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Department of Transport
Australia

Air Safety Investigation Branch

INCIDENT INVESTIGATION REPORT

**McDonnell Douglas DC-9-31 Aircraft,
VH-TJP at Melbourne Airport, Victoria
on 29 November 1978**

Special Investigation Report 79-2

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Trans-Australia Airlines McDonnell Douglas DC-9-31 Aircraft VH-TJP at Melbourne Airport, Victoria, on 29 November 1978

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

Prepared by Air Safety Investigation Branch

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Note 1: All times are Australian Eastern Summer Time (Greenwich Mean Time plus 11 hours) and are based on the 24-hour clock. Where applicable, seconds are shown using a six figure time group.

Note 2: Metric units are used except for airspeed and wind speed which are given in knots; and for elevation, height and altitude which are given in feet. Unless otherwise noted, all elevations and altitudes are above mean sea level.

Note 3: Minimum Altitude is defined in the Department of Transport's Aeronautical Information Publication as follows:
The minimum altitude for a particular instrument approach procedure is the altitude specified by the Secretary (Department of Transport) at which an aircraft shall discontinue an instrument approach unless continual visual reference to the ground or water has been established and ground visibility is equal to or greater than that specified by the Secretary for landing.

THE INCIDENT

At approximately 1342 hours on 29 November 1978, McDonnell Douglas DC-9-31 aircraft, registered VH-TJP, landed 192 metres short of the threshold of Runway 27 at Melbourne Airport, Victoria. The aircraft was conducting an Instrument Landing System (ILS) approach to Runway 27 in conditions of reduced visibility caused by heavy rain. During the ground roll to the threshold, the main landing gear of the aircraft struck and destroyed six lights in the high intensity approach lighting system serving the runway.

The aircraft was operating a regular public transport flight and there were ninety-one passengers and a crew of six on board. No one was injured and the damage sustained by the aircraft was minor.

1. FACTUAL INFORMATION

1.1 HISTORY OF THE FLIGHT

McDonnell Douglas DC-9-31 aircraft VH-TJP was operated by Trans-Australia Airlines (TAA) under the terms of a current airline licence. The holder of the certificate of registration for the aircraft was the Australian National Airlines Commission. At the time of the incident, the aircraft was engaged on a regular public transport service, designated Flight 8489, from Brisbane, Queensland, to Melbourne, Victoria with an intermediate landing at Coolangatta, Queensland.

The flight from Brisbane to Coolangatta was without known incident and, at 1151 hours, the aircraft departed from Coolangatta on an Instrument Flight Rules (IFR) category flight plan to Melbourne. Throughout this stage the Captain flew the aircraft from the left-hand pilot seat.

As the aircraft approached the destination area, Melbourne Airport Automatic Terminal Information Service (ATIS) was broadcasting information Papa. This contained the following : Runway 34, wind 340 degrees at 25 knots, gusting to 35 knots, QNH 1001 millibars, temperature 22 degrees Celsius, cloud six oktas at 2500 feet with lower patches and showers in area.

At 1334:06 hours the aircraft made contact with Melbourne Approach Control and was immediately cleared to descend to 3000 feet, on a QNH of 1001 Millibars, in accordance with the altitude restrictions specified in the Distance Measuring Equipment (DME) Arrival Procedures. Approach Control also advised the aircraft it had 30 miles (nautical) to run to Melbourne, that the runway had been changed to 27 and that it was to track via the Epping locator and the Runway 27 localiser. Twenty seconds after acknowledging this instruction, the aircraft was advised that the wind was coming around to the west at 30 knots and that a new ATIS would be available in about 30 seconds.

The crew retuned the aircraft's radio navigation receivers to the appropriate aids for an approach to Runway 27 but stated that the change of runway did not cause any extra cockpit workload.

The rapid change in surface wind was associated with the passage of a cold front, crossing the Melbourne area from west to east, at about 30 knots. Both the flight crew of VH-TJP and air traffic control (ATC) were aware of the frontal movement from meteorological forecasts, which had predicted a time of passage over the airport between 1400 hours and 1600 hours. Associated with this passage, over the period 1200 hours to 1900 hours, reductions in visibility and thunderstorm activity, of up to one hour duration, had also been forecast. Consequently, ATC had issued an Operational Requirement (OPR) that aircraft estimating arrival at Melbourne between 1130 hours and 1930 hours were to

carry an additional fuel reserve. VH-TJP carried fuel sufficient for a diversion to Sydney, New South Wales.

At 1336:19 hours the aircraft was advised '. . . . the QNH now one zero zero two decimal five, the visibility two thousand metres and heavy rain, wind two four zero degrees, three zero gusting to four zero, you have one eight miles to run, clear for final Runway 27 ILS'. Nine seconds later, the aircraft was further advised that the QNH was now 1005 millibars, and that the cloud cover was '. . . . six oktas at one five zero zero with lower patches, the temperature now one seven'. At 1339:35 hours the aircraft was instructed to call Melbourne Tower and was given a QNH of 1004 millibars.

As a result of the advised rapid changes in QNH and surface wind the Captain stated he considered there was a probability of encountering wind shear during the approach. As a precaution he decided to make a faster than normal approach with only 25 degrees flaps extended. The calculated landing weight was 40 518 kilograms and the Captain referred to the 90 000 pounds (40 823 kilograms) Landing Weight Data Card to obtain an approach Reference Airspeed (VRef), for 50 degrees flaps, of 122 knots. He added a 10 knot increment to this figure to allow for the reduced flaps configuration and set the inner reference pointer on his airspeed indicator at 132 knots. However, to compensate for the advised strong wind gradient and gust effects he added a further increment of 20 knots to this VRef, to arrive at a selected approach airspeed of 152 knots.

The Captain stated that he advised the First Officer of this decision, but he did not otherwise elaborate upon the manner in which the approach and landing would be carried out.

During interview the crew advised that when the aircraft passed over the Epping locator at about 3000 feet, neither pilot could see the runway. At about 2000 feet, however, they could both see the airport terminal buildings and the first half of the runway, but not the control tower. Their recollections of drift at this stage of the approach were confused; the Captain believed drift was about six degrees left while the First Officer thought it was six degrees right. With regard to airspeed and power, the Captain stated that the indicated airspeed (IAS) was never low, and that there were no significant changes in airspeed during the approach. At one point the IAS was 155 knots and the Captain reduced power to about 60 per cent, but then increased it back to about 70 per cent for the remainder of the approach.

At 1339:44 hours Melbourne Tower called VH-TJP and the flight crew replied that the aircraft was on final approach, leaving 2000 feet. At 1339:58 hours, the aircraft was advised : 'Roger, continue approach, I've no idea of the cloud base, it's quite low, visibility is two thousand metres in heavy rain, surface wind two five zero degrees, two zero gusting three zero, runway and approach lighting are on stage five'. This was acknowledged and, at 1340:46 hours, the aircraft was advised that the QNH was 1004.5 millibars and was cleared to land.

At about 1500 feet, in increasing rain, the crew adopted full instrument flight procedures. At this point both pilots referred to their Instrument Approach and Landing (IAL) charts, and verbally confirmed the approach minima and the overshoot procedure. The rain continued to increase in intensity and at about 1000 feet the windscreen wipers were switched on. Both pilots stated the aircraft was then aligned with the localiser and on glideslope. At 800 feet (400 feet above ground level (AGL) and 100 feet above the minimum altitude) the First Officer called the descent rate, in accordance with standard company procedures. To the best of his recall it was about 650 feet per minute. He also advised the Captain that he had the high intensity approach 'lead-in lights' in sight. The Captain looked out and also saw the lights.

From this point both pilots concentrated their attention primarily outside the cockpit. The Captain stated he supplemented this with instrument cross checks down to about 200 feet AGL, whilst the First Officer stated he stopped monitoring his instruments about 300 feet AGL. At this last instrument check the Captain recalled the aircraft was still close to glide slope, perhaps 'half a dot' low. The First Officer had no recollection of glide slope

indication during the final segment of the approach. The Captain also stated that about 400 feet AGL, the aircraft encountered wind shear. Both pilots' recollections of drift at this time were approximately 12 degrees left.

Visibility ahead, in very heavy rain, was poor. Despite operation of the wipers, the rain on the windscreen blurred the pilots' vision and both stated the approach lights were badly diffused. Neither could see the runway ahead and they concentrated their attention on scanning for the row of green lights marking the threshold.

At an estimated 100 feet AGL, still without visual contact of the threshold lights, the Captain stated he 'sensed' the aircraft sinking rapidly. He attempted to counter this by pulling back on the control column, but did not increase power.

As the Captain rotated the aircraft the First Officer sighted the right-hand threshold lights and commented they were 'looking a bit low'. He could not remember making any further comment but the Captain recalled that, just before impact, the First Officer said, 'You are going to hit the lights'. Both pilots then felt the landing gear strike the ground and the approach lighting.

Touchdown was in a near normal landing attitude, 192 metres short of the runway threshold. A total of six approach lights, in the last four rows leading to the threshold, were struck by the main wheels as the aircraft rolled across the grassed area. The nose wheel probably touched down on the runway just beyond the threshold (see Appendix C) The aircraft remained within the confines of the runway as it slowed down. It was then taxied to the terminal under its own power and the passengers disembarked by normal means.

1.2 INJURIES TO PERSONS

Injuries	*Crew*	*Passengers*	*Others*
Fatal	—	—	—
Serious	—	—	—
Minor/None	6	91	—

1.3 DAMAGE TO AIRCRAFT

The bottom of the left engine cowl, a section of the lower rear fuselage, three main landing gear tyres and components of the right main landing gear sustained minor damage.

1.4 OTHER DAMAGE

Six lights in the Runway 27 approach lighting system were destroyed by the landing gear of the DC-9 during the aircraft's ground roll. The lights were mounted on frangible supports about one metre high, set in concrete bases flush with the ground. The supports were designed to break off at the base under impact forces and, in all cases, they failed as intended.

