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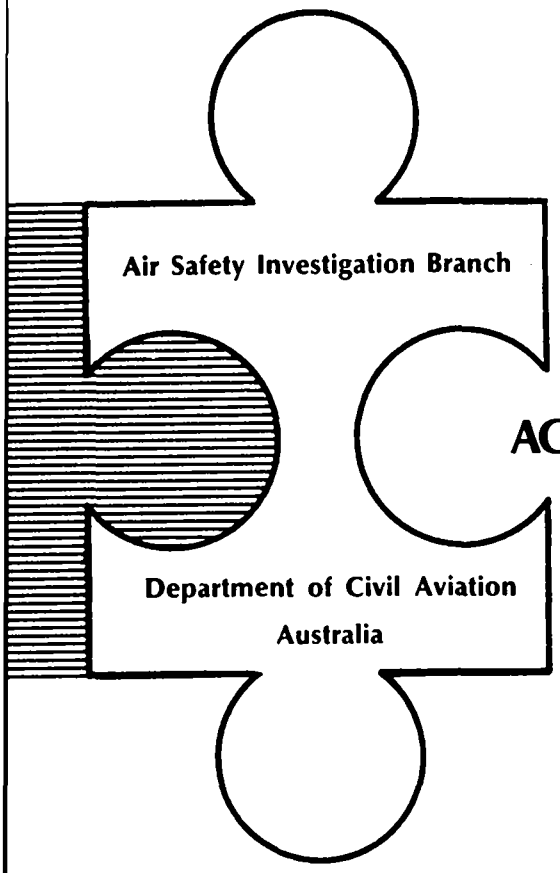
Air Safety Investigation Branch

Department of Civil Aviation
Australia

ACCIDENT INVESTIGATION REPORT

DC8-63 Aircraft CF-CPQ
and Boeing 727 Aircraft VH-TJA
at Sydney (Kingsford-Smith) Airport
New South Wales on 29 January, 1971

SPECIAL INVESTIGATION REPORT 71-1



ACCIDENT INVESTIGATION REPORT

CANADIAN PACIFIC AIRLINES DC8-63 AIRCRAFT CF-CPQ and TRANS-AUSTRALIA AIRLINES BOEING 727 AIRCRAFT VH-TJA AT SYDNEY (KINGSFORD SMITH) AIRPORT NEW SOUTH WALES ON 29 JANUARY, 1971

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

Prepared by:
Air Safety Investigation Branch Melbourne

August, 1971

CONTENTS

THE ACCIDENT

At approximately 2137 hours Eastern Standard Time on 29 January 1971, a Trans-Australia Airlines Boeing 727 aircraft, VH-TJA, struck the tail fin of a Canadian Pacific Airlines DC8-63 aircraft, CF-CPQ, whilst the former was taking off on Runway 16 at Sydney (Kingsford-Smith) Airport, New South Wales. Both aircraft were engaged in regular public transport services and the Boeing 727 aircraft continued with its take-off but landed again at Sydney Airport 40 minutes later after dumping fuel and when preparations for the emergency landing had been completed. At the time of the collision the DC8-63 aircraft was on the ground, having just landed, and it taxied under its own power to the parking apron. Both aircraft were substantially damaged in the collision but none of the 240 persons on board the two aircraft was injured.

1—INVESTIGATION

1.1 HISTORY OF THE FLIGHTS

At 2129 hours EST on 29 January 1971, the flight crew of the Boeing 727 aircraft, registered VH-TJA, called the surface movement controller in Sydney Tower, informed him that they were Flight 592 bound for Perth, Western Australia and requested a clearance to taxi from the loading apron. This aircraft is owned by the Australian National Airlines Commission and operated by Trans-Australia Airlines who hold an airline licence to operate Boeing 727 aircraft between a number of Australian airports including Sydney and Perth. The aircraft was under the command of Captain W.O. James and there were seven other crew members and 84 passengers on board. The aircraft was given instructions for clearing the apron area and it proceeded along Taxiways 'L' and 'G' towards the holding point for Runway 16 (see Appendix A).

At 2130:20 hours the crew of the DC8-63 aircraft, registered CF-CPQ, first called the aerodrome controller in Sydney Tower, having just left 3,000 feet at the West Pymble locator on an Instrument Landing System (ILS) approach to Runway 16. This aircraft is owned by Canadian Pacific Airlines Ltd., who hold an appropriate international airline licence to operate DC8-63 aircraft between Vancouver and Sydney. The aircraft was under the command of Captain C.E.Magrath, with 11 other crew members and 136 passengers on board. The aerodrome controller, in response to this call, instructed the aircraft to report again at the outer marker.

Whilst CF-CPQ was continuing with its instrument approach to Runway 16, the crew of VH-TJA obtained their airways clearance from the surface movement controller and, having reached the holding point, informed the aerodrome controller, on the appropriate frequency at 2133:47 hours, that they were ready to take off. At this time CF-CPQ, which was on short final approach, had been cleared to land and VH-TJA was instructed to line-up on the runway behind that aircraft. After CF-CPQ was observed to pass the threshold of the runway, the crew of VH-TJA proceeded to line-up and await their clearance for take-off.

As the landing DC8-63 aircraft neared the end of its landing run, the aerodrome controller instructed it to "...take taxiway right–call on 121.7" and this instruction was acknowledged. The crew of the Canadian aircraft, however, state that they read this instruction as "–backtrack if you like–change to 121.7" and they proceeded to turn the aircraft right about on the runway and to taxy back directly towards the Boeing 727. The landing run of CF-CPQ finished directly opposite the entrance to Taxiway "I", which leads off to the right from Runway 16 (see Appendix A). As this very long aircraft, sometimes known as a 'stretched' or Super DC8, approached its taxying speed in the landing roll, Captain Magrath steered it towards the left-hand edge of the runway so that he would have available the full width of the runway which is needed to turn this aircraft onto a reciprocal heading. The length and weight of an aircraft of this type demand, even under ideal conditions, that taxying manoeuvres shall be carried out with great care and at quite slow speeds. The fact that it had been raining at Sydney and the runway surface was wet heightened the need for care in taxying. It is apparent that the right-hand turn on the runway was carried out very slowly and took a significantly longer time than is customary for other aircraft commonly using the airport. Coincidentally, the turn was carried out opposite the entrance to Taxiway 'I' although it was not necessary to use any part of the taxiway to complete the turn. Nevertheless, the aerodrome controller saw the landing run of CF-CPQ finish opposite the taxiway and saw the aircraft turn towards the taxiway. When he believed that, in conformity with his instructions, the aircraft had entered the taxiway and was clear of the runway, he cleared VH-TJA for take-off. This clearance was given at 2135:38 hours.

The evidence indicates that, following the instruction issued by the aerodrome controller, the flight crew of CF-CPQ changed to the surface movement control radio frequency, 121.7 mc., at about the time they commenced the turn on the runway. In these circumstances they would not have been able to overhear the clearance for take-off issued to VH-TJA. It has been calculated that some 16 seconds after the take-off clearance was acknowledged, CF-CPQ would have completed its turn about on the runway. The flight crew of the aircraft have stated that, at this time, they still had all of their four landing lights illuminated, as well as the wing flood lights, the navigation lights and the upper and lower rotating anti-collision beacons. Soon after Captain Magrath commenced to backtrack down the centre of the runway he noticed that the aircraft, whose landing lights he had already seen near the threshold of Runway 16 was, in fact, coming towards him. He immediately increased power and commenced to steer his aircraft off the runway towards its eastern side. Before he could vacate the runway, however, but at about the time that the nose of his aircraft reached the eastern edge, the approaching aircraft, which he watched rotate and lift off, flew over the top of CF-CPQ. He felt a jolt which he interpreted as his nosewheel entering a depression off the edge of the runway or, alternatively, over-running an elevated runway light but, the immediate danger having passed, he then steered his aircraft back towards the centreline of the runway.

Captain James, in VH-TJA, says that his attention was not attracted to any obstruction in his aircraft's path until he had commenced the rotation action for

which the nominated speed was 131 knots. He says that it was at this point he saw the DC8-63 aircraft but he judged it too close to be avoided by abandoning the take-off and so he concentrated his attention on continuing to use a normal take-off technique, guarding particularly against any over-rotation, in the belief that this would be the best means of clearing the obstructing aircraft.

As Captain Magrath steered CF-CPQ towards the eastern edge of the runway in order to avoid the on-coming aircraft the sweep of his landing lights was observed in the control tower and the surface movement controller, believing that the aircraft was commencing a turn from Taxiway 'V' into Taxiway 'A', which leads back onto the runway, instructed the aircraft, first of all, to "hold position" and then "...continue straight ahead along the taxiway and cross Runway 07". By this time, however, the crew of CF-CPQ had observed the landing lights of a DC9 aircraft, VH-TJN, which was approaching to land on Runway 16. They pointed this out to the surface movement controller who then asked them to confirm that they were on the taxiway and the answer given from CF-CPQ was "Negative sir, we're on the runway, we were cleared to backtrack on the runway". The approaching DC9 aircraft, VH-TJN, was instructed immediately to go around and the crew of CF-CPQ were given fresh instructions to vacate the runway at the next taxiway on their left.

It was at about this time that the crew of VH-TJA informed the aerodrome controller that they had struck the DC8 during their take-off and that they had lost hydraulic pressure in their "A" system, which is one of the primary hydraulic systems of the aircraft. This aircraft then proceeded to an off-shore position to dump fuel and returned for a successful landing on Runway 16 at 2216:30 hours. The crew of CF-CPQ was informed of the report that the departing aircraft had struck them but, since there was no indication in the cockpit of abnormal operation, they continued to their parking position. Here it was observed that substantial portions of the upper fin and rudder were missing from the aircraft.

1.2 INJURIES TO PERSONS

Injuries	Crew	Passengers	Others
Fatal	–	–	–
Non-Fatal	–	–	–
None	20	220	

1.3 DAMAGE TO AIRCRAFT

Both aircraft were substantially damaged.

1.4 OTHER DAMAGE

There was minor damage to a building when some components fell from VH-TJA during the landing approach to Runway 16, post-accident.

1.5 PERSONNEL

Flight Crew–Boeing 727 VH-TJA

Captain Warren Owen JAMES, aged 50 years, was the pilot-in-command of this aircraft and he held a first class airline transport pilot licence which was not due for renewal until 31 May 1971. His licence endorsements authorised him to fly Boeing 727 aircraft and he held a first class instrument rating endorsed for ADF, VAR, VOR, ILS and Localiser radio navigation aids. Captain James' total flying experience at the time of this accident was 19,874 hours of which 4,100 hours had been gained in command of Boeing 727 aircraft. His most recent proficiency check was successfully completed on 5 October 1970, and his most recent medical examination successfully passed on 30 October 1970. In the 90 days preceding this accident he had flown 165 hours, all in Boeing 727 aircraft.

First Officer Douglas Arthur SPIERS, aged 28 years, was the first officer of this aircraft and he held a second class airline transport pilot licence which was not due for renewal until 31 March 1971. First Officer Spiers' licence endorsements authorised him to fly Boeing 727 aircraft. He held a second class instrument rating endorsed for ADF, VAR, VOR, ILS, DME and Localiser radio navigation aids. At the time of this accident, First Officer Spiers' total flying experience amounted to 2,953 hours of which 525 hours had been gained in Boeing 727 aircraft. His most recent proficiency check was successfully completed on 8 January 1971, and his most recent medical examination was successfully passed on 12 August 1970. In the 90 days preceding this accident, First Officer Spiers had flows 139 hours, all in Boeing 727 aircraft.

James Raymond RYAN, aged 28 years, was the flight engineer on board this aircraft and he held a flight engineer's licence which was not due for renewal until 31 July 1971. His licence endorsements authorised him to undertake flight engineer duties on Boeing 727 aircraft. His total flight engineering experience amounted to 2,872 hours of which 762 hours had been gained in Boeing 727 aircraft. In the 90 days prior to this accident he had flown 150 hours, all in Boeing 727 aircraft. His most recent proficiency check was successfully completed on 4 December 1970 and he passed his most recent medical examination on 7 July 1970.

Captain James' familiarity with Sydney Airport was considerably in excess of the minimum requirements specified in Air Navigation Regulation 215 and the recent duty time of each member of the crew was within the limitations specified in Air Navigation Orders Part 48.

The cabin crew of the aircraft comprised Hostesses B. TOBY, B.I. LONG, A.A. PARIS, R.L. WIDMER and S. McKIE. Each of these crew members received training in emergency procedures prior to commencing duties with Trans-Australia Airlines and, where applicable, annual refresher training courses had been carried out.

Flight Crew—DC8-63, CF-CPQ

Captain Charles Edward MAGRATH, aged 40 years, was the pilot-in-command of CF-CPQ and he was the holder of a Canadian airline transport pilot licence which authorised him to fly DC8 type aircraft. He held a Class 1 instrument rating. At the time of this accident Captain Magrath's total flying experience amounted to 10,723 hours of which 5,277 hours had been gained in DC8 aircraft. During the 90 days preceding this accident, he had flown 65 hours in DC8 aircraft. His most recent proficiency check was carried out in a DC8 simulator on 8 October 1970. Captain Magrath's most recent medical examination was carried out on 26 October 1970 and he was not due for re-examination until 29 April 1971.

The last occasion, prior to this accident, on which Captain Magrath had flown into Sydney Airport was in July 1962, when he visited Sydney as first officer of a Bristol Brittania aircraft. Prior to the flight of 29 January 1971, however, on 7 October 1970, Captain Magrath carried out a simulated approach to Runway 16, Sydney Airport using the flight simulation equipment installed at the Operator's headquarters in Vancouver. Although Captain Magrath had not seen the training film for Sydney Airport, he was supplied with the Pilot's Route and Terminal Study Guide for the South Pacific Area which provides information relating to weather conditions, air traffic control procedures, navigation facilities, communications procedures, airport characteristics and search and rescue facilities for routes and airports in the South Pacific area, including Sydney. Captain Magrath was also given a final briefing relating to Sydney Airport prior to his departure from Honolulu and he had in his possession the most recently issued Jeppersen Approach Chart for Sydney Airport dated 6 November 1970.

First Officer Walter James MUDE, aged 37 years, was the holder of a Canadian airline transport pilot licence which authorised him to fly DC8 aircraft. He also held a Class 1 instrument rating. First Officer Mude's total flying experience amounted to 5,195 hours of which 2,291 hours had been gained in DC8 aircraft. In the 90 days preceding this accident, he had flown 153 hours on DC8 aircraft. His most recent proficiency check was carried out in a DC8 simulator on 2 January 1971. First Officer Mude's most recent medical examination was carried out on 25 January 1971 and he was not due for re-examination until 12 August 1971. First Officer Mude last visited Sydney Airport on 9 October 1970 as first officer of a DC8 aircraft.

Second Officer Arnold Richard BJORNDAHL, aged 27 years, was the holder of a Canadian senior commercial 'B' pilot licence with single and multi-engine airplane land and sea ratings. He also held a Class 1 instrument rating. Second Officer Bjorndahl's total flying experience amounted to 1,494 hours of which 534 hours had been gained in DC8 aircraft. In the 90 days preceding this accident, he had flown 90 hours in DC8 aircraft. Second Officer Bjorndahl's most recent proficiency check was carried out in a DC3 aircraft on 23 January 1971, and his latest medical examination on 11 January 1971. He was not due for medical re-examination until 23 July 1971. He last visited Sydney Airport on 10 September 1970 as second officer of a DC8 aircraft.

Check Captain Lewis Andrew ELLERT, aged 51 years, was also on the flight deck of this aircraft at the time of the accident. His responsibilities were to observe a route qualification being undertaken by Captain Magrath and an extension of the period of validity of First Officer Mude's route qualification. A secondary responsibility for Captain Ellert was to introduce to the flight crew, under en-route conditions, a recently installed Inertial Navigation System. Captain Ellert was the holder of a Canadian airline transport pilot licence which authorised him to fly DC8 type aircraft. He held a Class 1 instrument rating. At the time of this accident Captain Ellert's total flying experience was 20,381 hours of which in excess of 5,000 hours had been gained in DC8 aircraft. During the 90 days preceding this accident he had flown 136 hours in DC8 aircraft. His last proficiency check was undertaken on 17 January 1971, in a DC8 aircraft. Captain Ellert's most recent medical examination was carried out on 9 October 1970, and he was not due for re-examination until 9 April 1971. The last occasion, prior to this accident, on which Captain Ellert had flown into Sydney Airport as a member of a flight crew was on 23 April 1967 when he flew in and out of this airport as captain of a DC8 aircraft. His last simulated approach, however, in respect of Sydney Airport, was carried out in the flight simulator at Vancouver on 23 November 1970, on which day he also viewed the training film relating to Sydney Airport.

