FINAL BEHIND THAT AIRCRAFT LINE UP
1554.49	MHQ	ADC	MIKE HOTEL QUEBEC
1554.51	ADC	HIZ	HOTEL INDIA ZULU CLEAR TOUCH AND GO AND MAKE LEFT CIRCUIT
1554.55	HIZ	ADC	HOTEL INDIA ZULU LEFT CIRCUIT
1555.52	FNO	ADC	COOLANGATTA TOWER FOXTROT NOVEMBER OSCAR IS TWO FOUR DME TO THE WEST INBOUND ON THE TWO NINER TWO RADIAL LEFT NINER THOUSAND FOR SIX THOUSAND VISUAL RECEIVED FOXTROT REQUEST A PRODEDURE TURN TO ENTER THE ONE FOUR OMNI APPROACH
1556.15	ADC	FNO	FOXTROT NOVEMBER OSCAR COOLANGATTA TOWER GOOD AFTERNOON MAINTAIN SIX THOUSAND QNH ONE ZERO ZERO SEVEN DO YOU WANT TO DO THE FULL ENTRY PROCEDURE AND THE PROCEDURE TURN CORRECT FOR THE OMNI APPROACH
1556.28	FNO	ADC	NEGATIVE JUST STRAIGHT INTO THE PROCEDURE TURN IF WE CAN
1556.37	ADC	FNO	WELL THE OUTBOUND LEG OF THE OMNI APPROACH IS 0 SEVEN FIVE DO YOU WANT TO GO STRAIGHT OUTBOUND ON THE 0 SEVEN FIVE IS THAT WHAT YOU ARE ASKING FOR
1556.44	FNO	ADC	AH ROGER WE'RE TALKING ABOUT THE ONE FOUR APPROACH THAT WAS THE RUNWAY WE CAN DO USE THE ONE AH NUMBER THREE TWO IF YOU LIKE
1556.53	ADC	FNO	NO NO WE HAD YOU DOWN FOR AN OMNI APPROACH AN OMNI APPROACH DOESN'T INVOLVE THE DME THAT IS JUST THE ONE THAT GOES OUT TO THE EAST IF YOU WANT THE ONE FOUR OMNI DME THAT IS AVAILABLE

TIME	FROM	TO	TEXT
1557.03	FNO	ADC	RIGHT-O WE'LL DO THAT ONE THANKS
1557.07	ADC	FNO	FOXTROT NOVEMBER OSCAR ROGER DESCEND VISUALLY TO FOUR THOUSAND QNH ONE ZERO ZERO SEVEN TRACK DIRECTLY OVERHEAD FOR A PROCEDURE TURN OF THE ONE FOUR OMNI DME APPROACH REPORT AT FIVE DME REPORT APPROACHING FOUR THOUSAND
1557.26	FNO	ADC	ROGER THERE IS A BIT OF CONFUSION HERE AH WE'LL GO BACK TO WHAT YOU THINK WE'RE DOING THAT'S A COOLANGATTA OMNI WITHOUT THE DME
1557.34	FSU	ADC	FOXTROT UNIFORM IS ON THE WATER FOR AN IMMEDIATE DEPARTURE READY
1557.39	ADC	FNO	FOXTROT NOVEMBER OSCAR ROGER DESCEND VISUALLY TO FOUR THOUSAND IF YOU INTERCEPT THE TWO EIGHT FIVE RADIAL YOU'LL BE WITHIN THE THIRTY DEGREE SPAN FOR TO GO STRAIGHT OUTBOUND ON THE INTERMEDIATE LEG REPORT ONE ZERO DME
1557.51	FNO	ADC	FOXTROT NOVEMBER OSCAR THANK YOU THAT'S FOUR THOUSAND
1557.56	ADC	MHQ	MIKE HOTEL QUEBEC CLEAR FOR TAKE OFF MAKE RIGHT CIRCUIT
1558.00	MHQ	ADC	MIKE HOTEL QUEBEC
1558.02	BUY	ADC	COOLANGATTA TOWER THIS BRAVO UNIFORM YANKEE AH TWO SIX DME FIVE THOUSAND INBOUND ON THE THREE THREE ZERO RADIAL WITH INFORMATION FOXTROT
1558.17	ADC	BUY	BRAVO UNIFORM YANKEE COOLANGATTA TOWER GOOD AFTERNOON LEAVE CONTROL AREA RE-ENTER CONTROL ZONE ON DESCENT TO THREE THOUSAND QNH ONE ZERO ZERO SEVEN EXPECT RUNWAY ONE FOUR STRAIGHT-IN APPROACH REPORT AT ONE ZERO DME
1558.29	BUY	ADC	BRAVO UNIFORM YANKEE THREE THOUSAND LEFT FIVE THOUSAND
1558.32	ADC	BUY	BRAVO UNIFORM YANKEE
1558.34	ADC	FSU	SIERRA FOXTROT SIERRA UNIFORM THE WIND IS AH A LIGHT EASTERLY REPORT AIRBORNE
1558.39	FSU	ADC	FOXTROT UNIFORM
1558.51	FSU	ADC	FOXTROT UNIFORM IS AIRBORNE TO THE SOUTH IN A LEFT TURN

TIME	FROM	TO	TEXT
1558.55	ADC	FSU	FOXTROT SIERRA UNIFORM ROGER REPORT PASSING THE TOWER NORTHBOUND
1558.58	FSU	ADC	SIERRA UNIFORM
1559.04	MCS	ADC	AH COOLANGATTA TOWER THIS IS MIKE CHARLIE SIERRA AT TWO ZERO DME NORTH OVERLAND AT ONE THOUSAND FIVE HUNDRED FEET REQUESTING INBOUND CLEARANCE
1559.16	ADC	BUY	BRAVO UNIFORM YANKEE REQUIREMENT TO REMAIN VISUALLY EAST OF THE COAST OVER WATER UNTIL ADVISED
1559.22	BUY	ADC	BRAVO UNIFORM YANKEE ROGER WE ARE TURNING EAST TO MAINTAIN OVER WATER
1559.27	ADC	BUY	BRAVO UNIFORM YANKEE
1559.28	ADC	MCS	MIKE CHARLIE SIERRA ENTER THE CONTROL ZONE CRUISING ONE THOUSAND FIVE HUNDRED TRACK OVER LAND FOR A STRAIGHT-IN APPROACH RUNWAY ONE FOUR REPORT ABEAM JUPITERS CASINO
1559.38	MCS	ADC	MIKE CHARLIE SIERRA ONE THOUSAND FIVE HUNDRED FEET OVERLAND
1559.43	FNO	ADC	FOXTROT NOVEMBER OSCAR NINER DME
1559,46	ADC	FNO	FOXTROT NOVEMBER OSCAR DESCEND TO TWO THOUSAND FIVE HUNDRED VISUAL FROM OVERHEAD TRACK OUTBOUND ON THE ZERO SEVEN FIVE RADIAL FOR CIRCLING OMNI APPROACH REPORT OVERHEAD THE AID
1559.56	FNO	ADC	FOXTROT NOVEMBER OSCAR THANK YOU TWO THOUSAND FIVE HUNDRED
1600.04	HIZ	ADC	HOTEL INDIA ZULU BASE TOUCH AND GO
1600.13	ADC	HIZ	HOTEL INDIA ZULU CLEAR TOUCH AND GO WILL CONFIRM THE CIRCUIT DIRECTION
1600.16	HIZ	ADC	HOTEL INDIA ZULU
1600.22	SON	ADC	COOLANGATTA TOWER GOOD AFTERNOON SIERRA OSCAR NOVEMBER IS TWO TWO MILES SOUTH AH MAINTAINING TWO THOUSAND COPIED FOXTROT
1600.31	ADC	SON	SIERRA OSCAR NOVEMBER GOOD AFTERNOON ENTER THE ZONE CRUISE TWO THOUSAND TRACK AH OVERLAND FOR A RIGHT BASE RUNWAY ONE FOUR REPORT CROSSING THE TWEED RIVER

TIME	FROM	TO	TEXT
1600.41	SON	ADC	SIERRA OSCAR NOVEMBER TWO THOUSAND
1601.08	FSU	ADC	FOXTROT SERRA UNIFORM IS ABEAM THE TOWER AT FIVE HUNDRED
1601.13	ADC	FSU	FOXTROT SIERRA UNIFORM REPORT PASSING BURLEIGH HEADS
1601.16	FSU	ADC	SIERRA UNIFORM
1602.35	ADC	HIZ	HOTEL INDIA ZULU MAKE A RIGHT CIRCUIT
1602.39	HIZ	ADC	HOTEL INDIA ZULU RIGHT CIRCUIT
1602.42	MHQ	ADC	MIKE HOTEL QUEBEC AH BASE TOUCH AND GO
1602.53	ADC	MHQ	MIKE HOTEL QUEBEC CLEAR TOUCH AND GO MAKE A RIGHT CIRCUIT
1602.57	MHQ	ADC	MIKE HOTEL QUEBEC
1602.59	ADC	FNO	FOXTROT NOVEMBER OSCAR JUST CONFIRMING YOU ARE CLEAR FOR FINAL REPORT TURNING INBOUND
1603.07	FNO	ADC	FOXTROT NOVEMBER OSCAR (—)
1603.10	ADC	FNO	SORRY TWO IN TOGETHER FOXTROT NOVEMBER OSCAR JUST CONFIRMING YOU ARE CLEAR FOR FINAL REPORT TURNING INBOUND
1603.15	FNO	ADC	(OSCAR)
1603.17	KZG	ADC	COOLY COOLY (–) FIVE MILES WEST OF SPRINGBROOK INBOUND AT FIVE THOUSAND REQUEST CLEARANCE AT THREE THOUSAND
1603.27	ADC	KZG	KILO ZULU GOLF COOLANGATTA TOWER ENTER THE ZONE ON DESCENT TO THREE THOUSAND QNH ONE ZERO ZERO SEVEN REPORT OVERHEAD SPRINGBROOK
1603.49	BUY	ADC	BRAVO UNIFORM YANKEE IS MAINTAINING THREE THOUSAND
1603.52	ADC	BUY	BRAVO UNIFORM YANKEE YOUR DME DISTANCE
1603.54	BUY	ADC	BRAVO UNIFORM YANKEE ONE ZERO DME
1604.00	ADC	BUY	BRAVO UNIFORM YANKEE DESCEND TO TWO THOUSAND REMAIN OVER WATER AND WILL HAVE CONFIRMED THE APPROACH TO THE CIRCUIT YOU MAY HAVE TO DO AN ORBIT APPROACHING THE FIELD
1604.09	BUY	ADC	BRAVO UNIFORM YANKEE TWO THOUSAND