1.5 PERSONNEL INFORMATION

Captain Michael Frederick Victor CROOKE, age 50 years, was the pilot in command. He was the holder of current First Class Airline Transport Pilot Licence No. 009608, last revalidated on 1 September 1978. His licence endorsements authorised him to fly DC-9 aircraft and he held a current first class instrument rating endorsed for the appropriate radio navigation aids.

He had last completed a licence medical examination on 21 July 1978 and the records of the eyesight test indicate a reduction in near-vision acuity. Accordingly Captain Crooke's licence was endorsed with the requirement that correcting lenses must be kept available for immediate use.

Captain Crooke's total pilot experience at the time of the incident was 19 063 hours, of which 2545 hours had been gained in DC-9 aircraft. His last Line, Base and Simulator

Proficiency Checks were on 5, 15 and 16 August 1978, respectively. All were assessed satisfactory. The Simulator Proficiency Check had included a single-engine, ILS approach with a missed approach from the minimum.

First Officer Robert Baden LUPTON, age 29 years, was the holder of Second Class Airline Transport Pilot Licence No. 009659, last revalidated on 1 July 1978. His licence endorsements authorised him to fly DC-9 aircraft and he held a current second class instrument rating endorsed for the appropriate radio navigation aids.

He had last completed a licence medical examination on 1 June 1978, at which he met the required standard.

First Officer Lupton's total pilot experience at the time of the incident was 4053 hours, of which 1058 hours had been gained in DC-9 aircraft. His last Line and Simulator Proficiency Checks were on 9 May 1978 and 30 October 1978, respectively. Both were assessed satisfactory. The Simulator Proficiency Check had included a single-engine, ILS approach with a missed approach from the minimum.

The two pilots had been operating as a crew for the month of November 1978. They both described their relationship as friendly but 'correct' for the working environment.

Both pilots had spent the two days prior to 29 November 1979 off-duty at their home base of Brisbane, Queensland. They had commenced duty at Brisbane Airport at 1000 hours and had flown Brisbane - Coolangatta - Melbourne. At the time of the incident they had been on duty 3 hours 42 minutes.

1.6 AIRCRAFT INFORMATION

1.6.1 History

VH-TJP is a McDonnell Douglas DC-9-31 aircraft which had flown a total of 22 706 hours at the time of the incident. The aircraft was maintained in accordance with the TAA Maintenance System Manual and had a current Certificate of Airworthiness which was to remain valid indefinitely, provided the aircraft continued to be maintained in accordance with the approved maintenance system. There was no record of any engineering deficiency which could have been relevant to this incident.

1.6.2 Loading

The maximum permissible gross weights for take-off and landing in this aircraft were 46 720 kilograms and 43 227 kilograms, respectively. The calculated actual take-off and landing weights of 46 004 kilograms and 40 518 kilograms, respectively, were within these limits. The centre of gravity throughout the flight was also within permissible limits.

1.6.3 Defects

Inspections subsequent to the incident found no evidence of aircraft defects contributing to this occurrence.

1.7 METEOROLOGICAL INFORMATION

During the day of 29 November 1978 a cold front, aligned north–north-west/south–south-east, crossed the State of Victoria from west to east at a speed between 20 and 30 knots.

The Bureau of Meteorology initiated standard aviation alerting in respect of the weather conditions associated with the frontal passage. At 0737 hours the Melbourne Airport Meteorological Office issued an Airport Warning indicating strong northerly winds with gusts to 50 knots ahead of the front. The Melbourne Regional Forecasting Centre issued two alerts; a Situation Report, at 0852 hours, which advised the front had reached the western boundary of the State at 0600 hours, was moving east at about 20 knots and was preceded by widespread areas of rain and isolated thunderstorms, and a Sigmet alert, at 0838 hours, forecasting severe clear air turbulence below 10 000 feet.

An amended terminal forecast for Melbourne Airport, for the period 1000 hours to 0100 hours (30 November 1978), was issued at 0958 hours. This indicated a surface wind of 350 degrees magnetic at 22 knots, with gusts to 45 knots, visibility of 10 kilometres or greater, rain, six oktas cumulus base 5000 feet and six oktas altocumulus/altostratus base 10 000 feet : rapidly, between 1400 hours and 1600 hours, a change of surface wind to 200 degrees magnetic at 20 knots and six oktas stratus base 1000 feet: during the period 1200 hours to 1900 hours, temporary reductions, of up to one hour duration, in visibility to 3000 metres, associated with thunderstorm activity and four oktas of cumulonimbus cloud base 5000 feet. Surface temperature and pressure variations over the forecast period were 23/24/17/16 degrees Celsius and 1004/1003/1002/1004 millibars, respectively.

All these reports and forecasts, together with other relevant enroute and terminal forecasts, were made available to the flight crew of VH-TJP at Brisbane Airport at the time of preflight briefing.

In addition, the flight crew confirmed receipt en route of an updated terminal forecast for Melbourne issued at 1102 hours, for the period 1300 hours to 0700 hours (30 November 1978). This indicated a surface wind of 340 degrees magnetic at 20 knots, with gusts to 45 knots, visibility of 10 kilometres or greater, rain, three oktas cumulus base 4000 feet and seven oktas altocumulus/altostratus base 10 000 feet : rapidly, between 1400 hours and 1600 hours, a change of surface wind to 200 degrees magnetic at 15 knots, visibility of 10 kilometres or higher, rain showers, six oktas stratus base 700 feet and five oktas cumulus base 2000 feet: during the period 1200 hours to 1900 hours, temporary reductions of up to one hour duration, in visibility to 3000 metres, associated with thunderstorm activity and three oktas of cumulonimbus cloud base 4000 feet. Surface temperature and pressure variations over the forecast period were 23/16/15/14 degrees Celsius and 1002/1004/1006/1008 millibars, respectively.

Bureau of Meteorology procedures require that a forecasting service be provided in respect of low level wind shear. A description of low level wind shear procedures is at Section 1.17.2 of this report. Although conditions associated with the frontal passage indicated a high probability of wind shear a forecast to this effect was not issued.

The cold front passed over Melbourne Airport some 26 minutes earlier than forecast. Observations made at 1300 hours noted a surface wind of 360 degrees magnetic at 30 knots with gusts to 43 knots, visibility 40 kilometres, three oktas stratocumulus base 3500 feet and eight oktas altocumulus base 13 000 feet, surface temperature 22 degrees Celsius and surface pressure 1001 millibars. By 1330 hours the low level cloud had increased to seven oktas stratocumulus base 3000 feet, with lower patches of cumulus, and the pressure had risen to 1003 millibars. A marked roll cloud and heavy rain was visible approaching from the west.

About 1334 hours the surface wind at the airport backed to 240 degrees magnetic at 28 knots, with gusts to 39 knots. Approximately one minute later heavy rain commenced and a total of 12 millimetres was recorded in the next 20 minutes. After another minute the surface pressure rose, over a 30 second interval, a further two millibars to 1005 millibars. A temperature fall of 7 degrees Celsius, to 15 degrees Celsius, was recorded over this period.

By 1400 hours conditions were improving; the wind was from 240 degrees magnetic at 16 knots, visibility was 5000 metres in rain, cloud was two oktas stratus base 600 feet and six oktas cumulus base 2000 feet. Some 20 minutes later the rain reduced to occasional showers, visibility was 25 kilometres and there was no cloud below 1500 feet.

When VH-TJP was on descent into Melbourne, the ATIS was broadcasting information Papa. This had been placed on the ATIS at 1307 hours and indicated the conditions as the front approached from the west. Information Papa complied with the appropriate Department of Transport requirements, except that visibility information was omitted. This was in accordance with a general practice, when visibility was 10 kilometres or greater, as being of no significance to operations. The ATIS was not amended to information Quebec, advising conditions immediately subsequent to frontal passage, until 1338 hours. However,

the crew of VH-TJP was provided with frequent advice as conditions changed, firstly by Melbourne Approach Control and then by Aerodrome Control. Details of this advisory service have been included in Section 1.1 of this report.

One item of information provided to the crew of VH-TJP by Approach Control at 1336:19 hours was that the visibility was 2000 metres, in heavy rain. This was reaffirmed by Aerodrome Control when the aircraft was on final approach, at 1339:58 hours. In both instances this information was an estimate made by the Aerodrome Controller.

As a guide to estimating visibility, Aerodrome Controllers and Meteorological Observers refer to a series of landmarks at known distances from the airport control tower. Specifically, at the time of frontal passage, reference was made to the airport terminal buildings, some 1500 metres east of the tower, the Route Surveillance Radar aerial, about 2000 metres to the north, and a maintenance hangar, some 3000 metres to the southeast (refer Appendix A). It is normal to supplement this procedure with pilot reports of flight visibility on final approach, and radar range of aircraft when first sighted from the tower.

It is a requirement, however, that when visibility is less than 2000 metres, Runway Visual Range (RVR) shall be used instead of visibility. As Melbourne Airport is not equipped with transmissometers the information is obtained by despatching an officer to the runway threshold to gauge RVR by reference to specific assessment lights on Runways 27 and 16.

There was evidence that for a period the visibility reduced below 2000 metres. At 1338:11 hours the Aerodrome Controller was unable to see two aircraft at the holding point for Runway 27, some 1650 metres from the tower. About one minute later one of these aircraft took off and was not sighted by tower staff until just prior to the intersection of the two runways. This intersection is 1000 metres from the tower and hence the aircraft was probably some 1100 to 1300 metres distant when sighted. Finally, at 1340 hours, the Meteorological Observer, located in the control tower, recorded the visibility as 1500 metres. However, the Aerodrome Controller did not despatch an officer to the Runway 27 threshold to assess the RVR.

1.8 AIDS TO NAVIGATION

Runway 27 is served by a full ILS to Category 1 standard in accordance with the provisions of ICAO Annex 10. The localiser is aligned on a track of 264 degrees magnetic and the glide slope angle is 3 degrees. Associated with the ILS are middle and outer marker beacons and the Epping locator. These are aligned with the centreline and are 1074 metres, 6963 metres and 15 760 metres, respectively, from the threshold.

