Department of Transport and Regional Development

Bureau of Air Safety Investigation

INVESTIGATION REPORT

9501246

Israel Aircraft Industries Westwind 1124 VH-AJS Alice Springs, NT 27 April 1995

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CONTENTS

GLOSSARY OF TERMS AND ABBREVIATIONS

ADF	Automatic Direction Finder
AIP	Aeronautical Information Publication
ATPL	Airline Transport Pilot Licence
CASA	Civil Aviation Safety Authority
COMM	Communications
CST	Central Standard Time
DH	Decision Height
DME	Distance Measuring Equipment
fpm	Feet Per Minute
FSF	Flight Safety Foundation
GPWS	Ground-Proximity Warning System
hPa	Hectopascals
ICAO	International Civil Aviation Organisation
ILS	Instrument Landing System
LSALT	Lowest Safe Altitude
MDA	Minimum Descent Altitude
ME	Multi-Engine
MSALT	Minimum Safe Altitude
MTAF	Mandatory Traffic Advisory Frequency
NDB	Non-Directional Beacon
NOTAM	Notice to Airmen
Octa	Cloud amount expressed in eighths.
OLS	Obstacle Limitation Surface
QNH	An altimeter sub-scale setting to show height above sea level.
RNAV	Area navigation. A method of navigation that allows an aircraft to operate on any desired course within the coverage of station-preferred navigation signals or within the limits of self-contained system capability.
T-VASIS	'Tee' Visual Approach Slope Indicating System
VOR	Very high frequency Omni Range
VREF	Reference speed. The minimum speed at 50 feet above the runway during a normal landing approach.
Note 1	All times are in Australian Central Standard Time (Co-ordinated Universal Time + 9.30 hours).
Note 2	All bearings are in degrees magnetic.
Note 3	Distances expressed as miles are nautical miles.
Note 4	All temperatures are in degrees Celsius

INTRODUCTION

The main purpose of investigating air safety occurrences is to prevent aircraft accidents by establishing what happened, how, and why the occurrence took place, and determining what the occurrence reveals about the safety health of the aviation system. Such information is used to make recommendations aimed at reducing or eliminating the probability of a repetition of the same type of occurrence and, where appropriate, to increase the safety of the overall system.

To produce effective recommendations, the information collected and the conclusions reached must be analysed in a way that reveals the relationship between the individuals involved in the occurrence, and the design and characteristics of the system within which those individuals operate.

This investigation was conducted with reference to the general principles of the analytical model developed by James Reason of the University of Manchester (see Reason, *Human Error* (1990)).

According to Reason, common elements in any occurrence are:

- *organisational failures* arising from managerial policies and actions within one or more organisations (these may lie dormant for a considerable time);
- *local factors*, including such things as environmental conditions, equipment deficiencies and inadequate procedures;
- *active failures* such as errors or violations having a direct adverse effect (generally associated with operational personnel); and
- *inadequate or absent defences* and consequent failures to identify and protect against technical and human failures arising from the three previous elements.

Experience has shown that occurrences are rarely the result of a simple error or violation but are more likely to be due to a combination of a number of factors, any of which by itself was insufficient to cause a breakdown of the safety system. Such factors often lie hidden within the system for a considerable time before the occurrence and can be described as *latent failures*. However, when combined with local events and human failures, the resulting combination of factors may be sufficient to result in a safety hazard. Should the safety defences be inadequate, a safety occurrence is inevitable.

An insight into the safety health of an organisation can be gained by an examination of its safety history and of the environment within which it operates. A series of apparently unrelated safety events may be regarded as *tokens* of an underlying systemic failure of the overall safety system.

SYNOPSIS

The crew was conducting a practice locator/NDB approach to Alice Springs, at night, in clear moonless conditions. The approach involved a stepped descent in three stages using three navigation aids. The pilot in command had earlier briefed the co-pilot that the ‘not below’ altitude after the final approach fix for the approach (2,780 feet) would be used as ‘the minimum’ for their purposes.

The flight proceeded normally until the aircraft passed overhead the final approach fix when the pilot in command asked the co-pilot to set the ‘minima’ in the altitude alert selector. The co-pilot responded by calling and setting ‘2300 feet’. This altitude was the Category A/B aircraft minimum descent altitude as depicted on the Jeppesen chart for the approach. The minimum descent altitude for the Westwind, which is a Category C aircraft, was 3,100 feet. The 2,300 feet called by the co-pilot was acknowledged by the pilot in command, and the aircraft then descended to that altitude. Shortly after levelling at about 2,250 feet, the aircraft struck the top of the Ilparpa Range and was destroyed.

The crew had descended to the incorrect minimum descent altitude before reaching the appropriate sector of the approach.

The investigation revealed a number of factors relating to the performance of the crew. Also revealed were a number of pre-existing conditions which contributed to the actions of the crew. These ranged from crew experience and training, to procedures and policies of the operator and regulator.

The report concludes with a number of safety recommendations.

1. FACTUAL INFORMATION

1.1 History of the flight

The aircraft was on a scheduled freight service from Darwin via Tindal, Alice Springs, and Adelaide to Sydney under the IFR. The flight from Darwin to Tindal was apparently normal, and the aircraft departed Tindal slightly ahead of schedule at 1834 CST. The pilot in command occupied the left cockpit seat. At 1925, the aircraft reported at position DOLPI (200 miles north of Alice Springs) Flight Level 330, to Melbourne Control. Another Westwind aircraft was en route Darwin–Alice Springs and was more than 40 miles ahead of VH-AJS.

Information from the aircraft cockpit voice recording confirmed that the pilot in command was flying the aircraft. At about 1929, he began issuing instructions to the co-pilot to program the aircraft navigation system in preparation for a locator/NDB approach to Alice Springs. The pilot in command asked the co-pilot to enter an offset position into the area navigation (RNAV) system for an 11-mile final for runway 12. The co-pilot entered the bearing as 292 degrees Alice Springs. (This was the outbound bearing from Alice Springs NDB to Simpson’s Gap locator indicated on the locator/NDB approach chart.) The pilot in command stated that he had wanted the bearing with respect to the runway, 296 degrees, entered but said that the setting could be left as 292 degrees. He then instructed the co-pilot to set Alice Springs NDB frequency on ADF 1, Simpson’s Gap locator on ADF 2, and to preset the Temple Bar locator frequency on ADF 2 so that it could be selected as soon as the aircraft passed overhead Simpson’s Gap. He indicated his intention to descend to 4,300 feet until overhead Simpson’s Gap, and said that the co-pilot should then set 3,450 feet on the altitude alert selector. On passing Temple Bar, the co-pilot was to set 2,780 feet on the altitude alert selector which the pilot in command said would be used as the minimum for the approach.

At 1940, the co-pilot contacted Adelaide Flight Service (FIS) and was given the Alice Springs weather, including the local QNH. At 1945, he advised Adelaide FIS that the aircraft was leaving Flight Level 330 on descent. At about 30 miles from Alice Springs, the pilot in command turned the aircraft right to track for the offset RNAV position 292 degrees/11 miles Alice Springs. The crew set local QNH passing 16,000 feet and then completed the remaining transition altitude checks. These included selecting landing and taxi lights on.

At 1949, the co-pilot advised Adelaide FIS that the aircraft was transferring frequency to the Alice Springs MTAF. At 1953, the aircraft passed Simpson's Gap at about 4,300 feet and the co-pilot set 3,500 feet in the altitude alert selector. About 15 seconds later, the pilot in command told the co-pilot that, after the aircraft passed overhead the next locator, he was to set the 'minima' in the altitude alert selector. At 1954 , the pilot in command called that the aircraft was at 3,500 feet. A few seconds later, the co-pilot indicated that the aircraft was over the Temple Bar locator and that they could descend to 2,300 feet. The pilot in command repeated the 2,300 feet called by the co-pilot and asked him to select the landing gear down. The crew then completed the pre-landing checks. Eleven seconds later, the co-pilot reported that the aircraft was 300 feet above the minimum descent altitude. This was confirmed by the pilot in command. About 10 seconds later, there were two calls by the co-pilot to pull up. Immediately after the second call, the aircraft struck the top of the Ilparpa Range (approximately 9 kilometres north-west of Alice Springs Airport), while heading about 105 degrees at an altitude of about 2,250 feet in a very shallow climb.

At approximately 1950, witnesses in a housing estate on the north-western side of the Ilparpa Range observed aircraft lights approaching from the north-west. They described the lights as appearing significantly lower than those of other aircraft they had observed approaching Alice Springs from the same direction. The lights illuminated buildings as the aircraft passed overhead and then they illuminated the northern escarpment of the range. This was followed almost immediately by fire/explosion at the top of the range.

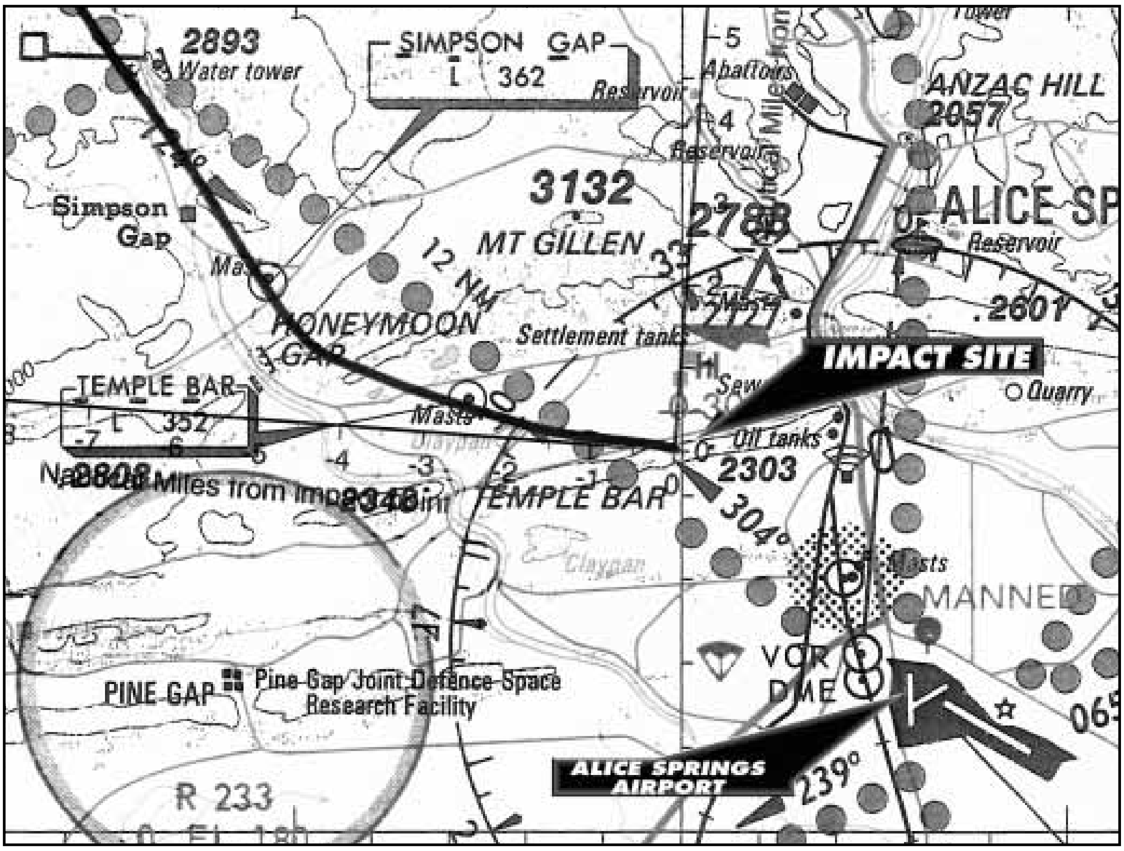

Figure 1. Locality map showing the accident site in relation to Alice Springs Airport.

1.2 Injuries to persons

	Crew	Passengers	Other	Total
Fatal	2	1	-	3
Serious	-	-	-	-
Minor	-	-	-	-
None	-	-	-	-
TOTAL	2	1	-	3

1.3 Damage to aircraft

The aircraft was destroyed by impact forces and post-impact fire.

1.4 Other damage

No other damage was reported.

1.5 Personnel information

	Captain	**First officer**
Sex	Male	Male
Age	48	32
Licence category	ATPL	ATPL
Medical certificate	Class one	Class one
Instrument rating	ME command	ME command
Total hours	10,108.8	3,747.1*
Total on type	2,591	80.7
Total last 90 days	133.9	100
Total on type last 90 days	133.9	80.7
Total last 24 hours	2.5	2.5
Total night	1,329.3	469.5
Last flight check	6 December 1994	13 March 1995
	(Route check)	(2nd class endorsement)

* Includes 2,664.8 helicopter flight hours.

1.5.1 Previous 72-hour history

Both crew members were on the same duty schedule during the 72 hours prior to the accident. On 24 April, they commenced duty at 0300 and flew a Westwind aircraft Darwin–Tindal–Alice Springs–Adelaide, completing duty at 0800. The crew had the following day off in Adelaide. On 26 April, they flew Adelaide–Alice Springs–Tindal–Darwin, being on duty 0300–0800. The crew was then off duty until 1700 on 27 April, prior to departing Darwin. Both crew members were reported to have rested in Darwin from approximately midday 26 April to midday 27 April.

1.5.2 Relevant operational experience

Pilot in command

Records indicated that the pilot in command gained his student licence in June 1965. In December 1982 he gained a senior commercial licence and in August 1991, a 1st Class ATPL. His flying career included three years as co-pilot on DC-9 aircraft from late 1987 until 1989. In July 1987, while employed by a regional airline, he completed a crew resource management course run by a major Australian airline. This course included modules on crew teamwork, communications styles, self management, cockpit communications, and team decision making.