TIME	FROM	TO	TEXT
1604.13	MCS	ADC	MIKE CHARLIE SIERRA JUPITER'S
1604.18	FSU	ADC	FOXTROT UNIFORM IS BURLEIGH HEADS FIVE HUNDRED
1604.21	ADC	FSU	FOXTROT SIERRA UNIFORM REPORT PASSING JUPITER'S
1604.24	FSU	ADC	SIERRA UNIFORM
1604.26	ADC	MCS	MIKE CHARLIE SIERRA CONTINUE SOUTHBOUND OVER LAND THE CLEARANCE LIMIT IS BURLEIGH HEADS DO NOT PROCEED SOUTH OF THAT POSITION UNTIL ADVISED REPORT APPROACHING
1604.43	ADC	MCS	MIKE CHARLIE SIERRA YOUR CLEARANCE LIMIT IS BURLEIGH HEADS DO NOT PROCEED SOUTH OF BURLEIGH TILL ADVISED
1604.49	MCS	ADC	MIKE CHARLIE SIERRA BURLEIGH HEADS
1604.54	FNO	ADC	FOXTROT NOVEMBER OSCAR IS ON FINAL INBOUND REQUEST A COUPLE OF TOUCH AND GO'S
1604.59	ADC	FNO	FOXTROT NOVEMBER OSCAR SAY AGAIN
1605.01	FNO	ADC	REQUEST TWO TOUCH AND GO'S
1605.03	ADC	FNO	ROGER ONWARDS CLEARANCE IS OPERATE CIRCUIT AREA NOT ABOVE ONE THOUSAND ONCE AT THE MINIMA MAKE A RIGHT TURN TO ENTER LEFT DOWNWIND
1605.11	FNO	ADC	FOXTROT NOVEMBER OSCAR THAT IS NOT ABOVE ONE THOUSAND
1605.28	KZG	ADC	COOLY TOWER KILO ZULU GOLF FIVE MILES WEST OF SPRINGBROOK INBOUND AT FIVE THOUSAND REQUEST CLEARANCE AT THREE THOUSAND
1605.38	ADC	KZG	KILO ZULU GOLF ENTER THE CONTROL ZONE ON DESCENT TO THREE THOUSAND
1605.49	MCS	ADC	MIKE CHARLIE SIERRA MAKING A RIGHT ORBIT AT AH BURLEIGH HEADS
1605.54	ADC	MCS	MIKE CHARLIE SIERRA YES REMAIN AT BURLEIGH HEADS THERE IS NO POSITION FOR YOU AT THE MOMENT
1605.58	MCS	ADC	MIKE CHARLIE SIERRA RIGHT RIGHT CIRCUIT
1606.01	ADC	HIZ	HOTEL INDIA ZULU TURN BASE AND KEEP YOUR SPEED UP
1606.05	HIZ	ADC	HOTEL INDIA ZULU

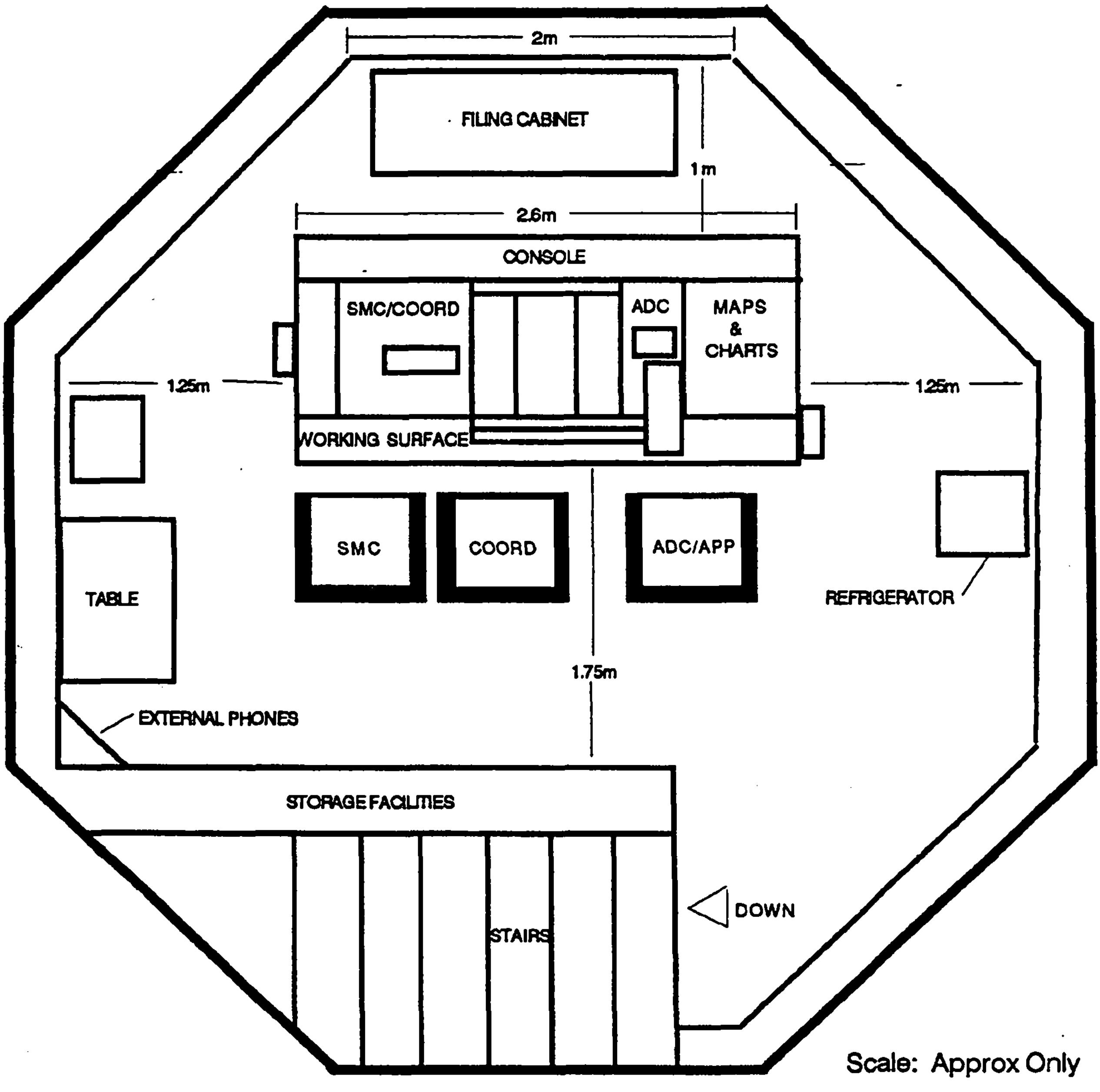
TIME	FROM	TO	TEXT
1606.06	SON	ADC	SIERRA OSCAR NOVEMBER IS CROSSING THE TWEED
1606.09	ADC	SON	SIERRA OSCAR NOVEMBER DESCEND TO ONE THOUSAND FIVE HUNDRED REPORT ABEAM THE TOWER
1606.12	SON	ADC	SIERRA OSCAR NOVEMBER ONE THOUSAND FIVE HUNDRED LEFT TWO THOUSAND
1606.15	ADC	BUY	BRAVO UNIFORM YANKEE YOU WILL BE FOLLOWING A FRIENDSHIP IN THE CIRCUIT HE IS OFF ABOUT YOUR ELEVEN O'CLOCK POSITION NOW DO YOU HAVE HIM SIGHTED
1606.21	BUY	ADC	BRAVO UNIFORM YANKEE AFFIRMATIVE
1606.23	ADC	BUY	MAKE VISUAL APPROACH FOLLOW THE FRIENDSHIP
1606.26	BUY	ADC	BRAVO UNIFORM YANKEE
1606.29	FSU	ADC	FOXTROT UNIFORM PASSES JUPITER'S
1606.30	ADC	FSU	FOXTROT SIERRA UNIFORM REPORT CLEAR OF THE ZONE
1606.33	FSU	ADC	SIERRA UNIFORM
1606.35	KZG	ADC	COOLY TOWER KILO ZULU GOLF TWO MILES WEST OF SPRINGBROOK INBOUND AT FIVE THOUSAND FIVE HUNDRED REQUEST CLEARANCE AT THREE THOUSAND
1606.46	ADC	KZG	KILO ZULU GOLF ARE YOU READING COOLANGATTA
1606.50	KZG	ADC	KILO KILO ZULU GOLF AFFIRMATIVE
1606.56	ADC	KZG	KILO ZULU GOLF I HAVE TRANSMITTED TO YOU ABOUT FOUR TIMES ENTER THE ZONE ON DESCENT TO THREE THOUSAND REPORT OVERHEAD SPRINGBROOK
1607.03	KZG	ADC	KILO ZULU GOLF THREE THOUSAND
1607.06	ADC	FNO	FOXTROT NOVEMBER OSCAR YOU ARE NUMBER TWO IN THE LANDING SEQUENCE FOLLOWING A CESSNA HE'S ON A SHORT FINAL HE'LL BE TOUCH MAKING A TOUCH AND GO AND CLEARING THE CIRCUIT FOR YOU
1607.13	FNO	ADC	FOXTROT NOVEMBER OSCAR I HAVE GOT HIM SIGHTED THANKS
1607.15	ADC	HIZ	HOTEL INDIA ZULU CLEAR TOUCH AND GO MAKE RIGHT CIRCUIT REQUEST EARLY RIGHT TURN
1607.20	HIZ	ADC	HOTEL INDIA ZULU