During the morning of 29 November 1978 the Runway 27 localiser underwent routine maintenance, but by 1107 hours it had been returned to service and subsequently monitored as serviceable. At 1400 hours a check of navigational aids at Melbourne showed all were operating normally. Neither the flight crew of VH-TJP nor crews of other aircraft which landed on Runway 27 shortly after the incident reported any malfunction or abnormality of the aids serving that runway.

The Runway 27 ILS instrument approach chart, current at the time of the incident, listed minima for landing of 700 feet (308 feet above airport elevation) and 1200 metres visibility (see Appendix B). Without the high intensity approach lighting system, the required minimum visibility increased to 1500 metres. Alternatively, an approach to lower minima of 610 feet and 800 metres visibility was permitted for specifically approved operators, under certain conditions.

During the approach by VH-TJP the high intensity approach lighting system was operational. TAA did not hold the relevant approval for reduced minima approaches, hence the applicable minima were 700 feet and 1200 metres visibility.

1.9 COMMUNICATIONS

Communications relevant to the incident were recorded on continuously running magnetic tape and a transcript is at Appendix F. Communications were normal in all respects.

1.10 AERODROME INFORMATION

Melbourne Airport has two sealed runways designated 16/34 and 09/27. Runway 09/27 is 2286 metres long and 45 metres wide, and has an asphalt surface (see Appendix A). The elevation of the Runway 27 threshold is 407 feet. Standard precision approach runway markings are painted on the runway.

Runway 27 has a Calvert pattern high intensity precision approach lighting system with associated runway lighting, variable over six stages, to Category 2 standard in accordance with the provisions of ICAO Annexe 14. The threshold is marked by a row of green lights flush with the surface of the runway and spaced at intervals across the runway at right angles to the centreline.

There were no deficiencies in, or limitations upon, the aerodrome facilities on the day of the incident.

1.11 FLIGHT RECORDERS

1.11.1 Flight Data Recorder

The aircraft was equipped with a Sunstrand Data Control F542B Flight Data Recorder (FDR). It recorded the aircraft pressure altitude, indicated airspeed, heading and vertical acceleration against a time base by means of engravings made on a stainless steel tape. In addition, a binary channel recorded the duration of VHF transmissions made from the aircraft. All the parameters had been recorded clearly and actively with no indication of recorder malfunction or abnormality.

The section of the tape which recorded the movements of the aircraft during the 15 minutes prior to completion of this landing was read out. Appendix D is a representation of the flight data record for the three minutes prior to and the 1½ minutes after touchdown.

After calibration corrections the accuracy of the data was established as:

Pressure altitude:	± 100 feet (for values outside ground effect)
Airspeed:	± 5 knots (for values greater than 100 knots)
Heading:	± 2 degrees
Acceleration:	±0.1g
Time:	± 2 seconds

The FDR indicated that the aircraft descended from 3250 feet pressure altitude to touchdown, at 660 feet pressure altitude, in 3 minutes. The indicated airspeed record showed that the airspeed 3 minutes prior to touchdown was 244 knots and that during the next 40 seconds it reduced to 200 knots. For the remainder of the approach the airspeed was in the range 197 to 163 knots, with a value of 171 knots at touchdown. From 10 to 20 seconds after touchdown there was considerable scatter in the airspeed trace and the results are shown with a dashed line in this area. The 'g' activity during the approach shown by the acceleration trace varied from a maximum of 1.24g, at 2 minutes 47 seconds before touchdown, to a minimum of 0.84g, at 1 minute 16 seconds before touchdown. The peak 'g' recorded at touchdown was 1.63g followed by a second oscillation to 1.38. The magnetic heading recorded during the approach was between 225 and 280 degrees.

1.11.2 Cockpit Voice Recorder

The aircraft was equipped with a Sundstrand V412 Cockpit Voice Recorder (CVR) which, for the last 60 minutes of recorder operation, was designed to provide a record of all radio communications between the aircraft and ground stations as well as audible speech and other sounds in the cockpit. When CVRs 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 source of information available on other occasions, the then Department of Civil Aviation agreed to this demand for the time being. Consequently, the evidence contained in the cockpit audio record of VH-TJP was not available for use in this investigation.

1.12 WRECKAGE AND IMPACT INFORMATION

Not relevant to this investigation.

1.13 MEDICAL AND PATHOLOGICAL INFORMATION

Captain Crooke's medical history showed a gradual reduction in near vision acuity, typical of accommodation change with age. His eyesight was tested at his last routine medical examination and it was established that his visual acuity over medium to long range was satisfactory. His ability to effectively scan both the instrument panel and outside the aircraft was unaffected. In respect of near vision, however, such as reading, he required correcting lenses. Captain Crooke was not wearing his spectacles during the approach in question and it is not considered his reduced visual acuity was a factor in the incident.

There was no evidence of any other physiological or psychological conditions which might have affected the flight crew in the performance of their duties.

1.14 FIRE

There was no fire.

1.15 SURVIVAL ASPECTS

None of the crew nor the passengers were injured. The interior of the aircraft was not damaged and the maximum recorded positive load factor of 1.63g at touchdown was not such as to raise the question of survival in this investigation.

1.16 TESTS AND RESEARCH

1.16.1 Simulator Tests

The TAA DC-9 Simulator was used to conduct a series of test ILS approaches to Melbourne Airport Runway 27. The base parameters were an aircraft weight of some 40 500 kilograms and a wind of 240 degrees magnetic at 25 knots. This approximated the conditions appropriate to VH-TJP during the final 80 seconds of approach. A series of 25 degrees and 50 degrees flaps configuration approaches were carried out, maintaining various constant IAS and on-glideslope indications.

The results were as follows:

Flaps	*IAS*	*Body Angle*	*Thrust (N1/RPM)*
25°	170 Kts	-1°	approx 70 per cent
25°	150 Kts	+3°	approx 58 per cent
25°	140 Kts	+5°	approx 58 per cent
50°	140 Kts	0°	approx 72 per cent
50°	130 Kts	+2°	approx 72 per cent

1.16.2 Visual Illusion Research

Considerable international research has been carried out over the past 20 years into visual illusionary effects experienced by pilots. This has included studies of visual errors induced by heavy rain on aircraft windscreens.

The research conclusions describe three effects of rain on windscreens. Firstly, a blurring of vision. Secondly, a prismatic refraction by the water pooling on the windscreen, in a thicker layer at the top as the result of wind effect. This causes an apparent downward displacement of objects. Finally, a light dispersion that causes perception of the visible horizon to appear as gradient blur. The last two effects act in the same direction and cause the 'horizon' to appear depressed as much as 1:12. This tends to cause a pilot to believe that he is higher than he is, and therefore descend the aircraft too low.

1.16.3 Approach Flight Path Derivation and Evaluation

The Bureau of Meteorology conducted a post-analysis of upper wind conditions and vertical temperature gradient in the air masses on both sides of the front. This was based on radiosonde balloon flights made from two locations along the frontal path (Mount Gambier, South Australia and Laverton, Victoria) prior, and subsequent to, passage. The results were:

Altitude	*Pre-front*	*Post-front*
(feet AMSL)	(degrees magnetic/knots/degrees Celsius)	
1000	330/20/+20	240/25/+15
2000	330/40/+18	240/35/+13
3000	310/50/+15	260/40/+9

The rate of frontal movement, as it passed over Melbourne Airport, was measured as approximately 30 knots. Frontal passage was noted at the airport anemometer site at about 1334 hours. Assuming these figures as exact, frontal movement back along the approach to Runway 27 was calculated at:

	Hours
Runway 27 threshold	1335:12
(1000 metres east of anemometer)	
Middle Marker	1336:22
Outer Marker	1342:43
Epping Locator	1352:13

From inspection of the FDR traces, a marked increase in total energy was noted, primarily in the airspeed record, over the period 65–75 seconds before touchdown. On the assumption that this was indicative of frontal passage, pre- and post-frontal atmospheric conditions were appropriately applied to the FDR information to derive an approach flight path. This is at Appendix E.

Touchdown was estimated, from communication records, at close to 1342 hours. Assuming this time as exact, and applying the derived ground speed profile back along the approach, gave the following times of station passage for the aircraft:

	Hours
Middle Marker	1341:48
Outer Marker	1340:37
Epping Locator	1339:14

Comparing this timetable to the frontal movement schedule indicated aircraft passage of the front at 1340:50 hours; 70 seconds before touchdown.

Various other times of frontal passage were applied to the FDR information but none of the resultant station passage schedules, when matched to the calculated frontal movement schedule, resulted in as close a fit. Hence, the base assumption as to frontal passage was considered valid.

The following reconstruction of the approach was made. All times are in seconds prior to touchdown.

VH-TJP passed over Epping locator at 175 seconds, descending through 2950 feet, on a heading 268 degrees magnetic but closing the localiser from the north under the influence of the strong northerly wind. The IAS was about 235 knots and decreasing. At approximately 165 seconds the descent was stopped and the aircraft flown level until the glideslope was captured from below. On passing through the glideslope the descent was recommenced and the 3 degree profile maintained, with minor deviations of about half a dot on the glideslope indicator (each dot equals 0.25 degres deviation) until 95 seconds. During this period the localiser was captured and maintained at an aircraft heading of approximately 275 degrees magnetic. The IAS had continued to decrease, but at a slower rate, and at 95 seconds was about 180 knots, still some 30 knots above the selected approach airspeed. The aircraft altitude was about 1830 feet; an average rate of descent since passing the Epping locator of 840 feet per minute. There were still some 8000 metres to run to the runway threshold.

The rate of descent was then reduced and the aircraft began to deviate above the glideslope. At the same time a left turn of approximately five degrees was made and the aircraft also began to deviate left of the localiser. The Outer Marker was crossed at 83 seconds. At 75 seconds the aircraft encountered wind shear associated with the passage of the front. The IAS increased approximately 15 knots, to 195 knots, over a 10 second period. This was accompanied by a brief pause in descent which caused the aircraft to be displaced some two dots above glideslope.