The pilot in command completed a 2nd class endorsement on Westwind aircraft in December 1989 and gained a 1st class endorsement on the type in July 1992. He then flew Westwind aircraft until mid-1994 before spending six months flying Shorts SD3-30 aircraft. In December 1994 he returned to flying Westwind aircraft and continued to do so until the time of the accident.

The pilot in command had flown regular night freight operations during April 1995, including five flights through Alice Springs. On the night of 4 April 1995, he flew a practice Alice Springs locator/NDB approach (see paragraph 1.17.6). The operator advised that the pilot in command had flown into Alice Springs in daylight some 2–3 times in the past 12 months and six times in the past two years in Westwind aircraft.

The pilot in command had substantial experience in two-crew operations. This included some 3,300 hours as co-pilot and 3,200 hours as pilot in command.

The following extracts were obtained from company records of route checks and instrument rating renewals undergone by the pilot in command:

24 November 1991—base/route check

> NDB: Final tracking needs improvement otherwise very good.

17 April 1992—instrument rating renewal

> Final tracking NDB needs improving; crew coordination very good; F/O [first officer] monitoring very good.

16 December 1992—route check

> Orientation; you must know where you are at all times.

17 December 1992—route check

> Allow for errors in ADF when turning; keep the F/O in the loop, tell him what to do even if it is easier to do yourself.

21 December 1992—route check

> More ICUS [in command under supervision] and non-precision approaches needed before cleared to operate unrestricted as captain.

28 June 1993—route check

> Excellent pilot with well developed crew resource management principles.

It was reported that on an earlier flight into Alice Springs, the pilot in command believed that the jet circuit height of 1,500 feet above ground level was equivalent to an altimeter reading of 2,300 feet. It was pointed out to him that this placed the aircraft at 500 feet above ground level.

Co-pilot

The co-pilot obtained a 2nd class endorsement on the Westwind aircraft on 13 March 1995 and had flown about 80 hours since then, all on Westwind aircraft on night freighter operations. He had regularly flown during April 1995 both to and from Darwin via Alice Springs. Details of his flights with the pilot in command were as follows:

Date	Aircraft	Route
20 April 1995	VH-AJK	Sydney–Adelaide–Alice Springs–Tindal–Darwin
24 April 1995	VH-AJK	Darwin–Tindal–Alice Springs–Adelaide
26 April 1995	VH-AJK	Adelaide–Alice Springs–Tindal–Darwin
27 April 1995	VH-AJS	Darwin–Tindal–**

** = accident flight.

The co-pilot had over 1,000 hours experience in two-crew operations. This included 600 hours on Fairchild Metro III aircraft and 440 hours in helicopters. The Westwind was the only Category C aircraft the co-pilot had flown. There was no evidence that the he had received any formal crew resource management training.

1.5.3 Crew relationship

Information was obtained from other pilots who had flown with the pilot in command and company management. Overall, the pilot in command was considered to be a capable pilot who was conscientious and very knowledgeable about the Westwind and flying procedures. He was noted for his attention to detail. However, there was some comment about the manner in which the pilot in command related to co-pilots in the cockpit. To some, this manner was viewed as firm but acceptable. Others felt that the pilot in command was over-critical and intolerant of junior co-pilots. One co-pilot reported that he had felt distressed when in the cockpit with the pilot in command and that it was difficult to concentrate on his flying duties. However, as he gained experience these difficulties had eased. The company chief pilot advised that there had previously been an instance of a conflict between the pilot in command and another co-pilot. He had spoken to both individuals in resolving the issue.

The co-pilot on the accident flight had complained to one of his colleagues that the pilot in command had been critical of his performance on the flight from Adelaide to Darwin on 26 April 1995. The co-pilot was concerned that the pilot in command was adopting an over-critical approach in the cockpit. However, he was encouraged to do his best and told that the situation would improve as he gained experience. It was reported that, before the aircraft departed Darwin on the evening of the accident, the co-pilot had discussed his concerns with the pilot in command. However, the outcome of this conversation was not established. There was evidence on the cockpit voice recording of the pilot in command criticising the co-pilot during the accident flight (see paragraph 1.11.2).

1.6 Aircraft information

1.6.1 Significant particulars

Manufacturer	Israel Aircraft Industries
Model	1124 Westwind
Serial number	221
Registration	VH-AJS
Year of manufacture	1978

Place of manufacture		Israel
Engines		2 x Garrett TFE 731-3
Certificate of airworthiness		
	No.	KSA 279/02
	Issued	16 September 1993
Category of operation		Transport
Certificate of registration		
	No.	KSA 279/02
	Issued	16 September 1993
Maintenance release		
	No.	1675
	Issued	7 April 1995
	Valid to	11,543.2 hours or 7 October 1995
Total airframe hours at		
	27 April 1995	11,508.9 (estimated)

1.6.2 Additional engine data

The left engine (Serial No. P77142c) had a total time in service of 15,423.6 hours at the time of the accident. Its time since last overhauled was 532.3 hours. The right engine (Serial No. P77175) had a total time in service of 11,021.5 hours. Its time since last overhauled was 1,154.1 hours.

1.6.3 Weight and balance

The estimated basic operating weight of the aircraft for the flight was 5,735 kg, which included the weight of the passenger. The freight load was 639 kg and 2,270 kg of fuel was on board the aircraft. This gave an estimated ramp weight of 8,644 kg, well below the maximum take-off weight of 10,727 kg. The centre of gravity was within limits.

1.6.4 Ground-proximity warning system (GPWS)

The aircraft was not fitted with a GPWS, nor was this required by regulation.

1.6.5 Altimeters

The aircraft was equipped with two pressure altimeters. The unit on the pilot in command's instrument panel was an electrically powered altimeter, servo-driven from the air data computer. The co-pilot's altimeter was a standard mechanically driven pressure altimeter. At high climb or descent rates, the co-pilot's altimeter showed some lag compared to the electrically powered unit.

The aircraft was also fitted with a radio altimeter (see paragraph 1.18.8).

1.7 Meteorological information

At the time of the accident, the weather at Alice Springs was fine with visibility 40 kilometres and 1 octa of highlevel cirrus cloud. The surface wind was from the east at about 9 kilometres per hour. The ambient air temperature was 18 degrees Celsius and the barometric pressure 1,021 hectopascals. The night was dark and clear with moonrise after midnight.

1.8 Aids to navigation

The following navigation and approach aids were functioning at Alice Springs at the time of the accident:

1. Australian DME;
2. ILS;
3. VOR; and
4. NDB.

In addition, there are three locator beacons—Simpson's Gap, Temple Bar, and Wallaby.

Functional checks were conducted on these aids following the accident and no abnormalities were found.

At the time of the accident, the following instrument approaches were published for Alice Springs:

1. DME arrival;
2. runway 12 ILS;
3. runway 12 VOR/DME;
4. runway 30 VOR/DME; and
5. locator/NDB.

1.9 Communications

Outside the hours of 0630–1900, the Alice Springs Tower was closed and the airport became an MTAF aerodrome. (An MTAF is a designated frequency, the carriage and use of which are mandatory for pilots to exchange traffic information while operating to or from an aerodrome without an operating control tower.) The MTAF frequency for Alice Springs was 118.3 MHz and applied within the Alice Springs Control Zone which extended to 4,000 feet above airport elevation to a radius of between 13 miles and 25 miles from the Alice Springs DME.

Above Flight Level 200, the aircraft was in controlled airspace and under the control of Brisbane Control until position DOLPI where it transferred to Melbourne Control. During the descent, at Flight Level 160, the aircraft transferred to the Alice Springs MTAF and remained on that frequency.

Communications between the aircraft and air traffic control were recorded by automatic voice recording equipment. The quality of recorded transmissions associated with the aircraft was good.

1.10 Aerodrome information

Alice Springs Airport is operated by the Federal Airports Corporation and is situated about 13 kilometres south-south-east of the Alice Springs township. Its elevation is 1,789 feet above mean sea level. The main runway is designated 12/30, is aligned 116/296 degrees, and is 2,438 metres long.

Runway 12 is equipped with runway lights, high intensity approach lighting, and T-VASIS set to a 3-degree glide slope. All these lights were on during the approach by VH-AJS.

At the time of the accident, NOTAM CO129/95 was current. This NOTAM advised that the Alice Springs aerodrome beacon was not available due to works in progress. This had no bearing on the accident.

1.11 Flight recorders

1.11.1 Digital flight data recorder (DFDR)

The aircraft was equipped with a Sunstrand Data Control Inc. digital flight data recorder. The parameters recorded were:

- Magnetic heading;
- Pressure altitude;
- Indicated airspeed;
- Vertical acceleration;
- Radio press-to-transmit; and
- Elapsed time.

Good quality data was obtained from the recording. Graphical presentations of the aircraft track and descent profile are shown at figs. 2 and 3.

Horizontal navigation

At 30 miles from Alice Springs, the pilot in command turned the aircraft right, heading 165 degrees to track towards the pre-set area navigation position 292 degrees/11 miles from Alice Springs. Passing about 5,000 feet, he instructed the co-pilot to de-select the area navigation position and to select the Alice Springs NDB (at time 1950.48). The aircraft then turned left heading 143 degrees and was tracking directly towards Simpson's Gap. When the aircraft passed overhead Simpson's Gap, its track was some 28 degrees right of the inbound track for the approach. About 1 mile after passing this position, when about 0.5 miles right of the Simpson's Gap–Alice Springs NDB track, the aircraft turned left to 102 degrees to pass almost overhead Temple Bar. The aircraft heading after Temple Bar veered further left to 092 degrees 10 seconds before the recording ended. In the final 10 seconds of recording, the aircraft turned right to 105 degrees.

Aircraft speed during the approach remained fairly constant at 160–170 knots until the final 26 seconds of flight where it reduced gradually to about 140 knots at the end of the recording. At these speeds, the flight time between Simpson's Gap and Temple Bar was about 1 minute, and between Temple Bar and levelling at 2,250 feet, about 50 seconds.

Vertical navigation

Approaching Simpson's Gap, the aircraft descended through 4,300 feet to about 4,000 feet before climbing back to 4,300 feet. It maintained this altitude to overhead Simpson's Gap before commencing a steady descent at about 1,100 feet per minute. The aircraft reached 3,500 feet a few seconds before passing Temple Bar and levelled briefly before descending again. The aircraft's descent rate was about 670 feet per minute for 18 seconds after passing Temple Bar and then increased to average about 1,500 feet per minute until levelling at 2,250 feet just before impact. The final 3 seconds of data recorded indicate that the aircraft was level at about 2,250 feet for 2 seconds before climbing some 12 feet, at which point the recording ended.