TIME	FROM	TO	TEXT
1607.25	TYZ	ADC	COOLY TOWER TANKO YANKEE ZULU IS READY
1607.27	ADC	TYZ	TANGO YANKEE ZULU HOLD THERE
1607.29	TYZ	ADC	YANKEE ZULU
1607.44	ADC	MHQ	MIKE HOTEL QUEBEC MAKE A LEFT HAND ORBIT
1607.47	MHQ	ADC	MIKE HOTEL QUEBEC
1607.52	ADC	FNO	FOXTROT NOVEMBER OSCAR CLEAR TOUCH AND GO MAKE A LEFT CIRCUIT
1607.55	FNO	ADC	FOXTROT NOVEMBER OSCAR
1607.56	ADC	BUY	BRAVO UNIFORM YANKEE ARE YOU ON BASE
1607.58	BUY	ADC	BRAVO UNIFORM YANKEE TURNING BASE
1608.00	ADC	BUY	THANK YOU
1608.01	ADC	SON	SIERRA OSCAR NOVEMBER TRAFFIC FOR YOU TO SIGHT IS A TOMAHAWK HE IS AT A THOUSAND FEET HE IS ABEAM THE TOWER ABOUT TO MAKE A LEFT HAND ORBIT
1608.11	SON	ADC	SIERRA OSCAR NOVEMBER ROGER AH WE DON'T HAVE THE TRAFFIC SIGHTED YET
1608.16	ADC	SON	TWELVE O'CLOCK TWO MILES
1608.20	TIGER TEAM	ADC	TOWER THIS IS TIGER TEAM WE'RE ON CLIMB THROUGH ROMEO THIRTEEN REQUEST AIRWAYS CLEARANCE
1608.26	ADC	TIGER TEAM	TIGER TEAM CLEARANCE NOT IMMEDIATELY AVAILABLE GO THE LONG WAY ROUND CALL ME APPROACHING INBOUND AH SURFERS GARDEN CORRECTION AH SEAWORLD
1608.34	TIGER TEAM	ADC	TIGER TEAM ROGER WE'LL TRACK OCTA TO SEAWORLD
1608.37	ADC	BUY	BRAVO UNIFORM YANKEE CLEAR TO LAND
1608.40	BUY	ADC	BRAVO UNIFORM YANKEE
1608.43	ADC	SON	SIERRA OSCAR NOVEMBER HAVE YOU GOT HIM NOW
1608.44	SON	ADC	NEGATIVE
1608.45	ADC	SON	CONFIRM YOU ARE AT ONE THOUSAND FIVE HUNDRED AT THE MOMENT

TIME	FROM	TO	TEXT
1608.47	SON	ADC	SIERRA OSCAR NOVEMBER AFFIRMATIVE
1608.49	ADC	SON	ROGER LOOK OFF TEN O'CLOCK POSITION NINE O'CLOCK NOW
1608.55	FSU	ADC	FOXTROT SIERRA UNIFORM CLEAR OF THE ZONE CHEERS
1608.58	ADC	FSU	FOXTROT SIERRA UNIFORM GOOD DAY
1609.00	ADC	SON	SIERRA OSCAR NOVEMBER MAKE VISUAL APPROACH
1609.03	SON	ADC	SIERRA OSCAR NOVEMBER
1609.05	MDG	ADC	COOLANGATTA TOWER GOOD AFTERNOON MIKE DELTA GOLF ARE NOW FOUR ONE DME ON THE ONE SEVEN SEVEN OMNI RADIAL AT SEVEN THOUSAND VISUAL RECEIVED FOXTROT
1609.17	ADC	MDG	MIKE DELTA GOLF GOOD AFTERNOON SAY AGAIN THE DME DISTANCE
1609.19	MDG	ADC	MIKE DELTA GOLF FOUR ZERO DME
1609.22	ADC	MDG	MIKE DELTA GOLF
1609.25	ADC	MDG	MIKE DELTA GOLF DESCEND TO FOUR THOUSAND REPORT AT AH TWO ZERO DME
1609.29	MDG	ADC	MIKE DELTA GOLF FOUR THOUSAND
1609.32	ADC	MCS	MIKE CHARLIE SIERRA TRAFFIC I WANT YOU TO SIGHT IS A // SIXTEEN SECOND PAUSE//
1609.51	ADC		//GENERAL TRANSMISSION FROM TOWER// ALL STATIONS THIS FREQUENCY STAND BY

Appendix 4

COOLANGATTA CONTROL TOWER CABIN FLOOR LAYOUT



Appendix 5

COOLANGATTA AIR TRAFFIC MOVEMENTS

The annual air traffic movements at Coolangatta for the period 1973 until the end of 1987 are listed below. They indicate all departures and arrivals at Coolangatta aerodrome and all flights which require communications and airways clearances to transit the Coolangatta control zone without landing at Coolangatta. These flights are classified as "Through" flights.

YEAR	AERODROME	THROUGH	TOTAL	RATE OF CHANGE PER ANNUM
1973	43893	9482	53375	00
1974	39587	7060	46647	-16.6%
1975	45249	8372	53576	14.8%
1976	49729	8685	58414	9.0%
1977	50058	7480	57538	-1.5%
1978	53668	7882	61550	6.8%
1979	53742	7956	61698	.2%
1980	51062	8223	59285	-4.0%
1981	69580	9508	79088	33.4%
1982	57676	8951	66627	-15.8%
1983	51617	7830	59447	-10.8%
1984	60849	9168	70017	17.7%
1985	65991	9807	75798	8.2%
1986	67028	11718	78746	3.8%
1987	72567	18507	91074	15.6%

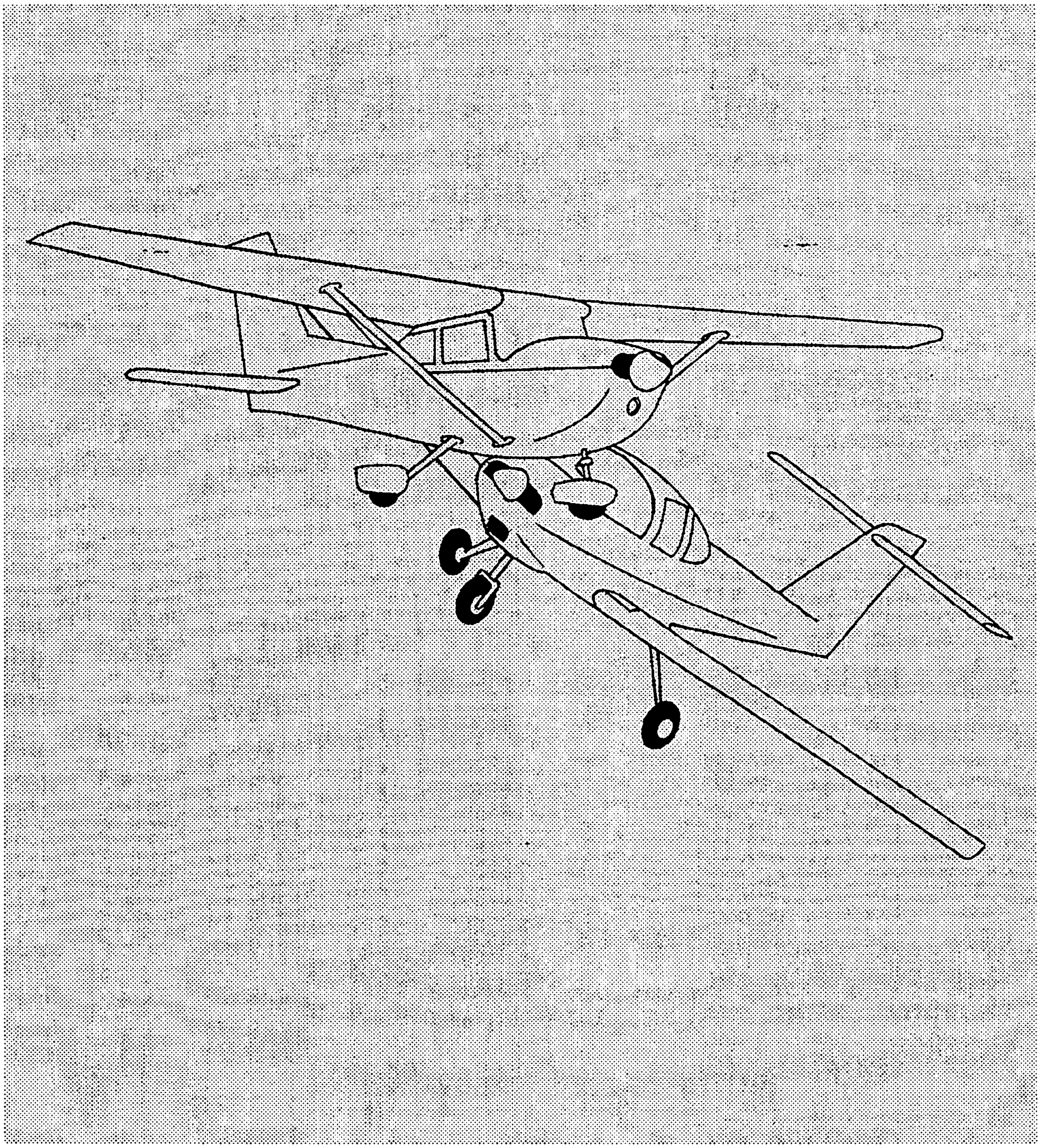
Aerodrome Movements:
For the above 14 year period, actual aerodrome movement increased by 65.3%.

Through Movements:
For the above 14 year period, actual through movements increased by 95.1%.