The only other member of the flight crew was Mr A. KING, the navigator, who, at the time of the accident, was in his normal seat on the flight deck. He has said, however, that, at the time of this accident, and in the relevant minutes preceding it, he was not watching outside the aircraft and he was not listening to the radio communications being transmitted or received. Since it was apparent that he had no information which could usefully contribute to this investigation, he was not examined further.

The flight crew of CF-CPQ commenced duty at Honolulu following an off-duty rest period and they had been on duty for approximately 13 hours at the time of this accident.

The cabin crew of the aircraft comprised of Purser A. HOLZHAUS, Steward ALBRECHT and Stewardesses H. APT, M. PARFITT, K. NICHOLSON, S. GRIFFIN and S. SADD. The cabin staff were not interrogated in the investigation of this accident.

Air Traffic Control Staff–Sydney Tower.

Robert Edwin GUNN, aged 48 years, was the senior tower controller on duty in Sydney Tower at the time of this accident. He held a current air traffic controller licence with a current Sydney senior tower controller rating. This rating authorised him to carry out any of the air traffic control functions provided from Sydney Tower. At the time of this accident; Mr Gunn had approximately 13½ years experience of air traffic control duties and he had been employed continuously at Sydney since 1964. He first obtained his senior tower controller rating in October, 1968. At his last proficiency check on 27 January 1971, he was given a general assessment of 'above average'. His most recent medical examination was successfully passed on 8 June 1970 and he was not due for re-examination until 7 June 1972.

Lindsay Stuart HILL, aged 25 years. was the aerodrome controller on duty in Sydney Tower at the time of this accident. He held a current air traffic controller licence with current Sydney aerodrome control and surface movement control ratings. Mr Hill commenced his air traffic control career in July, 1965, and he had been stationed at Sydney since the completion of his training in July, 1967. During the month of December, 1970, he was trained as an aerodrome controller and he obtained his rating for this position on 30 December. He had previously gained some three months' experience in Sydney Tower as a surface movement controller. His last proficiency check was carried out on 30 December 1970, on completion of his aerodrome control training, at which time he was assessed as having reached the required standard. His last medical examination was successfully passed on 3 July 1969 and he was not due for re-examination until 2 July 1971.

Robert DAVISON, aged 28 years, was the surface movement controller on duty in Sydney Tower at the time of this accident. He held a current air traffic controller licence with a current Sydney surface movement control rating. Mr Davison joined Air Traffic Control in August, 1969. On completion of his training in April, 1970, he was engaged on flight data duties in Sydney until 3 January 1971, when, after two weeks training, he obtained his surface movement controller rating. His last proficiency check was carried out on 14 January 1971, on completion of his surface movement controller training, at which time he was assessed as a safe air traffic controller. His most recent medical examination was successfully completed on 29 June 1970, and he was not due for re-examination until 28 June 1972.

Richard John KING, aged 22 years, was the only other officer on duty in Sydney Tower on the night of this accident and he was there to discharge the responsibilities of tower flight data officer. He held a current air traffic controller licence with a current Sydney tower flight data officer rating. He first joined Air Traffic Control in July, 1968, and he completed his training in July, 1970. He obtained his rating for the position he occupied on the night of this accident on 21 July 1970. His most recent medical examination was successfully completed on 2 July 1970, and he was not due for re-examination until 1 July 1972.

1.6 AIRCRAFT INFORMATION

VH-TJA—History

The aircraft, VH-TJA, is a Boeing 727 manufactured by The Boeing Company, Seattle, U.S.A., in 1964 and allotted Serial No. 18741. The aircraft is owned by the Australian National Airlines Commission, in whose name it is registered, and it was maintained and operated by Trans-Australia Airlines. There was a certificate of airworthiness current for the aircraft which was to remain valid until 30 October 1973, provided that the aircraft continued to be maintained in accordance with the Trans-Australia Airlines maintenance system approved by the Director-General.

The aircraft's total time in service at the time of this accident was 21,307 hours. Prior to the aircraft's departure from Sydney on this night a pre-flight check was carried out and a maintenance release issued at 2105 hours. The rectification of several reported defects was deferred at this time but the existence of these defects did not invalidate the certificate of airworthiness and they could not have had any bearing on this accident

VH-TJA–Loading

The maximum permissible gross weight for take-off in this aircraft, having regard to structural considerations, is 160,000 lb. The stage length of the direct flight from Sydney to Perth required the carriage of maximum fuel (i.e. 50,000lb.) and it is calculated that the gross weight of the aircraft at the commencement of this take-off was 159,080 lb. At this weight the permissible range of the aircraft's centre of gravity is 13% to 34.2% mean aero-dynamic chord and it is calculated that the centre of gravity of the aircraft at the time of commencement of this take-off was at 22.4% mean aerodynamic chord. Having regard to the weight of the aircraft, the use of flap in this take-off was limited to 15 degrees to ensure that the aircraft would be able to achieve the minimum acceptable engine-out climb gradient in the second segment (i.e. between the landing gear retraction point and a height of 400 feet). The calculated V_1/V_R for this take-off was 131 knots and the V_2 was 146 knots.

CF-CPQ–History

CF-CPQ is a McDonnell-Douglas DC8-63 aircraft manufactured by the McDonnell-Douglas Corporation of the U.S.A. in 1968 and allotted Serial No. 45928. The aircraft is owned, operated and maintained by Canadian Pacific Airlines Ltd., in whose name it is registered.

A certificate of airworthiness was issued for this aircraft by the Canadian Minister for Transport on 28 December 1968. This certificate was to remain valid whilst the aircraft was owned and operated by Canadian Pacific Airlines and maintained by them in accordance with the maintenance system approved by the Minister.

The aircraft's total time in service at the time of this accident was 11,340 hours. A maintenance release was issued at Vancouver prior to the aircraft's departure and this was still current at the time of the accident. At the time of its issue no recorded defects remained unrectified but several minor irregularities were recorded by the crew during the flight from Vancouver to Sydney. None of these irregularities could have had any bearing upon this accident.

CF-CPQ–Loading

The maximum permissible gross weight for landing specified by the operating company for this aircraft is 245,000 lb. It was calculated that the gross weight of the aircraft at take-off from Nadi was 293,267 lb. and the anticipated fuel burn-off during the flight to Sydney was 57,570 lb. Thus the landing weight at Sydney was expected to be 235,697 lb. The loading calculations also show that the aircraft's centre of gravity would have remained within safe limits during the whole of this flight. The target threshold speed computed for the landing at Sydney was 136 knots.

1.7 METEOROLOGICAL INFORMATION

The terminal forecast prepared by the Sydney Airport Meteorological Office and transmitted to Nadi for the briefing of the crew of CF-CPQ predicted, for the expected time of the aircraft's arrival at Sydney Airport, that the surface wind would be from 180 degrees at 15 knots, the surface visibility would be three miles with rain showers in the area, and that the cloud cover would comprise 5/8 stratus, base 600 feet and 6/8 cumulus, base 2,000 feet.

As CF-CPQ approached the Sydney area, the meteorological information being broadcast in the Automatic Terminal Information Service and designated "Sierra" was "Runway 16, wet, wind 160 degrees 10 to 15 gusting to 20 knots, QNH 1010, dry bulb 20, low cloud 4/8 at 1500, 2/8 at 900, lower patches expect localiser approach.....". This information was noted by the crew of CF-CPQ and also by the crew of VH-TJA in their preparation for take-off.

The routine aerodrome weather report based on observations made at Sydney Airport at 2125 hours on this night was, wind 160 degrees one knot; visibility 10 miles with rain in the area; 4/8 stratus cloud with a base of 700 feet, 8/8 nimbo stratus with a base of 5,000 feet; dry bulb temperature 20°C, dew point 19°C; QNH 1011 mb. The routine weather observation made after the accident at 2155 hours was, wind 170 degrees 6 knots; visibility 15 miles; 3/8 stratus cloud with a base of 700 feet, 3/8 strato cumulus cloud with a base of 3,000 feet and 8/8 nimbo stratus cloud with a base of 5,000 feet; dry bulb temperature 20°C, dew point 19° C; QNH 1011 mb. At both of these times it was reported that, in some areas, the visibility was reduced to three miles in rain showers and there was 6/8 cloud at 600 feet. The pluviograph at Sydney Airport shows that 5 points of rain fell in the 60 minutes preceding this accident but almost all of this rainfall was recorded between 2045 and 2115 hours.

The weather conditions encountered on the approach to Runway 16 at Sydney Airport at the relevant time were consistent with the conditions forecast and observed from the ground. The captain of CF-CPQ reported that he had the runway lights in sight on reaching approximately 1,500 feet in his approach at which point

he would have been approximately 5 miles from the threshold and coming up to the outer marker. Captain Magrath says that he had no need to use his windscreen rain removal system during operations in the vicinity of the airport.

The flight crew of the DC9 aircraft, VH-TJN, which was the succeeding aircraft in the landing sequence, reported they became fully visual on the approach at 800-1000 feet at which point they would have been approximately three miles from the Runway 16 threshold. They are also of the opinion that the visibility beneath the cloud base was not less than 5 miles. In general, the conditions below the cloud base may be described as a dark but clear night with intermittent patches of drizzle which were sufficient to keep all airport pavement surfaces in a lightly wetted condition.

1.8 AIDS TO NAVIGATION

Runway 16 at Sydney Airport is fully equipped for instrument approaches. There is available a full instrument landing system including markers, twin locators and high intensity approach lighting. Although the crew of CF-CPQ carried out their landing approach by reference to these facilities no special serviceability checks were carried out in respect of these aids because the accident occurred after the landing had been completed.

1.9 COMMUNICATIONS

VHF communications facilities were used between Sydney Tower and the aircraft involved in this occurrence. The Aerodrome Control Service separating traffic on the active runways and on final approach, was provided on a frequency of 120.5 mc. whilst the Surface Movement Control Service was provided to all traffic operating on the airport surface, other than on the active runways, on a frequency of 121.7 mc. There is no evidence that the communication equipment in Sydney Tower or in any of the aircraft involved was subject to any fault which could have had a bearing on this accident.

All communications originating from the Sydney Area/Approach Control Centre and from Sydney Tower or from the aircraft under their control are recorded on the ground. At Appendix B, there is a transcript of the relevant communications which passed between the Sydney Control Centre or Sydney Tower and the aircraft involved in this occurrence commencing at the time that the crew of VH-TJA signified that they were about to taxy from the TAA loading apron.

1.10 AERODROME AND GROUND FACILITIES

Runway 16 at Sydney Airport is aligned 156 degrees magnetic (168 degrees true). With the exception of 500 feet at the northern extremity, which is of cement concrete, the runway surface is composed of bituminous concrete material. It is 150 feet wide and 8,900 feet long although this is reduced for landing by a dis-

placement of the northern threshold by 280 feet. The height of the northern threshold is 7½ feet above mean sea level and the first 2,300 feet of this runway is level. In the succeeding 4,000 feet of runway length, the height of the runway continually increases to a maximum of 21.7 feet above mean sea level at a point 6,300 feet from the northern end. Thereafter, the height of the runway continuously decreases to the southern end where it is 17 feet above mean sea level. It is apparent that, when this collision occurred, CF-CPQ was virtually at the highest point of the runway above mean sea level.

The configuration of runways and taxiways at Sydney Airport is depicted in Appendix A. It may be seen that Runway 16 is parallelled on its western side by Taxiway 'V' with several connecting taxiways. There are also taxiway exits from the runway on its eastern side but the last of these is 5,418 feet from its northern end. The entrances to each of the taxiway exits from the runway are delineated by turning guide lines and each taxiway is marked by centreline green lighting. In each case this lighting commences on the taxiway entrance turning guide line at a point just inside the line of the edge of the runway.

Runway 16 is served by low intensity omni-directional and high-intensity uni-directional side lighting with the total system having available six stages of brilliance. No record is kept of the history of stage variation for this lighting system but the air traffic controllers on duty at the time of this accident have stated that the runway lighting was set either to Stage 1 or Stage 2 and their recollections lean towards the probability that Stage 2 was in use. In the light wind conditions which prevailed, both runways were in use, and thus, virtually the whole of the runway and taxyway lighting system for the airport was illuminated.

1.11 FLIGHT RECORDERS

Boeing 727 Aircraft, VH-TJA

This aircraft was equipped with a United Control Corporation type F-542 Flight Data Recorder which records the aircraft's pressure altitude, indicated airspeed, heading and vertical acceleration against a time base by means of engravings made on a moving stainless steel tape. The recorder was installed in the rear fuselage aft of the rear pressure bulkhead and was not damaged in any way in the accident.

The section of the foil which recorded the behaviour of the aircraft from the commencement of its movement from the holding point on the taxiway through to the point on the initial climb, where the aircraft passed through two hundred feet, has been read out and the results are presented at Appendix C. The times at which some of the events significant to this investigation occurred and which can be derived from the flight recorder data are indicated below the time scale at the foot of the appendix. To assist towards a useful appreciation of the aircraft's probable performance, some slight smoothing of the graphed curves has been effected. In respect of the indicated airspeed, readings which were more than

1.5 knots from the smoothed curve have been separately shown and, in respect of altitude, readings which were more than 15 feet from the smoothed curve have also been separately shown. This type of recorder is not designed for high accuracy in the lower speed ranges and, accordingly, no great reliance should be placed upon the absolute values of airspeed shown during the aircraft's taxying manoeuvres.

This aircraft was also equipped with a United Control Corporation V-412 Cockpit Voice Recorder which, for the last 60 minutes of recorder operation, makes and retains a record of radio communications between the aircraft and ground stations as well as of audible speech and other sounds heard on the flight deck. Having regard to the fact that the aircraft landed, post accident, 47.5 minutes after it had been cleared to taxy for take-off, it was expected that the cockpit audio record for the significant period prior to the accident and for the whole of the flight post-accident would be available for the benefit of this investigation. The recorder was removed from the aircraft and was found to contain a record of the cockpit audio programme as well as a record of the transmission made on the surface movement control and aerodrome control frequencies during the periods relevant to this investigation.

When cockpit audio recorders were first installed in Australian airline aircraft the Australian Federation of Air Pilots (AFAP) insisted that the information they contained should not be used in the investigation of air safety incidents or of any accident which the flight crew survived. In the interests of having this very valuable source of information available, at least in those cases where the flight crew did not survive an accident, the Department of Civil Aviation agreed to this restriction for the time being but, in its considerations, the Department only had regard to accidents occurring within Australia to Australian registered aircraft.

The pilot crew members of VH-TJA, in this accident, were members of the AFAP and the Federation forcefully contended that the arrangement previously reached should also encompass this accident despite the fact that the accident involved a foreign registered aircraft and, therefore, an investigation controlled by the terms of an international standard which in no way recognises such a restriction upon the availability of evidence. Notwithstanding the fact that the Department had not contemplated the application of this arrangement to accidents involving foreign registered aircraft, the record of the arrangement between the Department and the Federation did not specifically provide for this exemption. In this circumstance and pending any re-negotiation of the arrangements, the Department conceded that the arrangements should apply to this accident. Therefore, the evidence contained in the cockpit audio record for this aircraft has not become available for use in this investigation.

DC8-63 Aircraft, CF-CPQ

This aircraft was fitted with a Davall Recycling Recorder Type No. 1190 installed in the cabin just forward of the rear pressure bulkhead. The recorder test facility at the flight engineer's station was placarded indicating that this equipment was inoperative and the minimum equipment list contained in the operations manual relevant to this aircraft also stated that this recorder was inoperative. Nevertheless, as installed, power was available to the unit and the reel brake was found in the

OFF position. Since the possibility existed that this recorder was, in fact, operating and may have contained some information relevant to the investigation of this accident, it was removed and forwarded to the Canadian Ministry of Transport for examination. This kind of equipment is not installed in any Australian registered aircraft and no facilities for the reading out of the recorded information are available in this country. On examination by an officer of the National Research Council in Canada it was found that the wire recording medium in this equipment had broken some time prior to the commencement of the flight which culminated in this accident and, therefore, the recorder contained no information useful to this investigation.

This aircraft was also equipped with a Fairchild A100 Cockpit Voice Recorder. The flight crew stated that, after being informed by Sydney Tower that their aircraft had been struck by the departing Boeing 727 aircraft and before they reached their parking position on the international apron, a Canadian Pacific Airlines ground engineer who was travelling on the aircraft was brought to the flight deck and requested to pull the circuit breakers relevant to the cockpit audio recorder so that its operation would cease at that point and, thus, the information relevant to the accident which had just occurred, would be preserved. Some 40 minutes after the aircraft had been parked, the cockpit audio recorder was removed by another ground engineer, taken into custody by Captain Ellert and, on the following day, handed into the custody of the investigator-in-charge. This record was examined, using the specialised facilities of the Air Safety Investigation Branch, but it was found to contain only a record of the cockpit audio programme for a period subsequent to the parking of the aircraft at Sydney. It was then discovered that the ground engineer on board the aircraft had inadvertently pulled the circuit breakers for the flight data recorder and thus permitted the cockpit audio recorder to continue in operation whilst electrical power was available to it. Since it is a recycling recorder which retains a record of the cockpit audio programme only for a period of 30 minutes prior to the point at which it is stopped by the interruption of power supply, the record for the significant period leading up to this accident had been erased by continued operation of the recorder after the aircraft was parked and whilst ground power was being supplied.