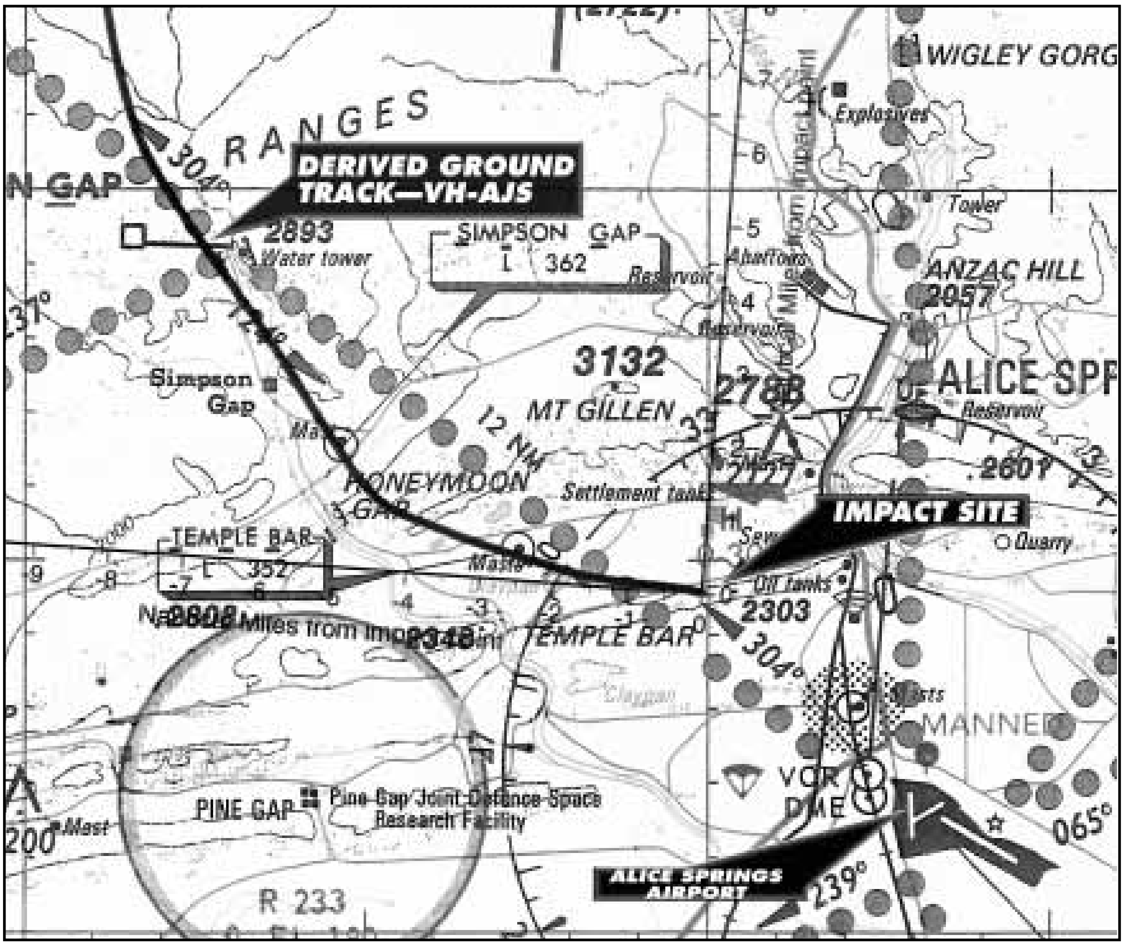

Figure 2. Plan view showing the track of VHS-AJS during the approach

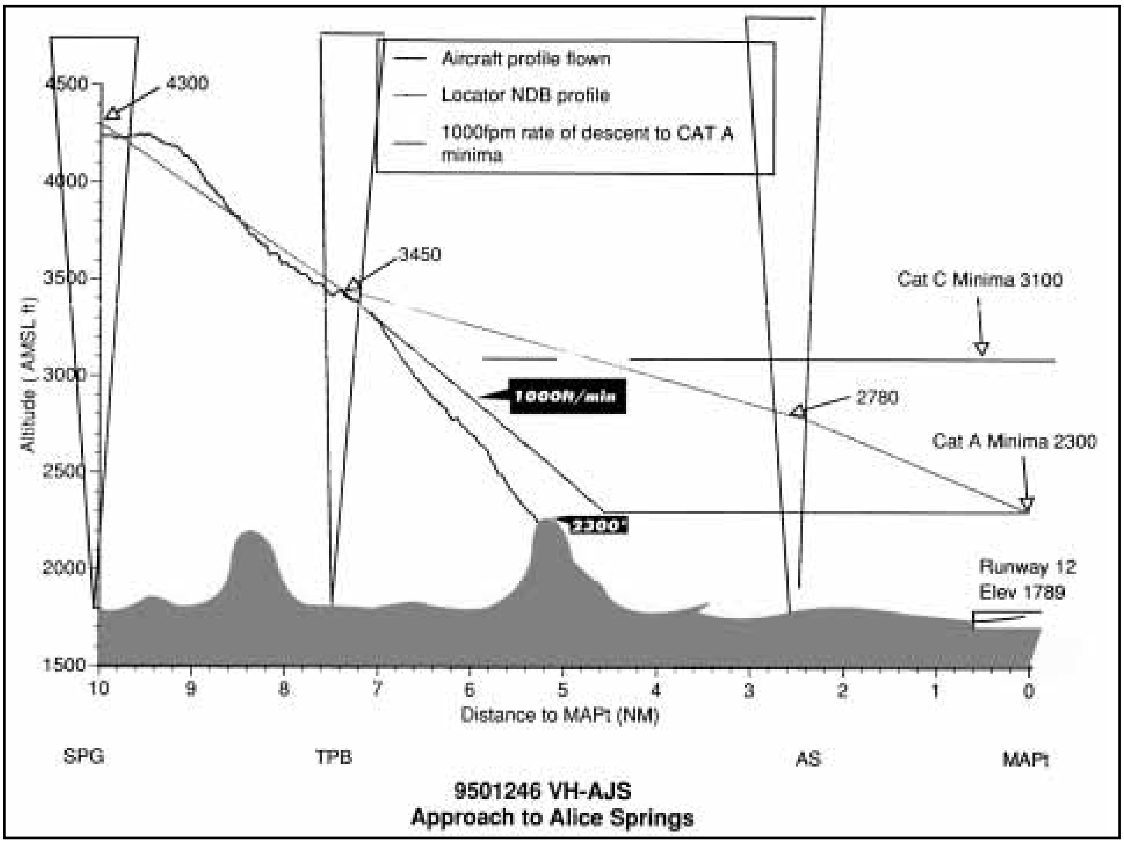

Figure 3. Side view showing vertical profile of the approach by VH-AJS.

1.11.2 Cockpit voice recorder (CVR)

The aircraft was equipped with a Loral Data Systems (Fairchild) Model A100 cockpit voice recording. The recording medium was an endless loop of magnetic tape with a recording duration of 30 minutes. Sound was recorded from a cockpit area microphone and the headsets of the captain and the co-pilot. The quality of the recording was good.

There was no indication at any stage of the recording, from either crew member or from background noise, that the aircraft was functioning other than normally. Noise of engine spool up/down was evident during the locator/NDB approach segment of the recording. Relevant extracts from the cockpit voice recording are at APPENDIX (II)

The cockpit voice recording contained several comments by the pilot in command to the co-pilot which were critical in tone and/or content. These included:

(a) At time 1925.46, the pilot in command made a comment to the co-pilot concerning a paper plate the co-pilot had placed on the centre console. The tone of the co-pilot's response indicated that he was unsettled by the comment.

(b) At 1939.50, the co-pilot initially transmitted on the wrong frequency when contacting Adelaide Flight Service. This followed a comment by the pilot in command regarding radio procedures.

(c) At 1941.51, there was an exchange between the crew regarding a heading flag. This was followed by a period of over one minute during which the co-pilot did not speak.

The cockpit voice recording indicated that the co-pilot made several errors including the following:

(a) He stated 7 miles final rather than 11 miles (1931.45).

(b) He incorrectly concluded that a traffic conflict may have existed with the Westwind aircraft ahead of VH-AJS (1932.15).

(c) He requested assistance monitoring a radio channel which did not require monitoring (1939.42).

(d) He attempted to contact Adelaide Flight Service on the wrong frequency (1940.05).

(e) He did not detect or report a heading flag (1941.51).

The cockpit voice recording revealed that the pilot in command used the phrases 'OK we'll have a fiddle with this' and 'see how it looks just for a giggle' (times 1931.59, 1934.05, and 1943.04). The chief pilot of the company operating the aircraft stated that he had not heard the pilot in command use these phrases. However, a friend of the pilot in command indicated that he had heard these phrases used by the pilot in command regularly. He further indicated that the phrases were not normally used by the pilot in command to convey a casual or frivolous intent.

At 1947.53, passing 16,000 feet on descent, the crew set the Alice Springs QNH and compared altimeter readings. According to the cockpit voice recording , the altimeter on the right instrument panel (the instrument used by the co-pilot) was indicating 150 feet lower than the pilot in command's altimeter.

1.12 Wreckage and impact information

1.12.1 Accident site description

The accident site was on the Ilparpa Range, 9 kilometres north-west of Alice Springs Airport at position 23°45.30' S, 133°49.43' E. The Ilparpa Range rises sharply some 300 feet above the surrounding terrain. It has a flat top about 100 metres wide. The range is of rocky composition with a light covering of small trees.

The impact position was close to the 300-degree bearing from the Alice Springs NDB and some 775 metres left of the runway 12 extended centreline. The elevation of the accident site was about

2,250 feet above mean sea level, some 461 feet above the Alice Springs Airport elevation.

1.12.2 Aircraft wreckage description

The aircraft struck the range tracking approximately 105 degrees, in a wings-level attitude, while climbing at an angle of about 5 degrees. Aircraft configuration at impact was landing gear down, and flaps extended 20 degrees.

Initial impact occurred when the right wingtip tank struck a rock on the north-western edge of the escarpment. The first major impact occurred 60 metres further on when the landing gear and the lower fuselage struck large rocks. The fire trail began at this point. The aircraft then progressively broke up as it continued across the top of the escarpment before cartwheeling into a ravine on the southern side. The wings and empennage, along with both engines, were at the base of the ravine. Most components had been severely affected by fire.

1.12.3 Wreckage technical examination

Structure

All aircraft extremities and control surfaces were located at the accident site. All damage was consistent with excessive loads during the impact sequence and the subsequent fire. There was no indication of any pre-existing abnormality.

Flight controls

The extent of damage precluded a complete and detailed examination of all components of the flight control system. However, it was established that at impact, flaps were extended 20 degrees and the stabiliser trim was in the neutral position.

Powerplants

The fan blades of both engines were bent in a manner consistent with fan rotation at impact. Both thrust reversers were in the stowed position. The evidence from the cockpit voice recording confirmed that the engines were operating normally during the flight.

Fuel system

The aircraft fuel system was destroyed during the impact sequence and fire. There were approximately 1,400 litres of Jet A1 fuel on board the aircraft at impact.

1.13 Medical and pathological information

Medical certificates for both crew members were valid at the time of the accident. Post-mortem examination did not reveal evidence of any pre-existing condition which might have affected the performance of either crew member.

1.14 Fire

Site examination indicated that the fuselage fuel tanks were disrupted early in the impact sequence. Ignition probably resulted from electrical arcing and/or contact with high-temperature engine components.

1.15 Survival aspects

All occupants of the aircraft received injuries consistent with high impact forces, aircraft breakup, and fire. The crew seats had torn loose from the cockpit structure. The pilot in command's seat had the complete harness still attached; all four individual straps were undone, and the loose seat buckle lay nearby. Examination of the end fittings and buckle revealed no indication of abnormal loads pulling the end fittings from the buckle. The pilot in command's injuries indicated that both the lap and shoulder harnesses were secure at impact. It is likely, therefore, that the harness abnormalities were caused during the impact and breakup sequence.

On the co-pilot's seat, the remains of the straps were securely attached. However, the buckle was not found. Information from the cockpit voice recording indicated that the passenger was probably positioned at the cockpit door observing the operation of the aircraft and was not strapped into the passenger seat at impact.

1.16 CASA surveillance

In the period July 1994–April 1995, CASA conducted surveillance activities on the operator on six occasions. No significant deficiencies were recorded on any of the surveillance reports.

1.17 Alice Springs locator/NDB approach

1.17.1 Instrument approach design criteria

The criteria used in Australia for approach design are contained in volume 2 of the ICAO document, *Procedures for Air Navigation Services—Aircraft Operations (Pans-Ops)*. Briefly, an approach may consist of up to five separate segments—the arrival, initial, intermediate, final, and missed approach segments. The segments begin and end at designated fixes. For each segment, an associated area is provided and a minimum altitude/height is calculated by considering a minimum obstacle clearance. Track guidance is normally provided for all phases of flight through all segments. The only criterion for the approach slope is that it should not exceed 400 feet per nautical mile. Non-precision approaches such as the Alice Springs locator/NDB approach, which utilise either a racetrack procedure or a reversal (base turn or procedure turn), do not contain an intermediate approach segment. Upon completion of the reversal or racetrack procedure, the aircraft is considered to be on final approach.

Non-precision approaches have calculated minimum descent altitudes. Minimum descent altitudes are partly a function of aircraft approach speed and are listed on charts and are shown as Categories A (the slowest approach speed) to D (the highest approach speed).

1.17.2 Alice Springs locator/NDB approach

The AIP Alice Springs locator/NDB approach chart current at the time of the accident (dated 11 November 1993) is shown at fig. 4. It required the pilot to fly to overhead the Alice Springs NDB not below 5,000 feet. The aircraft was then to track approximately 11 miles north-west to the Simpson's Gap locator at a minimum altitude of 4,300 feet. After passing overhead this position, the aircraft had to complete a procedure turn through 180 degrees to again track overhead Simpson's Gap onto the final segment of the approach. This segment involved the aircraft tracking overhead the Temple Bar locator to the Alice Springs NDB while descending from 4,300 feet. The minimum altitude permitted between Simpson's Gap and Temple Bar was 3,450 feet, and between Temple Bar and the Alice Springs NDB 2,780 feet. After passing the Alice Springs NDB, the procedure required the aircraft to continue straight ahead to the minimum descent altitude. For aircraft Categories A and B, the minimum descent altitude was 2,300 feet (using actual QNH) and for Category C aircraft it was 3,100 feet. The Westwind is a Category C aircraft. On a normal profile, the Category C minima would be reached between Temple Bar and the Alice Springs NDB.

1.17.3 History of the approach

The Alice Springs NDB and the Simpson's Gap and Temple Bar locators were installed in the mid-1960s. On 8 November 1973, a runway 12 twin locator DME approach was published. On 5 April 1990, this was replaced by the locator/NDB approach.

In August 1992, an Alice Springs based pilot wrote to the then Civil Aviation Authority drawing attention to apparent inaccuracies in the then current locator/NDB approach chart. The writer noted that the Simpson's Gap and Temple Bar locators were on the ILS inbound track of 116 degrees. On the locator/NDB chart, the inbound track via the two locators was shown as 112 degrees. The locator/NDB chart also showed the track joining the two locators and the NDB as a straight line.

In its response to the letter, the Civil Aviation Authority acknowledged that there was an error in the chart and advised its intention 'to re-draw the chart at a future date to remove this confusion'. A note of action on the file indicated that the Temple Bar locator was within navigation tolerance for the procedure and that the approach chart would be amended at the next update. The next amendment was due in December 1992. However, an amended chart was not issued. CASA advised that Temple Bar was 381 metres right of the Simpson's Gap-Alice Springs NDB track. The cone of ambiguity for Temple Bar touched the Simpson's Gap-Alice Springs NDB track. Temple Bar was therefore within navigation tracking tolerance. Consequently, chart amendment was not considered urgent. Temple Bar was included in the approach as a step-down fix to provide a lower circling minimum, particularly for Category A and B aircraft.

On 1 February 1996, CASA issued an amended Alice Springs locator/NDB chart. This showed the Simpson's Gap-Alice Springs NDB track as 110 degrees and depicted Temple Bar slightly right of this track and corrected the Simpson's Gap-Temple Bar distance error on the previous chart (see paragraph 1.17.4). On 20 June 1996, a revised procedure was issued which deleted Simpson's Gap from the approach, and showed the procedural turn commencing after overhead Temple Bar. This amendment also showed the Temple Bar-Alice Springs NDB track as 108 degrees.