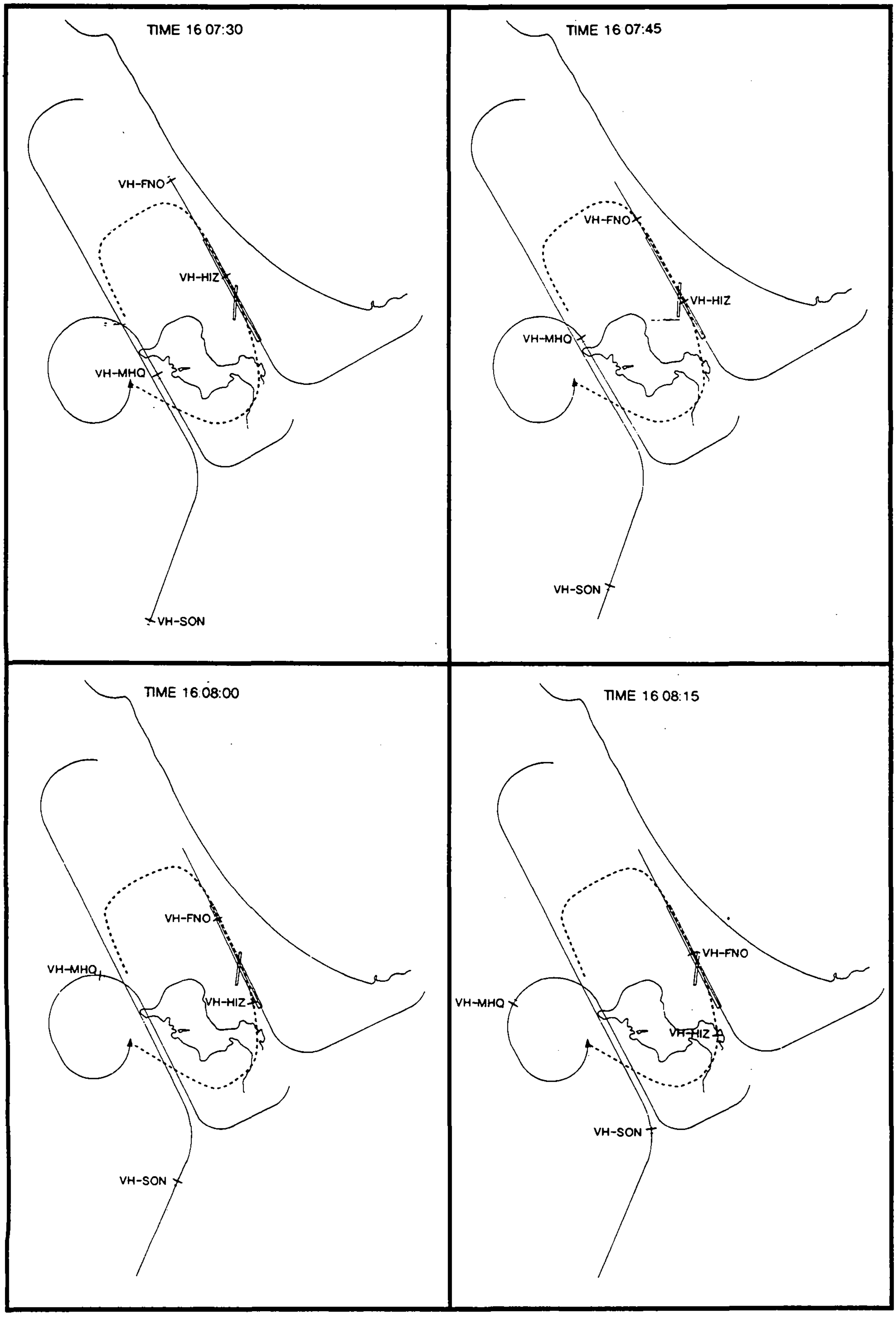
Total Movements:
For the above 14 year period, total movements for the Coolangatta control zone increased by 70.6%.