The aircraft then entered a descent at about 1200 feet per minute. At the same time the aircraft began to turn to the left but, because of the cessation of left drift, the localiser was still closed at approximately 60 seconds. A more rapid left turn onto 255 degrees magnetic was then made, and this caused the aircraft to again deviate left of the localiser by about one dot on the course deviation indicator (each dot equals 1.25 degrees of localiser deviation). Immediately following this turn the rate of descent increased to about 1500 feet per minute, and this expedited closure of the glideslope. However, as the high rate of descent was as maintained the aircraft passed through the glideslope at approximately 38 seconds. It was at this time that a right turn to a heading of about 267 degrees magnetic was commenced.

By 30 seconds the aircraft was some two dots below glideslope and approaching the minimum altitude of 700 feet. The descent was halted and this altitude maintained until the aircraft was back on glideslope, at about 20 seconds. The descent was then resumed at an initial rate of some 900 feet per minute. Throughout this period the IAS remained in the 175–180 knots range.

During the last 20 seconds of flight the rate of descent increased, and averaged some 1100 feet per minute over this period. The aircraft remained approximately on localiser but rapidly dropped below glideslope. The IAS fluctuated downwards, but at touchdown was still 171 knots.

The FDR vertical acceleration record indicated moderate activity throughout the approach, increasing in frequency over the last 90 seconds of the flight. Much of this was probably the result of atmospheric disturbance, and was reflected in the airport anomometer record of an 11 knot surface wind gust range. However, some of the vertical acceleration activity was undoubtedly caused by control input; the level-off at about 30 seconds, the resumption of descent at about 20 seconds and the rotation of the aircraft during the last 5 seconds of the flight are examples.

There were two marked excursions in the IAS record, commencing at 38 seconds and 16

seconds. The first was a fall and recovery of approximately 14 knots and the second was a fall of 16 knots followed by a rise of 10 knots. Each excursion occupied some 10 seconds of time. Possibly these reflected some changes to aircraft power setting or flight control inputs, but the rates of deceleration were such as to suggest that wind gust activity was also a factor.

In support of this conclusion, the Douglas Aircraft Company provided data for the reported aircraft configuration and atmospheric temperature and pressure conditions, that indicated if both engines were reduced to idle thrust the theoretical rate of aircraft deceleration would be 2.4 feet per second per second. Such a reduction in power would be normal just prior to touchdown, and possibly earlier if some attempt was being made to eliminate excessive airspeed. However, this would not by itself acount for the recorded decelerations of 3.9 and 3.0 feet per second per second, respectively.

1.17 ADDITIONAL INFORMATION:

1.17.1 TAA Operating Procedures

TAA flight crew operating procedures and instructions are contained in two documents; an Operations Manual and a Flight Training Manual. All procedures described in this section were current at the time of the incident.

The TAA DC-9 Operations Manual contained instructions relevant to Approach and Landing in a section titled Normal Procedures. These instructions were general in nature; applying to both visual and all varieties of instrument approaches. The terminology used allowed for either Captain or First Officer to manipulate the flight controls by addressing duties to titles such as 'the pilot not at the controls'. Included were requirements for cross-check procedures between the two pilots; to provide alerting of IAS variations of ± 5 knots from the selected approach airspeed and rates of descent in excess of 800 feet per minute when below 1500 feet above aerodrome elevation. A further requirement was that 'the aircraft will be established on glideslope or in the "slot" in the landing configuration at the selected airspeed at a point not less than 700 feet above the airport level'.

Additional information specifically related to instrument approach was contained in the same section of the Operations Manual, under the title Monitored Approach. This information commenced with a statement of TAA policy; that the normal procedure for all instrument approaches was to be a monitored approach with the aircraft flown by the First Officer whilst the Captain supervised the over-all approach sequence. In amplification the instructions stated that the First Officer was to remain 'on instruments' throughout the approach, even if the aircraft entered visual flight conditions and the Captain assumed physical control to complete the landing. Should the aircraft remain in instrument flight conditions at the approach minimum altitude then the First Officer was to initiate a go-around. The instructions also reaffirmed the cross-check procedures between pilots, in respect of excessive IAS and rate of descent excursions.

The Operations Manual also stated that the monitored approach procedure could be discontinued at any time at the Captain's discretion. However, the manual did not provide instructions or procedures specific to the case where a Captain elected to physically control the aircraft during all or part of an instrument approach, prior to encountering visual conditions.

In respect of approach speeds, the Operations Manual instructed that the minimum airspeed was titled Reference Airspeed (VRef) but that an approach airspeed in excess of VRef was to be selected in strong wind conditions, to compensate for gradient and gust effects. The Flight Training Manual amplified this instruction, and advised that VRef should be increased by 50 per cent of the gradient wind plus 100 per cent of the gust factor, to a maximum total increase of 15 knots. This instruction, however, had been contained in an amendment to the Flight Training Manual that was issued on 1 November 1978. Previously the maximum total increase in airspeed due to wind effects had been 20 knots.

Both the Operations Manual and Flight Training Manual indicated that landings were to be made with 50 degrees flaps extended. The only exception to this practice was in respect of single-engine approaches when flaps extension was to be limited to 25 degrees. In this circumstance, VRef, related to the 50 degrees landing, should be increased by 10 knots to obtain a new Reference Airspeed for 25 degrees flaps. The Flight Training Manual also contained the advice that in the reduced flaps configuration there was a markedly higher body angle of approximately six degrees, on approach.

Neither manual contained instructions or procedures to be followed when wind shear was expected or encountered.

1.17.2 Low Level Wind Shear Procedures

On 1 November 1976 the Department of Transport issued a NOTAM which introduced Low Level Wind Shear Procedures at aerodromes within primary control zones. Due to the lack of suitable ground-based equipment to measure wind shear the procedures consisted of limited advisory measures, based on Bureau of Meteorology prognoses of wind shear or pilot reports of encounters with wind shear on approach or take-off.

Introduction of the Bureau of Meteorology wind shear forecasting service was delayed until September 1977. Prior to this, the wind shear procedures had been reviewed and an amended NOTAM was issued on 11 August 1977. Under the revised procedures: (a) the Bureau of Meteorology provided ATC with probability forecasts whenever weather conditions were conducive to the presence of wind shear, (b) pilots were required to report encounters with wind shear to ATC, and (c) ATC was responsible to include forecasts, reports and observations of wind shear on aerodrome ATIS broadcasts and also relay direct to following aircraft all pilot reports of wind shear. Should severe wind shear, in association with thunderstorm activity be reported, ATC would close either the aerodrome or affected runway. Unless ATC closed an aerodrome or runway, the decision to continue an approach or take-off rested with pilots in command.

1.17.3 Aerodrome Closure Procedures

Department of Transport instructions contained procedures requiring closure of controlled aerodromes under certain circumstances. One occasion was when the cloud base and/or visibility was less than the specified minima for take-off or landing.

In addition, senior tower controllers were not permitted to authorise an instrument approach unless reasonably satisfied that an aircraft could be flown clear of cloud, in sight of ground or water and with the specified minimum visibility from the minimum altitude to touchdown. In this respect, the requirement to assess RVR when visibility was below 2000 metres has been described in Section 1.7 of this report.

When conditions were marginal or fluctuating about the minima, a tower controller could permit operations to continue, provided each aircraft was advised of the prevailing conditions. However, operations should not be permitted when RVR assessments were in use, unless it was certain that the specified minimum RVR existed.

2. ANALYSIS

2.1 METEOROLOGICAL ASPECTS

The general weather conditions encountered in the Melbourne area by VH-TJP were essentially as forecast before the aircraft's departure from Brisbane. However, the movement of the front across Victoria was not at a constant rate; it was measured at about 20 knots at the western border of the State but was moving at approximately 30 knots as it passed over Melbourne Airport. Consequently the forecast was in error by 26 minutes from the 1400 hours to 1600 hours period predicted for airport passage. The early arrival

coincided with that of VH-TJP and the approach and landing were made at a time of rapid weather variation. Such variation is common with the passage of a major weather disturbance. The more extreme conditions are generally of limited endurance and, in this instance, improved markedly within 30 minutes, and stabilised after 50 minutes. This was consistent with the forecast duration of up to one hour.

The most significant departure from forecast conditions was in respect of visibility. A reduction, because of rain, to 3000 metres was predicted and during the approach the flight crew of VH-TJP was advised the (ground) visibility was 2000 metres. For a period of several minutes, however, covering the time that the aircraft transitted the final segment of its approach, there was evidence that ground visibility at the airport was between 1100 metres and 1500 metres. There is not a constant relationship between ground and flight visibility and hence evidence of the former does not permit the visual range available to the flight crew to be calculated.

The Bureau of Meteorology omission in respect of a wind shear forecast is not considered significant to the incident. The flight crew of VH-TJP was alert to the probable existence of wind shear on final approach from the reports of changing weather conditions provided by ATC.

2.2 AIR TRAFFIC CONTROL ASPECTS

Twice during the approach, VH-TJP was advised by ATC that visibility was 2000 metres. On the second occasion (the Aerodrome Controller's direct advice at 1339:58 hours) there was evidence that visibility from the tower was less than this figure and probably in the range 1100 to 1500 metres.

A specific reason for the incorrect advice to VH-TJP was not established. From the available evidence it would appear that the second advisory was a restatement of the initial evaluation, and that the Aerodrome Controller had not assimilated the visual cues that indicated the figure of 2000 metres was no longer valid. Possibly contributing to this omission were the rate of weather deterioration, some degree of variation in the visibility from minute to minute and the increased workload resulting from the change.

Had the controller correctly interpreted the visual cues it was possible that subsequent events might have been entirely different. Following an assessment that the visibility was below 2000 metres an officer would have been dispatched to the threshold of Runway 27 to assess the RVR. Then, because of the time involved in this procedure, it is probable that VH-TJP's approach clearance would have been cancelled. The subsequent events of a delayed approach would most likely have varied from those of the incident.

As an RVR assessment was not made, it was not established whether the minimum required 1200 metres existed at the time of the incident. However, as visual observations from the tower towards the threshold of Runway 27 covered, in the reciprocal direction, approximately the same area as that which would be included in a RVR assessment, it is considered that a RVR of 1100 to 1500 metres was likely to have existed.