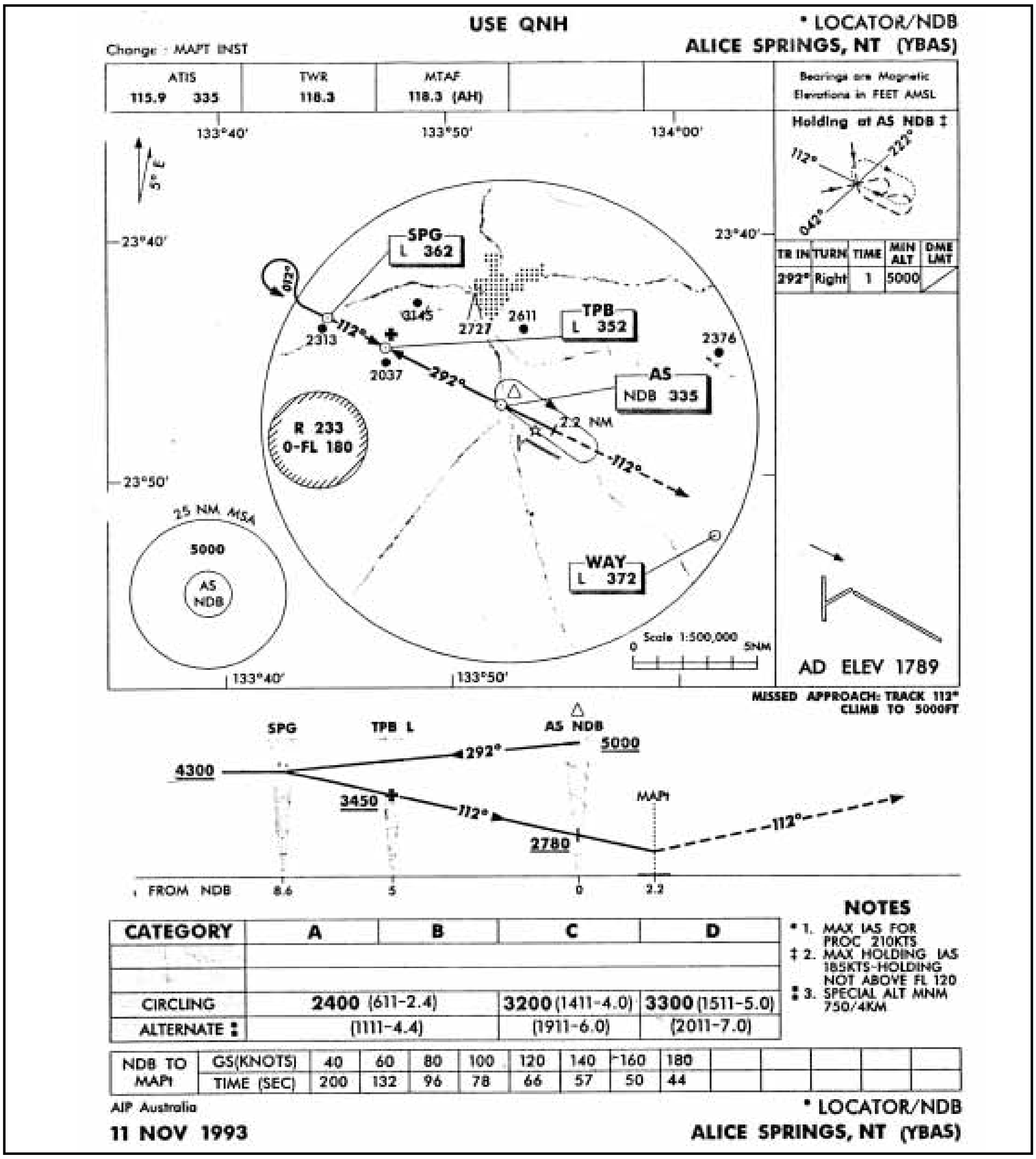

Figure 4. The AIP Australia Alice Springs locator/NDB approach chart dated 11 November 1993.

1.17.4 Alice Springs locator/NDB chart anomalies

Examination of the Alice Springs locator/NDB approach chart dated 11 November 1993 revealed the following anomalies:

1. The track between Simpson's Gap and the Alice Springs NDB was depicted incorrectly as 112 degrees instead of 110 and shown as a straight line. However, Simpson's Gap and Temple Bar were aligned with the runway while the Alice Springs NDB was north of this line. In other words, the Simpson's Gap–Temple Bar–Alice Springs track was not a straight line as depicted on the chart. Rather, Temple Bar was south of the Simpson's Gap-Alice Springs NDB track.

2. The locator/NDB chart showed the distance between Simpson's Gap and Temple Bar as 3.6 miles. The runway 12 ILS (Category 1) or LLZ/DME chart correctly showed the distance as 2.67 miles.

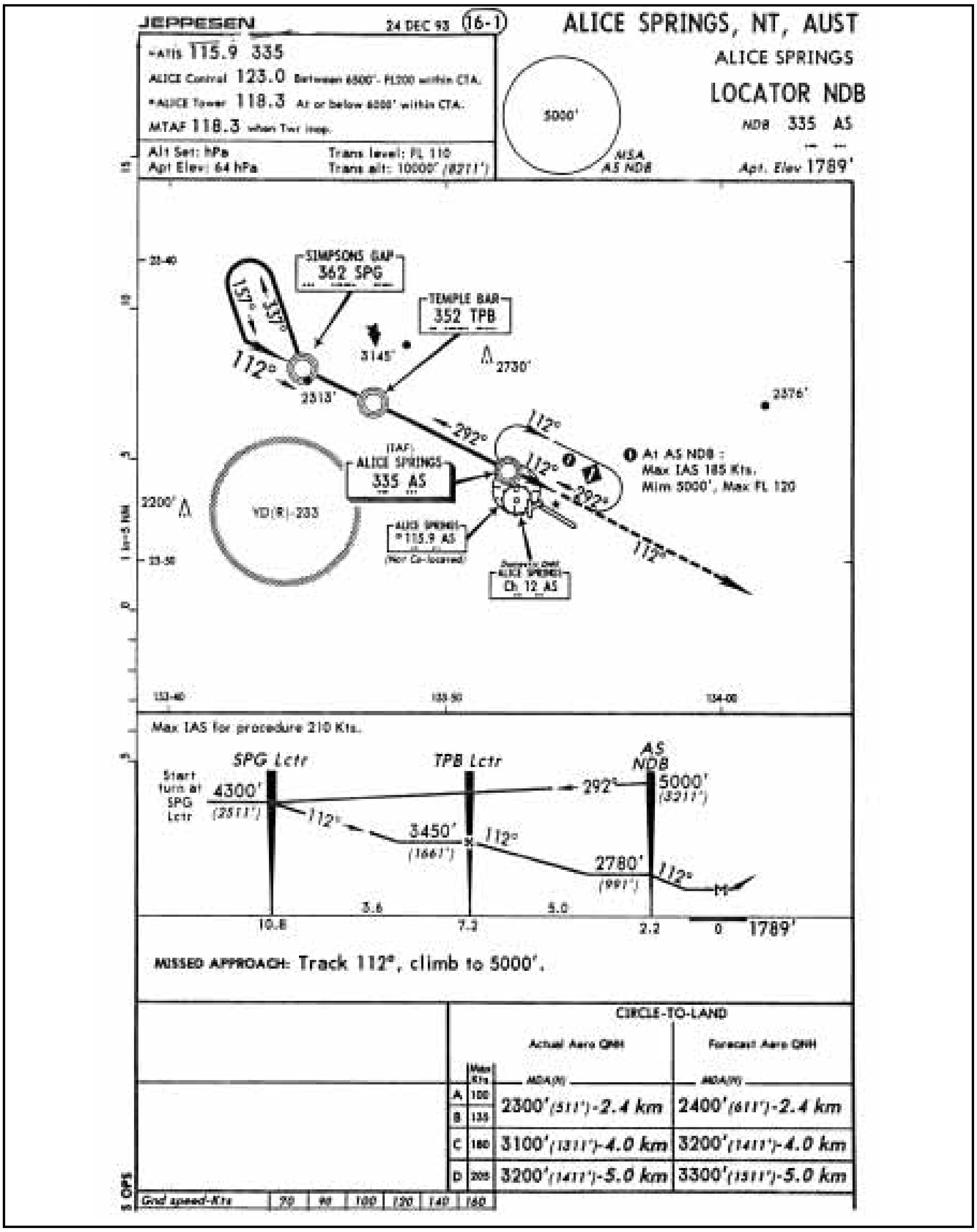

Figure 5. The Jeppesen Alice Springs locator NDB chart dated 24 December 1993.

1.17.5 AIP/Jeppesen Alice Springs locator/NDB approach chart comparison

There are two types of approach chart approved for use in Australian airspace—AIP charts supplied by Airservices Australia, and charts supplied by Jeppesen Sanderson Inc., commonly known as Jeppesen charts. Jeppesen charts are compiled from information supplied by Airservices Australia.

The AIP and Jeppesen Alice Springs locator/NDB charts current at the time of the accident (dated 11 November 1993 and 24 December 1993 respectively) are at figs. 4 and 5. While the information displayed on each chart was generally the same, a number of differences were noted:

1. The inbound descent profile on the AIP chart was shown as a straight line with 'not below' altitudes above the Temple Bar locator and Alice Springs NDB. The Jeppesen chart showed the inbound descent profile as a stepped descent to the 'not below' altitudes and the minimum descent altitude.
2. Both charts showed Temple Bar to be on the Simpson's Gap-Alice Springs NDB track. That is, the Simpson's Gap–Temple Bar–Alice Springs track was shown as a straight line with the Simpson's Gap–Temple Bar track as 112 degrees, and the bearing from Temple Bar to the Alice Springs NDB as 292 degrees.
3. The side elevation view on the AIP chart showed the distances between the locators and the NDB as roughly in proportion whereas on the Jeppesen chart they were not.
4. Distances on the AIP chart were depicted as miles from the NDB while distances on the Jeppesen chart were taken from the missed approach point (Alice Springs Airport).
5. The minima for the various category aircraft were displayed in a horizontal table on the AIP chart and in a vertical table on the Jeppesen chart.
6. The AIP minima were based on forecast area QNH. The Jeppesen chart displays two sets of minima based on actual area QNH and forecast area QNH.
7. Terrain information on both charts consisted of a number of spot heights. There were inaccuracies in some of the spot heights displayed.

1.17.6 Practice locator/NDB approach—4 April 1995

A few weeks before the accident, the company chief pilot reminded all company pilots of the recent experience requirements for instrument approaches. These requirements are detailed in Civil Aviation Order 40.2.1.11.3 and indicate that, to maintain NDB approach recency, a pilot must fly an NDB approach at least every 90 days. It was probably in response to this reminder that the pilot in command flew a practice locator/NDB approach to Alice Springs on the night of 4 April 1995 (his logbook showed that he last flew an NDB approach on 6 December 1994).

The co-pilot on the 4 April flight (who was employed by another operator) reported that the pilot in command did not fully brief the approach. He did not recall 2,780 feet being mentioned either as a 'minimum' or in any other context; nor did he mention the Category C minimum (3,100 feet). He recalled that the pilot in command tracked the aircraft to an RNAV final approach position. RNAV was then deselected and the aircraft tracked for Simpson's Gap. Altitude control was normal during the approach but track holding inbound was what he termed 'within tolerances but sloppy'. The pilot in command discontinued the approach shortly after passing overhead Temple Bar at about the Category C minimum of 3,100 feet and then manoeuvred the aircraft for a straight-in approach to runway 12.

There was anecdotal evidence that, before departing Darwin on the day of the accident, the pilot in command briefly told another company pilot of the practice approach on 4 April. The pilot in command indicated that he had experienced difficulties in flying the approach and that he intended to fly it again that evening.

1.17.7 Locator/NDB approach experience—co-pilot

There was no evidence that the co-pilot had previously flown the Alice Springs locator/NDB approach. Further, no evidence could be found of him having flown any twin locator approach. (A twin locator approach is similar to a locator/NDB approach but is structured around two navigation aids compared to three in the case of a locator/NDB approach.)

The co-pilot last flew an NDB approach on 15 February 1995 in a Metro aircraft. He had not flown an NDB approach in the Westwind.

1.17.8 Similar approaches within Australia

A check was made of AIP Australia for other approaches within Australia which might be similar to the Alice Springs locator/NDB approach. Four such approaches were identified:

1. Melbourne/Essendon (runway 17 twin locator);
2. Avalon (runway 18 twin locator);
3. Brisbane/Archerfield (twin NDB (Categories A & B)); and
4. Perth/Jandakot (twin NDB).

These approaches are structured around two navigation aids, while the Alice Springs locator/NDB approach involves three aids—two locators and an NDB. In this sense, therefore, the Alice Springs locator/NDB approach is unique.

1.17.9 Non-precision approach procedures and charts—approach profiles

ICAO *Pans-Ops* states that, in non-precision approaches, the descent gradient should not exceed 3 degrees. It also states that the maximum permissible gradient is 3.7 degrees. However, the document does not contain any guidance on the minimum gradient for non-precision approaches.

For many years, States which are signatories to the Convention on International Civil Aviation (the Chicago Convention) have supported the use of a 3-degree approach slope as standard for all approaches, be they instrument, visual, precision, or non-precision. A 3-degree approach is equivalent to a rate of descent of 300 feet per nautical mile, or a 5 per cent descent gradient. Most precision approach and visual approach slope indicator profiles provide a 3-degree slope. These standards and practices are part of the stabilised approach doctrine which is strongly established throughout the aviation community.