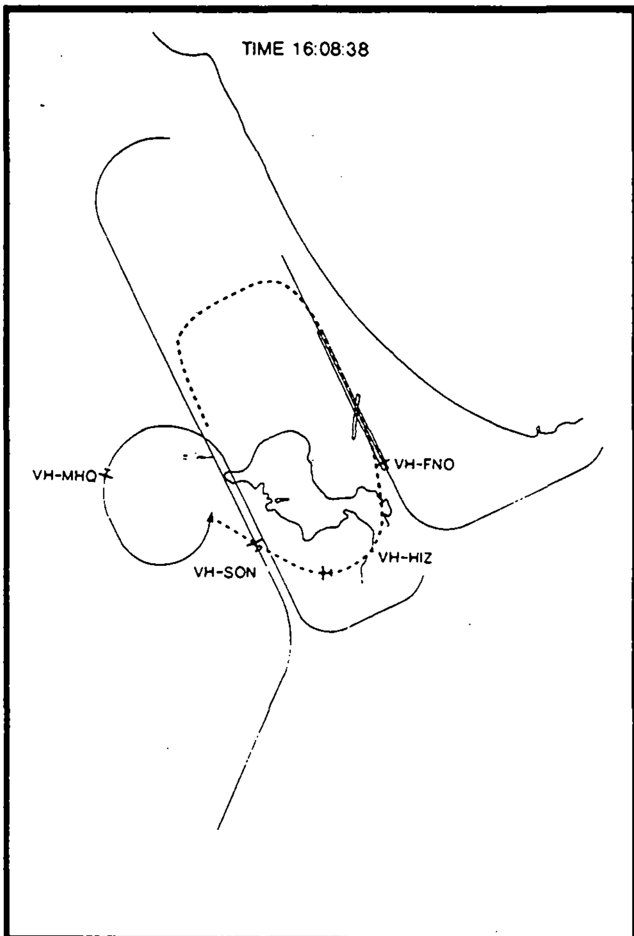
Appendix 6

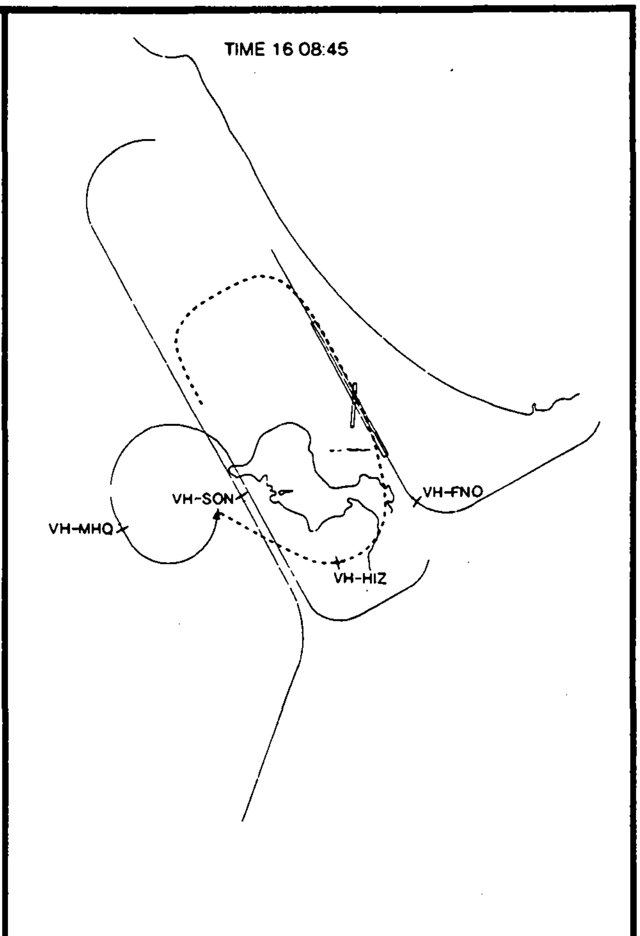
PROBABLE ATTITUDES AT IMPACT

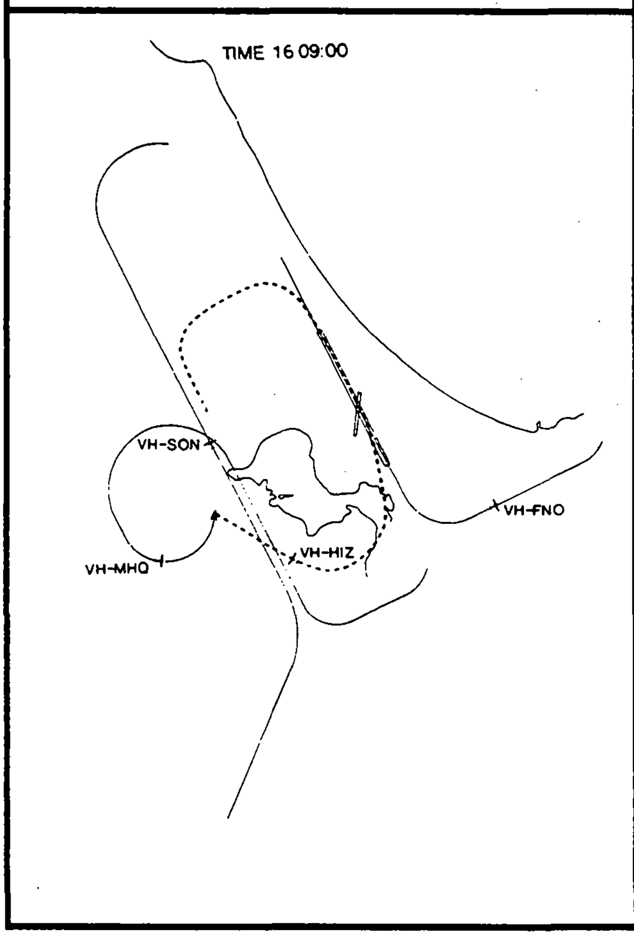


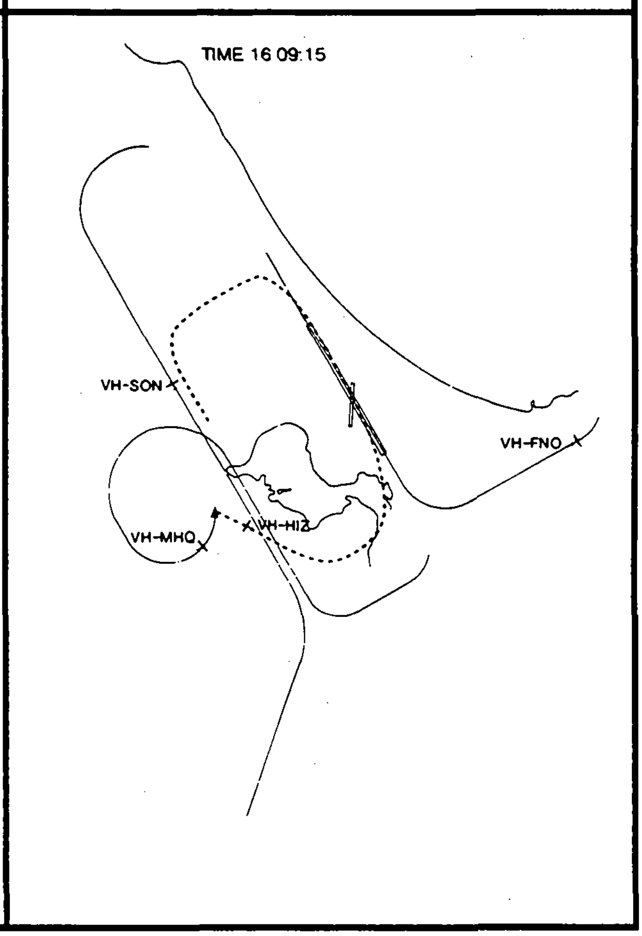
PRESENTATION OF PROBABLE FLIGHT PATHS

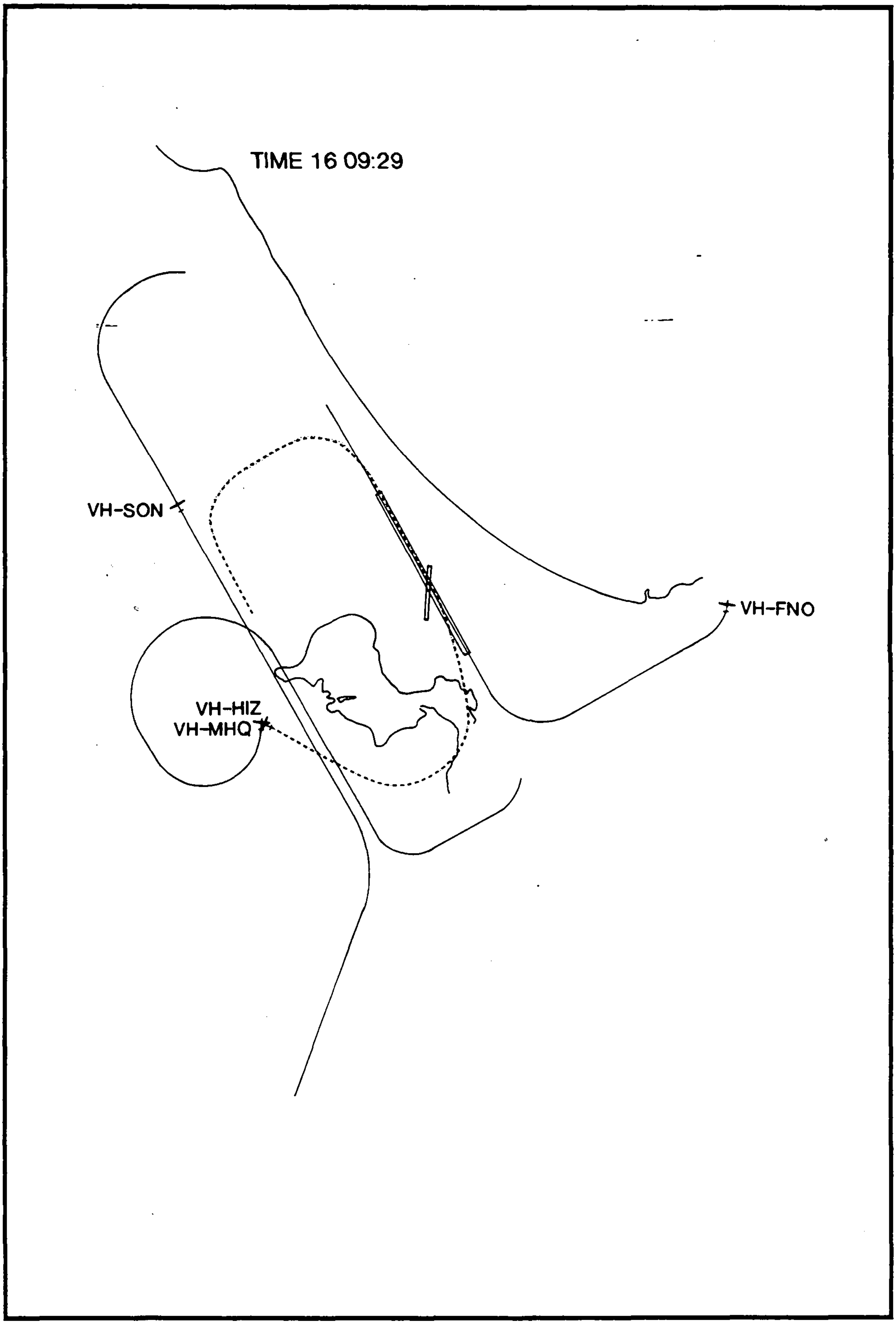



TIME 16:08:38
VH-MHQ
VH-FNO
VH-SON
VH-HIZ

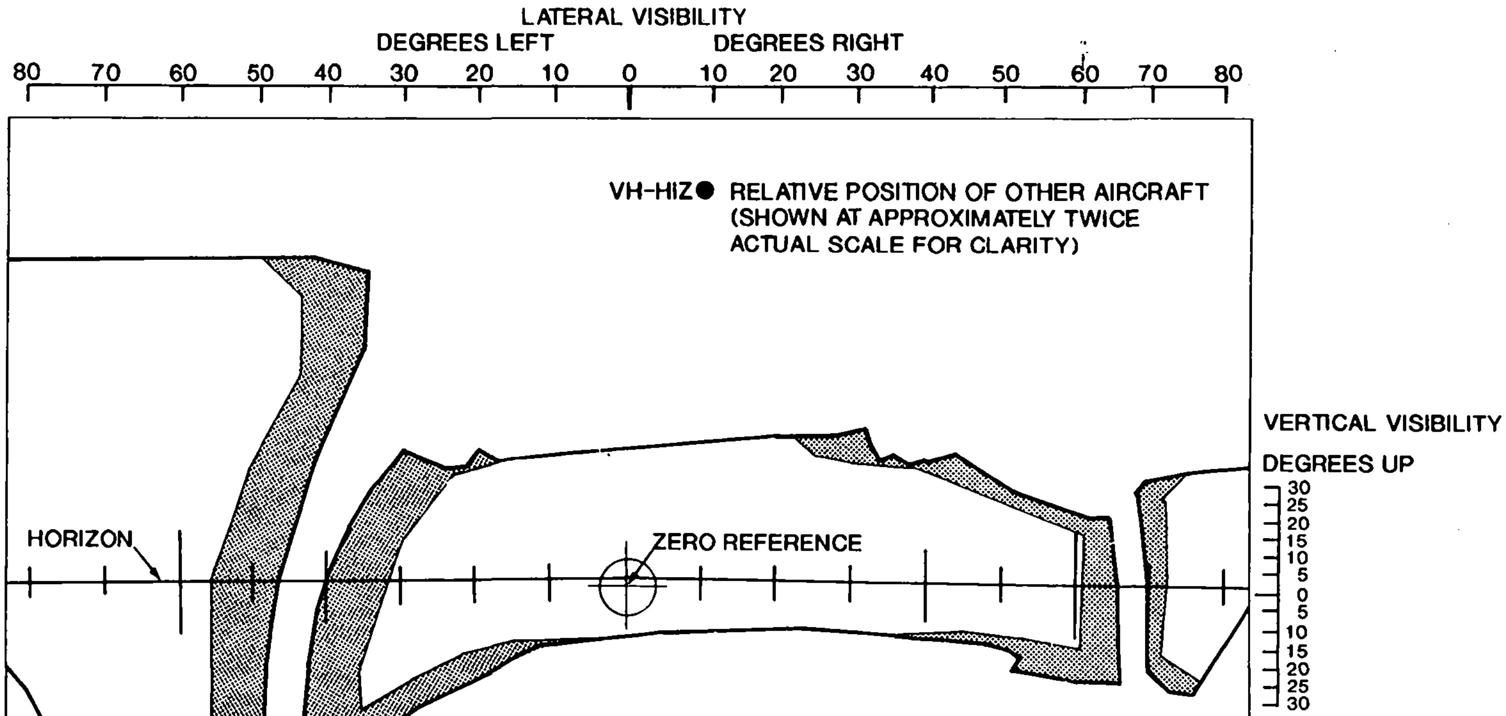

TIME 16 08:45
VH-SON
VH-FNO
VH-MHQ
VH-HIZ


TIME 16 09:00
VH-SON
VH-FNO
VH-HIZ
VH-MHQ


TIME 16 09:15
VH-SON
VH-FNO
VH-MHQ
VH-HIZ


TIME 16 09:29
VH-SON
VH-FNO
VH-HIZ
VH-MHQ

COCKPIT VISIBILITY DIAGRAMS



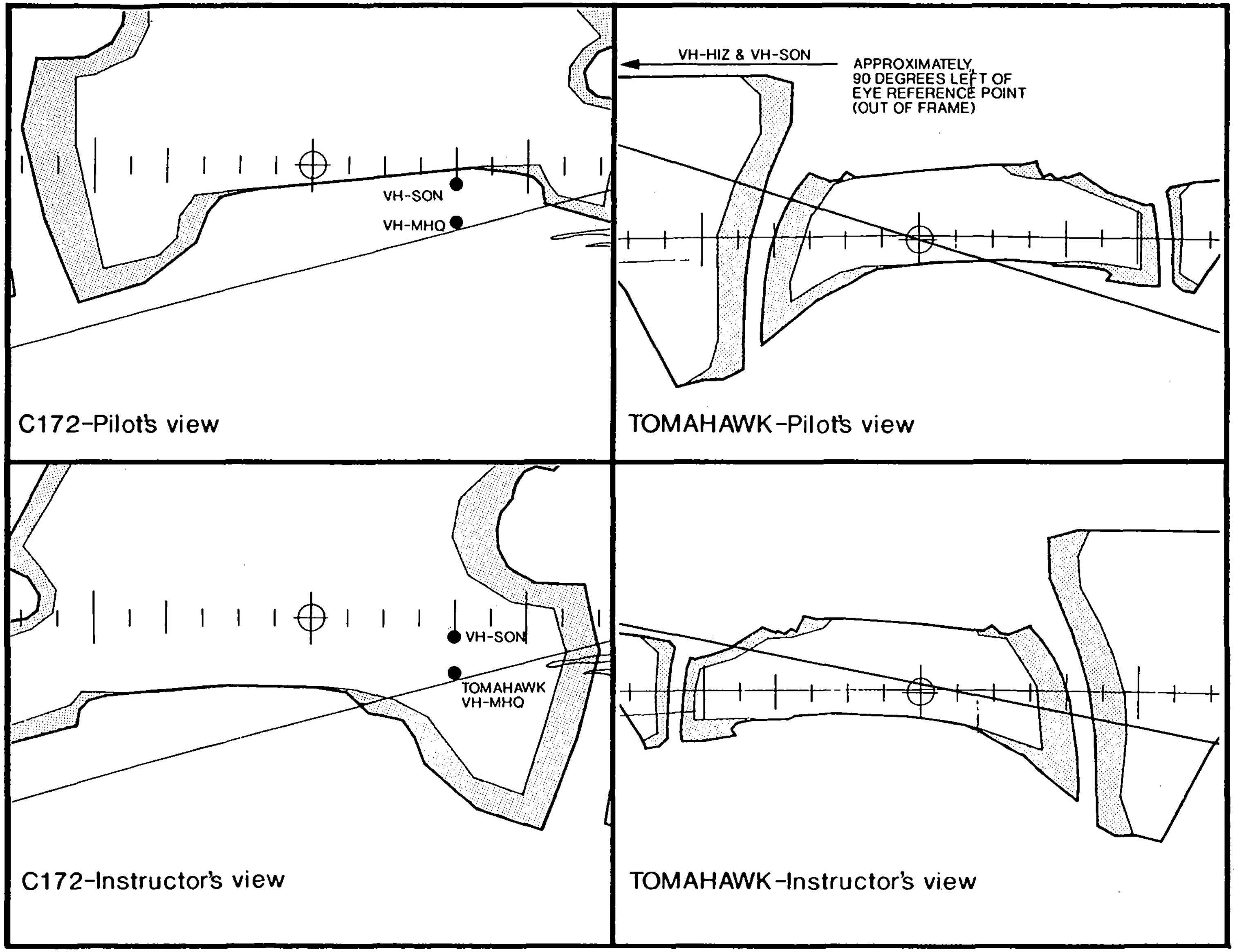
LOCATION OF CREW ZERO REFERENCE POINTS

	ABOVE FLOOR HEIGHT	AFT OF INSTRUMENT PANEL
C172 PILOT	97.79	43.18
C172 INSTRUCTOR	104.14	50.8
TOMAHAWK PILOT	105.41	54.61
TOMAHAWK INSTRUCTOR	105.41	54.61