If a RVR assessment had been made, and a figure of less than 1200 metres determined, then the runway should have been closed. Alternatively, an assessment of 1200 metres or greater would have permitted authorisation of the approach and landing. The advice of marginal RVR, that would have accompanied such a clearance, might have provided a timely warning to the flight crew of VH-TJP that there was doubt of their gaining the necessary outside reference to continue below minimum altitude.

In evaluating the significance of ATC involvement in the incident, it is relevant that both ground visibility estimates and RVR assessments may vary significantly from the flight visibility available to a flight crew on approach to land. Hence, this ground information can, at best, be only a guide to aircraft and, except in the case where ATC closes an aerodrome or runway because of extremely poor visibility, it is the flight crew's ultimate responsibility to establish that adequate visual reference, above the specified minimum, exists before continuing an approach below minimum altitude.

Thus it is concluded that the Aerodrome Controller's omission contributed to the occurrence, but only insofar as the flight crew were not provided with secondary information to assist in assessing the adequacy of landing visibility.

2.3 FLIGHT CREW ASPECTS

Without access to the CVR information, and with some restriction on the availability of flight crew witness evidence because of industrial restraints, it was not possible to develop the human factors investigation to the extent obviously warranted by the incident circumstances. The following considerations are, however, suggested by the available evidence.

There were no known abnormal pressures on the flight crew to complete the flight without delay. Periods of weather deterioration, of up to one hour duration, had been forecast and the aircraft carried a fuel reserve to permit avoidance of extreme weather conditions. The flight had not experienced any significant delay prior to arrival in the Melbourne terminal area, so presumably the only pressure on the flight crew was the normal desirability of maintaining the operator's schedule.

Yet the evidence suggests there was some haste in the manner in which the approach was flown. A non-standard configuration of 25 degres flaps was chosen and a consequently high selected approach airspeed of 152 knots calculated. Then, throughout the approach, an IAS of some 20 to 30 knots higher than that selected was maintained.

It is a possibility that the excessive airspeed reflected a lack of familiarity with, or consideration of, the aircraft's performance in the 25 degrees flaps configuration. Simulator test results indicated a close comparison of body angle and required power between the 25 degrees flaps/170 knots IAS and the 50 degrees flaps/140 knots IAS approaches. If during the approach the Captain had selected an attitude and power setting equating to the 50 degrees flaps configuration with which he was more familiar, then the aircraft would have achieved an airspeed of the order recorded on the FDR.

It was indicated that the reduced flap configuration was a precaution against the possibility of encountering windshear. Such is not a commonly accepted counter and, for the readily predictable wind shear effect that would be met during the frontal passage, was more likely to result in a subsequent problem of excessive airspeed and overshoot potential at landing. As the strong wind associated with the front backed from the north to the west, an aircraft, on approach to a westerly runway, could be expected to experience a cessation of left drift and an increase in IAS, with a resultant tendency to climb above glideslope. Such a change, generally described as 'overshoot shear', would be on the 'safe' side. Rather the danger lay in over-correction of the displacement. A reduced flap configuration and associated higher approach airspeed would compound the recovery problem as a greater power reduction would be necessary to correct for the unwanted energy gain.

It is considered relevant that the operator's manuals did not contain information and/or procedures for guidance when wind shear was known or expected. This lack of available reference was possibly a factor in the incident, as it left the formation of the best approach procedure to the Captain, based on what was possibly an incomplete understanding of the wind shear phenomenon.

The addition of a 20 knot component to the selected approach airspeed, to compensate for wind gradient and gust effects, was contrary to the Flight Training Manual limitation of 15 knots, but the change from a total additive of 20 knots had only been introduced some four weeks before. Apparently neither pilot had assimilated the change because although the Captain made the initial calculation he discussed it with the First Officer and was not corrected. However, as the actual IAS throughout the approach bore no relation to the selected approach airspeed, this error is not considered relevant to the incident.

The omission of a pre-approach briefing and the delay in checking IAL data until some 1500 feet on final approach suggests that although engaged in an IFR flight, and cleared for

an ILS approach, the two pilots were largely employing non-instrument procedures. Their initial arrival expectancy was probably based on the ATIS information Papa, which indicated visual flight conditions could reasonably be expected by no lower than 2500 feet. The initial exchanges with Approach Control, whilst advising of a change of runway, did not contradict this conclusion.

The first information to indicate a need for meaningful IFR procedures was at 1336:19 hours, when the aircraft had some 30 kilometres to run, and Approach Control advised of reduced visibility and heavy rain. Why the flight crew did not immediately adopt full instrument flight procedures was not determined. Perhaps there was some resistance to accept the sudden deterioration as other than a brief, transitory event. Possibly subsequent direct observation was an influence as, within a further three minutes, both pilots could see the initial half of the runway from some 2000 feet on final approach. In the event, it seems the crew's acceptance that a primarily visual approach technique was not possible did not occur until about the 1500 feet point; and even then instrument procedures were not fully implemented. This is considered a major factor in the incident.

Adoption of full instrument procedures, as laid down in the Operations Manual, would have involved the First Officer taking over the flying to complete a monitored approach. The manual does, however, acknowledge the Captain's command prerogative to discontinue the monitored approach procedure at any time, and such was apparently the decision in this instance; the monitored approach procedure was never initiated. The considerations on which this decision was based were not established.

Whilst acknowledging that the Captain may discontinue monitored approach procedures, the Operations Manual did not extend to the inclusion of alternative procedures, based on the Captain personally flying an instrument approach. It would, however, be reasonably expected that the general instructions relating to IAS and rate of descent cross-checks, contained in the Approach and Landing Subsection of the Normal Procedures Section, still applied.

This lack of detailed alternative procedures could possibly have been an influence in the resultant, unco-ordinated actions of the flight crew. From their subsequent descriptions it appears that the Captain primarily flew by reference to the instruments from 1500 feet whilst the First Officer monitored outside, with some instrument cross-checks, but that from about 800 feet (400 feet AGL) both pilots were almost exclusively concentrating outside and the instruments were ignored. It is not, however, considered reasonable to classify the Operations Manual omission as a factor in the incident in view of the flight crew's general neglect of published procedures as a whole.

With respect to flight instrument checks, the flight crew subsequently recounted only three specific items of recall. The First Officer stated he believed the rate of descent was about 650 feet per minute at 800 feet. This is consistent with the FDR information that the aircraft was in the process of levelling off at minimum descent altitude at that time. The Captain stated he recalled an on-glideslope to half-a-dot low indication at 300 feet AGL; again this is consistent with the derived flight path plot. The final item of recall, that the IAS indicated 155 knots at one stage of the approach, cannot be resolved; the FDR airspeed record does not indicate so low an IAS throughout the entire approach.

The investigation did not establish what cross-checks, if any, occurred in respect of the Operations Manual requirement to alert the pilot at the controls of IAS variations of + 5 knots from the selected approach airspeed and rates of descent in excess of 800 feet per minute when below 1500 feet above aerodrome elevation. Either the First Officer did not monitor the instruments, or he noted the abnormal indications and elected not to alert the Captain or, having issued the alerts, was ignored by the Captain. Whichever was the case, it is evident that a major breakdown in crew co-operation and co-ordination ocurred during the approach.

It is considered that prudence would have dictated a delay in the commencement of the final approach, at least long enough to evaluate the rapidly changing weather situation, and

plan, brief and action appropriate instrument approach procedures. Certainly, the Operations Manual implies that the approach should have been abandoned when stability, particularly in respect of approach airspeed, had not been established by 700 feet AGL. Yet the approach was continued to, and the aircraft briefly levelled at, the minimum altitude.

The decision to continue the approach beyond this point, if the excessive airspeed could be overlooked, was dependent on the Captain's assessment that adequate conditions existed for visual flight and that forward visibility was 1200 metres or greater. The investigation was not able to establish precisely what flight visibility existed at the minimum altitude because the flight crew could not subsequently indicate any fixed reference point by which to gauge this value. Certainly, the crew sighted approach lights but they did not provide sufficient information, such as how many rows were in view at any given time, to serve as a basis for calculation of visibility. The best available information was that the First Officer initially sighted the green threshold lights at an estimated 100 feet AGL. At that altitude, by reference to the flight path plot, the aircraft was some 550 metres short of the threshold.

In terms of completing a safe landing, the First Officer's visual range was of less importance than that of the Captain, who was physically flying the aircraft. In this respect, the captain's subsequent statement that he sighted neither the threshold nor the threshold lights prior to touchdown indicates that flight visibility was considerably less than that necessary to fly by external reference alone. Yet the approach was continued.

It was not established whether continuation of the approach resulted from an indefinite deferral of the continue/go-round decision or a determination to land that overrode the evidence of sub-minimal visibility. However, it is considered the failure to recognise that conditions were unsuitable for a visual landing, and initiate a go-round, was the primary casual factor in the incident.

In considering the circumstances of the final large deviation below glideslope, it is significant that neither pilot monitored the aircraft instruments. Instead, by attempting to fly solely by reference to the runway approach lights the crew risked their judgment being influenced by illusory effects resulting from the heavy rain on the windscreen. The research into this phenomenon indicates a depression of the 'horizon' by up to 1:12. The gradient from the 'on-glideslope at minimum altitude' point to where VH-TJP touched down was 1:14. Whilst not conclusive evidence of visual illusory effect, it is considered this possibility cannot be excluded.

Although lacking adequate visual reference the Captain did report that he 'sensed' the aircraft sink. This was probably the result of wind gust effects, as indicated by the FDR and airport anemometer records, although aircraft power changes and flight control inputs might have contributed to the sensation. With the limited FDR information and the uncertainty of flight crew recollection, it was not possible to make a comprehensive evaluation of the effect of gust activity on the aircraft's descent profile. It is considered that the extent of any gust-induced displacement would have been largely dependent on the speed of recognition of the change. If a disturbance had been recognised early, say by flight instrument indication,and timely opposing control input made, the effect of the gusts upon aircraft descent profile at the high existing airspeed would probably have been slight. However, from the available evidence it seems likely that the Captain recognised a gust-induced sink in sufficient time to rotate the aircraft to approximately a normal landing attitude, but not sufficiently early to significantly reduce the final rate of descent.