The stepped profile shown on Jeppesen non-precision approach charts is the profile that provides the minimum required obstacle clearance. It is not meant to depict the profile that should be flown.

1.18 Additional Information

1.18.1 AIP Procedures

Civil Aviation Regulation (CAR) 178 addresses the minimum height for flight under the instrument flight rules. It states, in summary, that an aircraft may not be flown along a route segment at a height lower than the lowest safe altitude for that segment except, among other things, during an instrument approach. CAR 179 states that, when on an IFR flight, a pilot in command 'shall follow the instrument approach procedures approved in respect of the aerodromes used'.

Aeronautical Information Publication (AIP) Departure and Approach Procedures (DAP), Holding and Instrument Approach to Land Procedures (IAL) detail the provisions which apply to aircraft operating under instrument flight rules. It states, with respect to minimum route altitudes (paragraph 1.2), the following:

> Except when complying with the requirements for a visual approach, when conforming to a published DME arrival procedure, or when under radar control, an aircraft approaching an aerodrome must not descend below the LSALT or the MSA for the route segment being flown until it has arrived over the IAF (initial approach fix) or facility.

AIP DAL IAL also includes the conditions under which a pilot may discontinue an approved instrument approach procedure. This states in part (paragraph 1.8):

> The pilot may discontinue the approved instrument approach procedure to that aerodrome when:
>
> By night. At an altitude not below the MDA for the procedure being flown, the aircraft is established:
>
> (1) clear of cloud;
>
> (2) in sight of ground or water;
>
> (3) with a flight visibility of not less than 5,000 metres; and
>
> (4) within the circling area (see Note 1); or
>
> (5) within 5 MILES of that aerodrome, aligned with the runway and on the VASIS; or
>
> (6) on the ILS glide path, at or within 10 MILES of that aerodrome, with less than full scale azimuth deflection.

AIP DAP IAL paragraph 1.5, note 2, states:

> The circling area is determined by drawing an arc centred on the threshold of each useable runway and joining these arcs by tangents.

The radius for Category C performance aircraft is 4.2 miles.

AIP DAP IAL paragraph 1.9 ('Handling Speeds') lists the handling speeds for aircraft categories during IAL procedures. For Category C aircraft, the final approach speed range is 115–160 knots. Paragraph 1.14 ('Descent Gradients') states that the rate of descent after the final approach fix 'should not normally exceed 1,000 feet per minute'.

Paragraph 1.2 of the General Information section of AIP Instrument Departure and Arrival Procedures contains the following caution:

> Spot heights on IAL charts do not necessarily indicate the highest terrain or obstacle in the immediate area.

Paragraph 1.6 of the same section contains a number of notes. Included in note 1 are the following:

> Plan and profile diagrams of holding and approach procedures in the instrument charts are diagrammatic.
>
> The profile line of a non precision segment of an instrument approach does not necessarily represent the optimum descent profile.

1.18.2 Operations manual extracts

In addressing approach procedures, section C3, subsection 3.3 of the Company Operations

Manual ('Visual and instrument departures and approach procedures') stated:

Approaches:

> The approach should be discussed and planned before commencing descent. Items to be considered are listed below:
>
> (i) descent point
>
> (ii) LSALT and MSALT
>
> (iii) DME arrival procedures
>
> (iv) field elevation
>
> (v) aids to be used
>
> (vi) commencement altitude of approach
>
> (vii) tracks and altitudes of approach
>
> (viii) height at Outer Marker or procedure turn
>
> (ix) any departure from routine
>
> (x) minimum and visibility (set DH)
>
> (xi) aiming point, runway approach, threshold elevation
>
> (xii) circling altitude for min height
>
> (xiii) overshoot procedure
>
> (xiv) planned runway and normal circuit entry height, and direction
>
> (xv) Vref and manoeuvring speeds
>
> (xvi) request non-flying pilot to give standard back-up calls.

Section C3, subsection 3.3 later addresses the responsibilities of the non-flying pilot during an instrument approach. With respect to a locator/NDB approach, these include:

- Call out deviations of 5 degrees or more on an NDB approach
- Call out vertical speed whenever it exceeds 1,000 fpm
- Call out deviations from Vref or normal profile speed
- Call out 300 feet and 100 feet above DH or MDA
- When becoming visual, call out what is in sight and its relative position to the aircraft, such as: "runway lights straight ahead"—or "approach lights slightly left".

1.18.3 Collins NCS-31A Navigation Control System

The aircraft was fitted with a Collins NCS-31A Navigation Control System. The NCS-31A is a fully integrated area navigation system which provided the aircraft crew with 22 features which include:

1. facility to pre-set data for up to 10 waypoints;
2. calculation of RNAV and regular VOR courses; and
3. storing of pre-set COMM and ADF frequencies.

The operator advised that pilots new to the aircraft generally took a number of months to become completely familiar with operating the NCS-31A. However, the system was popular with pilots, once they became familiar with it. The co-pilot on VH-AJS was not atypical in his rate of adjustment to the NCS-31A.

1.18.4 Cockpit lighting and chart illumination

At 1949.24, the pilot in command asked the co-pilot to dim his light as it was causing a distraction. The light the pilot in command was referring to was probably the co-pilot's flood light.

The aircraft was not equipped with approach chart holders. The operator advised that pilots normally placed charts in their lap or on the centre console. Pilots used the cockpit flood lighting to read the charts.

1.18.5 Operator navigation documents policy

At the time of the accident, company pilots were required to supply and maintain their own navigation documents. There was no company policy regarding the type of documents pilots were to use. Pilots were free to use either AIP or Jeppesen documents. There was no company policy concerning the use of approach charts during flight, whether each pilot was to use his own chart, or whether one chart was to be shared between the pilots.

It was established that the pilot in command used Jeppesen documents while the co-pilot used AIP documents.

1.18.6 Obstruction lighting

The criteria for determining whether an object (including terrain) is an obstacle and whether it needs to be marked or lit are given in the CASA manual, *Rules and Practices for Aerodromes* (RPA) (chapters 10 and 12). These chapters are for use by the owner or operator of an aerodrome to determine what constitutes an obstacle.

An area that should be free of marked obstacles is known as the 'obstacle limitation surface' or OLS. This area extends to 15 kilometres from the end of a runway with an ILS to a height of 150 metres (492 feet) above runway elevation in a series of steps.

The definition of an obstacle appears in RPA as 'any fixed...object...that extends above a defined surface intended to protect aircraft in flight'.

Natural terrain, defined as an obstacle in RPA, should not be marked or lit, 'except when, after an aeronautical study, it is determined that the terrain would adversely affect the safety or significantly affect the regularity of operations of aeroplanes'.

No evidence of CASA having performed an aeronautical study was found during the course of the investigation, although CASA advised that such a study had been completed in 1972. However, calculations indicate that the height of the OLS in the area of the Ilparpa Range is 2,281 feet above mean sea level. A comparison of this figure with survey information shown on the operating limitation chart (Type A) for Alice Springs indicates that four spot heights on the Ilparpa Range within the 15-degree splay area of the OLS protrude above the OLS by between 22 feet and 58 feet. All these spot heights are south of the runway 12 extended centreline and extend from 325 metres to 1,275 metres from this line. The spot height nearest the extended centreline is shown as 2,313 feet. It protrudes through the OLS by 32 feet.

1.18.7 Ground proximity warning systems (GPWS)

Civil Aviation Order 20.18.9 details the Australian requirements concerning GPWS. The order applies only to turbine-engine aircraft with a take-off weight in excess of 15,000 kg or authorised to carry more than 30 passengers and engaged in regular public transport or charter operations. There is no reference in the order to smaller turbine-engine aircraft engaged in regular public transport or charter operations. However, a number of aircraft types/models with take-off weights between 5,700 kg and 15,000 kg operating in Australia are equipped with GPWS. These include a number of Westwind aircraft. VH-AJS, however, was not so equipped.

1.18.8 Radio altimeters

While a radio altimeter is standard fitment in many turbine-engine aircraft, there is no Australian regulatory requirement for such equipment to be fitted.

VH-AJS was equipped with a Collins ALT-50 radio altimeter which included a digital display of aircraft altitude from zero to 900 feet in 10-feet steps. The system could be activated to provide a warning when the aircraft reached a pre-set height. The warning consisted of a light on the flight director display. The equipment had no aural warning capability.

In section BW1, 'Normal Procedures', of the company operations manual, the aircraft checklist contained no reference to the radio altimeter. However, section C3, subsection 3.1(c)—'Altitude Alert, Radio Altimeter and VLF/Omega' stated:

> The captain will always set the radio altimeter when the required DH has been checked by the co-pilot.

1.18.9 Flight tolerances

CAO 40.2.1 section 3 specifies the flight tolerances necessary for a pilot to be judged proficient in certain manoeuvres. It states that 'there shall be no sustained errors in excess of the specified tolerances'. For an NDB approach the tolerance specified is ± 5 degrees of the nominated track. The aircraft must be established within this tolerance before commencing descent.

1.18.10 Crew resource management (CRM)

According to *ICAO Circular 217-AN/132, Human Factors Digest N0 2*, over the past decade or so, the failure of the flight crews to effectively use available resources has been recognised as contributing to more than 70 per cent of accidents and incidents in commercial aviation. Often the problems encountered by flight crews are the result of ineffective communication, inadequate leadership, poor group decision making, and/or poor management. These conclusions have led to a recognition that greater emphasis should be given to the factors which affect the management of crew resources - hence the term 'crew resource management'. ICAO Circular 217-AN/132, *Human Factors Digest* No. 2 , defines crew resource management as 'the effective use of all available resources, i.e. equipment, procedures and people , to achieve safe and efficient flight operations'. The circular lists six components for effective CRM. These, along with amplifying comments from the circular, are:

[a] Communication/interpersonal skills. Specific skills associated with good communication practices include such items as polite assertiveness and participation, active listening and feedback. Polite assertiveness is a skill frequently ignored in communications training but vital to a healthy cockpit. A pilot-in-command may be open to communication but temporarily unable to receive and comprehend. Other crew members must be aware of the importance of the information they hold and have a strong feeling of self value; a single hesitant attempt to communicate important data constitutes a failure to discharge individual responsibility. The concept of 'legitimate avenue of dissent' is an important avenue for 'clearing the air', maintaining lines of communication, and maintaining self-image.

[b] Situational awareness. Situational awareness refers to one's ability to accurately perceive what is going on in the cockpit and outside the aircraft. Maintaining a state of awareness of one's situation is a complex process, greatly motivated by the understanding that one's perception of reality sometimes differs from reality itself. This awareness promotes on-going questioning, cross-checking, and refinement of one's perception.

[c] Problem solving/decision making/judgement. These three topics are very broad and interrelate to a great extent with each other as well as the other areas. One may consider problem solving as an over-all cycle of events beginning with information input and ending with pilot judgement in making a final decision. During the phase in which information is requested and offered, some conflicting points of view may be presented. Skills in resolving conflict are therefore especially appropriate at this time. All decisions must come from the pilot-in-command because the team will fail if command authority is not maintained.

[d] Leadership/'followership'. In this area, there is clear recognition that the command role carries a special responsibility. This command authority must be acknowledged at all times. The effectiveness of command authority cannot be assumed by position alone. The credibility of a leader is built over time and must be accomplished through conscious effort. Similarly, every non-command crew member is responsible for actively contributing to the team effort, for monitoring changes in the situation, and for being assertive when necessary.

[e] Stress management. Stress creates a special kind of problem for a crew since its effects are often subtle and difficult to assess. Although any kind of emergency situation generates stress, there is also the stress, both physical and mental, that a crew member may bring to the situation and which others may not be able to detect. A crew member's overall fitness to fly may nevertheless decline because of fatigue, mental and emotional problems, etc., to the extent that other crew members should consider that individual as incapacitated. Skills related to stress management refer to one's ability not only to perceive and accommodate to stress in others but primarily to anticipate, recognise and cope with one's own stress as well. This would include psychological stresses such as those related to scheduling and rostering, anxiety over training courses and checks, career and achievement stresses, interpersonal problems with both cabin crew and other flight crew, as well as the home and work interface, including domestic problems.

[f] Critique. Skills of critique generally refer to the ability to analyse a plan of action whether future, current, or past. Since techniques for accomplishing critique vary according to the availability of time, resources, and information, three basic types of critique are distinguished:

1. Pre-mission analysis and planning.
2. On-going review as part of the in-flight problem solving process.
3. Post-mission debriefing.

All three are vital but are often overlooked both in operations and during instruction.

At the time of the accident there were no regulations requiring CRM training for Australian operators although some had introduced the concept, albeit to varying degrees. The operator of VH-AJS had no CRM policy in force. However, a CRM program was being developed in conjunction with a review of its operations manual which was in progress at the time of the accident.

2. ANALYSIS

Introduction

Evidence from the flight data recorder and the cockpit voice recording indicated that the aircraft was in controlled flight at impact. Engine spool up/down was audible on the cockpit voice recording and there was no indication from the crew that the aircraft was functioning abnormally. The 150-feet discrepancy between the pressure altimeters as the aircraft descended through 16,000 feet was not abnormal, given the different response rates of the mechanical and servo-driven units.

The pilot in command occupied the left control seat and was the handling pilot for the flight. There was no evidence that the performance of either crew member was affected by any physiological condition which might have affected his ability to operate the aircraft.

The accident can be categorised under the generic term ‘controlled flight into terrain’ (CFIT). Such occurrences usually arise following loss of situational awareness by the flight crew. The circumstances of this accident indicate that such a loss of situational awareness did occur which resulted in the aircraft descending to 2,300 feet between the Temple Bar locator and the Alice Springs NDB.