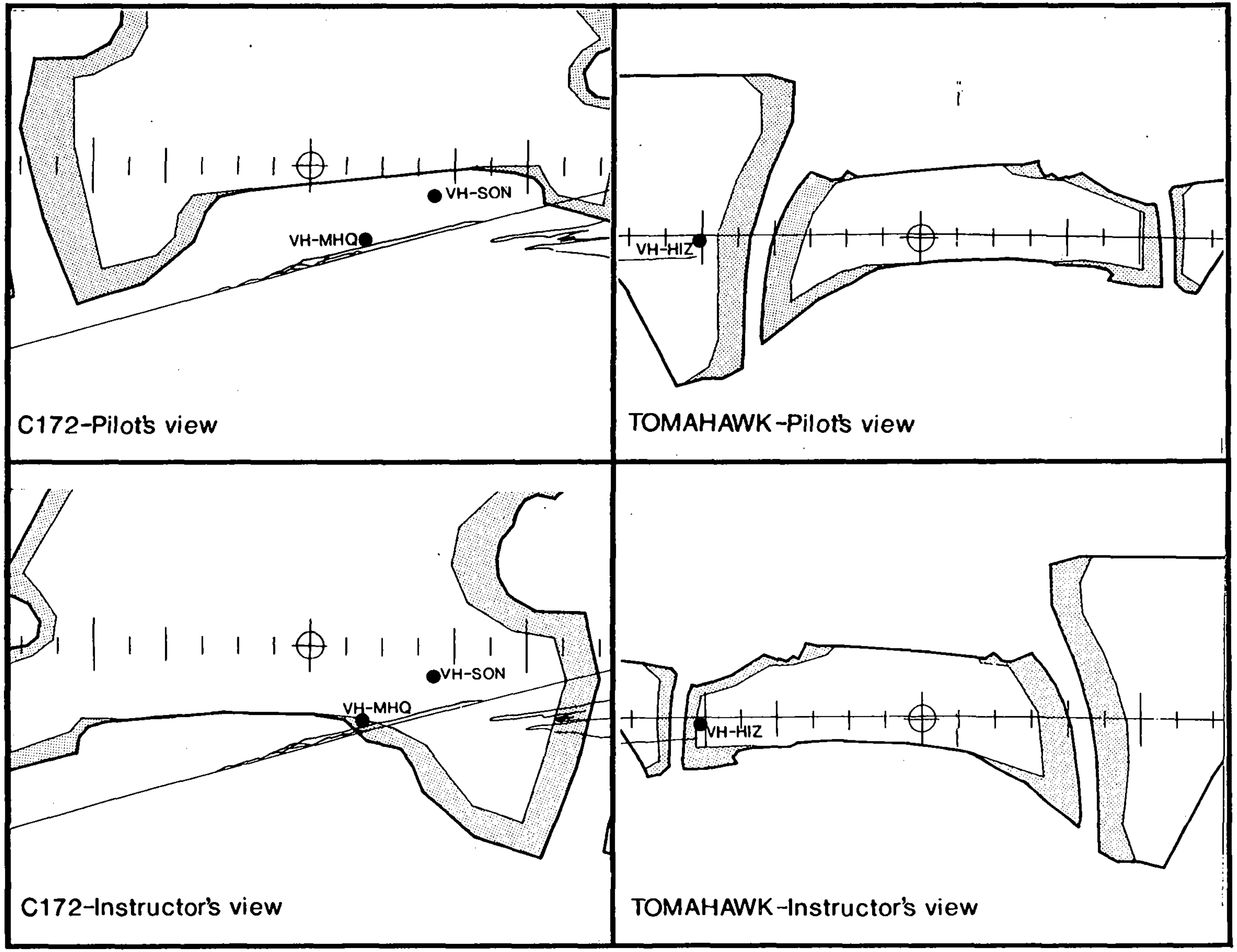
NOTE: BLACK LINE REPRESENTS THE LIMIT OF EXTERNAL VISION
SHADED AREAS REPRESENT MONOCULAR VISION
CLEAR AREAS REPRESENT BINOCULAR VISION