The First Officer's calls concerning 'looking a bit low' and 'you are going to hit the lights' may also have influenced the outcome of the incident. Lacking adequate visual reference it was possibly the stimulus of these warnings, combined with the gust-induced sink, that caused the Captain to apply back-control input. Consequently, although the touchdown was hard it was not sufficiently severe, or in such an attitude, as to cause structural failure.

3. CONCLUSIONS

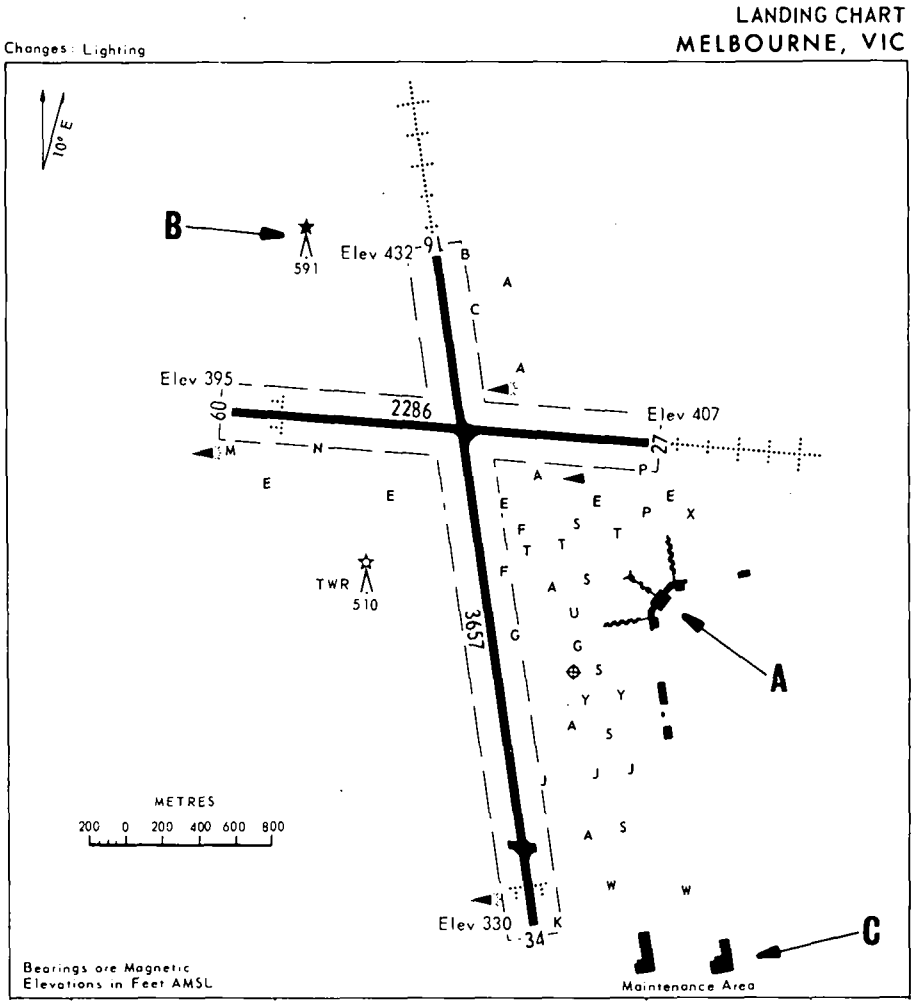
1. The flight crew was appropriately qualified and licensed.
2. There was a current Certificate of Airworthiness for the aircraft. There was no evidence of defect or malfunction which might have contributed to the incident.
3. The aircraft was loaded within safe limits.
4. Relevant Melbourne Airport facilities, specifically Runway 27, its associated instrument landing system and high intensity approach lighting system, complied with prescribed standards. There was no evidence of defect or malfunction of these facilities which might have contributed to the incident.
5. The weather at Melbourne Airport was essentially as forecast by the Bureau of Meteorology, except that the passage of a cold front was some 26 minutes earlier than predicted and visibility in heavy rain was less than the forecast 3000 metres.
6. Associated with the frontal passage was a change in surface wind; backing from about 340 degrees magnetic, at 25 knots with gusts to 35 knots, to about 240 degrees magnetic, at a similar speed and gust range. This change was predicted but the Bureau of Meteorology had not issued the additionally required wind shear forecast.
7. ATC provided the aircraft with advice of the rapidly changing weather conditions at the airport, except that the minimum visibility advised was 2000 metres when actual ground visibility from the tower was probably in the range 1100 to 1500 metres.
8. ATC did not comply with procedures that required the assessment of RVR when visibility was below 2000 metres, and the determination that RVR was at or above the specified minimum of 1200 metres before authorising an approach and landing.
9. The company's Operations Manual and Flight Training Manual did not contain procedures to be adopted when wind shear was encountered or expected. Nor did these documents contain procedures to be employed when a Captain elected not to carry out the monitored approach procedure.
10. The Captain of VH-TJP elected to make a landing approach during the period of frontal passage and, in anticipation of probably encountering wind shear, selected a non-standard approach configuration of 25 degrees flaps extension. This configuration was unsuited to the predictable conditions to be met during the approach.
11. A detailed approach briefing and study of the appropriate instrument approach and landing documents were not carried out prior to the commencement of the approach. Nor was a Monitored Approach procedure, as contained in the company Operations Manual, adopted.
12. The approach was unstable, with the IAS generally some 20 to 30 knots in excess of the selected approach airspeed of 152 knots.
13. Wind shear associated with the frontal passage was encountered at an altitude of approximately 1650 feet, about 8 seconds after the aircraft passed over the outer marker beacon. As a result the aircraft became displaced from the glideslope but the correct descent profile was re-established at about the minimum altitude.
14. The Operations Manual requirement for the approach to be stabilised by 700 feet above aerodrome elevation was not achieved.
15. The approach was continued below the minimum altitude although external reference sufficient to safely complete a visual landing had not been established. The existing flight visibility was less than the specified 1200 metres minimum.
16. There was a major breakdown in crew co-ordination. As a result the flight instruments were not monitored below the minimum altitude.
17. The aircraft's rate of descent increased to average approximately 1100 feet per minute during the final 15 seconds of flight. An illusory effect, induced by heavy rain on the windscreen, and wind gust activity may have contributed to this high rate of descent.
18. The aircraft did not sustain damage as a result of the high rate of descent at touchdown and only minor damage from impact with the approach lights.

4. CAUSE

The probable cause of the incident was that the approach to land was continued below the minimum altitude, when external reference was insufficient to permit the completion of a safe landing.

APPENDIX A

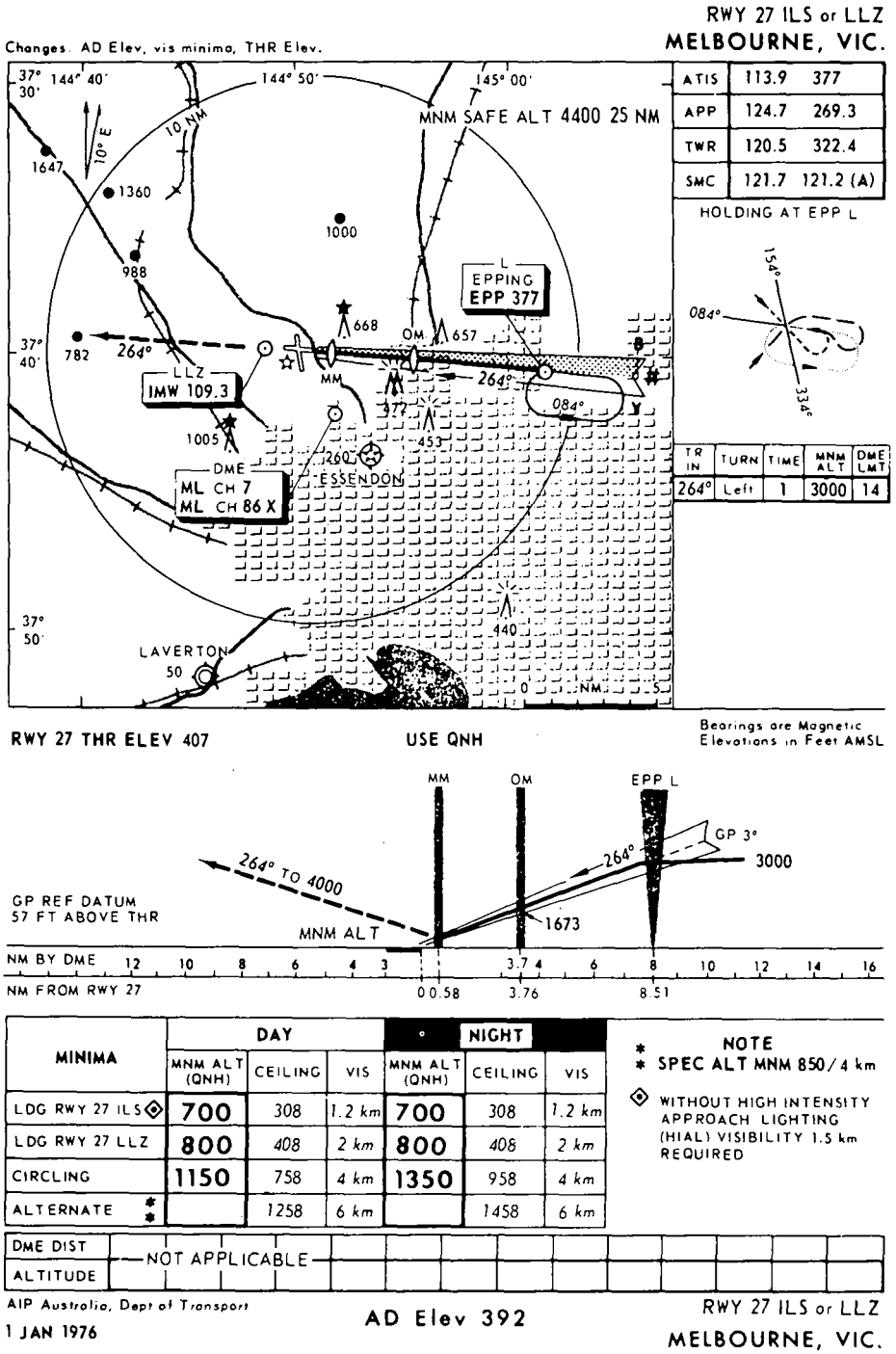
AIRPORT PLAN



VISIBILITY CHECK LANDMARKS:

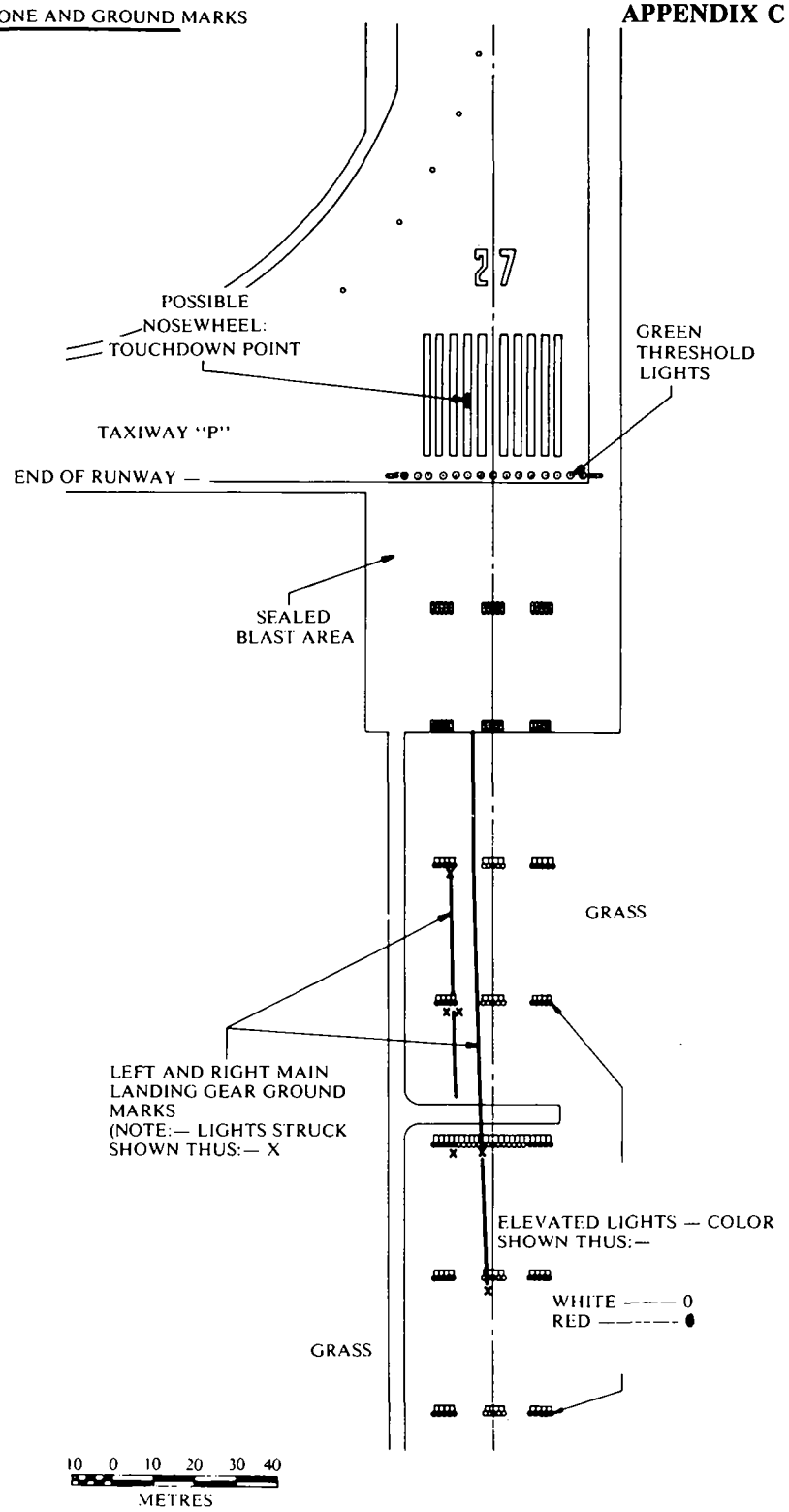
- **A — Airport terminal buildings [1500 metres]**
- **B — Route Surveillance Radar aerial [2000 metres]**
- **C — Maintenance Hangar [3000 metres]**

APPENDIX B

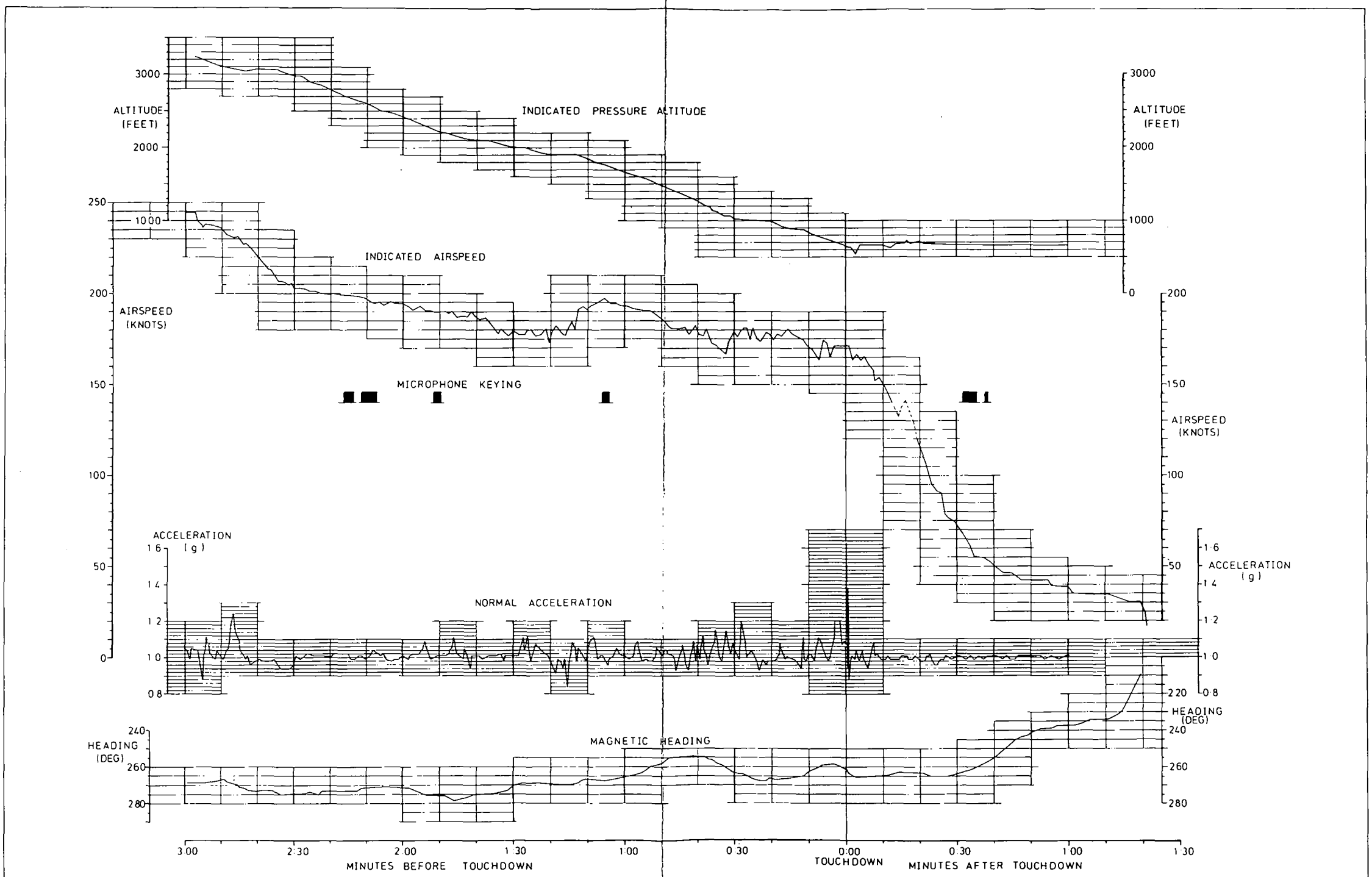

RWY 27 ILS or LLZ
MELBOURNE, VIC.
Changes: AD Elev, vis minima, THR Elev.
ATIS 113.9 377
APP 124.7 269.3
TWR 120.5 322.4
SMC 121.7 121.2 (A)
HOLDING AT EPP L
MNM SAFE ALT 4400 25 NM
EPPING
EPP 377
LLZ
IMW 109.3
DME
ML CH 7
ML CH 86 X
ESSENDON
LAVERTON
TR IN | TURN | TIME | MNM ALT | DME LMT
264° | Left | 1 | 3000 | 14
RWY 27 THR ELEV 407
USE QNH
Bearings are Magnetic
Elevations in Feet AMSL
GP REF DATUM
57 FT ABOVE THR
264° TO 4000
MNM ALT
1673
GP 3°
3000
NM BY DME
NM FROM RWY 27
0 0.58 3.76 8.51
MINIMA | DAY | NIGHT
MNM ALT (QNH) | CEILING | VIS | MNM ALT (QNH) | CEILING | VIS
LDG RWY 27 ILS ◈ | 700 | 308 | 1.2 km | 700 | 308 | 1.2 km
LDG RWY 27 LLZ | 800 | 408 | 2 km | 800 | 408 | 2 km
CIRCLING | 1150 | 758 | 4 km | 1350 | 958 | 4 km
ALTERNATE * * | | 1258 | 6 km | | 1458 | 6 km
NOTE
* SPEC ALT MNM 850/4 km
◈ WITHOUT HIGH INTENSITY APPROACH LIGHTING (HIAL) VISIBILITY 1.5 km REQUIRED
DME DIST — NOT APPLICABLE
ALTITUDE
AIP Australia, Dept of Transport
1 JAN 1976
AD Elev 392
RWY 27 ILS or LLZ
MELBOURNE, VIC.