The accident will be analysed under the following headings:

1. The activity and interaction of the crew during the flight.
2. The aviation system in which the crew was operating.
3. Approach chart discrepancies.

Finally, those system defences which failed or which were inadequate will be highlighted.

2.1 Activity and interaction of the flight crew

In any complex system which involves people, such as the aviation system, some kinds of human failures can have an immediate and direct adverse effect on the operation of the system. Characteristically, such failures involve the actions of operational personnel, such as pilots.

During the investigation, a number of features of crew behavior were identified as contributing to the accident. These included:

(a) communication between the crew;

(b) the approach briefing;

(c) the approach method; and

(d) the descent to 2,300 feet.

2.1.1 Communication between the crew

There was evidence of difficulties in the relationship between the two pilots before the flight, at least from the co-pilot’s perspective. Although the crew may have spoken about the problem in Darwin before departure, the outcome of this meeting was not established. However, the cockpit voice recording revealed that the difficulties between the crew continued during the accident flight (paragraph 1.11.2). The recording indicated that these difficulties affected the co-pilot’s willingness to communicate with the pilot in command. There were also indications that his task performance was affected and that he was reluctant to query the instructions or the performance of the pilot in command (paragraph 1.11.2). For example, there were no questions from the co-pilot concerning the approach briefing, even though a number of significant items were omitted. Also, he did not comment on the performance of the pilot in command during the approach, despite the fact that tracking and descent rate limits were exceeded.

In such a cockpit environment, the ability of the two pilots to operate as an effective team was reduced.

2.1.2 The approach briefing

The cockpit voice recording indicated that the pilot in command used the relevant Jeppesen chart to brief the locator/NDB approach. The comment by the pilot in command at time 1936.52 ('hard to read after the CAA ones aren't they') appears to be in reference to Jeppesen charts being different to AIP charts. In briefing his intentions for the approach itself (time 1932.47-1934.05), the pilot in command appears to have been pointing to entries on the chart (he uses the terms 'that one', 'there', and 'over there' a number of times to refer to the locators). This implies that the co-pilot was looking at the same (Jeppesen) chart during the briefing. At no stage after this, or earlier for that matter, is there any reference to the co-pilot using his (AIP) chart. It follows, then, that the Jeppesen chart may have been kept close at hand (perhaps placed on the centre console) and referred to continually during the remainder of the flight.

The cockpit voice recording revealed that the pilot in command omitted important information in the approach briefing, including several items required by the Company Operations Manual. The most important omissions were:

- (a) an overall explanation of the approach, including a statement of its name;
- (b) the minimum descent altitude which applied to the Westwind aircraft (3,100 feet);
- (c) an explanation for the intended departure from the published procedure, using 2,780 feet as the 'minimum';
- (d) how the approach would be flown after the nominated 'minimum' (2,780 feet) was reached; and
- (e) what was expected of the co-pilot during the approach.

The pilot in command also provided an incomplete approach briefing when he flew the approach on 4 April 1995. These briefings were not consistent with his reported usual high standard. Possible explanations for this are that both attempts involved a practice approach on a clear night, performance was not being monitored or rated, and there was no necessity to complete the procedure as it could have been changed to a visual approach at any stage. In other words, the pilot in command probably viewed his plan as involving minimal risk.

During the briefing, the pilot in command used the expressions 'OK, we'll have a fiddle with this', and 'see how it looks just for a giggle' (times 1931.59, 1934.05, and 1943.04). These comments may have been perceived by the co-pilot as suggesting that the pilot in command was approaching the task in a casual manner. Such a perception may not have been accurate, but it could have further reduced the co-pilot's willingness to query the approach briefing or the performance of the pilot in command during the approach.

In summary, the briefing did not provide the co-pilot with a full understanding of the intentions of the pilot in command. As a result, he was not in a position to participate fully and effectively in the operation of the aircraft.

2.1.3 The approach method

Evidence from the flight data and cockpit voice recordings revealed that the aircraft descended below the published route LSALT, below the 25-NM minimum safe altitude , and below the DME arrival steps. The aircraft therefore did not have the required obstacle clearance when it approached Simpson's Gap. These procedural breaches, however, had no bearing on the accident.

For the aircraft to be at Simpson's Gap at 4,300 feet, the pilot in command was required to fly the complete approach - that is, join the approach over at the Alice Springs NDB at not below 5,000 feet and track outbound to Simpson's Gap before completing the procedural turn. A possible reason for him taking the 'shortcut' (he adopted a similar procedure for the practice approach he flew on 4 April 1995) was to save time as an additional five or so minutes flying time would have been required to fly the complete procedure. It is also possible that, because freight from VH-AJS had to be transferred to the aircraft ahead of it at Alice Springs, the pilot in command was reluctant to cause any delay to this aircraft. However, there was no evidence that there was any policy or pressure from company management concerning procedural shortcuts.

The CVR indicated that the pilot in command was probably aware that the Simpson's Gap and Temple Bar locators were aligned with the runway as he indicated to the co-pilot that he had wanted '296' set as the bearing for the offset area navigation position (CVR time 1931.29). However, he accepted the 292-degree bearing set by the co-pilot. During the descent, he manoeuvred the aircraft so that, at Simpson's Gap, it was heading some 28 degrees to the right of the inbound track for the locator/NDB approach. At the same time, the aircraft was approaching the Simpson's Gap 'not below' altitude of 4,300 feet. This was a high workload period for the pilot in command. His error in calling Simpson's Gap 'Spring Hill' (time 1951.41) as the aircraft approached Simpson's Gap, along with the descent below 4,300 feet, could be explained by this workload demand. A more appropriate technique, involving significantly less workload, would have been for the pilot in command to establish the aircraft on the inbound track a few miles before Simpson's Gap. Alternatively, he could have flown the complete approach.

After passing Simpson's Gap, the pilot in command had to manoeuvre the aircraft left towards the inbound track while conducting the descent to the next approach step. Again, this involved a substantial workload.

The pilot in command flew the vertical profile of the approach as a series of steps. While this technique has the advantage of the aircraft reaching the next level quickly, it also involves a high workload. The alternative technique of flying the approach at a constant descent angle on a stabilised descent, as depicted on the AIP chart for the approach, involves significantly less workload because the frequent changes in aircraft attitude and engine power settings involved in flying a stepped descent are not required.

Until the aircraft was descending through about 2,900 feet after passing Temple Bar, its speed during the approach was 160–170 knots. A more appropriate speed for the approach would have been about 140–150 knots. Ideally, aircraft speed should have been reduced to this level by about 15 miles from Alice Springs. This lower speed would have reduced pilot workload by allowing more time for the thought processes and aircraft manipulation required during the approach. To fly the complete procedure in a Westwind aircraft from overhead Alice Springs NDB, an appropriate technique is to reduce speed to 140–150 knots for the inbound procedure turn.

For much of the period between Simpson's Gap and Temple Bar, the aircraft was outside the 5-degree tolerance limit. The co-pilot did not bring this to the attention of the pilot in command. However, his behaviour must be viewed against the background of the visual conditions existing at the time, his relationship with the pilot in command, and the content and context of the approach briefing.

In summary, the approach method adopted by the pilot in command was not in accordance with the required procedures and involved a high cockpit workload. There were techniques available to significantly reduce this workload.

2.1.4 The descent to 2,300 feet

There was no direct evidence from the CVR of the co-pilot using his (AIP) approach chart during the briefing or the approach. At time 1953.35, the co-pilot said 'two four (um)? three'. This followed the pilot in command telling the co-pilot to 'put the minima in' 'after we go over that next NDB' (Temple Bar). The co-pilot possibly spoke these words while checking what the 'minima' was from the chart. On the one hand, the words could have been taken from the table of minima on the Jeppesen chart which shows '2,400' and '2,300' as the Categories A and B minima for forecast and actual area QNH respectively. On the other hand, it is possible that the co-pilot was looking at the AIP chart, saw '2,400' as the Categories A and B circling minimum and mentally adjusted it for actual area QNH. However, given the earlier evidence on the CVR that pointed to the Jeppesen chart being used for the briefing (see paragraph 2.1.2), it is probable that the co-pilot continued to use, and then read the 'minima', from this chart.

Several factors could have contributed to the co-pilot calling 2,300 feet instead of the briefed altitude of 2,780 feet:

(a) Just before Temple Bar, the pilot in command asked the co-pilot to enter the 'minima' when the aircraft reached that position. During the approach briefing, he had referred to this step as the 'minimum'. (The terms 'minimum' and 'minima' are interchangeable in the case of the approach being flown and are usually associated with the minimum descent altitude table printed at the bottom of approach charts.) However, the pilot in command did not discuss the actual minimum descent altitude which applied to the aircraft category at any stage. Further, he mentioned '2,780 feet' only once during the approach briefing which took place about 20 minutes earlier, and he did not explain why he was using this as the 'minimum'. It is therefore likely that the co-pilot did not remember the briefed altitude and assumed that the pilot in command was referring to the minimum descent altitude. This would have necessitated him consulting the approach chart.

(b) The co-pilot may have believed that the approach was a twin locator rather than a locator/NDB approach. (He called it a 'twin locator' during the descent.) The two approach types are similar, and the co-pilot had little experience with either type.

If the co-pilot believed the approach was a twin locator approach, he would have assumed that the only relevant altitude to be entered after passing the second locator was the minimum descent altitude. Therefore, he may not have looked at the approach profile on the chart where '2,780 feet' is displayed but looked at the table of minima only.

There was no indication that the co-pilot looked at the minima boxes during the flight before time 1953.25, nor was there any crew discussion on them. Therefore, when the co-pilot looked to select the minimum, it may have been the first occasion that he had viewed this section of the chart.

(c) The co-pilot was performing the task in reduced lighting conditions. His overhead light had been dimmed before the start of the approach as it was distracting the pilot in command. Dimming the light may have reduced the ability of the co-pilot to accurately extract information from the approach chart.

(d) When the co-pilot checked the minima table, it is likely that the workload he was experiencing caused him to revert to a more automatic, established pattern of behaviour. Consequently he selected the Categories A and B minimum (2,300 feet) instead of the appropriate Category C minimum (3,100 feet), as he had only limited experience in Category C aircraft.

(e) The pilot in command immediately read back the 'twenty-three' called by the co-pilot when the aircraft reached Temple Bar, and then assigned him another task. This readback and task assignment probably removed any doubt that may have existed in the co-pilot's mind concerning the altitude he had selected, particularly given the background of the briefing, his experience with this type of approach, and the crew relationship.

At the time he accepted 2,300 feet as the 'minimum', the pilot in command (the pilot flying the aircraft) was probably unable to verify this figure from the approach chart because of the high cockpit workload he was under at the time. Also, his immediate response to the co-pilot's call of 'twenty-three' probably did not allow sufficient time for him to check the chart. Therefore, the only reasonable explanation for him accepting the 'it's down to twenty-three' call by the co-pilot is that he had forgotten the altitude that he had earlier briefed and did not have a precise idea of where the aircraft was positioned in the approach. The high workload he experienced throughout the approach could have been sufficient to cause this error (the cockpit voice recording revealed other instances where the pilot in command had forgotten names and altitudes). Also, the visual conditions prevailing at the time may have encouraged a subtle lowering of awareness of the significance of the 'minimum'. The high descent rate after Temple Bar appears to indicate some haste to reach the 'minimum', perhaps so that the aircraft could be better positioned for a straight-in approach to runway 12.

CATEGORY	A	B	C	D
CIRCLING	2400 (611-2.4)		3200 (1411-4.0)	3300 (1511-5.0)
ALTERNATE ‡	(1111-4.4)		(1911-6.0)	(2011-7.0)

NOTES

- * 1. MAX IAS FOR PROC 210KTS
- ‡ 2. MAX HOLDING IAS 185KTS-HOLDING NOT ABOVE FL 120
- ‡ 3. SPECIAL ALT MNM 750/4KM

NDB TO MAPt	GS(KNOTS)	40	60	80	100	120	140	*160	180					
	TIME (SEC)	200	132	96	78	66	57	50	44					

AIP Australia

11 NOV 1993

* LOCATOR/NDB

ALICE SPRINGS, NT (YBAS)

Figure 6. Showing the tables of minima for the AIP charts (above) and the Jeppeseon charts (below)

		CIRCLE-TO-LAND	
		Actual Aero QNH	Forecast Aero QNH
	Max Kts	MDA(H)	MDA(H)
A	100	2300'(511')-2.4 km	2400'(611')-2.4 km
B	135		
C	180	3100'(1311')-4.0 km	3200'(1411')-4.0 km
D	205	3200'(1411')-5.0 km	3300'(1511')-5.0 km

Gnd speed-Kts	70	90	100	120	140	160

2.2 The aviation system

The efficiency and reliability of human performance can be influenced by the task, situational, and environmental framework in which the crew is operating. In this way, the system can contribute to active failures such as those discussed above. The components of the aviation system which were identified as influencing the crew's behaviour are as follows:

1. Crew resource management training.
2. Uniqueness of the approach.
3. Cockpit equipment and lighting.
4. Radio altimeter procedures.
5. Visual cues.

2.2.1 Crew resource management (CRM) training

The cockpit voice recording revealed a low standard of CRM from both crew members. The pilot in command was critical of the co-pilot and did not adequately inform the co-pilot of his intentions. The co-pilot did not use an appropriate, assertive style in communicating with the pilot in command. Had the pilots communicated more effectively, the accident may have been avoided.

The low standard of CRM reflected a lack of training. Although the pilot in command had completed a course in CRM training, this was several years before the accident, when he was a co-pilot. The co-pilot had received no CRM training.