Appendix 8 (Continued) **Time 1608:38, Figures 2 to 5**

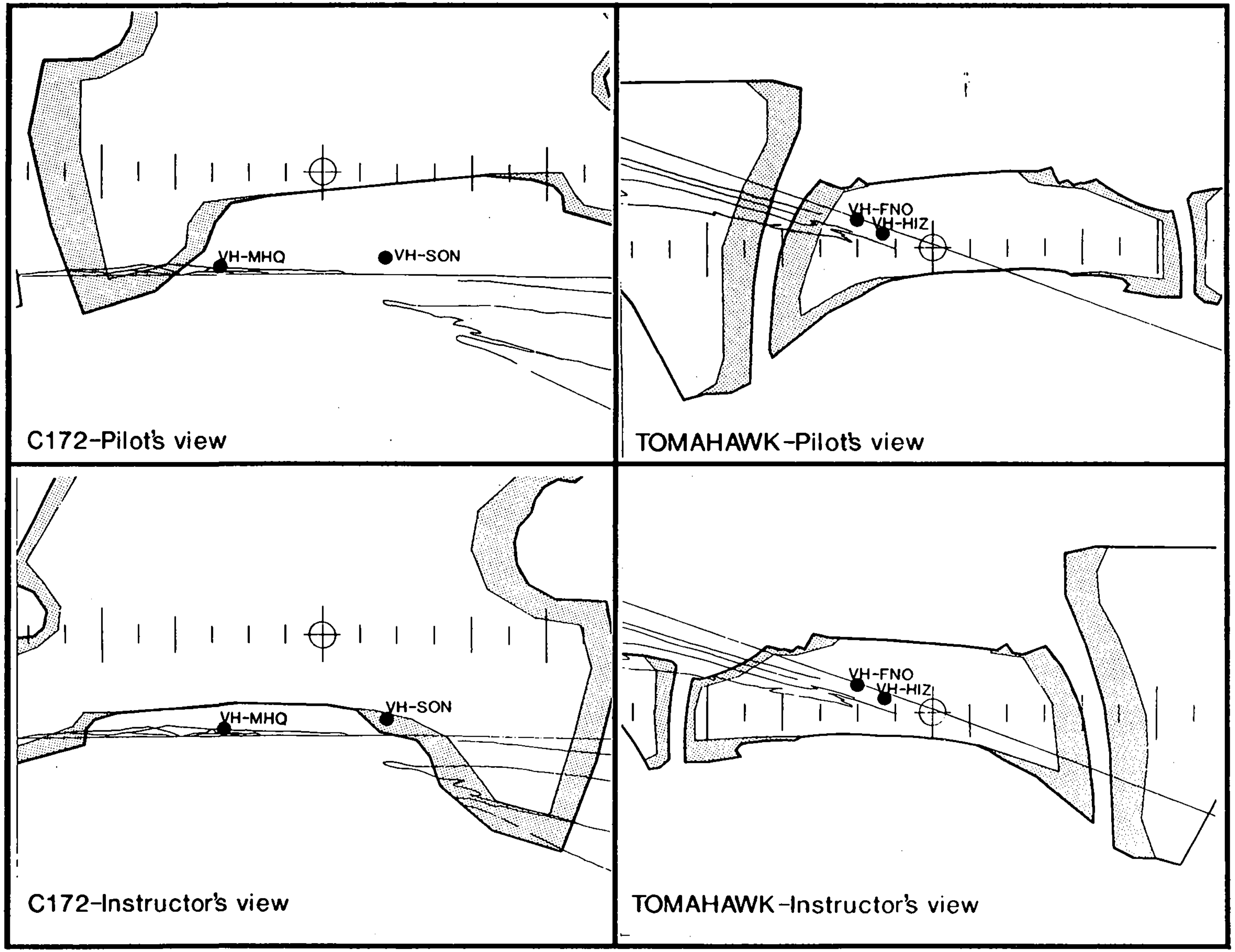
COCKPIT VISIBILITY DIAGRAMS



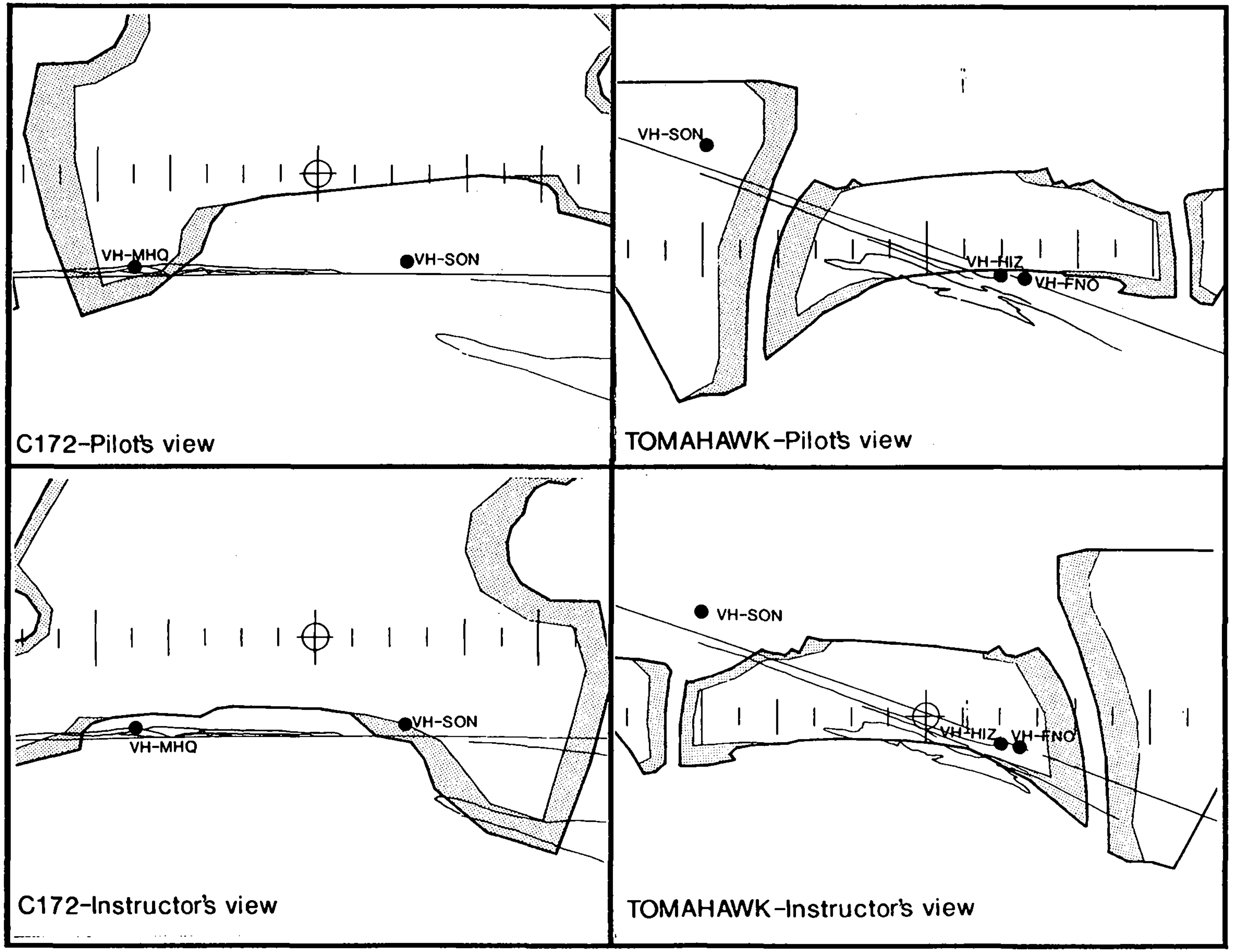
COCKPIT VISIBILITY DIAGRAMS



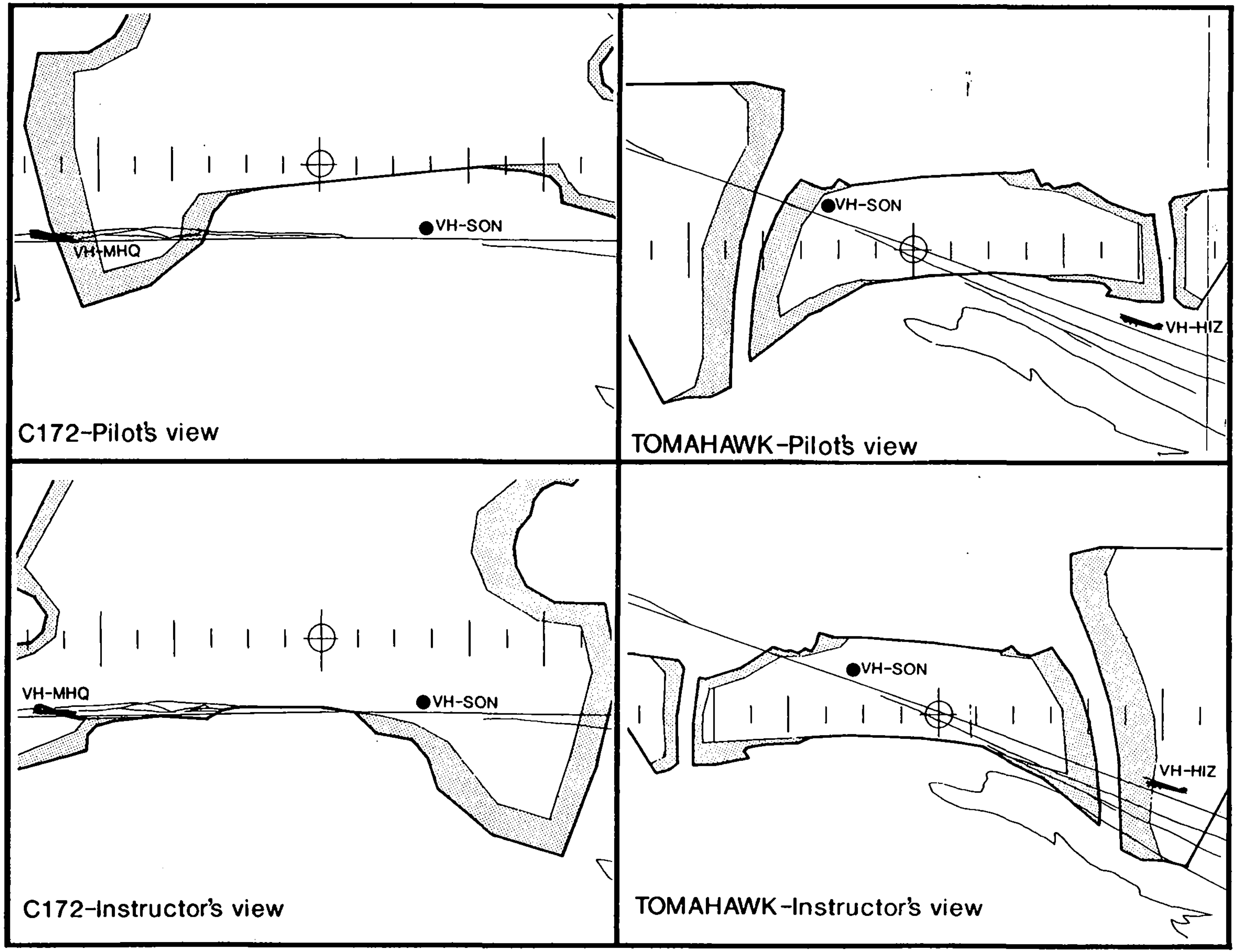
COCKPIT VISIBILITY DIAGRAMS



COCKPIT VISIBILITY DIAGRAMS

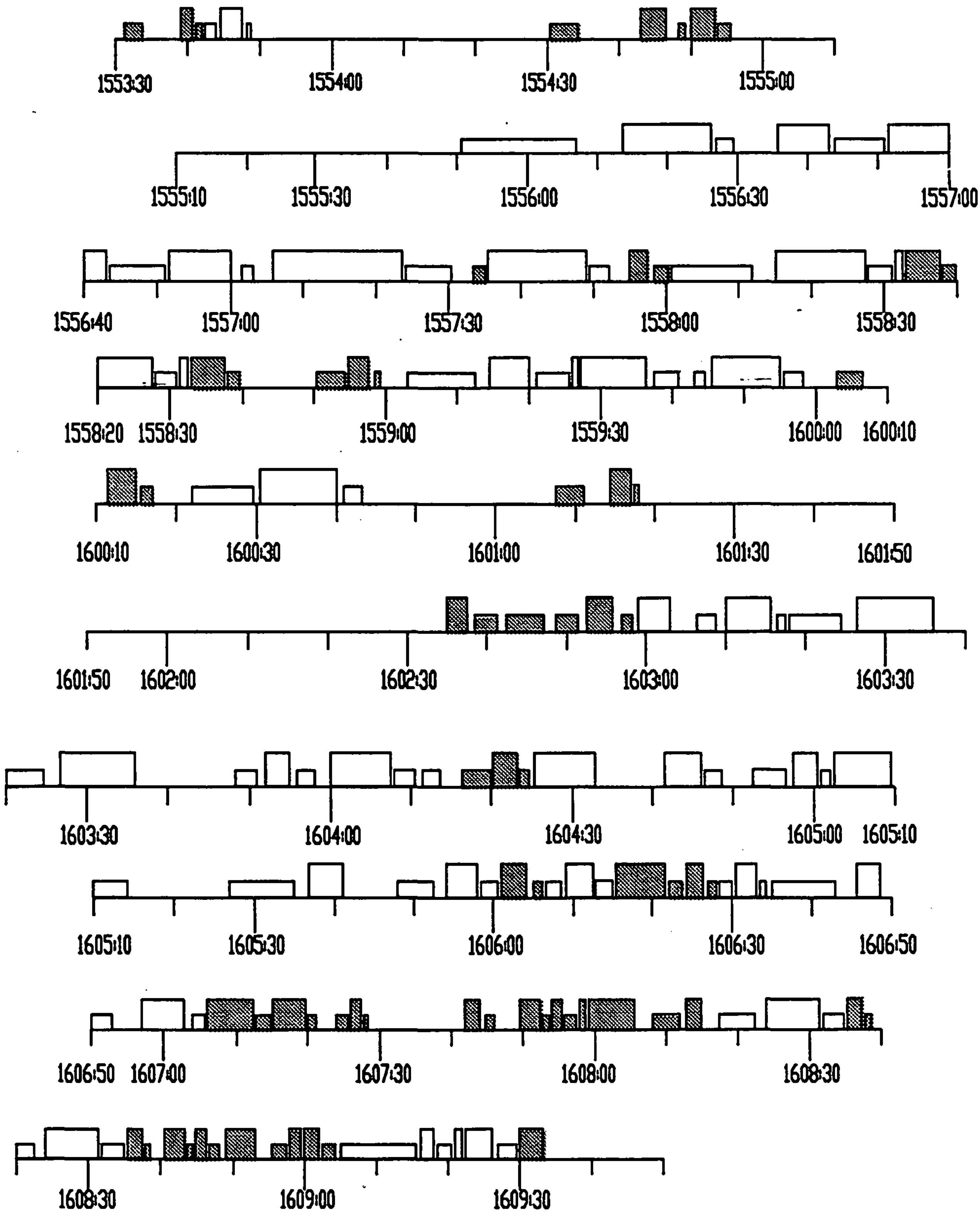


COCKPIT VISIBILITY DIAGRAMS



Appendix 9

ANALYSIS OF TOWER COMMUNICATIONS



Duration of radio transmissions recorded at Coolangatta tower on 5 May 1988 between 1553:30 and 1609:30 hours.