1.12 WRECKAGE

Boeing 727 Aircraft, VH-TJA—Damage

The first contact between the two aircraft was sustained by VH-TJA on the starboard main wheel bay fairing approximately 50 inches forward of and 20 inches below the wing leading edge. The area of damage widened as it progressed rearwards and extended down to near the fuselage centreline and upward and outward along the wing under-surface to the leading edge flap (see Appendix D, Fig. 1).

Most of the fairing which normally encloses the air-conditioning ducting, heat exchangers and cooling turbine unit, forward of the starboard wheel bay, was torn from the aircraft. The fin of the DC8 aircraft penetrated into the air-conditioning compartment with the result that the ground-air fan, primary heat

exchangers, cooling turbine and the associated duct work were torn from the aircraft. Adjacent to the air-conditioning compartment heavy score marks were present on the aircraft pressure shell but it had not been penetrated.

The hydraulic lines from System A which pass from the fuselage through the air-conditioning compartment to the wing leading edge slats and flaps were severed in the impact. The wing leading edge slat and flap panels were in the extended position at the time and the hydraulic lock system in the individual jacks kept the panels extended. The wing leading edge attachment lug on the fuselage frame was fractured.

The lower portion of the starboard wheel bay forward bulkhead received a heavy rearward blow. The impact severed the lower frames and penetrated vertically into the diaphragm to a depth of approximately 15 inches (see Appendix D, Fig. 2). The metal air-conditioning duct located on the forward face of the diaphragm was crushed and punctured and some wires in an adjacent electrical loom were severed.

The starboard main gear inboard doors were torn from their hinges and actuating rods. The door outboard of the gear was undamaged. A portion of the DC8 aircraft struck and slashed each starboard main tyre causing the inboard one to deflate. The impact also dislodged and severed one brake de-booster unit which is normally mounted on the forward face of the main gear leg. The structural members of the main gear and its associated locking mechanism were not damaged.

The starboard wheel bay rear bulkhead received a heavy upward and rearward impact, the centre of which was located 15 inches from the inboard bulkhead and extended up the bulkhead about 12 inches. Three of the heavy bulkhead stiffeners were broken and the lower edge of the bulkhead was forced rearwards three inches.

A series of score marks and lower fuselage skin punctures extended rearward and inboard from the point of heavy impact on the wheel bay rear bulkhead to the tail bumper (see Appendix D, Fig. 3). This bumper had been broken from its hinge and shock absorbing strut. The failure was caused by impact on the bumper frame in a rearward direction consistent with it having struck the DC8 fin.

DC8-63 Aircraft, CF-CPQ–Damage

The extent of damage to this aircraft was confined to the fin, rudder, starboard tailplane and elevator. The fin was severed along an approximately horizontal plane reducing its vertical height by some eight feet six inches (see Appendix D, Fig. 4). The fracture surfaces along this plane all showed scratches and bending consistent with the structure above the separation line having received a blow from the forward left side of the aircraft.

The rudder was severed immediately above the centre hinge in a chord-wise direction. The direction of failure was consistent with there being a substantial right rudder deflection at the time of the impact.

Several small punctures were also present in the upper surface of the starboard tailplane, starboard elevator and trim tabs. One puncture still retained a portion of the fin skin and it seems probable that all of these resulted from small pieces of the detached portion of fin striking the starboard tailplane and elevator top surface.

Wreckage Distribution.

As a result of this collision the southern portion of Runway 16 was strewn with many hundreds of small aircraft fragments together with some larger components. The larger elements of the wreckage were moved off the runway by the emergency crews shortly after the accident in order to allow VH-TJA to land on the longest into-wind runway and so, in the investigation phase, it was not possible to reconstruct a precise and useful pattern of wreckage distribution. An examination of the scene on the following morning, however, showed that the most northerly items of wreckage were just off the edge of the runway at a point corresponding very closely with the southern edge of the General Holmes Drive underpass (i.e. 6,286 feet from the northern end of the runway). From this point further southward, the runway and the immediately adjacent grassed areas were liberally strewn with aircraft fragments. The intensity of distribution was greatest in the vicinity of the runway entrance to Taxiway 'I' and then it progressively decreased towards the southern end of the runway.

Two items of wreckage fell from VH-TJA into suburbs north of the airport, apparently during the aircraft's final approach for landing after the accident. These items were identified as sections of the starboard main undercarriage doors.

The Impact Configuration

From an examination of the damage caused to each aircraft and the pattern of wreckage distribution on the ground, some facts can be established as to the relative configuration of the two aircraft at the time of this collision. Although the position of CF-CPQ along the length of the runway at this time cannot be precisely determined by any mark on the runway it seems fairly obvious that its tail fin would not have been further south than the point at which the most northerly items of wreckage were discovered. The fixing of this position is also assisted by the evidence of the crew of CF-CPQ who noticed in the beam of their lights a protrusion of rough textured bitumen off the side of the runway when they diverted to its eastern edge in their unsuccessful attempt to avoid the collision. There is just such a protrusion immediately above the General Holmes Drive underpass. In the absence of any more precise evidence it has been assumed that the tail fin of CF-CPQ was 6,286 feet south of the northern end of the runway at the time it

was struck (i.e. level with the most northerly items of wreckage). There is good reason to believe that any error in this assumption would be so small as to be insignificant to any conclusions which may flow from it.

An examination of the bending and scoring of material at the separation line on the CF-CPQ tail fin indicates that the direction of movement of VH-TJA at the time of impact was 30 degrees to the longitudinal axis of CF-CPQ with VH-TJA approaching the Canadian aircraft from its forward port side. Add to this the evidence of the crew of CF-CPQ that the nosewheel of their aircraft was at or very close to the eastern edge of the runway at the time that the aircraft taking-off passed their position and it becomes possible to fix the position of the leading edge of the tail fin of their aircraft when it was struck as also being six feet west of the runway centreline.

The circumstances in which the flight crew of VH-TJA conducted this take-off do not contain any factor which, necessarily, would lead to any lateral displacement of their aircraft from the centreline of the runway during the take-off roll or immediately after lift-off. The proposition, therefore, that the leading edge of the CF-CPQ tail fin was six feet west of the runway centreline at the time of impact is consistent with VH-TJA being substantially over the runway centreline at this time, since the first contact with VH-TJA occurred on the starboard side of its fuselage which is laterally displaced six feet from its longitudinal axis.

Having regard to the nature and extent of damage to both aircraft, it is also possible to reconstruct their height relationship at the time of impact. It is apparent that, at this time, the body angle of VH-TJA was approximately 11 degrees above the horizontal making due allowance for a climb gradient of approximately 2½ degrees, which is what is to be expected in the circumstances and is reflected in the flight data record. The flight crew of VH-TJA did not retract the undercarriage during this take-off. It is estimated that the clearance between the lowest portion of the main gear of VH-TJA and the top of the fuselage of CF-CPQ at the time of impact was of the order of nine feet (see Appendix E).

1.13 FIRE

There was no fire as a result of this accident, but as a precautionary measure all emergency services attended the uneventful post-accident landing of VH-TJA.

1.14 SURVIVAL ASPECTS

None of the persons on board the two aircraft involved in this accident sustained any injury. The forces involved were not such as to introduce any question of survival.

1.15 TESTS AND RESEARCH

During the examination of radio communications on the aerodrome control frequency, 120.5 mc, recorded on the ground, it was noticed that, at 2136:12 hours, a five word question "How far ahead is he", from an unidentified source, was recorded (see Appendix B). Each air traffic controller in Sydney Tower at the relevant time and each member of the flight crews of VH-TJA, VH-TJN and VH-EWJ, all of whom were listening on this frequency at the relevant time, was questioned as to whether he originated or overheard these words. Each of the persons questioned denied having uttered the words and none of them could recall having heard them at the time they were spoken. Since the nature of the question implicit in the words "How far ahead is he" and the time at which it was spoken were potentially quite significant in the investigation of this accident, it was decided that an attempt should be made to identify the originator of these words by more positive means.

The assistance of the National Transportation Safety Board (NTSB) in the United States of America and, in particular, that of Mr R.D. Rudich, the Chief of the Board's Audio Laboratory was enlisted. For some time now the Board has been equipped with "Voiceprint Sound Spectrograph" facilities and, in using this equipment, Mr Rudich has developed, to a high degree, methods of identifying the source of sounds, including voice sounds, audible on an aircraft flight deck. The technique involves a visual comparative evaluation of frequency spectrograms produced by this equipment. It is in use in many other contexts including the teaching and medical professions as well as in communications engineering and crime detection. Persons who are expert in this specialised field state that they can identify a person by his speech characteristics as certainly as he could be identified by his fingerprints.

Several re-recordings were produced in Australia by copying from the original recordings not only the phrase "How far ahead is he" but also a number of other transmissions selected to embrace all the aircraft and the aerodrome controller who were on this frequency at the relevant time. From these transmissions Mr Rudich selected sounds or phonemes similar to those contained in the phrase under investigation and, after a comparative evaluation of five such phonemes, he concluded that the words "How far ahead is he" originated from the aircraft VH-TJA and did not originate from any of the other aircraft on the frequency or from Sydney Tower.

A further examination was then made by Mr Rudich of a wide range of transmissions made from VH-TJA both before and after the accident. From this study Mr Rudich concluded that the words "How far ahead is he" were originated in VH-TJA by the same person as also originated the communications made from that aircraft at 2139:52, 2140:50 (second transmission made from VH-TJA) 2141:27 and 2142:47 hours (see Appendix B). Having regard to the content and phrasing of these communications there can be no doubt that they were originated by Captain James.

In the light of this conclusion, consideration has been given to the means whereby the words "How far ahead is he", spoken by Captain James, could have been recorded on the ground. Obviously the words were transmitted on the radio frequency 120.5 mc. but, in themselves, they contain no indication as to whom they are addressed or to whom any reply should have been directed, There is, however, at least one tenable explanation of this otherwise puzzling event. In Boeing 727 aircraft operated by Trans-Australia Airlines the flight crew normally communicate with each other during critical flight operations, such as take-off, via the aircraft intercommunication system using head phones and boom microphones. Of course the same equipment is used for the transmission and reception of radio communications on the particular frequency being guarded at the moment. At any desired time the captain or first officer may transmit a radio communication by depressing the upper half of a rocker switch mounted on his control yoke. If he wishes to communicate with other members of his flight crew via the aircraft's inter-communication system, he merely depresses the lower portion of this same rocker switch. It is by no means impossible or unlikely that the captain or first officer may inadvertently depress his switch in such a way that a communication intended only for the other flight crew members in the aircraft is also transmitted on the radio frequency being guarded. Such an inadvertent selection would not necessarily deprive the other flight crew members of the communication intended for them but would merely allow it to be heard and recorded outside the aircraft. It seems likely that some such inadvertent operation of the captain's transmitter selector switch occurred during this take-off.

2–ANALYSIS

2.1 CORRELATION OF EVENTS

In this accident there were three distinct and separate locations at which important decisions had to be made affecting the safety of the two aircraft involved. These three locations were the flight decks of the two aircraft, VH-TJA and CF-CPQ, and the control room of Sydney Tower. To some degree there was intercommunication between these three locations either by radio or by visual observation but, to a significant degree, the decisions in each place had to be made quickly, based upon the data immediately available. Each of the decision makers and others who were present in these locations have given evidence as to their recollections of the decisions which were made and the information upon which they were based. Unfortunately, the only other evidence available to the investigation is the ground record of voice communications, including all transmissions on the aerodrome control and surface movement control frequencies, and the flight data record of the movements of VH-TJA.

Neither the flight data record nor the cockpit audio record from CF-CPQ contained information of use in this investigation because of equipment faults or handling errors and the cockpit audio record in respect of VH-TJA was not available to the investigation for reasons which have already been described. The integration of evidence and the correlation of the movements of both aircraft with the instructions issued by Sydney Tower would have been greatly assisted by the availability of this evidence and a much higher level of confidence in the accuracy of this analysis could have been achieved. In its absence, an attempt has been made, on the evidence that is available, to correlate the events and decisions made in each location against a common time scale so that an overall picture of the events leading to this accident can be established. The results of this analysis are set out in the chart at Appendix G.

The chart is concerned with the events which occurred within the three minute period immediately prior to the collision of the two aircraft. It records some facts which may be regarded as having been reliably established, since they are drawn either from the record of voice communications or from the flight data recorder installed in VH-TJA. To some extent the chart also relies upon the recollections of witnesses, particularly in the absence of any reason to doubt the accuracy of their recollections. Unavoidably, however, the chart also incorporates some assumptions and it is the acceptability of these assumptions which must first be examined. Some of the assumptions have been included only to make the picture of events within this three-minute period as complete as possible and they are not critical to any conclusion of importance which might be drawn. On the other hand, some assumptions have been made which bear upon the more important conclusions to be drawn from the chart. In each case, however, there is a fairly narrow range of feasibility and any variation of the assumption within this range will not greatly alter the substance of the conclusions which might be drawn.

First of all it is assumed that the 180 degree turn carried out by CF-CPQ on the runway opposite the entrance to Taxiway "I" was made with an average nosewheel speed through the turn of three knots. Captain Magrath has said that the DC8-63 aircraft is a very slow aircraft moving around an airport and he has further pointed to the fact that the runway surface was wet on the night of this accident imposing an even greater demand for care in turning an aircraft of this weight and length. Even under ideal conditions the aircraft requires nearly the full width of the runway at Sydney to complete a 180 degree turn and this assumes that a nosewheel slip angle of 3.6 degrees will apply. There are obvious limitations to the adoption of any lower average nosewheel speed particularly when this speed reflects even slower movement at the mainwheels and the aircraft centre of gravity. The assumption of any substantially higher average speed would tend to increase the nosewheel slip angle and thereby increase the turning circle beyond the runway width capacity. The assumed speed of three knots controls the conclusions which may be drawn about the length of time taken by the aircraft to carry out the turn as well as any conclusions as to the position of the aircraft at the time that VH-TJA was cleared for take-off.

It is also assumed that, on completion of the 180 degree turn on the runway, the taxying speed of CF-CPQ was increased to 10 knots but did not exceed this figure prior to the collision. It is most probable that Captain Magrath would have increased the taxying speed of the aircraft after the problems of the turn manoeuvre had passed. As the whole airport surface was wet and further turns had to be made, however, a normal acceleration to a 10 knot maximum taxying speed has been assumed.

An important assumption in this chart is that the power increase for take-off in VH-TJA commenced one second after the take-off clearance issued by Sydney Tower had been completed and just as the acknowledgement from the aircraft was commenced. This assumption is consistent with Captain James' evidence that he would have commenced to spool-up whilst the clearance was being received. A one-second reaction time after the words "clear for immediate take-off" has been adopted. This assumption establishes a time relationship between the recorded radio communications and the recorded or deduced movements of the two aircraft involved. Alternative assumptions could have been made but the feasible range is very limited and it is considered that none other would have had superior merit to the one adopted.

A further assumption associated with the commencement of the Boeing 727 take-off is that, at the time of commencement of the power increase, the nosewheel of the aircraft was on or very close to the marked threshold of the runway and the aircraft was being held, virtually stationary, under idle thrust. Captain James has said that, to the best of his recollection, the aircraft was still rolling forward at the time that the take-off clearance was received but he is certain that it had not reached the threshold lights. Having regard to the fact, however, that the nosewheel of the aircraft would only have been some 20 feet short of the landing threshold markings when it first reached the lined-up position, it is inconceivable that the aircraft could have continued to move forward, except in a barely

perceptible creep, for the whole of the 47 second period until the take-off clearance was received without passing substantially beyond the threshold. For all practical purposes, therefore, it is reasonable to assume that the aircraft was stationary at the threshold and being restrained under idle thrust at the time the spool-up for take-off was commenced.

Finally, it is assumed in this chart that the abrupt "G" trace deviation at 152.5 knots observed in the VH-TJA flight data record shortly after the aircraft became airborne in fact defines the impact as is suggested in Appendix C. It is obvious that the collision must have occurred very close to this time and, in the absence of any recourse to the cockpit audio record, this assumption seems entirely reasonable.

Looking then at the content of Appendix G, it may be seen that Columns 1 and 6 of the chart contain a reference time scale defining each second of time from 2133:40 hours to 2136:45 hours. In Column 2 the "Relevant Communications", originated in each of the two aircraft and in Sydney Tower during this period and which are recorded on tape with an accurate time datum, are set out, each at the appropriate time. There were other communications within this time period on the two frequencies involved but they have been omitted from this chart since they are not relevant to its purpose.