2.2.2 Uniqueness of the approach

In any complex system, it is undesirable to have in place procedures which are unique. Such situations limit the ability of system operators to become familiar with and maintain currency in the procedure. The uniqueness of the Alice Springs locator/NDB approach meant that both crew members would have had limited experience to call on in flying the approach. Reference by the co-pilot to the approach as a 'twin locator', and his selection of 2,300 feet as the 'minimum' might indicate that he did not appreciate the unique nature of the approach.

2.2.3 Cockpit equipment and lighting

There were no chart holders in the cockpit into which charts could be placed for convenient referral by the crew members. This could have increased the co-pilot's workload and reduced his ability to extract accurate information from the chart.

There was no facility available to the crew to illuminate the approach chart in harmony with other cockpit lighting settings. The provision of approach chart holders with integral lighting would have overcome this deficiency.

2.2.4 Radio altimeter procedures

The crew could have used the radio altimeter to obtain information concerning terrain proximity, albeit directly below the aircraft. The steep gradient of the Ilparpa Range would have reduced the warning time given of rising ground ahead of the aircraft. However, the aircraft was below 500 feet above ground level for about 20 seconds before impact. Thus, if the radio altimeter had been used during the approach, it may have prompted some action by the crew.

Use of the radio altimeter was not included in the normal checklist procedures for the aircraft. Had it been, the crew may have been conditioned to using it, as well as being prompted to use it on this occasion.

2.2.5 Visual cues

There was no obstruction lighting on the Ilparpa Range which might have provided the crew with any warning of the presence of the range. Consequently, in the dark, moonless conditions prevailing, it is unlikely that the crew could have seen the range until it became illuminated by the aircraft's landing lights. The time taken for the co-pilot to interpret what he saw reflected by the landing lights and to alert the pilot in command to pull up, and for the pilot in command to react to the call, did not allow sufficient time for the evasive manoeuvre to succeed.

Given the minor infringement of the obstacle limitation surface by the spot heights, compared to the clearance over the range provided by the locator/NDB and ILS approach profiles, it seems reasonable that the spot heights were not marked or lit. Notwithstanding this conclusion, the relevance of obstruction lighting on the spot heights to the performance of the crew needs to be addressed.

From the vertical and horizontal profiles of the aircraft's flight path from Temple Bar to impact, calculations were made of the angles and distances of the 2,313-feet spot height (that is, the spot height nearest the runway 12 extended centreline and nearest the track flown by the aircraft) from the aircraft at various stages of the descent from Temple Bar. The results are shown in the following table:

Event	Dist./time to impact	Dist. to spot height	Rel. bearing from aircraft	Elev. of aircraft
Aircraft leaves 3,500 ft	4,250 m/59 s	3,300 m	20 deg. right	+1,187 ft
'Runway clear' call (3,000 ft)	2,250 m/32 s	1,500 m	40 deg. right	+687 ft
'Three hundred to run' call (2,550 ft)	825 m/12 s	960 m	105 deg. right	+237 ft
Aircraft first reaches 2,250 ft	140 m/2 s	1,200 m	125 deg. right	-63 ft

This information leads to two conclusions. First, had the 2,313-feet spot height been lit, it is arguable that the crew may not have seen the light, given its position relative to the aircraft as it descended from 3,500 feet. It is further arguable that, if the obstruction had been seen by the crew, its distance and bearing relative to the aircraft was unlikely to have prompted any concern on their part about terrain along the aircraft's track.

The co-pilot called 'runway clear' about 25 seconds after the aircraft passed over Temple Bar, as it descended through about 3,100 feet. At this stage, the aerodrome lights would have appeared to the right of the aircraft with the T Vasis indicating full "red". Neither of these indications would have appeared abnormal to the co-pilot because of the track of the aircaft and the descent profile being flown.

2.3 Approach and approach chart design

The stepped descent profile shown on the Jeppesen chart depicted the minimum altitude below which the aircraft should not be flown at any point during the approach. It did not necessarily depict the desired flight path and contrasted with the AIP chart which showed a constant descent path. Had the pilot in command flown a constant-angle stabilised descent, cockpit workload would have been significantly reduced.

There was an error in the Simpson's Gap–Temple Bar distance on the locator/NDB chart (3.6 miles shown, instead of the correct distance of 2.67 miles). At the speed that the aircraft was flying, the error meant that the aircraft would have covered the actual distance in about 60 seconds, instead of the 80 seconds that would be expected to fly the distance shown on the chart. Had the pilot in command considered the time intervals for different stages of the approach, he may have been surprised when the aircraft reached Temple Bar earlier than expected. However, there was no indication that either crew member was aware of the distance error, or that the pilot in command had considered the time intervals for the approach. The flight data recording revealed that the aircraft reached 3,500 feet about 10 seconds before Temple Bar. As soon as the aircraft had passed Temple Bar, the descent was continued to 2,300 feet. As indicated earlier in this analysis, the workload of the pilot in command may have contributed to his acceptance of 2,300 feet as the minimum. However, there appears to have been no direct link between his acceptance of 2,300 feet as the 'minimum' and the distance error on the chart.

As discussed previously, the pilot in command may have been aware of the chart error concerning the alignment of the locators and the NDB. This error would have increased the workload involved in flying the approach. However, in the context of the lateral navigation technique employed by the pilot in command in positioning the aircraft for the approach, the effect on cockpit workload of this chart error was probably not significant.

Terrain information on the locator/NDB chart consisted of a number of spot heights on the plan view of the approach. There was no terrain information on the approach profile diagram, nor was any required. Spot height information is of little use in determining a picture of the terrain in the area of the approach. Had the crew sought such information, they would have had to consult a topographical chart such as the Alice Springs visual terminal chart. There was no indication on the cockpit voice recording that this was done; nor was there any discussion concerning terrain along the approach track.

The pilot in command probably had some knowledge of the terrain from his daylight flights into Alice Springs. However, without such experience, the co-pilot's knowledge of the terrain was probably minimal. Had terrain contour and profile information been displayed on the approach chart, the crew may have been aware of the position and height of the Ilparpa Range.

In summary, the approach chart errors may have had some impact on pilot workload during the approach. However, considering the poor CRM of the crew, the technique adopted by the pilot in command in setting up for the approach, his likely awareness of the alignment error on the chart, and the stepped descent technique he employed, the chart discrepancies were probably not significant factors in the accident.

2.4 Failed or absent defences

Defences are system components which provide a 'safety net'. That is, their purpose is to reduce or eliminate the possible effects of hazards resulting from human or technical failures. The investigation identified a number of defences which were circumvented, which failed, or which were absent.

(a) Approach briefing

By not conducting a complete approach briefing, the pilot in command circumvented the defences which the standard briefing format provided. The nomination by the pilot in command of a ‘minimum’ different to that shown on the approach chart circumvented the defence provided by the minimum descent altitude for the aircraft category depicted on the chart.

(b) Crew resource management (CRM)

The level of CRM evident from the cockpit voice recording indicated that the performance of the crew as a unit was poor. In this sense, the ‘safety net’ which good CRM provides, was absent.

(c) Ground-proximity warning systems (GPWS)

The aircraft was not fitted with a GPWS, nor was such equipment required by regulation. The function of such systems, which are required by legislation in high-capacity, turbine-powered RPT aircraft, is to prevent controlled flight into terrain (CFIT) occurrences.

(d) Company radio altimeter procedure

The use of the radio altimeter was not covered in the normal checklist, but was included in a separate subsection of the operations manual. In this sense, the defence which would have been provided by including it in the normal checklist used on every flight, and thus making it a part of normal operations, was absent.

3. CONCLUSIONS

3.1 Findings

1. Both flight crew members held valid pilot licences, endorsed for Westwind aircraft.
2. Both crew members held valid multi-engine command instrument ratings.
3. The pilot in command occupied the left cockpit seat and was the handling pilot for the flight. The co-pilot occupied the right cockpit seat.
4. No evidence was found to indicate that the performance of either crew member was affected by any pre-existing physiological condition.
5. The aircraft was operating under a valid maintenance release at the time of the accident.
6. No evidence was found of any unserviceability of the aircraft which might have contributed to the accident.
7. The aircraft carried sufficient fuel for the flight.
8. At the time of the accident, the weight and balance of the aircraft were within limits.
9. Recorded radio communications relevant to the operation of the aircraft were normal throughout the flight.
10. The airport lighting, obstruction lighting, and navigation aids at Alice Springs were operating normally.
11. The Alice Springs aerodrome beacon was not functioning at the time of the accident. This had no bearing on the accident.
12. The weather in the Alice Springs area was fine and clear with dark moonless conditions existing.
13. There were a number of recorded instances of the pilot in command experiencing difficulties in track keeping while flying non-precision approaches.
14. The pilot in command flew the Alice Springs locator/NDB approach, for practice, on 4 April 1995 during which his track-keeping was reported to have been 'sloppy'.
15. There was no evidence to indicate that the co-pilot had previously flown the Alice Springs locator/NDB approach or a twin locator approach.
16. The pilot in command normally used Jeppesen navigation documents while the co-pilot used AIP documents.
17. There was evidence from the cockpit voice recording, as well as other evidence, of a degree of ill-feeling between the crew members.
18. Approximately 10 minutes before commencing descent, the pilot in command advised the co-pilot of his intention to fly the locator/NDB approach into Alice Springs.
19. The pilot in command briefed that 2,780 feet, the minimum crossing altitude at the Alice Springs NDB, would be the 'minimum' for the approach.
20. During the briefing, the pilot in command did not refer to the Category C minimum for the approach (3,100 feet) which applied to the aircraft.
21. When the pilot in command called for the 'minima' after passing Temple Bar, the co-pilot responded with '2,300 feet', which was the minimum descent altitude for Category A & B aircraft at the missed approach point.

22. The pilot in command acknowledged the incorrect minimum called by the co-pilot and descended the aircraft to 2,300 feet.
23. During the approach, the aircraft's descent rate exceeded 1,000 feet per minute on a number of occasions. This was not brought to the attention of the pilot in command by the co-pilot.
24. The aircraft struck the top of the Ilparpa Range at about 2,250 feet above mean sea level, and 775 metres left of the runway 12 extended centreline, while in a shallow climb.
25. The accident was not survivable.
26. Analysis of the cockpit voice recording implied that the crew briefed the approach with reference only to the Jeppesen chart.
27. It could not be positively determined whether the co-pilot used the Jeppesen chart during the approach or his own (AIP) chart.
28. There was no indication on the cockpit voice recording that the pilot in command discussed the use of, or set, the radio altimeter.
29. Use of the radio altimeter was not included in Normal Procedures in the aircraft checklist.
30. The aircraft was not equipped with map/approach chart holders.
31. The Alice Springs locator/NDB approach was unique in Australia in that it was structured around three non-precision navigation aids.
32. Anomalies were identified in both the AIP and Jeppesen charts for the approach concerning the distance between Simpson's Gap and Temple Bar, and the alignment of the two locators and the NDB.
33. There were a number of differences in the layout of the AIP and Jeppesen charts, notably concerning the presentation of the tables of minima and the descent profile.
34. Both approach charts displayed very limited terrain information, which is in accordance with ICAO *Pans-Ops.*
35. There was a large difference in the experience levels of the crew members.
36. The pilot in command had completed a training course in crew resource management. The co-pilot had received no such training.
37. Four spot heights on the Ilparpa Range within the 15-degree splay area of the ILS protrude above the OLS by between 22 feet and 58 feet and extend between 325 metres and 1,275 metres south of the runway 12 extended centreline. There was no obstruction lighting on these spot heights; nor was it reasonable that such lighting be required.
38. Lighting of the spot height nearest the extended centreline was unlikely to have raised any concern amongst the crew about terrain along the aircraft's track.

3.2 Significant factors

The following factors were considered significant in the accident sequence:

1. There were difficulties in the cockpit relationship between the pilot in command and the co-pilot.
2. The level of crew resource management demonstrated by both crew members during the flight was low.
3. The Alice Springs locator/NDB approach was unique.

4. The briefing for the approach conducted by the pilot in command was not adequate.
5. When asked for the 'minima' by the pilot in command, the co-pilot called, and the pilot in command accepted, an incorrect minimum altitude for the aircraft category and for the segment of the approach.
6. The technique employed by the pilot in command in flying the approach involved a high cockpit workload.
7. The crew did not use the radio altimeter during the approach.

4. SAFETY ACTION

4.1 Recommendations

The Bureau of Air Safety Investigation makes two final safety recommendations as a result of this investigation. The recommendations, identified by the Bureau's reference number are printed below. A previous recommendation issued by the Bureau has relevance to this occurrence and is also reproduced below. In addition, relevant responses from the action agencies are reproduced.

4.1.1 GROUND PROXIMITY WARNING SYSTEMS

The current requirement for the fitment of a ground proximity warning system (GPWS) applies only to aircraft with a maximum certificated takeoff weight of 15,000 kg or greater, or aircraft authorised to carry more than 30 passengers engaged in regular public transport or charter operations. Some aircraft types engaged in regular public transport or charter operations in Australia are fitted with both these systems, some have a radio altimeter only, while others are equipped with neither.

These latter aircraft include types with a takeoff weight greater than 5,700 kg that are involved in regular public transport and charter operations. In excess of 250,000 fare paying passengers are carried per year in Fairchild Metro III and Metro 23 type aircraft and these aircraft are not required to be equipped with either GPWS or a radio altimeter.

ICAO Annex 6 part 1, paragraph 6.15.3 recommends that all turbine engined aircraft, with a maximum certificated take-off weight in excess of 5,700 kg, or authorised to carry more than 9 passengers be equipped with a GPWS on or after 1 January 1999.

The Australian Civil Aviation Safety Authority (CASA) is in the process of developing a discussion paper for the aviation industry on the changes made to the ICAO annex.