LEGEND:

Approach/Departures Control Functions shown as non-shaded boxes. — Transmission from Tower. — Transmission from Aircraft

Aerodrome Control Functions shown as shaded blocks. — Transmission from Tower. — Transmission from Aircraft

Appendix 10

SPECIALIST REPORT ON HUMAN FACTORS

Note

Full details of the accident are described in the report. The following specialist report does not repeat full details of the occurrence and should be read in conjunction with the main report, and the other specialist reports referred to.

Introduction

The air traffic controller who was occupying the ADC/APP position at the time of the accident was interviewed at his home over a period of several hours.

The broad objectives of the interview were:

(a) to determine whether the demands of the air traffic situation prior to and at the time of the collision exceeded the performance capabilities of this particular controller.

(b) to ascertain whether there were any psychological factors which may have negatively affected the controller's performance at the time of the accident.

The ATC Situation

In the period of time leading up to the collision the ADC/APP's workload built up rapidly, with ten aircraft on frequency. The rapidly changing situation required close attention and quick decision-making by the ADC/APP who described the situation as 'very busy', and time compressed. Reference to the time-annotated AVR transcript shows clearly that there was also considerable frequency congestion, some confusion regarding procedures onthe part of the FK27 crew, and an unexpected request for a touch-and-go on the part of that aircraft. All of these factors increased the workload of the ADC/APP.

However, this officer was a highly experienced controller and considered that the situation was well within his capabilities. He stated that he had handled instances of much greater ATC workload on many past occasions without difficulty. In this controller's view, he was not overloaded at the time of the accident.

A spectrographic analysis of the ADC/APP's transmissions on the AVR tapes tended to verify this: although his rate of speech increased as a function of the reduced transmission times available, given the number of aircraft involved and the dynamics of the situation, there were no behavioural indications that he was anxious about being overloaded or stressed.

Psychological Factors

The extensive interview of the ADC/APP revealed no evidence of psychological factors, such as pre-existing emotional stress or fatigue, which might have affected his performance on the day of the accident.

Areas covered in this comprehensive interview included possible psychosocial factors such as emotional, personal, marital, family, and financial difficulties, together with stressors such as fatigue.

The officer's answers were frank and detailed; he conveyed the strong impression that he was holding nothing back. He was eager to try and identify, explore and understand any possible factor which might, in his own mind, assist him in understanding what went wrong on the day of the accident.

It was concluded that at the time of the accident there were no underlying psychological factors which in my own or the officer's opinion could have caused him to be distracted or preoccupied, and therefore unable to focus his attention completely on his duties.

Further Analysis

The collision was a result of the combined outcome of the simultaneous departures from the normal circuit pattern by the two aircraft, each of which was acting in accordance with instructions/requests from the control tower. Either deviation from the normal pattern alone (ie the early right turn or the orbit) would have caused no breakdown in separation between VH-HIZ and VH-MHQ. However, in combination this was not so.

In setting up his game plan to accommodate the requirements of all of the aircraft in the scenario, the ADC/APP would have had to assess his continuously updated mental model of the situation, evaluate the options available, anticipate their outcomes, select the most appropriate course of action, then formulate and transmit the necessary instructions to all the aircraft involved. Each of these task components takes a finite time to complete.

Once the controller had selected what he considered to be the most appropriate game plan and issued instructions/requests accordingly to all aircraft concerned, their subsequent compliance with those instructions/requests had to be monitored by him.

To calculate and project ahead mentally the relative positions in time and space of a number of different aircraft of varying performance capabilities is an exceedingly complex cognitive process, but it is an essential and normal part of an ADC/APP's task.

The skills involved are acquired by extensive training and experience in a wide range of simulated and real ATC environments. However, even with such experience and training, unusual, infrequently encountered, or particularly complex ATC problems do impose an additional workload on the controller, requiring more time to analyse and resolve.

The AVR tapes showed that the ADC/APP was making decisions and issuing instructions very rapidly in the period prior to the accident. While he was not overloaded in the sense that the potential demands of the situation should not have exceeded his fundamental performance capabilities, the strategy, or game plan, adopted by the ADC/APP in dealing with the situation did not provide him with sufficient time to carry out properly the complex mental calculations required to anticipate the outcome of the combined effects of his request to VH-HIZ and his instruction to VH-MHQ. In other words, the strategy used by the controller could have caused him to become overloaded at some points in the sequence of events; a different strategy might have prevented this from happening - for example, if he had refused the request from the FK27 for a touch-and-go landing and thereby eliminated the need for the early right turn by VH-HIZ.

Human Information Processing

Research on human information processing since World War II has shown that at the level of conscious decision making, man functions as a single channel processor of limited capacity. This fundamental characteristic places critical restrictions on man as a component of many complex man-machine-environment systems, such as aircraft and air traffic control operations.

The topic was addressed in the 1987 Review of the Air Traffic Services System of Australia prepared by Ratner Associates Inc. for the Commonwealth Department of Aviation.

Unless human operators such as pilots and controllers are made fully aware of the nature and consequences of this basic limitation on their performance capabilities through appropriate training and awareness programs, they tend to assume that they can cope with high workload situations simply by 'trying harder'. It has sometimes proved to be a fatal assumption.

Through meetings with the Ratner Implementation Committee dealing with Recommendation 10, which concerns channelisation and lapses of attention, it was found that Australian air traffic service personnel do not receive any specific training or awareness education on these critical aspects of human performance. The Ratner Review's proposal that this obvious deficiency should be rectified is strongly supported.

Considering the issues discussed above, the ADC/APP's chosen 'game plan' was not inappropriate in the light of his training and experience. He did not expect to become overloaded by the demands of the situation, and he would have had no reason to do so, given that he had received no training on human performance which might have influenced his chosen strategy.

Responses to Information Overload

When confronted with a situation of information overload, ie when the time available is insufficient to complete the information processing demands of the situation, the human operator copes in one or more of the following ways:

OMISSION - ignore some signals or responsibilities

ERROR - process information incorrectly

QUEUEING - delay responses during peak loads; catch up during lulls

FILTERING - systematic omission of certain categories of information according to some prioity scheme

APPROXIMATION - make a less precise response

REGRESSION - respond with a previously overlearned habit pattern

ESCAPE - give up; abandon any attempt to cope

It is important to emphasise that not all of these effects may be consciously apparent to the human operator when they do occur - for example, under stress a pilot may not realise that he has regressed to an emergency procedure appropriate to another aircraft type with which he is more familiar.

Under the demands of the situation and the strategy he had chosen to cope with these demands the ADC/APP did not have sufficient time to appreciate the combined consequences of the request to VH-HIZ and the instruction to VH-MHQ. As a result, his responses fell primarily into the category of 'approximation' listed above. However, the fact that his responses were necessarily approximations because of the time constraints of the situation was probably not subjectively apparent to the ADC/APP.

Reference to the specialist task analysis elsewhere in this report shows that having given the request and instruction to VH-HIZ and VH-MHQ, the opportunity to monitor the two aircraft visually, particularly in the critical 25 second period immediately prior to the collision, and thus possibly become aware of the impending conflict, was denied to the ADC/APP by the continuing demands of his task. In addition, the potential effectiveness of the visual monitoring of traffic from the tower was reduced by the absence of the COORD until the last few seconds before the accident; this officer could have been called upon to assist the ADC/APP with the visual monitoring of traffic, even though it was not a designated part of his duty.

Appendix 11

VOICE STRESS ANALYSIS

Introduction

Both aircraft (VH-MHQ and VH-HIZ) were training flights operating under VFR. They collided in the circuit area with fatal injuries to all on board. Previously, VH-HIZ had made a touch-and-go and was requested to expedite a right turn. VH-MHQ was on a down-wind leg but was then instructed to make a left-hand orbit adjacent to the runway in use at about 1000 ft AGL, which ultimately placed the aircraft into conflict with VH-HIZ.

The AVR tape indicates that the ADC/APP's rate of issuing instructions increased considerably prior to the accident. One possible inference, therefore, is that the workload on the controller contributed to the accident by reducing his available information processing capacity, which consequently reduced his ability to appreciate fully the dynamics of the ATC situation and to anticipate the effects of his instructions on the aircraft in the circuit area.

In order to substantiate that inference, we require evidence that the controller's mental workload was sufficiently great at the time. Insofar as mental workload constitutes a stress on the individual, voice stress analysis is one potentially useful technique for estimating the level of that stress. The rationale for the technique is the empirical evidence that the nature of a person's voice may change during stressful events. A spectrogram of the voice then provides a formal (visual) means of assessing the extent of that change.

Voice stress analysis requires that the same phrase or word is inspected both before and during the assumed stressful event. Aircraft callsigns are good candidates for analysis because they are repeated often in an aviation environment. In order to test statistically whether subtle voice changes exist, at least 10 samples must be taken at each stress level. Alternatively, the analysis may simply be used to support what may already be heard, in which case a single sample at each stress level may confirm that a relatively gross change in voice exists. That has been the most common use of spectrographic analysis previously.

Analysis

Due to the limited number of callsign samples available from the AVR tape, comparisons between single samples only were made. The callsigns compared were 'Hotel India Zulu' (at 1554:51 hours and 1607:15 hours), 'Mike Hotel Quebec' (at 1554:42 hours and 1607:44 hours), and 'Foxtrot November Oscar' (at 1557:07 hours and 1607:06 hours).

In all cases, the later callsign was spoken at a faster rate, which is probably a reflection of the fact that the ADC/APP was issuing several instructions with limited available time at that point. With both VH-MHQ and VH-HIZ, some of the component syllables were not articulated as clearly and were slurred together, which is also consistent with a rapid speaking rate.

There was no evidence of a change in the controller's pitch around 1607 hours.

The conventional index of voice stress is a raising of pitch. That feature has been observed, for example, in pilots who were in imminent danger, although not without exception. The individual's personal response to the situation probably exerts a large influence on the voice.

In retrospect, it is not particularly surprising that no voice pitch changes were observed in this analysis. The inference being tested was that the ADC/APP was subject to a high degree of mental workload, ie, information processing load. Voice changes, however, have typically been observed in persons subject to a high degree of anxiety, which is a different category of stress from mental workload. It is possible for the processing demands of a task to generate anxiety in an individual if he/she perceives that he/she is not coping, but there was no evidence of that response in this analysis.

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