In Column 3 the significant events depicted in the flight data record of VH-TJA are set out in their proper time relationship to each other whilst Column 4 contains performance information relevant to the VH-TJA take-off which is derived principally from the speed/time history of the aircraft exhibited in the flight data record. Because of the doubtful accuracy of the speed trace in the lower range, it was necessary to construct the acceleration curve from the commencement of power application to the development of full thrust using information derived from Type Certification reports. The total speed/time history trace derived in this way was then compared with take-off performance curves provided by the manufacturer for the particular conditions of this take-off and a good agreement was evident.

With this information and using the known aircraft speed of 152.5 knots at impact it can be calculated, on the basis of the assumed commencing time, that the impact occurred at 2136:31.7 hours. The distance that would be covered by an aircraft experiencing such a speed/time history also fits closely the distance between the assumed starting position and the known impact point. The reasonableness of the assumptions made and the calculation methods employed is further supported by the fact that the real time applicable to the commencement of the airspeed rise on the data record can now be determined and it follows the assumed time for the commencement of power application by about one second.

Column 5 in the chart provides some important information as to the movements of CF-CPQ relative to those of VH-TJA and relative to the recorded communications. The inter-relationship of the events described in this column of the chart turns in large measure upon the validity of the assumptions already referred to, relating to the ground handling of CF-CPQ. The basic time relationship between

this column as a whole and the earlier columns relies upon the evidence as to the position of the aircraft at the time of impact and the knowledge that the aircraft's heading reversal on the runway was carried out immediately opposite Taxiway "I".

The assumptions made in the construction of this chart are consistent with the manner in which aircraft operations are normally conducted and they do not conflict with any of the other evidence available. Some important and significant probabilities can, therefore, be established and these are discussed hereunder. It must be remembered, however, that the times and distances quoted are the results of mathematical calculations and they must not be regarded as having the order of accuracy which the figures themselves might appear to imply. Accordingly, in drawing conclusions from these calculations, there has been a proper regard for the tolerances which should apply, considering the accuracy which can reasonably be claimed for the basic data and the method of calculation.

First of all the chart indicates that VH-TJA, having been cleared to line up on Runway 16 behind the landing DC8 aircraft, reached the "lined-up" heading 9 seconds prior to the time at which CF-CPQ commenced its turn on the runway opposite the entrance to Taxiway 'I' and 47 seconds prior to the time at which the power application for take-off was commenced. It is also apparent that the clearance for take-off was given by Sydney Tower commencing 33 seconds after CF-CPQ had commenced its turn on the runway. At this time CF-CPQ had completed a little more than half of its 180 degree turn and its longitudinal axis would have had a very similar alignment to that of the centreline of Taxiway 'I'.

The chart also indicates that the words "How far ahead is he" were uttered 12 seconds after CF-CPQ had completed its turn onto the reciprocal heading of the landing runway. At the time that these words were spoken, it is calculated that VH-TJA, in its take-off, had reached a speed of 100 knots and was at a point 2,260 feet from the northern end of Runway 16. A further calculation using Boeing 727 Type Certification data for similar ambient conditions indicates that, assuming recognition at this point and with due allowance for reaction times, VH-TJA could have been brought to a halt on the runway, without the benefit of reverse thrust, at a point 4,060 feet from the northern end of Runway 16 (see Appendix A). Finally, in relation to the utterance of the words "How far ahead is he", the chart indicates that VH-TJA reached its rotation speed of 131 knots in a further ten seconds and the collision with CF-CPQ occurred nine seconds after this rotation speed had been reached.

2.2 FLIGHT CREW PERFORMANCE–CF-CPQ

An examination of the recorded communications and other available evidence relative to the preliminary processing of the aircraft CF-CPQ in the Sydney terminal area on this night indicates that it was normal and uneventful. No problems were encountered in the several communications with the Sydney Area/Approach Control Centre and there were no requests either by the flight crew or by the controllers involved, for any repitition of communications which might have suggested that at this stage more than normal care may be necessary in the handling of this aircraft. In accordance with the instructions of the approach controller,

the aircraft changed to the aerodrome control frequency and called Sydney Tower at 2130:20 hours after passing over the West Pymble locator on descent from 3,000 feet.

Following the initial call to the aerodrome controller in Sydney Tower, the aircraft was instructed to report at the outer marker and there was a request for a repitition of this instruction. The aircraft, as it was approaching the outer marker, was cleared to land and a normal landing was carried out on Runway 16. At 2134:53 hours or 13 seconds before the aircraft reached the end of its landing roll, the aerodrome controller instructed it to "...take taxiway right, call on 121.7". The ground recording indicates that this instruction was clearly enunciated and, without hesitation, it was acknowledged "Roger". The intention of this instruction was obviously that the aircraft should leave the active runway via a convenient taxiway exit on its right-hand side and thence join Taxiway 'V' for its further movement to the international apron area.

The evidence indicates that the aerodrome control frequency was being monitored in CF-CPQ by the captain, the first officer, the second officer and the check captain. All of these crew members were wearing head phones and the communications from the aircraft were being originated by First Officer Mude. The evidence of all these crew members is that this clearance was heard as "...backtrack if you like—change to 121.7", and this evidence is consistent with the actions of the captain, in first of all moving his aircraft to the left-hand edge of the runway, turning it through 180 degrees and backtracking. It is also consistent with the subsequent communication from First Officer Mude on the surface movement control frequency, a little over two minutes later, when he said "...we were cleared to backtrack on the runway". Having regard to the way in which the taxying clearance was given, it is difficult to understand how four persons listening independently and using ear-phones could all have made precisely the same erroneous interpretation of the words. It is possible of course that not all of these four persons were giving their conscious attention to the clearance and the actions of the flight crew may well have been based upon an interpretation made by only one or two of its members. The inadvertant erasure of the cockpit audio record in this aircraft, however, deprived the investigation of any opportunity of exploring this proposition.

It is possible that the reception of this clearance in the aircraft was not as clear as it appears in the ground recording because of propogation conditions, transient radio equipment defects or the cockpit noise level. The unavailability of the cockpit audio records from either CF-CPQ or any other aircraft using the frequency at this time has prevented any further check of the propogation conditions or of the possibility of equipment deficiencies in CF-CPQ. The use of head phones by the flight crew of CF-CPQ should have eliminated any possibility of problem from the ambient noise level in the cockpit.

It is perhaps relevant that, on Page 56 of the "Pilot's Route and Terminal Study Guide", issued to their flight crews by Canadian Pacific Airlines, there is a statement, in relation to traffic control procedures at Sydney, which says "The Australian operators tend to speak rapidly. If you have any difficulty understanding them ask them to slow down". The fact that the taxying clearance was immed-

iately acknowledged without request for a repetition, however, indicates that the flight crew of CF-CPQ did not believe that they had encountered any difficulty as to its meaning. In the circumstances, however, the misinterpretation of the clearance may be attributable to a difficulty, not necessarily of speech speed, but perhaps of accent or idiom.

Looking further at their actions following the misreading of the clearance, the flight crew of CF-CPQ, believing that they had been given some choice in the further movement of their aircraft on the airport, should perhaps have indicated their intentions to the aerodrome controller and, in all probability, this would have revealed the error that had been made. Captain Magrath did not believe this action to be necessary since his intentions would be very shortly conveyed to the aerodrome controller through the latter's observation of the aircraft's movements. Nevertheless, Captain Magrath has said that, during his final approach to the runway, he noticed an "aircraft in the holding bay of Runway 16". It should also have been apparent to him, during his assimilation into the Sydney traffic pattern, that he was being followed by at least one other aircraft seeking a landing on Runway 16. In these circumstances a more careful consideration of the clearance might have caused him to doubt the wisdom of any instruction which implied a prolonged occupancy of the active runway by a slow-moving aircraft such as was under his command. It might even be argued that, whatever may have been his belief about the nature of the clearance issued, the difficulties of turning this very large aircraft through 180 degrees on the wet runway might well have prompted Captain Magrath to seek, alternatively, a clearance to enter Taxiway 'I' which was most conveniently placed for his use. It is apparent that none of these considerations, if they presented themselves to his mind, were of sufficient weight to raise any doubts as to the propriety of the course of action he followed.

Another error made by the crew of CF-CPQ in the procedures they followed on this night was to change from the aerodrome control frequency to the surface movement control frequency whilst their aircraft was still on the active runway and, as they believed, cleared to remain on the runway for a significant further period of time. The instruction at AIP RAC/OPS 1-48 para. 4.1.2. says, inter alia, "where separate frequencies for aerodrome control and surface movement control are in use, the pilot-in-command, on landing, should change from the aerodrome control frequency to the surface movement control frequency as he leaves the runway after landing". The instruction issued by the aerodrome controller to "call on 121.7" clearly contemplated the fact that CF-CPQ would be leaving the runway very shortly via Taxiway "I". The evidence indicates that the change of frequency was made shortly after CF-CPQ commenced its turn on the runway although the initial call on 121.7 mc. was not made until towards the completion of the turn. Quite apart from the clear import of the relevant instruction, it is rather surprising that an experienced flight crew did not entertain some doubt about the validity of an instruction which apparently required them to remain on the active runway and yet transfer from the control frequency on which instructions for its use are always issued. The unfortunate effect of this frequency change was to deprive the crew of CF-CPQ of any opportunity of overhearing the take-off clearance issued to VH-TJA and, consequently, of drawing the attention of Sydney Tower to the fact that they were still on the active runway and hence an obstruction to the aircraft cleared for take-off.

Having regard to the circumstances in which this clearance was misread by the flight crew of CF-CPQ, some attention has been given to the familiarity of its members with the features of Sydney Airport and the control procedures used in the Sydney terminal area. Pilots-in-command of aircraft operating regular public transport services must comply with certain minimum requirements for familiarity with the routes over which, and the airports into which, they operate. The applicable Australian requirement is Air Navigation Regulation 215 which imposes an obligation on operators to ensure, inter alia, that a pilot does not act as pilot-in command of an aircraft engaged in a service of this type unless he has made at least one trip over the route within the preceding 12 months. Since Captain Magrath's last visit to Sydney Airport was in July, 1962, and then in the capacity of first officer, it is clear that this provision of the Australian Regulation was not met. Since the international airline licence issued by the Director-General to Canadian Pacific Airlines specifically required that organisation to observe the provisions of the Australian Air Navigation Regulations, it is equally clear that both the operator and the pilot were obliged to observe this requirement or seek an appropriate exemption from the Director-General. No application for such an exemption was made to or granted by the Director-General.

Part 1 of Annex 6 to the Convention on International Civil Aviation also contains minimum standards for pilot route and airport familiarisation. Paragraph 9.4.3.6 of this Annex stipulates that an operator shall not continue to utilise a pilot as a pilot-in-command on a route unless he has made at least one trip between the terminal points of that route within the preceding 12 months. The Annex provisions also permit a qualification or re-qualification for this purpose to be gained by adequate instruction and procedural training in a flight simulator without the necessity of actually making a flight over the route within the preceding 12 months but, clearly, it is not the intention of the international standard that a pilot should be given command responsibility before the completion of his qualification training. The evidence indicates that, prior to undertaking this flight as pilot-in-command, Captain Magrath had not seen the training film relating to Sydney Airport and thus had not qualified in the view of his employers by the alternative means permitted under the Annex provisions.

The other requirements, which are considered to have some relevance in this matter, are those contained in the Canadian Pacific Airlines Operations Manual approved by the Canadian Minister for Transport. Paragraph 4-4.2 of this Manual says that "before a Captain can act as pilot-in-command of an aircraft type on a route, his competency must be certified by the Chief Pilot...". Since Captain Magrath had not completed the simulated route and airport qualification exercise or flown over the route in the preceding 12 months such a certificate could not be and apparently was not issued by the Chief Pilot. Although it seems that the appointment of Captain Magrath as pilot-in-command of this flight and his assumption of these responsibilities were actions taken other than in compliance with the operator's own standards, there was on the flight deck a check captain who had completed the simulated route and airport qualification exercise within the preceding 12 months, although he had not actually visited Sydney for some 2¾ years. In addition, the first officer, who was conducting the radio communications from CF-CPQ,

last visited Sydney Airport some four months prior to this accident and the second officer's last flight into Sydney occurred some five months prior to this accident. It could be argued therefore, that the aggregate knowledge of Sydney Airport possessed by the flight crew of CF-CPQ was adequate even though it fell in one respect short of the minimum standards applicable. Nevertheless, the prime responsibility for decision as to the movement of the aircraft and its safety rested with the pilot-in-command and, having regard to the way in which the instructions from Sydney Tower were misinterpreted, the possibility remains that this error would not have occurred if Captain Magrath's familiarity with Sydney Airport had been raised to a higher level.

2.3 AIR TRAFFIC CONTROL PERFORMANCE–SYDNEY TOWER

On the night of this accident, Sydney Tower was staffed by four air traffic controllers and their positions within the control room relative to each other and to their operating equipment is shown in Appendix H. Each of these controllers was trained, properly qualified and licensed for the duties he was undertaking. The officer-in-charge of the tower, is required to manage its operation to ensure the safe, orderly and expeditious flow of traffic on, and in the vicinity of, the aerodrome. In particular, he acts as a co-ordinator receiving and initiating communications with other air traffic control units except those for which direct and immediate co-ordination is required such as between the aerodrome controller and the approach and departures radar controllers or between the surface movement controller and the international apron controller. All of this inter-communication traffic, in addition to the radio communications with the aircraft under control, is recorded on tape. Co-ordination between the controllers within Sydney Tower however, is conducted by direct speech and is not recorded.

The aerodrome controller is responsible for the control of aircraft operating onto or from the active runway or runways between the time that approaching aircraft are transferred from the approach radar controller, normally at the commencement of final approach, and the time at which departing aircraft are airborne and instructed to change frequency to that of the departures radar controller. He is responsible for the issuance of all clearances to land or to take-off as well as for clearances for entry to and exit from the active runway and for the provision of aeronautical information essential to the safety of these operations. The surface movement controller is responsible for the direction of all aircraft and other traffic operating on the manoeuvering area of the airport except those operating on the active runway or on the apron areas. The flight data officer does not have any responsibility for control of aircraft but is responsible for the preparation and filing of control strips and other documentation essential to the services provided from the tower. At the time of this accident the flight data officer was standing in the control room close to the aerodrome controller and was observing the movement of aircraft onto and off the airport.

Sydney Tower is positioned in relation to the runways and taxiways of the airport as is shown in Appendix A. The eye level of the controllers is approximately 55 feet above mean sea level, or 33 feet above the level of the runway at the

point where this accident occurred. The control room is square-sided with clear glass panels on all sides but, under some weather conditions such as occurred on the night of this accident, some slight impediments to visibility in some directions may arise either from slight fogging of the glass or from rain deposits on the exterior surface. Although these factors could have presented some minor inconvenience for the controllers on this night they were not significant to this accident. The position of Sydney Tower is some three quarters of a mile from the point on the airport where this collision occurred and the angle of closure with the ground of the aerodrome controller's direct line of sight is approximately one-half degree (refer to Appendix H).

At or about the time of this accident, the aircraft under the control of the aerodrome controller, or significant to his actions, included CF-CPQ on its approach for landing followed, with a longitudinal separation of approximately 9 miles by a DC9 aircraft, VH-TJN, also on final approach. The relative positions of these two aircraft could be continuously monitored by the aerodrome controller using his radar presentation. In addition he had been informed that another aircraft was already being processed by the approach radar controller for a landing on Runway 07 and would be transferring to the aerodrome control frequency in proper sequence within a short period of time. The aircraft under his control preparing for departure at this time included VH-TJA, which had taxied to the holding point for Runway 16 and an F27 aircraft, VH-EWJ, which was also ready for take-off on Runway 16. Although this traffic situation was not one which presented any unusual problems for the aerodrome controller, his primary objective was to be able to clear the departing aircraft for take-off between the movements of the landing aircraft. In order to achieve this more efficiently, the aerodrome controller adopted the normal practice of clearing the next departing aircraft to line-up on the active runway whilst the preceding landing aircraft was completing its landing roll. It is apparent that, initially, the aerodrome controller contemplated the possibility of both VH-TJA and VH-EWJ being cleared for take-offs between the landings of CF-CPQ and that of the succeeding aircraft, VH-TJN. However, the clearance previously issued to VH-EWJ to line-up after the departure of VH-TJA was cancelled shortly after the take-off clearance was issued to VH-TJA when the aerodrome controller saw that the approaching DC9 aircraft was too close to permit both of these take-offs to be carried out consecutively, in safety. All of these aspects of control were proper and in accordance with established procedures but it is evident that any prolongation of runway occupancy by CF-CPQ was bound to introduce problems of separation between the arriving and departing aircraft.