TOUCHDOWN ZONE AND GROUND MARKS

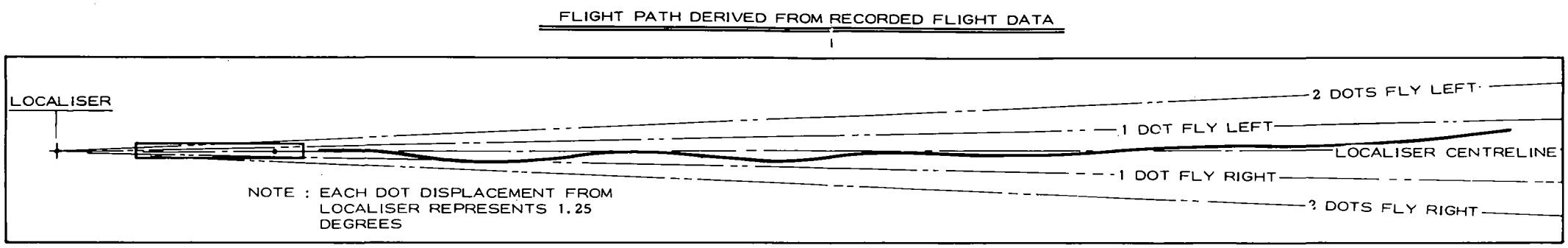
APPENDIX C

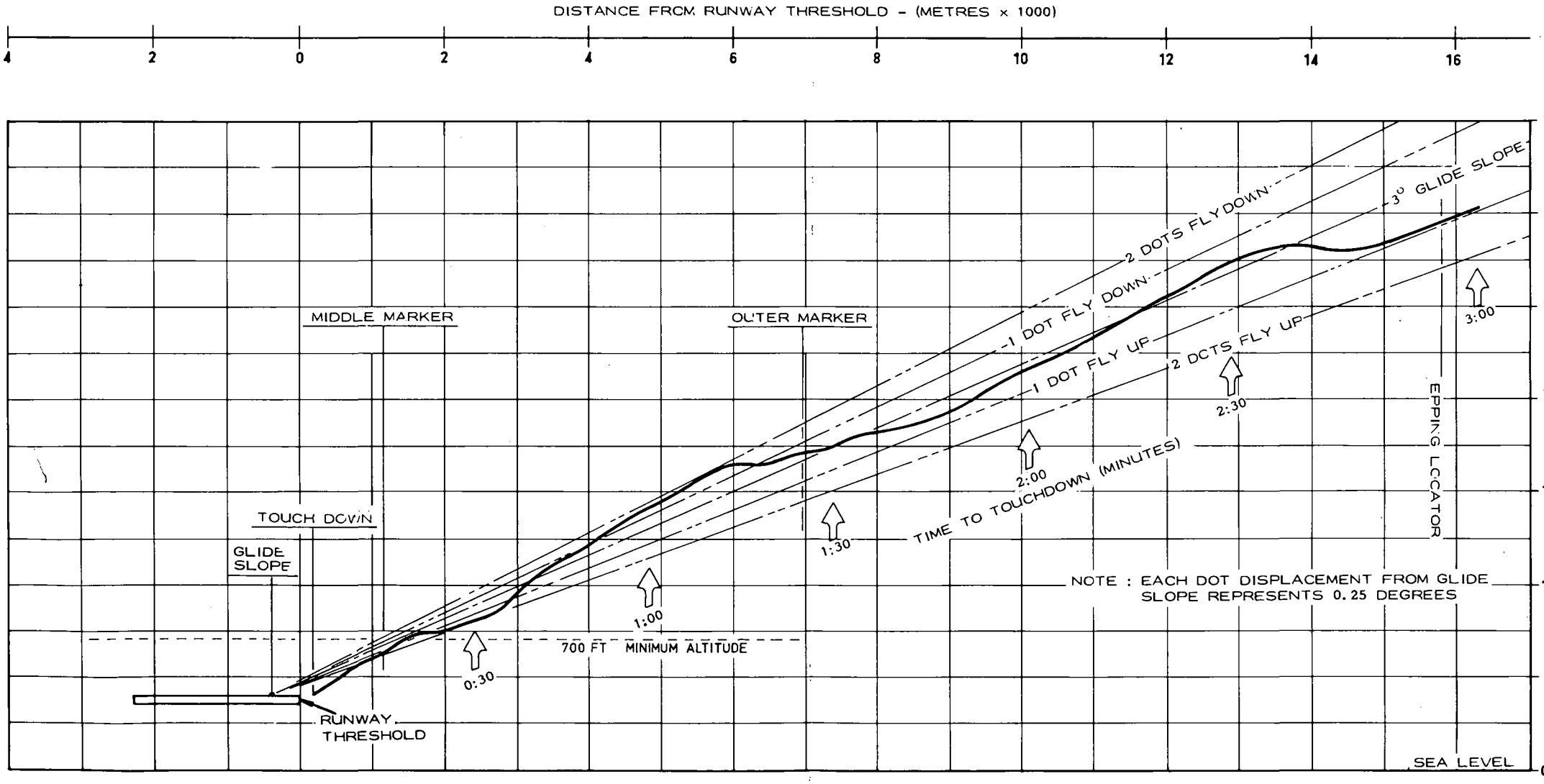


APPENDIX D


ALTITUDE (FEET)
3000
2000
1000
0
INDICATED PRESSURE ALTITUDE
INDICATED AIRSPEED
AIRSPEED (KNOTS)
250
200
150
100
50
0
MICROPHONE KEYING
ACCELERATION (g)
1·6
1·4
1·2
1·0
0·8
NORMAL ACCELERATION
HEADING (DEG)
240
260
280
MAGNETIC HEADING
3·00
2·30
2·00
1·30
1·00
0·30
0·00
0·30
1·00
1·30
MINUTES BEFORE TOUCHDOWN
TOUCHDOWN
MINUTES AFTER TOUCHDOWN

APPENDIX E


FLIGHT PATH DERIVED FROM RECORDED FLIGHT DATA
LOCALISER
2 DOTS FLY LEFT
1 DOT FLY LEFT
LOCALISER CENTRELINE
1 DOT FLY RIGHT
2 DOTS FLY RIGHT
NOTE : EACH DOT DISPLACEMENT FROM LOCALISER REPRESENTS 1.25 DEGREES


DISTANCE FROM RUNWAY THRESHOLD - (METRES x 1000)
4
2
0
2
4
6
8
10
12
14
16
3·5
3·0
2·5
2·0
1·5
1·0
0·5
0
HEIGHT ABOVE MEAN SEA LEVEL - (FEET X 1000)
3° GLIDE SLOPE
2 DOTS FLY DOWN
1 DOT FLY DOWN
1 DOT FLY UP
2 DOTS FLY UP
MIDDLE MARKER
OUTER MARKER
TOUCH DOWN
GLIDE SLOPE
RUNWAY THRESHOLD
700 FT MINIMUM ALTITUDE
0:30
1:00
1:30
2:00
2:30
3:00
TIME TO TOUCHDOWN (MINUTES)
EPPING LOCATOR
NOTE : EACH DOT DISPLACEMENT FROM GLIDE SLOPE REPRESENTS 0.25 DEGREES
SEA LEVEL

APPENDIX F
Transcript of Communications Concerning McDonnell Douglas DC-9-31 Aircraft VH-TJP Recorded at Melbourne Between 1334 Hours and 1343 Hours on 29 November 1978

Legend

TJP — McDonnell Douglas DC-9-31 Aircraft VH-TJP
APP — Melbourne Approach Control
TWR — Melbourne Tower (Aerodrome Control)
— — *Unintelligible word(s)*

Time h/min/sec	From	To	Text
1334:00			
1334:06	TJP	APP	MELBOURNE APPROACH TANGO JULIET PAPA is approaching - - - -
	APP	TJP	TANGO JULIET PAPA MELBOURNE APPROACH good afternoon descend to three thousand not below the DME steps QNH one zero zero one you have three zero miles to run straight in change of runway two seven track er via Epping locator and two seven localiser.
1334:26	TJP	APP	JULIET PAPA good afternoon three thousand
1334:46	APP	TJP	TANGO JULIET PAPA the wind's coming around to the west now at three zero knots I'll have a new ATI for you in about um thirty seconds
1334:55	TJP	APP	JULIET PAPA roger
1336:19	APP	TJP	TANGO JULIET PAPA the QNH now one zero zero two decimal five the visibility two thousand metres and heavy rain wind two four zero degrees three zero gusting to four zero you have one eight miles to run clear for final runway two seven ILS.
1336:41	TJP	APP	JULIET PAPA thank you
1336:50	APP	TJP	TANGO JULIET PAPA the QNH now one zero zero five
	TJP	APP	JULIET PAPA roger
1338:00	APP	TJP	TANGO JULIET PAPA the um cloud cover six oktas at one five zero zero with lower patches the temperature now one seven
	TJP	APP	TANGO JULIET PAPA
1339:35	APP	TJP	TANGO JULIET PAPA call the tower now one two zero decimal five the QNH now one zero zero four
	TJP	APP	JULIET PAPA
1339:44	TWR	TJP	TANGO JULIET PAPA this is MELBOURNE TOWER do you read
	TJP	TWR	MELBOURNE TOWER TANGO JULIET PAPA is on final leaving two thousand

Time h/min/sec	From	To	Text
	TWR	TJP	TANGO JULIET PAPA roger continue approach I've no idea of the cloud base its quite low visibility is two thousand metres in heavy rain surface wind two five zero degrees two zero gusting three zero runway and approach lighting are on stage five
1340:08	TJP	TWR	JULIET PAPA roger
1340:46	TWR	TJP	TANGO JULIET PAPA QNH one zero zero four decimal five clear to land
1340:52	TJP	TWR	TANGO JULIET PAPA
1342:00	TWR	TJP	TANGO JULIET PAPA are your ops normal
	TJP	TWR	JULIET PAPA roger yep they're okay
	TWR	TJP	Roger taxi with caution have a look when you get in will you
	TJP	TWR	Roger.

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