As has already been stated, the taxying clearance issued by the aerodrome controller to CF-CPQ was clearly enunciated. The word content of this clearance was not precisely in accordance with the phrase example given in AIP RAC/OPS –0–37 Subject 36 which suggests the use of the words "take next taxiway right". The inclusion of the word "next" in this phrase required a judgment on the part of the aerodrome controller as to whether or not the aircraft can be brought to a safe turning speed before reaching the next taxiway after the clearance is issued. It has been a practice in aerodrome control at Sydney Airport to omit this word on the grounds that the choice of the taxiway exit is the aircraft captain's prerogative. The controller's instructions to other aircraft are then based upon his observation of the action taken by the landing aircraft to clear the runway.

In another respect this clearance did not comply with the relevant instructions in that it required the aircraft to change to a new frequency, 121.7 mc., without giving any indication of the time or place at which this frequency change was to be made. It is probable that the aerodrome controller expected the aircraft to leave the runway almost immediately via Taxiway 'I' and thus an immediate change of frequency would not have been inappropriate. Nevertheless, the omission of the word "next" from the taxying instruction contained an implication that the aircraft could have continued for the full length of the runway and left via Taxiway 'W'. In these circumstances, an immediate change to 121.7 mc. would have been inappropriate since CF-CPQ would have had to remain on the runway for a significant time without direct communication with the aerodrome controller. In fact, the crew of CF-CPQ undertook a different type of manoeuvre which also involved a prolonged runway occupancy and the unqualified instruction to change to 121.7 mc. had the effect of depriving the Canadian crew of the opportunity of overhearing the take-off clearance issued to VH-TJA. It is apparent that such words as "when clear of the runway" should have been appended to the frequency change instruction. In this context, it is perhaps relevant to point out that, with few exceptions, taxying and frequency change instructions after landing are issued by Sydney Tower only to international aircraft. The pilots operating Australian domestic services, being familiar with the provisions of AIP RAC/OPS–1–48 Section 4 and well familiar with the airport, without instruction, promptly vacate the runway at the nearest suitable taxiway exit and change to the surface movement control frequency as they leave the runway. The proper frequency change location is also indicated in the frequency change plan provided to all pilots departing from Australian capital city airports for flight within controlled airspace.

As has already been described, the clearance issued by the aerodrome controller "...take taxiway right, call on 121.7" was misread as "...back track if you like–change to 121.7". The instruction was acknowledged "Roger". Since the aircraft's landing roll finished close to the entrance to Taxiway 'I' and the aircraft was seen to commence a turn on the runway to the right towards the entrance to that taxiway, there was no reason for the aerodrome controller to believe other than that his instruction had been received and understood as it was issued. Immediately after this clearance was acknowledged, the aerodrome controller's attention was momentarily diverted to a communication from the approach radar controller identifying on the radar screen another aircraft which was in the approach sequence for a landing on Runway 07. The aerodrome controller then resumed his observation of CF-CPQ making the turn to the right on the runway and he believed, from his observations, that the aircraft moved into Taxiway 'I'. There was no doubt in his mind that the aircraft had followed this course and, when he believed it to be off the runway, he issued the take-off clearance to VH-TJA. AIP RAC/OPS 1–35 paragraph 4.5.1.(b) says that "an aircraft will not be permitted to commence its take-off until a preceding aircraft using the same runway or path has vacated it and is taxying away from the runway or path." Thus, on the basis of the aerodrome controller's conviction as to the position of CF-CPQ, the take-off clearance was issued at the proper time.

It is obvious, on the evidence, that CF-CPQ did not enter Taxiway 'I' and that the aerodrome controller was in error in his assessment of the aircraft's position. It is considered that several factors probably led the to controller being deceived on this matter. In the first instance, the acknowledgment of his instruction probably led him to believe that the aircraft's crew had clearly understood its import and would comply with it. It is also probable that he was deceived by the unusually long period of time taken by the aircraft in its turn on the runway and by the fact that, during the critical 10 second period prior to the issuance of the take-off clearance to VH-TJA, CF-CPQ could be observed broadside on to the runway and moving, apparently in the direction appropriate to leaving the runway via Taxiway 'I'. Aircraft of this size and with such slow ground-moving characteristics do not frequently visit Sydney Airport and the situation was accentuated on this night by the need for extreme care whilst turning on the wet runway surface. Subsequent to this accident, investigating officers observed from the control tower other aircraft movements in this area of the airport and it is apparent that any judgment made solely on the basis of visual observation at night as to whether an aircraft at this distance from the tower is on the runway or on either Taxiways 'I' or 'V' is not a judgment which can be made with complete certainty. In the circumstances, it would have been prudent for the aerodrome controller to seek a report from CF-CPQ when it was clear of the runway before issuing the take-off clearance to VH-TJA. Such an action would almost certainly have revealed the misreading of the taxying clearance which had occurred on the flight deck of CF-CPQ and the take-off clearance to VH-TJA would have been withheld until such time as the runway was, in fact, clear.

Each of the four controllers on duty in Sydney Tower on this night watched, with varying degrees of attention, the movements of CF-CPQ at the completion of its landing roli. Each of them was separately convinced that the aircraft had entered Taxiway 'I' and that the clearance to VH-TJA was given in proper circumstances. The fact that each of these controllers was similarly deceived underlines the difficulties of making reliable visual observations in the circumstances which prevailed and the importance, when these circumstances exist, of seeking reports that aircraft are clear of the runway. The fact that none of these controllers had any doubt in his mind as to the movements of CF-CPQ on this night suggests that there was some inadequacy in their local training in that they were not able to recognise a situation in which it was dangerous to rely solely upon visual observation.

The Canadian crew called the surface movement controller on 121.7 mc., as their aircraft neared the completion of its turn-about on the runway, but this occurred some 20 seconds after the take-off clearance had been issued to VH-TJA. The surface movement controller, who also believed that CF-CPQ was proceeding via the taxiway system, cleared it to cross Runway 07. Since such a clearance was required whether the aircraft was proceeding northwards on the runway or on the taxiway, its issuance did not raise any doubts in the minds of the Canadian flight crew as to the validity of the course of action they were following. When Captain Magrath, observing the lights of VH-TJA approaching him on the runway, swung his aircraft towards its eastern edge, the high intensity beam of his landing lights traversed the control tower position and raised the first alarm in the minds of the

controllers that something was amiss. The surface movement controller immediately instructed CF-CPQ to hold its position believing that the sweep of its landing lights denoted a turn from Taxiway 'V' into Taxiway 'A' back towards the runway. At about this time, however, the collision with VH-TJA occurred. The continuing danger of the situation was then illustrated when the crew of CF-CPQ pointed out that there was another aircraft on final approach to the runway. The surface movement controller immediately asked the Canadian aircraft to confirm that it was on the taxiway and the reply received was "Negative Sir, we're on the runway, we were cleared to back track on the runway". The approaching aircraft VH-TJN was immediately instructed by the aerodrome controller to go around and CF-CPQ was directed by the surface movement controller to vacate the runway via the next taxiway on its left. Thus, immediately the dangers of the situation were appreciated in Sydney Tower, prompt and proper action was taken to eliminate them.

The fact that a collision between the two aircraft had occurred was not revealed to persons on the ground until advice to this effect was received some 30 seconds later from the crew of VH-TJA. The flight crew of CF-CPQ were not aware that their aircraft had been struck by VH-TJA and believed that the jolt felt as the departing aircraft overflew them was the result of the nosewheel either entering a depression off the edge of the runway or over-running an elevated runway light. The surface movement controller informed CF-CPQ of the report from VH-TJA but, since control of the aircraft seemed to be unaffected, the Canadian crew continued to their parking position on the international apron without assistance.

2.4 FLIGHT CREW PERFORMANCE–VH-TJA

At 2129 hours, the flight crew of VH-TJA called the surface movement controller in Sydney Tower and informed him that they were ready to leave the loading apron to conduct Flight 592 to Perth. Whilst taxying to the holding point for Runway 16, the surface movement controller gave the aircraft its airways clearance designating the departure route to be followed out of the Sydney terminal area and the flight level to which the aircraft was cleared to climb. When the flight crew reported ready for take-off on the aerodrome control frequency, CF-CPQ had almost reached the runway threshold in its landing approach and the aerodrome controller instructed VH-TJA to line up behind that aircraft. Up to this stage, the processing of the aircraft had been in accordance with established procedures and there was no occurence which could now be regarded as significant to this accident.

The crew of VH-TJA observed CF-CPQ pass the threshold immediately in front of them and, in lining up behind that aircraft, they would have been aware that their clearance for take-off could not be received until the landing aircraft had vacated the runway. Since both aircraft were listening out on the aerodrome control frequency at this time, it can be assumed that the crew of VH-TJA heard the taxying clearance issued to CF-CPQ

The preparation for this take-off did not pose any unusual problems for the crew of VH-TJA. The aircraft's gross weight was about 1,000 lb. below the maximum permissible gross weight for take-off but there was ample runway length available and the climb-out path contained no significant obstructions. Although some five points of rain had fallen during the hour prior to this accident, the weather conditions at the time were generally fine with a ground level visibility in excess of five miles. The crew of VH-TJA had their windscreen wipers in operation because of the presence of very light rain although the crew of CF-CPQ state that they did not notice any rain and their rain removal system was not in operation during their landing and subsequent taxying.

Runway 16 at Sydney is a black top runway, 150 feet wide with side lighting only. The landing roll of the Canadian aircraft was completed close to the highest point on this runway and, since there was no significant restriction of the visibility, it must be expected that at least one of its two red rotating beacons could have been seen from the threshold during its landing and subsequent manoeuvres on the runway. Nevertheless, the pilots of VH-TJA have both said that they did not observe the lights of CF-CPQ during their take-off until their aircraft had reached approximately its rotation speed of 131 knots. In the chart at Appendix G, it has been deduced that, at the time VH-TJA commenced its take-off, CF-CPQ would have completed slightly more than half of its 180 degree turn on the runway. At this stage, the four landing lights of CF-CPQ, which were still illuminated, were probably not visible to the crew of VH-TJA since the two underwing lights, one on each side of the fuselage, are located between the engine attachment pylons and the two nose lights are located between the nose gear doors. The position of CF-CPQ on the runway, however, would have become overwhelmingly obvious approximately 16 seconds after the commencement of spool-up since, at this time, CF-CPQ would have completed its 180 degree turn on the runway with all four landing lights still illuminated and pointing directly at VH-TJA.

Captain James was flying VH-TJA from the left hand control seat during this take-off. The technique specified in the relevant operations manual and adopted by Captain James involves a continuing transition from visual cues to instrument references during the acceleration of the aircraft such that, by the time the aircraft has reached its V_1 Speed (i.e. in this case 131 knots), only instrument references are being used. Take-offs must be monitored, of course, by the first officer and this involves a continuing division of his attention between the essential instrument references and visual references outside the aircraft. Captain James has stated that he became sub-consciously aware of something abnormal somewhere ahead of his aircraft at about the point in the take-off where he went on to full instrument reference. He believed that this impression derived from something not on the runway and, therefore, he decided it was not relevant to his take-off. Captain James goes on to say that, during the rotation of his aircraft, he saw the DC8-63 aircraft more or less across the strip but he could not determine how far ahead it was. First Officer Spiers says that he first saw a flashing red light shortly before the aircraft reached rotation speed but he also had difficulty in determining how far ahead it was. As the rotation speed was reached, he saw that it was an aircraft on the runway but he judged it to be too close for the take-off to be discontinued without a collision.

Although the investigation did not have recourse to the cockpit audio record for VH-TJA, the words "how far ahead is he" appearing on the ground record of communications has been determined, as is set out in Section 1.15 of this report, to have originated with Captain James. The correlation analysis at Appendix G shows that these words were spoken some 12 seconds after CF-CPQ had completed its 180 degree turn on the runway and it seems reasonable to conclude that they were prompted by an appreciation of the aircraft landing lights directed at VH-TJA from some point ahead on the runway. Neither Captain James not First Officer Spiers recall the recorded words being spoken during this take-off and so, without reference to the cockpit audio record, it is impossible to say whether or not this question was a continuation of earlier remarks or part of an exchange of remarks between flight crew members or even to speculate as to what reply there might have been. The only things that can reasonably be deduced from the terms of this question are that, at least by this time, there was an appreciation of something ahead of VH-TJA on the runway; there was some difficulty in determining how far ahead it was and the use of the personal pronoun "he" rather than "it" suggests that the object ahead was already identified in the mind of the speaker. In the circumstances this could have only been the DC8-63 aircraft still on the runway.

The analysis at Appendix G also illustrates that the words "how far ahead is he" were said when VH-TJA had reached a speed of approximately 100 knots in its take-off run and when it was some 2,260 feet from the northern end of Runway 16. As has already been pointed out, making due allowance for reaction time, from this point the aircraft could have been stopped on the runway at a point approximately 4,060 feet from the northern end or some 2,230 feet short of the point at which the collision ultimately occurred. Again, without reference to the cockpit audio record, it is impossible to say whether or not this was the point at which the take-off should have been abandoned. It may well have been that, at an earlier point in the take-off, there was sufficient recognition of the existence of an obstruction ahead, irrespective of how far ahead it was, which would have demanded an abandonment of the take-off at that point in time. On the other hand, the answer to the question posed, if there was an answer, may well have indicated that, at this stage, the flight crew of VH-TJA believed that the obstruction was so close to them as to be unavoidable.

Whatever may have been the assessment made on the flight deck of VH-TJA as to the distance of the obstruction ahead, the decision was to proceed with the take-off despite the fact that the aircraft had reached a speed of only 100 knots. Assuming that the decision to continue involved some consideration of the alternative (i.e. to abandon the take-off) it was rather a surprising one, having regard to the capability of this aircraft type at a high gross weight to accelerate and climb over an obstacle compared with its capability to stop or, at least, slow to a speed where deviation around the obstacle would have become feasible. With the advantage of hindsight one cannot be too critical of a decision which had to be made, presumably, in a very short space of time, but it does seem that, using only the information available to Captain James at the time of making this decision, abandonment of the take-off would have been a more logical course to follow. The evidence indicates that at least his own answer to the question he posed at 100 knots, led him to believe that he could safely overfly the obstruction.

Captain James has also said in his evidence that, having seen the obstructing aircraft ahead of him, he decided to continue using a normal take-off technique guarding, particularly, against any over-rotation. The flight data record indicates that, after rotation, he continued to accelerate the aircraft through the V_2 speed of 146 knots until the climb-out speed stabilised at about 175 knots on reaching 400 feet. This action also suggests that, right up to the time of impact, Captain James was still confident that he would clear the obstruction, since a much greater certainty of achieving this objective was available, even from a normal rotation at 131 knots by restricting the normal build-up of airspeed until the obstruction had been over flown. Here again, of course, this alternative course of action is postulated with the advantage of hindsight and, Captain James has said that in the aircraft, he was faced with an unexpected situation which required immediate decision. The course which he chose to follow and his own statement both indicate that the possibility of improving the climb angle of the aircraft did not occur to him. Either he remained confident that he would clear the obstructing aircraft or he accepted the possibility of collision as being an unavoidable risk.

The crew of VH-TJA knew immediately, of course, that they had collided with some part of the obstructing aircraft and they informed Sydney Tower of this fact shortly after becoming airborne. An immediate assessment of the aircraft's status revealed that the "A" hydraulic system pressure had been lost and some electrical circuits were disrupted including some fuel booster pump circuits. Having found that his aircraft was controllable in the air, Captain James decided to reduce the landing weight to within safe limits by dumping fuel over the sea. Whilst this was being done, Runway 16 was cleared of the major debris and, at 2216:30 hours, VH-TJA landed without further incident. The undercarriage was left extended throughout the flight and the wing flaps, which had been left at the 15 degree take-off position, were lowered to 30 degrees for the landing. The evidence indicates that Captain James and his crew handled the operation of the damaged aircraft with the calmness and skill to be expected having regard to their training and experience.

2.5 CAUSAL FACTORS

The evidence in respect of this accident indicates that it resulted from a combination of errors made by persons. The first of these errors was the misreading, by the flight crew of CF-CPQ, of the taxying clearance issued by the aerodrome controller. It is considered that there was nothing in the aerodrome controller's actions at this stage which contributed to this misreading and it arose fundamentally because inadequate attention to its words and its import was given by the flight crew. The problems of language and accent are not new to international aviation nor to the flight crew of CF-CPQ. This is all the more reason why international crews must give great care to the proper reading of clearances and ensure that they make sense in the context of the particular operation. There is little doubt that, if a clearance such as the one adopted by the Canadian crew, had been offered to an Australian crew having normal familiarity with operations and control procedures at Sydney Airport, it would not have been accepted without confirmation or query. Backtracking on a runway at a busy airport such as Sydney, is

a most unusual procedure used only when the normal taxying paths are not available. Similarly, a clearance which offers a choice of action to an aircraft without any request to be advised of the course to be followed is quite untypical of any air traffic control practice used in Australia. In these circumstances, it would seem that a greater familiarity with operations at Sydney Airport would have prevented the Canadian crew from falling into an error of this sort. Thus, in some degree, the circumstances in which Captain Magrath was appointed pilot-in-command of this aircraft and the effectiveness of Captain Ellert's supervision, must be regarded as relevant to the cause of the accident.

The second significant error was the belief of the aerodrome controller that CF-CPQ had vacated the runway via Taxiway 'I' and that it was safe to clear VH-TJA for take-off without obtaining a "clear of the runway" report from CF-CPQ. Having regard to the limitations of visual perception, it is not difficult to understand how the aerodrome controller could be deceived in attempting to discriminate some three quarters of a mile away on a dark night and with a very shallow line-of-sight closure with the ground. Undoubtedly, the problem was compounded by the very slow movements of CF-CPQ on the ground and the fact that its turn on the runway was carried out opposite the entrance to Taxiway 'I'. Although the aerodrome controller had undergone extensive training and was properly licensed and rated for this position, his experience of its responsibilities was still relatively small. In these circumstances, the origin of the flaw in his performance must be sought in his training rather than in his experience. All four of the air traffic controllers on duty in Sydney Tower on this night say that they believed CF-CPQ entered Taxiway 'I' and that the runway was clear when the take-off clearance was given. It is apparent, therefore, that adequate recognition of the difficulties of visual perception, in the circumstances that prevailed, had not been given in the training of these officers at Sydney.

The third factor of importance in the sequence of events which led to this accident, was the failure of the flight crew of VH-TJA to ensure that the runway was clear and safe for take-off. It is true that their aircraft had been cleared by the aerodrome controller for take-off and that such a clearance reflected the view of the aerodrome controller that the runway was, in fact, unobstructed. The expression of such a view, however, does not absolve the pilot-in-command of any aircraft from taking all of the actions necessary to satisfy himself that there is no impediment to a safe take-off. Air Navigation Regulation 143 (1)(a) clearly states that "The pilot-in-command of an aircraft which is being operated on or in the vicinity of an aerodrome shall observe other aerodrome traffic for the purpose of avoiding collision". The fact that a clearance issued by an air traffic controller does not detract from this responsibility is clear from the terms of Air Navigation Regulation 96(3) which says "If an emergency arises that necessitates a deviation from the requirements of an air traffic control clearance, in the interests of safety, the pilot-in-command may make such deviation as is necessary...". Indeed there can be no doubt that, in any circumstances, the pilot-in-command of an aircraft has an over-riding and final responsibility for its safety and for the safety of persons on board.

There is a tendency amongst those airline pilots who carry out most of their flying activities within controlled airspace, to accept the fact that they are protected by a traffic separation service in which they have some confidence. In many circumstances, of course, the pilot of an aircraft is not in a position to know whether or not a clearance issued to him is a safe one having regard to the disposition of other aircraft. Visual operations on and around an airport, however, are not in this category. It is considered that Captain James, on this occasion, accepted the clearance for take-off and, not only failed to satisfy himself as to its correctness, so far as it lay within his power, but persisted with the take-off, in the face of clear signs that the take-off operation was not a safe one. The Canadian aircraft with its upper and lower red rotating beacons illuminated should have been visible to the crew of VH-TJA throughout its occupancy of the runway. The evidence indicates that its presence on the runway was recognised by Captain James at a point where there could have been no doubt as to his capacity to avoid a collision by abandoning the take-off. In the event, he decided that he could overfly or would attempt to overfly the obstructing aircraft using normal take-off techniques. Even at this stage the aircraft had ample capacity to climb over the obstructing aircraft and Captain James' adherence to normal techniques in the face of the very real hazard in front of him was erroneous.

Although the stage for this accident was set, first of all, by the misreading of the clearance which occurred in CF-CPQ and then by the issuance of a take-off clearance arising from the aerodrome controller's misjudgement of its position, the accident could still have been avoided if the flight crew of VH-TJA had taken proper precautions to observe the runway ahead and to adopt new and more appropriate courses of action when the dangers of the situation became apparent. It was the conjunction of errors on the flight decks of both aircraft and in Sydney Tower which led to and, therfore, caused this accident.

3–CONCLUSIONS

1. The flight crews of both aircraft involved in this accident and the air traffic controllers on duty in Sydney Tower were all appropriately licensed for the duties they were undertaking. The pilot-in-command of the DC8-63 aircraft, CF-CPQ, however, had not satisfied all of the applicable route and airport familiarisation requirements prior to commencing this flight.

2. There is no evidence of any defect in either aircraft which could have contributed to this accident.

3. Both aircraft were loaded within the safe limits applicable to each.

4. A taxying clearance "...take taxiway right–call on 121.7" issued by the aerodrome controller to CF-CPQ as it neared the end of its landing roll was not given adequate attention by the flight crew, who misread it as "...backtrack if you like–change to 121.7". The aircraft was then turned through 180 degrees to backtrack on the runway, instead of entering an immediately available taxiway as was intended by the aerodrome controller.

5. The aerodrome controller did not recognise the difficulties of visual perception in the circumstances that prevailed and this, in conjunction with the slow manoeuvre of the aircraft on the runway as well as its direction of movement and position in relation to the taxiway entrance, led him to believe that CF-CPQ had taxied off the runway in accordance with the instructions issued.

6. The aerodrome controller issued, to VH-TJA, a clearance for take-off when the runway was still obstructed by CF-CPQ.

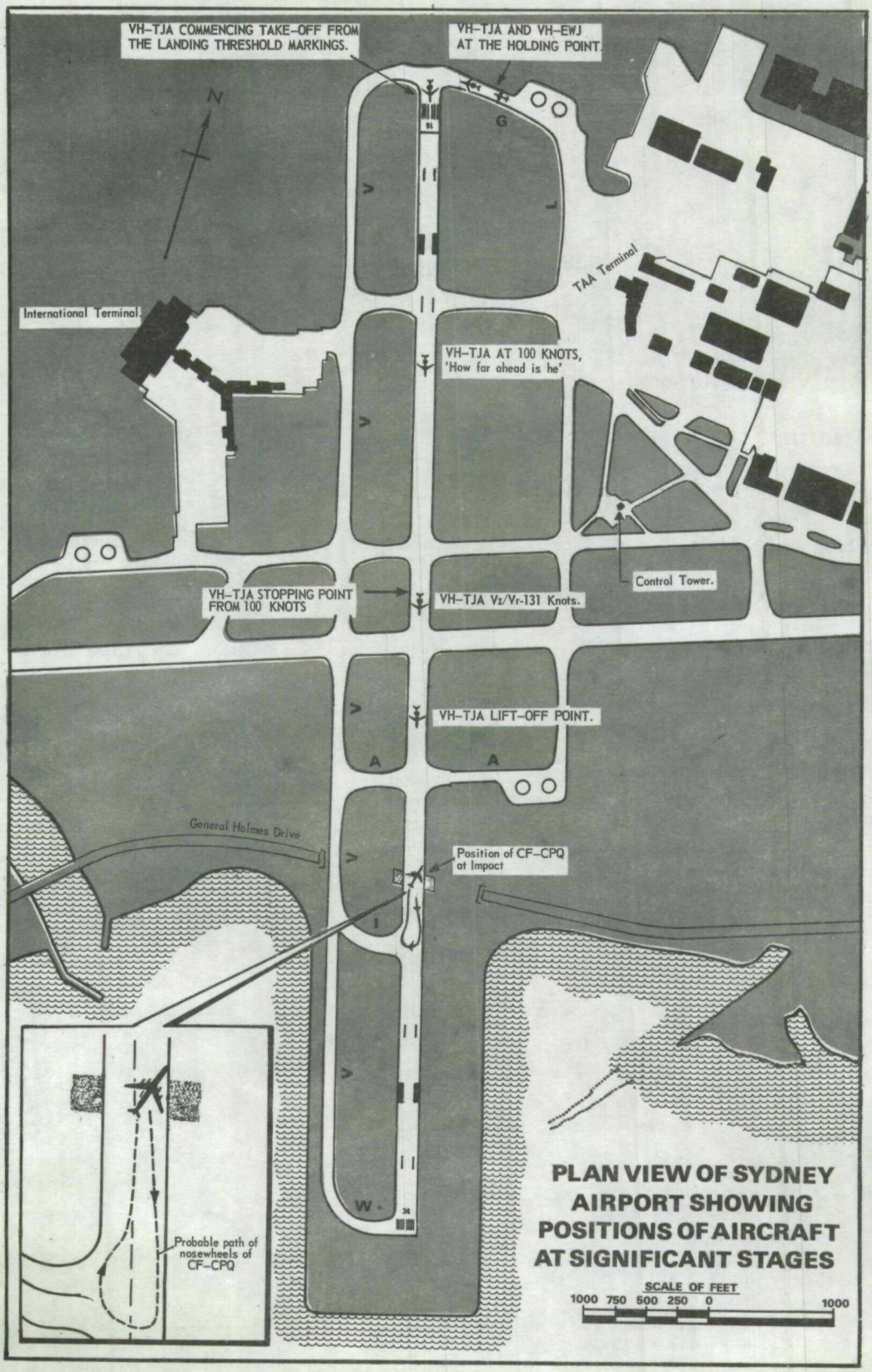
7. The flight crew of VH-TJA state that, at the commencement of their take-off, they did not observe CF-CPQ on the runway as an obstruction. Nevertheless CF-CPQ was observed at a time when the take-off could have been abandoned with safety. The pilot-in-command of VH-TJA elected to continue the take-off and attempted to overfly the obstructing aircraft.

8. Although the obstructing aircraft could have been cleared quite safely by the adoption of a steeper initial climb angle, the pilot-in-command of VH-TJA adhered to the normal take-off technique and the underside of his aircraft came into collision with the tail fin of CF-CPQ. Although substantially damaged, VH-TJA continued in flight, and after dumping fuel, landed at Sydney Airport again without further damage.

CAUSE: The cause of this accident was that the taxying clearance given after landing was misread by the flight crew of CF-CPQ and this error was not detected by the aerodrome controller, who cleared VH-TJA for take-off. The flight crew of VH-TJA, on detecting the obstructing aircraft, did not then adopt the most effective means of avoiding a collision.

APPENDICES

APPENDIX A


VH-TJA COMMENCING TAKE-OFF FROM THE LANDING THRESHOLD MARKINGS.
VH-TJA AND VH-EWJ AT THE HOLDING POINT.
N
TAA Terminal
International Terminal.
VH-TJA AT 100 KNOTS, 'How far ahead is he'
Control Tower.
VH-TJA STOPPING POINT FROM 100 KNOTS
VH-TJA V2/Vr-131 Knots.
VH-TJA LIFT-OFF POINT.
General Holmes Drive
Position of CF-CPQ at Impact
Probable path of nosewheels of CF-CPQ
PLAN VIEW OF SYDNEY AIRPORT SHOWING POSITIONS OF AIRCRAFT AT SIGNIFICANT STAGES
SCALE OF FEET
1000 750 500 250 0 1000

APPENDIX B

TRANSCRIPT OF SIGNIFICANT COMMUNICATIONS RECORDED AT SYDNEY AIRPORT - 29TH JANUARY 1971

LEGEND:

ADC - Aerodrome Controller. Frequency 120.5 mc.

SMC - Surface Movement Controller. Frequency 121.7 mc.

APP - Approach Controller - Radar. Frequency 124.7 mc.

E301 - EMPRESS THREE ZERO ONE, Canadian Pacific Airlines DC8-63 aircraft, CF-CPQ.

TJA - TANGO JULIETT ALPHA, Trans-Australia Airlines B727 aircraft, VH-TJA.

TJN - TANGO JULIETT NOVEMBER, Trans-Australia Airlines DC9 aircraft, VH-TJN.

EWJ - ECHO WHISKEY JULIETT, East-West Airlines F27-100 aircraft, VH-EWJ.

NOTE: The words and phrases underlined are those used in the voice identification tests conducted by the National Transportation Safety Board, U.S.A.

TIME (E.S.T.) Hrs/Mins/Secs	FROM	TO	TEXT
2129:00	TJA	SMC	SYDNEY TOWER, TANGO JULIETT ALPHA, Flight five nine two, Perth. Taxi clearance. Information SIERRA.
2129:06	SMC	TJA	TANGO JULIETT ALPHA, SYDNEY TOWER, time two nine, DC NINE inbound to the tarmac, pass behind that aircraft.
2129:16	TJA	SMC	TANGO JULIETT ALPHA.
2129:20	EWJ	SMC	SYDNEY TOWER, ECHO WHISKEY JULIETT, Special Flight zero two six, Taree. Information SIERRA. Taxi Clearance.
2129:28	SMC	EWJ	ECHO WHISKEY JULIETT, SYDNEY TOWER, time two nine a half, SEVEN TWO SEVEN outbound on your right follow that aircraft.

TIME (E.S.T.) Hrs/Mins/Secs	FROM	TO	TEXT
2129:35	EWJ	SMC	ECHO WHISKEY ALPHA - correction - ECHO WHISKEY JULIETT.
2129:40	SMC	TJA	TANGO JULIETT ALPHA, ECHO WHISKEY JULIETT, QNH now one zero one one.
	TJA	SMC	TANGO JULIETT ALPHA.
	EWJ	SMC	ECHO WHISKEY JULIETT.
2130:20	E301	ADC	SYDNEY TOWER, EMPRESS THREE ZERO ONE.
	ADC	E301	EMPRESS THREE ZERO ONE, SYDNEY TOWER, report outer marker
2130:30	E301	ADC	SYDNEY, THREE ZERO ONE, say again.
	ADC	E301	EMPRESS THREE ZERO ONE, SYDNEY TOWER, report the outer marker.
	E301	ADC	Roger Sir.
2130:34	TJA	SMC	TANGO JULIETT ALPHA airways clearance when available.
2130:38	SMC	TJA	TANGO JULIETT ALPHA, clearance seven six, cruise FLIGHT LEVEL three one zero.
2131:01	TJA	SMC	TANGO JULIETT ALPHA seven six FLIGHT LEVEL three one zero.
2131:32	EWJ	SMC	ECHO WHISKEY JULIETT, clearance?
	SMC	EWJ	ECHO WHISKEY JULIETT, clearance not yet available, will advise.
	EWJ	SMC	ECHO WHISKEY JULIETT.
2131:44	ADC	E301	EMPRESS THREE ZERO ONE clear to land.
	E301	ADC	EMPRESS THREE ZERO ONE is clear to land .....

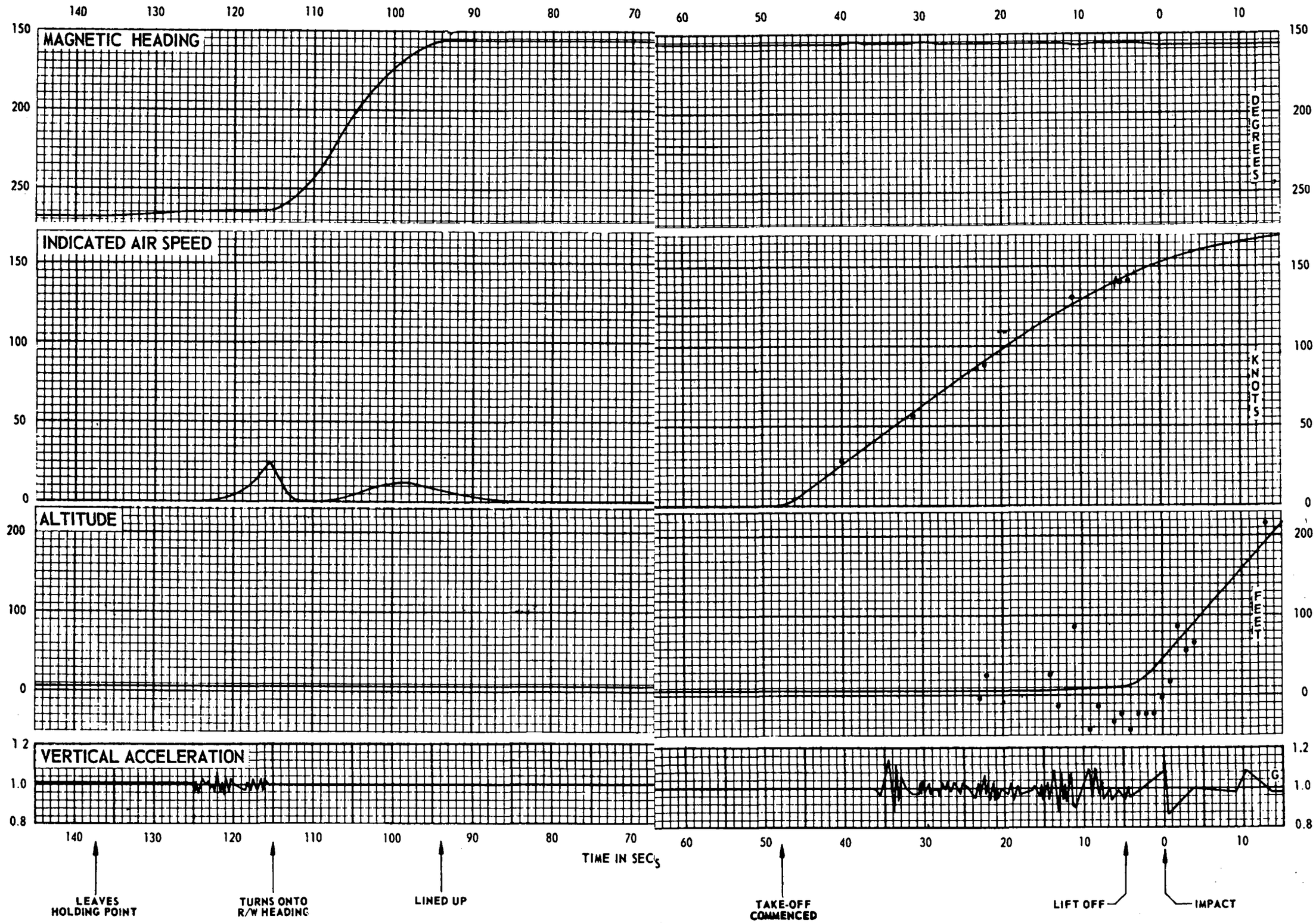
TIME (E.S.T.) Hrs/Mins/Secs	FROM	TO	TEXT
2133:41	SMC	EWJ	ECHO WHISKEY JULIETT airways clearance available.
2133:45	EWJ	SMC	ECHO WHISKEY JULIETT go ahead.
2133:47	SMC	EWJ	ECHO WHISKEY JULIETT clearance eight seven cruise FLIGHT LEVEL one three zero.
2133:48	TJA	ADC	TANGO JULIETT ALPHA ready.
2133:50	ADC	TJA	TANGO JULIETT ALPHA.
2133:50	EWJ	SMC	ECHO WHISKEY JULIETT eight seven FLIGHT LEVEL one three zero.
2133:54	ADC	TJA	TANGO JULIETT ALPHA, DC EIGHT on short final line up behind that aircraft.
	TJA	ADC	TANGO JULIETT ALPHA.
2134:07	TJN	ADC	SYDNEY TOWER, TANGO JULIETT NOVEMBER, left three thousand on final.
	ADC	TJN	TANGO JULIETT NOVEMBER, SYDNEY TOWER, report short final
2134:34	EWJ	ADC	ECHO WHISKEY JULIETT. Ready.
2134:36	ADC	EWJ	ECHO WHISKEY JULIETT, SEVEN TWO SEVEN departing line up behind that aircraft.
	EWJ	ADC	ECHO WHISKEY JULIETT.
2134:53	ADC	E301	EMPRESS THREE ZERO ONE take taxiway right call on one two one decimal seven.
2134:57	E301	ADC	Roger.
2135:38	ADC	TJA	TANGO JULIETT ALPHA radar departure turn right heading one seven zero clear for immediate take-off.
	TJA	ADC	TANGO JULIETT ALPHA.

TIME (E.S.T.) Hrs/Mins/Secs	FROM	TO	TEXT
2135:54	ADC	EWJ	ECHO WHISKEY JULIETT cancel line up clearance hold position.
2136:00	EWJ	ADC	ECHO WHISKEY JULIETT.
2136:03	E301	SMC	SYDNEY, EMPRESS THREE ZERO ONE.
2136:07	SMC	E301	EMPRESS THREE ZERO ONE cross runway zero seven.
2136:11	E301	SMC	Roger.
2136:12	TJA		How far ahead is he?
2136:16	ADC	TJN	TANGO JULIETT NOVEMBER clear to land.
2136:20	TJN	ADC	TANGO JULIETT NOVEMBER.
2136:30	SMC	E301	THREE ZERO ONE hold position.
2136:43	E301	SMC	TOWER THREE ZERO ONE.
2136:45	SMC	E301	EMPRESS THREE ZERO ONE continue straight ahead along that taxiway cross runway zero seven.
2136:50	E301	SMC	Roger you got a guy on final right now?
2136:54	SMC	E301	EMPRESS THREE ZERO ONE confirm you are on the taxiway.
2136:57	E301	SMC	Negative Sir, we're on the runway, we were cleared to backtrack on the runway.
2136:57	TJA	ADC	TANGO JULIETT ALPHA reading?
2136:59	SMC	E301	EMPRESS THREE ZERO ONE, take next taxiway left.
2137:00	E301	SMC	Roger.
2137:02	ADC		STATION calling SYDNEY TOWER - ah!
2137:05	ADC	TJN	TANGO JULIETT NOVEMBER go around, maintain runway heading, climb to two thousand.

TIME (E.S.T.) Hrs/Mins/Secs	FROM	TO	TEXT
2137:09	TJN	ADC	TANGO JULIETT NOVEMBER going round.
2137:13	TJA	ADC	TANGO JULIETT ALPHA reading?
2137:15	ADC	TJA	TANGO JULIETT ALPHA go a.....
2137:28	TJA	ADC	TANGO JULIETT ALPHA we're turning left - tell him we've lost - we've lost all our hydraulics.
2137:28	E301	SMC	EMPRESS THREE ZERO ONE is clear of the active runway.
2137:30	SMC	E301	EMPRESS THREE ZERO ONE take taxiway right cross runway zero seven.
2137:34	E301	SMC	Roger.
2137:34	ADC	TJA	TANGO JULIETT ALPHA say again.
2137:38	TJA	ADC	TANGO JULIETT ALPHA, we did strike the DC EIGHT and we are turning left we lost all hydraulics and we'll be turning round onto a downwind leg.
2137:48	ADC	TJA	TANGO JULIETT ALPHA, Roger make visual approach left base runway one six.
	TJA	ADC	TANGO JULIETT ALPHA
2137:54	SMC	E301	EMPRESS THREE ZERO ONE continue straight ahead after crossing the runway. After crossing the runway take the second taxiway left. We have a report that the departing aircraft struck your aircraft on take-off.
2138:06	E301	SMC	Roger check.
2138:10	SMC	E301	EMPRESS THREE ZERO ONE confirm operations normal.
2138:13	E301	SMC	As far as we know they are.
2138:15	SMC	E301	EMPRESS THREE ZERO ONE.
2138:30	ADC	TJA	TANGO JULIETT ALFA will approach and landing be normal?

TIME (E.S.T.) Hrs/Mins/Secs	FROM	TO	TEXT
2138:40	TJA	ADC	TANGO JULIETT ALFA Negative, lost all hydraulics. I've lost System A at the moment!
	ADC	TJA	TANGO JULIETT ALFA Roger
2139:52	TJA	ADC	TANGO JULIETT ALPHA reading. Ah! I will have to do a circuit or two to sort things out a bit. I want to keep below the cloud though.
2139:59	ADC	TJA	TANGO JULIETT ALPHA, Roger, circuit approved.
2140:38	ADC	TJA	TANGO JULIETT ALPHA call approach one two four decimal seven.
2140:46	TJA	ADC	TANGO JULIETT ALPHA one two four seven. Confirm?
2140:49	ADC	TJA	TANGO JULIETT ALPHA affirmative.
2140:50	TJA	APP	SYDNEY APPROACH, TANGO JULIETT ALPHA.
	APP	TJA	TANGO JULIETT ALPHA this is SYDNEY APPROACH. Climb to three thousand and report DME position.
	TJA	APP	TANGO JULIETT ALPHA, Negative ..... not in very good shape. I prefer to keep visual below the cloud.
	APP	TJA	TANGO JULIETT ALPHA. That's approved, where would you like to hold?
	TJA	APP	Just one more circuit ought to do if we can, or, do a big long, er, long one.
	APP	TJA	TANGO JULIETT ALPHA. Approved.
	TJA	APP	Roger dee.
2141:27	TJA	APP	TANGO JULIETT ALPHA, on second thoughts will have to dump, we will head out to sea, on a heading .... of one two zero degrees. How's that to you? For about four and a half to .....

TIME (E.S.T.) Hrs/Mins/Secs	FROM	TO	TEXT
	APP	TJA	TANGO JULIETT ALPHA. That's approved, report when ready to return.
	TJA	APP	WILCO
2142:47	APP	TJA	TANGO JULIETT ALPHA. After the dump would runway one six be suitable or would you prefer zero seven.
	TJA	APP	TANGO JULIETT ALPHA. One six I think. What is the wind at the moment.
	APP	TJA	TANGO JULIETT ALPHA. Its one five zero degrees, five to one zero.
	TJA	APP	One six preferably please.
	APP	TJA	TANGO JULIETT ALPHA. Expect a left, visual left, base runway one six.
	TJA	APP	Roger dee, I will call you in five.
	APP	TJA	TANGO JULIETT ALPHA.



Recorded Flight Data - VH-JA, during taxi and take-off.

APPENDIX D

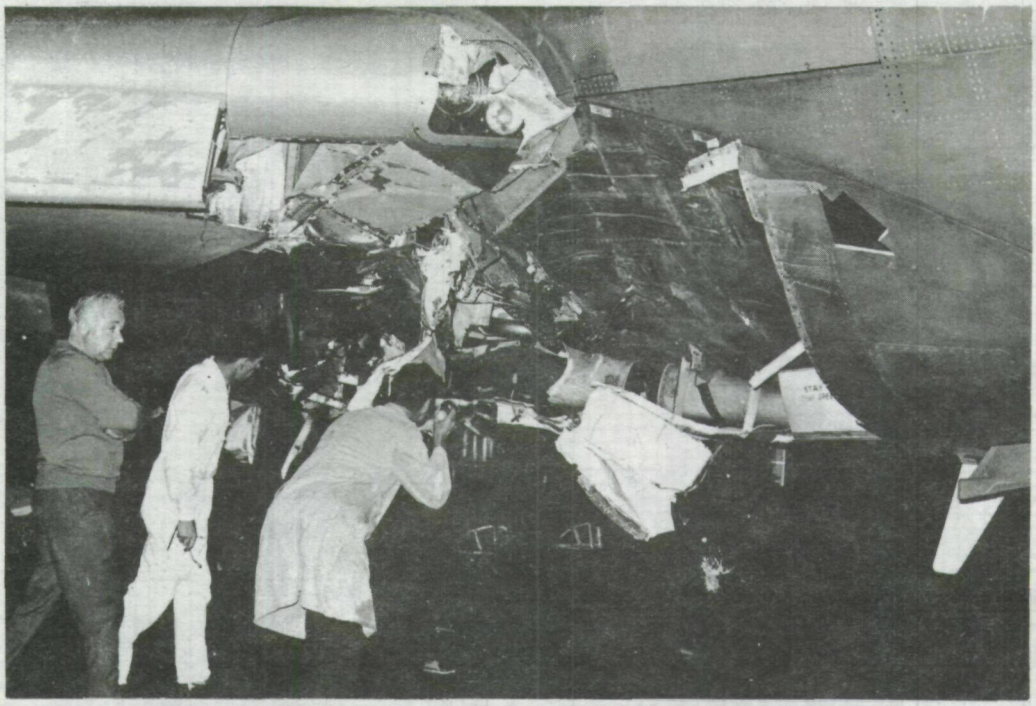


FIG. 1 Damage to VH-TJA in forward wing root area on starboard side. The arrow indicates the point of first contact.

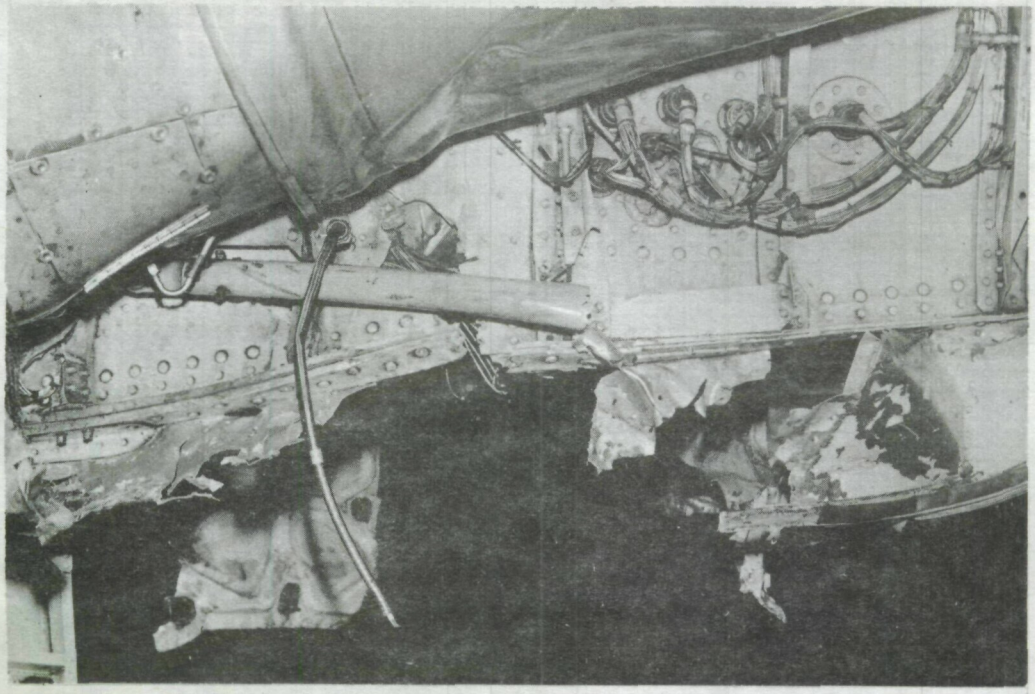


FIG. 2 View from within starboard wheel bay of VH-TJA, showing damage sustained by forward bulkhead.

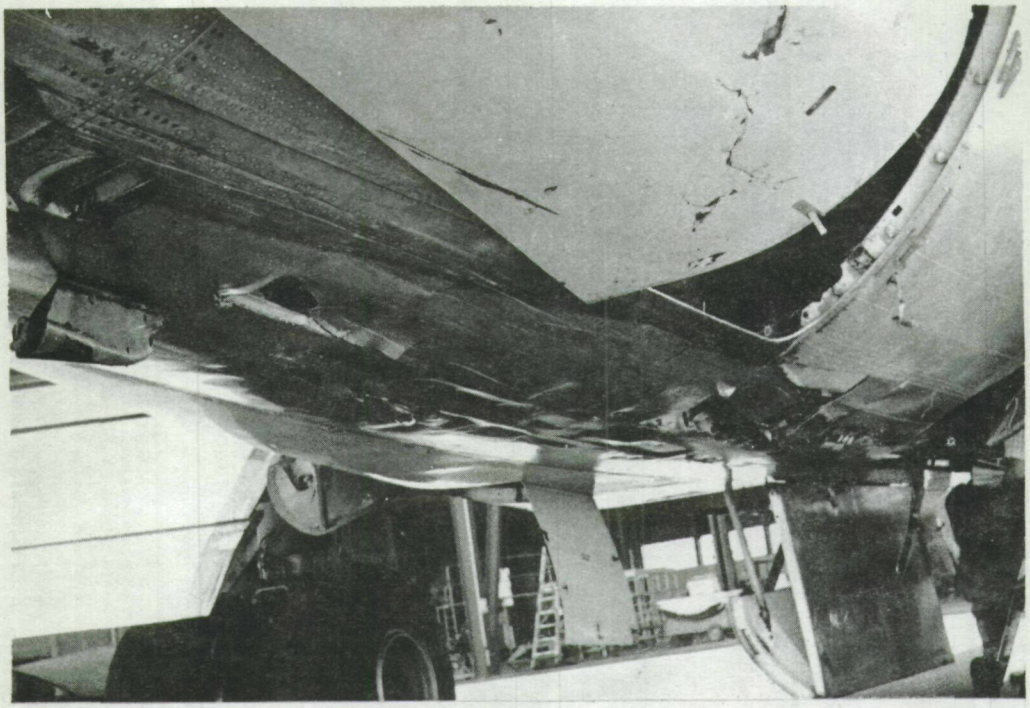


FIG. 3 Underside of fuselage of VH-TJA showing score marks and punctures between starboard wheel bay area and tail bumper.

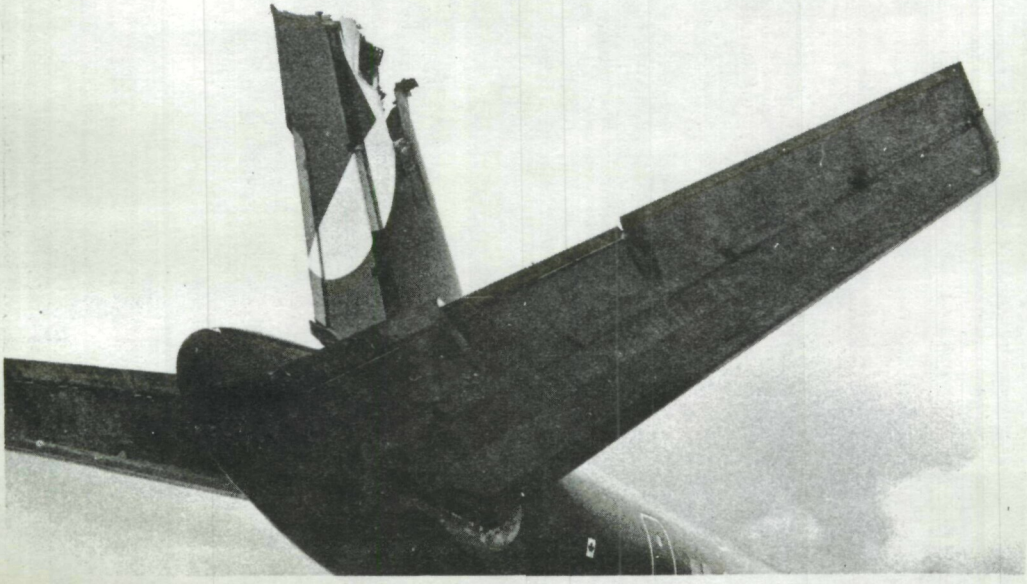
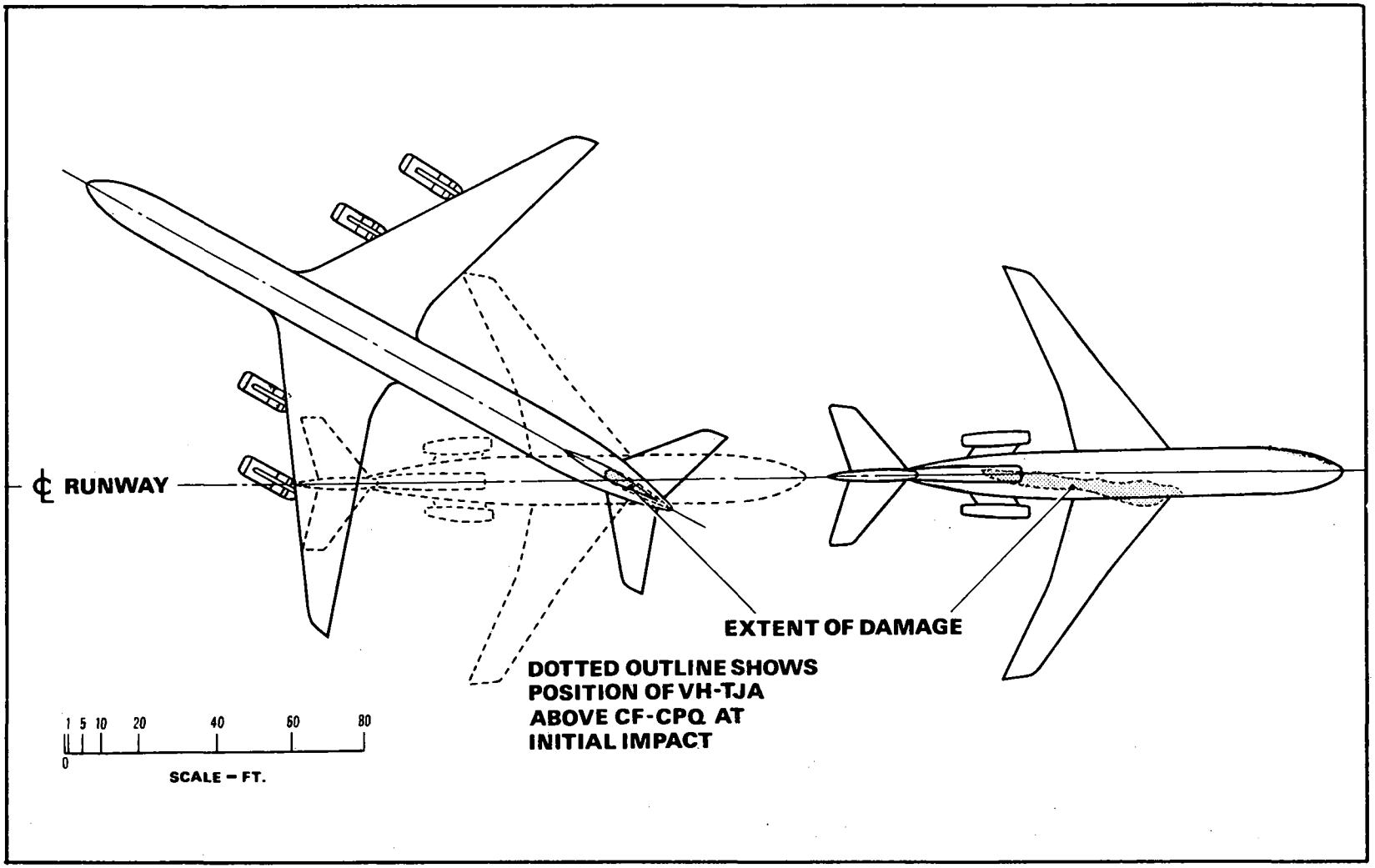


FIG. 4 Damage sustained by tail fin and rudder of CF-CPQ.

Relative positions of CF-CPQ and VH-TJA at and immediately after impact.


℄ RUNWAY
EXTENT OF DAMAGE
DOTTED OUTLINE SHOWS
POSITION OF VH-TJA
ABOVE CF-CPQ AT
INITIAL IMPACT
1 5 10 20 40 60 80
0
SCALE – FT.

APPENDIX F

NATIONAL TRANSPORTATION SAFETY BOARD
Bureau of Aviation Safety
Washington, D. C.

August 18, 1971

FACTUAL REPORT OF INVESTIGATION
AIR TRAFFIC CONTROL COMMUNICATIONS RECORDING

A. ACCIDENT

Location: Sydney, Australia
Date : January 29, 1971
Aircraft: Boeing 727, VH-TJA
Trans-Australia Airlines Flight 592

B. GROUP

Not applicable.

C. SUMMARY

This report is limited to the examination of a copy of the air traffic control communications recording of the Sydney Tower for the purpose of establishing the source of an unidentified communication thereon.

D. DETAILS OF INVESTIGATION

A request was made by the Director-General of Civil Aviation of the Commonwealth of Australia for assistance in ascertaining the identity of the source of a communication appearing on the tape recording of air traffic control communications at the Kingsford-Smith Aerodrome control tower, Sydney, Australia, during the time period in which a collision occurred between VH-TJA, a Boeing 727 operated by Trans-Australia Airlines as Flight 592 to Perth, and an arriving DC-8, Canadian Pacific Airlines Flight 301, while VH-TJA was executing takeoff. This request was detailed in a memorandum to the Civil Air Attache, Australian Embassy, Washington, file 6/712/1008, dated March 22, 1971. Accompanying this memorandum was a copy of the aforementioned recording, which contained communications both air-ground-air and intra-facility at the Sydney Tower. Subsequently, other rerecordings with a greater cross-section of voices and clarity of reproduction were provided the undersigned for more detailed examination.

Aircraft and persons whose communications appear on the tape copies provided are:

Tango Juliet Alpha	-	B-727
Echo Whiskey Julies	-	F-27

D. DETAILS OF INVESTIGATION (Cont'd)

Empress 301	-	DC-8
Tango Juliet November	-	DC-9
Foxtrot November Delta	-	Type unknown
Foxtrot November Sierra	-	Type unknown
Surface Movement Controller		
Aerodrome Controller		
Senior Tower Controller		
Departures Radar Controller		
Approach Radar Controller		
Approach Procedural Controller		

Spectrographic examinations were made of all speech components containing phonemes which appeared in the unidentified communication segment. Where such phonemes did not appear in a given transmission, it was examined only aurally. Each of the spectrograms made from an identified source was compared phonetically with the unidentified sample to determine whether there was a basis for associating the speakers of the known and the questioned statements.

The results of the examinations and analyses are contained in the analysis report of this investigation.

Robert D Rudich

Robert D. Rudich
Chief, Audio Laboratory

APPENDIX F (Continued)

NATIONAL TRANSPORTATION SAFETY BOARD
Bureau of Aviation Safety
Washington, D. C.

August 19, 1971

ANALYSIS OF INVESTIGATION
AIR TRAFFIC CONTROL COMMUNICATIONS RECORDING

A. ACCIDENT

Location: Sydney, Australia
Date : January 29, 1971
Aircraft: Boeing 727, VH-TJA
Trans-Australia Airlines Flight 592

B. GROUP

Not applicable.

C. SUMMARY

The previously unidentified communication was uttered by one of the occupants of the flight deck of VH-TJA.

D. DETAILS OF ANALYSIS

As indicated in the Factual Report of this investigation, detailed comparisons were made of the speech of each of the entities whose conversation is recorded on the tape copies provided for examination. The first screening consisted of an aural review to determine which identified communications would be examined by spectrographic means, the criterion being that those selected contain phonemes which appear in the unidentified segment.

The second phase of the examination involved the comparison of the "known" to "unknown" spectrograms of identical phonemes. As a result of this effort, it was ascertained, through comparison of five phonemes in identified speech with four from the unidentified segment, that the speaker of each of the transmissions was from VH-TJA. A comparison of 17 transmissions from VH-TJA of its call sign produced results delineated in the following table:

TIME OF TRANSMISSION 1/	IDENTIFICATION
2129:00	Voice 1
2129:16	Voice 1
2129:40	Voice 1
2133:48	Voice 1
2133:54	Voice 1
2135:38	Voice 1

1/ As per transcription provided with letter from Department of Civil Aviation dated March 22, 1971

D. DETAILS OF ANALYSIS (Cont'd)

TIME OF TRANSMISSION	IDENTIFICATION
2136:57	Voice 1
2137:13	Voice 1
2137:28	Voice 1
2137:38	Indeterminate 2/
2137:48	Voice 1
2139:52	Voice 2
2140:50-1	Voice 1
2140:50-2	Voice 2
2141:27	Voice 2
2142:47	Voice 2
2146:50	Voice 2

In respect to the unacknowledged transmission "How far ahead is he"?, the following phonemes served to identify the speaker thereof:

UNKNOWN	KNOWN	TIME
How	Cloud	2139:52
How	Cloud	2140:50-2
Ahead	Head	2141:27
Ahead	Heading	2141:27
Is	Is	2142:47
He	Sea	2141:27

It may thus be seen by comparison of the latter with the former table that the voice uttering the unacknowledged communication was that of the person identified herein as Voice 2.

The case file containing the final comparison, showing the points upon which identification was based, is provided as an attachment to this report.

2/ The transmission of "Tango Juliet Alfa" at this time is distorted by what appears to have been the transmitter carrier being modulated by two microphones simultaneously. This presumes that at least two flight crewmembers had selected the same VHF transmitter and that their respective microphones were both keyed during this distortion period.

Robert D Rudich

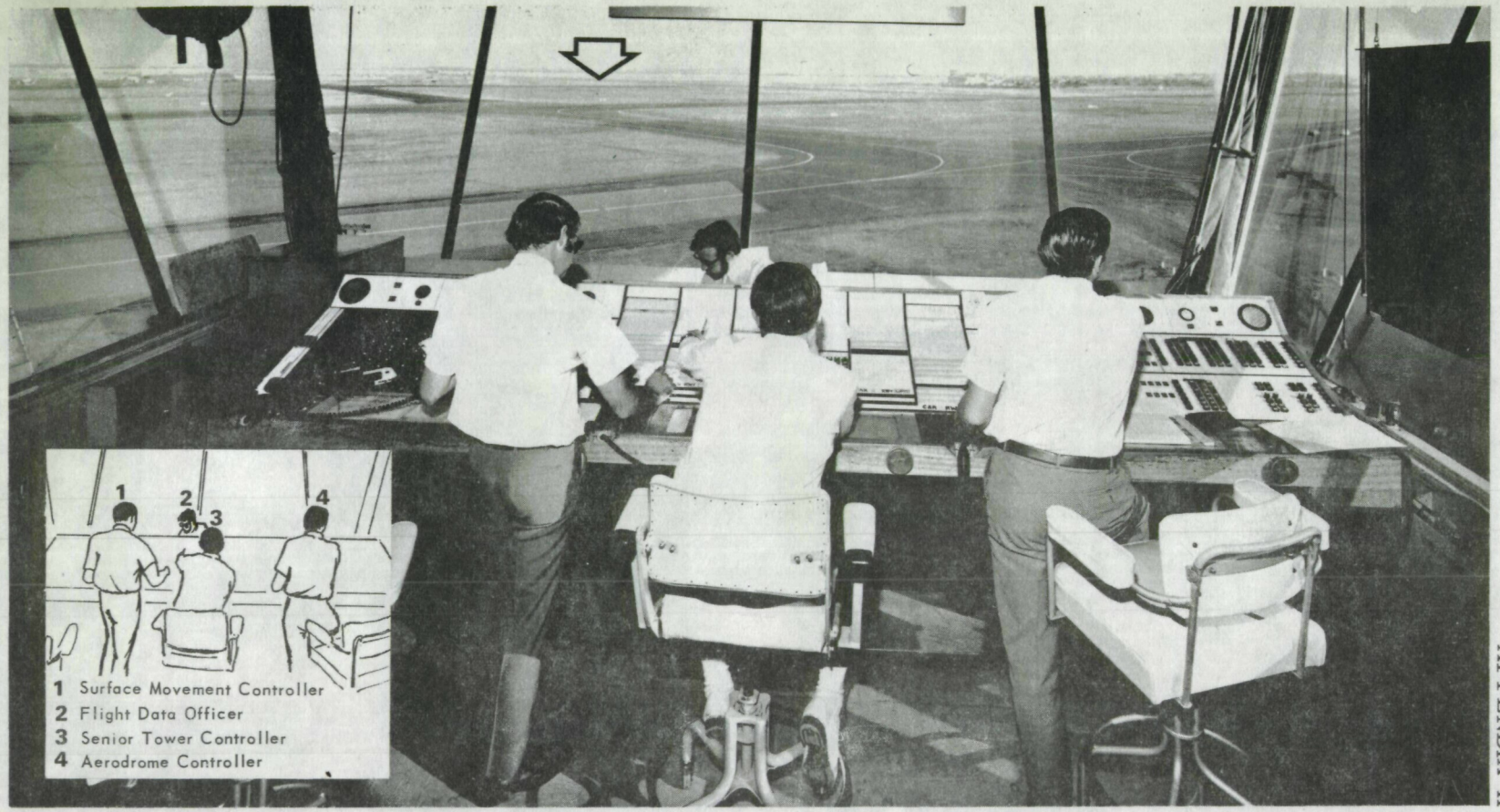
Robert D. Rudich
Chief, Audio Laboratory

Attachment

APPENDIX G

CORRELATION OF EVENTS — ANALYSIS

(1) TIME (E.S.T.)	(2) RELEVANT COMMUNICATIONS FROM	(2) MESSAGE	(3) B727 VH-TJA FLIGHT DATA RECORDER EVENTS	(4) B727 VH-TJA CALCULATED PERFORMANCE	(5) DC8 CF-CPQ ESTIMATED PERFORMANCE	(6) TIME
2133.40						33.40
	TJA	Tango Juliett Alfa—ready				
.50						.50
	ADC	Tango Juliett Alfa—DC8 on short final: line up behind that aircraft				
2134.00						34.00
	TJA	Tango Juliett Alfa				
.10					Aircraft passes over runway threshold	.10
			Start of heading change	Aircraft moves forward from holding point towards runway		
.20						.20
2134.30						34.30
.40						.40
.50		Empress Three Zero One—take taxiway right, call on 121·7				.50
	ADC					
	E301	Roger	Aircraft attains runway heading			
2135.00						35.00
					Aircraft reaches taxiway 'I' and commences a 180° turn at 3 kt nosewheel rolling speed	
.10						.10
.20						.20
2135.30						35.30
					Aircraft has turned through 90°	
	ADC	Tango Juliett Alfa—radar departure, turn right heading 170, clear for immediate take-off				
.40						.40
	TJA	Tango Juliett Alfa	First evidence of aircraft acceleration	Engines accelerate from idle, zero rolling speed, nosewheel at threshold lights		
.50						.50
2136.00		Sydney,				36.00
	E301	Empress Three Zero One			Aircraft completes 180° turn at taxiway 'I'	
		Empress Three Zero One—				
	SMC	cross runway 07				
.10	E301	Roger			Aircraft reaches and maintains a 10 kt taxi speed	.10
	TJA	How far ahead is he ?		100 kt IAS, nosewheel 2,260 ft. from end of runway		
.20				Vr 131 kt IAS, nosewheel 4160 ft. from end of runway		.20
					Aircraft commences turn towards edge of runway	
2136.30	SMC	Three Zero One hold position	Abrupt 'G' trace deviation	152·5 kt IAS. Impact with DC8 tail fin at 6,286 ft. from end of runway	Impact	36.30
.40						.40
	E301	Tower, Three Zero One				



View of airport from Sydney Tower with staff on duty at control console.
Arrow in distance indicates intersection of Runway 16 and Taxiway 'I'.

N.B. Persons in photograph were not those on duty at time of accident.

Wholly set up and photo-lithographed in the Printing Production Centre
Department of Civil Aviation