R960040

The Bureau of Air Safety Investigation recommends that the Civil Aviation Safety Authority expedite the discussion with industry with the aim of implementing the changes made to ICAO annex 6 part 1, paragraph 6.15.3 prior to 1 January 1999.

4.1.2 STABILISED APPROACH PATHS AND DESIGN CRITERIA

The Aeronautical Information Publication Departures and Approach Procedures section, paragraph 1.14, outlines descent gradients for instrument approach procedures. It lists the normal gradients for the initial and final segments of the approach as 4% and 5.2% respectively. It also contains advice that an aircraft should not descend at a rate of descent in excess of 1,000 feet per minute after passing the final approach fix.

The International Civil Aviation Organisation formed a task force in 1994 to look into the problems surrounding controlled flight into terrain. The task force concluded that design improvements to non-precision approaches could contribute significantly to reducing controlled flight into terrain accidents, and at little cost to the industry.

Recommendations included a need for non-precision approaches to be flown using stabilised approach criteria. Also recommended was the provision of a three degree approach slope where compatible with the obstacle environment, simplification of non-precision approach procedures, and emphasis to agencies on the urgency to have these recommendations implemented.

R960042

The Bureau of Air Safety Investigation recommends that the Civil Aviation Safety Authority reassess instrument approach procedures to ensure that where possible these are designed with a three degree approach gradient.

Also, an educational program should be implemented, advising the industry to be aware of the safety and workload benefits in flying non-precision approaches using a stabilised approach criteria, rather than a series of stepped descents.

4.2 Previous Safety Action

IR950101

The Bureau of Air Safety Investigation issued interim recommendation IR950101 arising from its investigation into the accident involving B747-312 aircraft VH-INH at Sydney airport on 19 October, 1994. IR950101 is relevant to this occurrence and the recommendation and sections of the response received from the Civil Aviation Safety Authority are reproduced below.

The Bureau of Air Safety Investigation recommends that the Civil Aviation Safety Authority (CASA) require operators involved in multi-crew air transport operations to ensure that pilots have received effective training in crew resource management (CRM) principles. To this end, CASA should publish a time-table for the phased introduction of CRM training to ensure that:

(a) CRM principles are made an integral part of the operator's recurrent check and training program and where practicable, such training should be integrated with simulator LOFT exercises;

(b) CASA provides operators and/or CRM course providers with an approved course syllabus based on international best practice;

(c) such training integrates cabin crew into appropriate aspects of the program; and

(d) the effectiveness of each course is assessed to the satisfaction of CASA.

The Civil Aviation Safety Authority responded in part as follows:

CASA fully endorses the principles of and accepts the benefits flowing from CRM and similar training as well as strongly encouraging such training for flight crew, cabin crew and other operating crew. However, CASA is not fully convinced that mandating CRM or similar training, particularly for high and low capacity RPT operations, will necessarily prevent or reduce the incidence of such accidents in the future.

Nonetheless, CASA is willing to further investigate CRM training including the position taken by leading overseas regulatory authorities in this regard, particularly in relation to high and low capacity RPT operations. To this end, CASA intends to consider the issue as part of a major project to commence in the latter part of 1995. This project is to review all aspects of RPT operations conducted under CAR 217 in relation to training and checking organisations and is the first major review of such operations to be carried out for some time.

CASA undertakes to advise BASI of the outcome of that review in relation to CRM and similar training.

The Bureau's response to this reply is classified as—OPEN.

4.3 Safety action taken

4.3.1 Safety action by the Civil Aviation Safety Authority

A number of safety actions were undertaken by CASA as a result of this occurrence. This safety action resulted from consultation between BASI and the Instrument Procedures Design section of CASA. This consultation was undertaken as part of the investigation into this occurrence.

A number of deficiencies were noted on the approach charts for Alice Springs. The first of these dealt with the incorrect depiction of the location of the Temple Bar Locator. As a result of these deficiencies CASA reviewed the Alice Springs Locator/NDB approach chart. As a result of this review the chart was reissued on 7 December 1995 with the Temple Bar locator in the correct position.

Additional deficiencies were noted in the depiction of various spot heights on the approach charts. These spot heights were reviewed and an amended chart was issued on 1 February 1996.

Further consultation between the Bureau and CASA led to the redesign of the chart, with a new Locator/NDB approach being designed and issued on 20 June 1996.

4.3.2 Safety action by the operator

The operator involved carried out a number of local safety actions. These included:

- the fitment to all company aircraft of approach plate holders on the control column. These approach plate holders are also equipped with integral lighting systems, which enable each crew member to individually illuminate the approach plate.
- the establishment of a company policy whereby all crew are issued with Jeppesen navigation and instrument approach charts. Training for all crews employed by the operator in the use of Jeppesen charts is a part of this policy.

APPENDIX I CONTROLLED FLIGHT INTO TERRAIN (CFIT)

Controlled flight into terrain (CFIT) occurs when situational awareness is lost by the aircraft's flight crew. Some general statistics concerning CFIT include:

1. CFIT accidents account for about 74 per cent of fatal accidents worldwide in commercial aircraft.
2. About 50 per cent of all CFIT accidents occur during step-down instrument approaches.
3. About 10 per cent of CFIT accidents involve aircraft flying abnormally shallow (less than 1–degree) approach slope procedures.
4. About 50 per cent of CFIT accidents involve freight, charter, or positioning flights.
5. About 50 per cent of CFIT accidents involve less than 3 per cent of the world's fleet. This 3 per cent are not GPWS-equipped.
6. Less than 30 per cent of the corporate and business aircraft fleet is GPWS-equipped.

In late 1992, in response to the high CFIT accident rate, the Flight Safety Foundation formed a CFIT and Approach and Landing Task Force. By mid-1993, ICAO and FSF had agreed to a co-operative approach to the CFIT problem. A number of teams were formed, focussing on such aspects as aircraft equipment, flight crew training and procedures, flight operations, and ATC training and procedures. From the work of these teams, a number of issues were highlighted. Those relevant to this accident include:

1. Instrument approach charts—terrain awareness

The task force considered that greater awareness of terrain and the problems presented by terrain was necessary. Consequently, coloured contours should be used to present either terrain or minimum flight altitude on instrument approach charts. Significant spot heights should be shown on the terrain contour presentation. The terrain profile below an approach should also be shown.

2. Non-precision approaches—stepped approaches

Significant deficiencies were identified in the design and presentation of non-precision approach procedures, particularly stepped final approaches and shallow final approach angles. The profile depicted for a non-precision approach is not the desired flight path. Rather, it is the altitude below which the aircraft should not be flown at a particular position on the approach. The steps which are normally shown encourage pilots to initiate an early descent at an angle greater than 3 degrees to achieve the next step altitude. The task force considered that a 3 degree approach slope (where this could be safely provided within the obstacle environment), would encourage and enable pilots to fly a normal stabilised approach and significantly reduce the potential for confusion and unnecessary low flight in many non-precision approaches.

3. Government produced charts vs commercial source charts

The task force identified instances where the descent profile depicted on government produced charts differed from the descent profile depicted on charts produced by commercial sources. The technical information was the same but it was depicted differently.

4. GPWS

Given the substantial safety benefits of GPWS, the task force considered that all aeroplanes in commercial and corporate use, including those involved in domestic operations only, should be equipped with GPWS.

5. Radio altimeter

The task force was convinced of the value of the radio altimeter and believed that the equipment was underutilised as a terrain awareness/avoidance aid in aircraft which are not GPWS-equipped. Procedures should be developed to make greater use of radio altimeters to increase crews' awareness of their aircraft's vertical position.

6. CFIT awareness material

The FSF CFIT task force has developed a CFIT checklist to assist aircraft operators in evaluating the CFIT risk for a particular route or flight. It also useful in highlighting aspects of company operations which might be contributing to CFIT risk. A copy of the checklist is attached.

Both Transport Canada and FSF have produced an educational video dealing with this subject.

Flight Safety Foundation

CFIT Check List

Evaluate the Risk and Take Action

Part 1: CFIT Risk Assessment

Section 1 - Destination CFIT Risk Factors	Value	Score
Airport and Approach Control Capabilities:		
• ATS approach radar with MSAWS	0	______
• ATC minimum radar vectoring charts	0	______
• ATC radar only	-10	______
• ATC radar limited by terrain masking	-15	______
• No radar coverage available (out of service/not installed	-30	______
• No ATC service	-30	______
Expected Approach:		
• Airport located in or near mountains	-20	______
• ILS	0	______
• VOR/DME	-15	______
• Nonprecision approach with the approach slope from the FAF to the airport TD shallower that 2¾ degrees	-20	______
• NDB	-30	______
• Visual night "black-hole" approach	-30	______
Runway Lighting:		
• Complete approach lighting system	0	______
• Limited Lighting system	-30	______
Controller/Pilot Language Skills:		
• Controller and pilots speak different primary languages	-20	______
• Controller's spoken English or ICAO phraseology poor	-20	______
• Pilot's spoken English poor	-20	______
Departure:		
• No published departure procedures	-10	______
Destination CFIT Risk Factors Total (-)		______

Section 2 - Risk Multiplier	**Value**	**Score**
Your Company's Type of Operation (select only on value):		
• Scheduled	1.0	______
• Nonscheduled	1.2	______
• Corporate	1.3	______
• Charter	1.5	______
• Business owner/pilot	2.0	______
• Regional	2.0	______
• Freight	2.5	______
• Domestic	1.0	______
• International	3.0	______
Departure/Arrival Airport (select single highest applicable value):		
• Australia/New Zealand	1.0	______
• United States/Canada	1.0	______
• Western Europe	1.3	______
• Middle East	1.1	______
• South East Asia	3.0	______
• Euro-Asia (Eastern Europe & Commonwealth of Independent States)	3.0	______
• South America/Caribbean	5.0	______
• Africa	8.0	______
Weather/Night Conditions (select only on value):		
• Night - no moon	2.0	______
• IMC	3.0	______
• Night & IMC	5.0	______
Crew (select only on value):		
• Single-pilot flight crew	1.5	______
• Flight crew duty day at maximum and ending with night nonprecision approach	1.2	______
• Flight crew crosses five or more time zones	1.2	______
• Third day of multiple time-zone crossings	1.2	______
Add Multiplier Values to Calculate Risk Multiplier Total		______

Destination CFIT Risk Factors Total

x

Risk Multiplier Total = CFIT Risk Fact Total (-) ______

Part 2: CFIT Risk Reduction Factors

Section 1 - Company Culture	Value	Score
Corporate/company management:		
• Places safety before schedule	20	_______
• CEO signs off on flight operations manual	20	_______
• Maintains a centralised safety function	20	_______
• Fosters reporting of all CFIT incidents without threat of discipline	20	_______
• Fosters communication of hazards to others	15	_______
• Requires standards for IFR currency and CRM training	15	_______
• Places no negative connotation on a diversion or missed approach	20	_______

115-130 points	Tops in company culture	
105-115 points	Good, but not the best	**Company Culture Total (+)** _______ *
80-105 points	Improvement needed	
Less than 80 points	High CFIT Risk	

Section 2 - Flight Standards	**Value**	**Score**
Specific procedures are written for:		
• Reviewing approach or departure procedure charts	10	_______
• Reviewing significant terrain along intended approach or departure procedure course	20	_______
• Maximising the use of ATC radar monitoring	10	_______
• Ensuring pilot(s) understand that ATC is using radar or radar coverage exists	20	_______
• Altitude changes	10	_______
• Ensuring checklists is complete before initiation of approach	10	_______
• Abbreviated checklist for missed approach	10	_______
• Briefing & observing MSA circles on approach charts as part of plate review	10	_______
• Checking crossing altitudes at IAF positions	10	_______
• Checking crossing altitudes at FAF & glideslope centering	10	_______
• Independent verification by PNF of minimum altitude during stepdown DME (VOR/DME or LOC/DME) approach	20	_______
• Requiring approach/departure procedures charts with terrain in colour, shaded contour formats	20	_______
• Radio-altitude settings & light-aural (below MDA) for backup approach	10	_______
• Independent charts for both pilots, with adequate lighting & holders	10	_______
• Use of 500-foot altitude call and other enhanced procedures for NPA	10	_______
• Ensuring a sterile (free from distraction) cockpit, especially during IMC/night approach or departure	10	_______
• Crew rest, duty times and other considerations especially for multiple-time-zone operation	20	_______
• Periodic third-party or independent audit of procedures	10	_______
• Route & familiarisation checks for new pilots		
Domestic	10	_______
International	20	_______
• Airport familiarisation aids, such as audio visual aids	10	_______
• First officer to fly night or IMC approaches & the captain to monitor the approach	20	_______
• Jump-seat pilot (or engineer or mechanic) to help monitor	10	_______
terrain clearance and the approach in IMC or night conditions	20	_______
• Insisting that you fly the way that you train	25	_______

300-335 points	Tops in CFIT flight standards		
270-300 points	Good, but not the best	**Flight Standards Total (+)**	_______ *
200-270 points	Improvement needed		
Less than 200 points	High CFIT Risk		

Section 3 - Hazard Awareness Training | | | |
|---|---|---|
| **Corporate/company management:** | **Value** | **Score** |
| • Your company reviews training with the training department or training contractor | 10 | ______ |
| • Your company's pilots are reviewed annually about the following: | | |
| Flight standards operating procedures | 20 | ______ |
| Reasons for & examples of how the procedures can detect a CFIT '"trap"" | 30 | ______ |
| Recent & past CFIT incidents/accidents | 50 | ______ |
| Audiovisual aids to illustrate CFIT traps | 50 | ______ |
| Minimum altitude definitions for MORA, MOCA, MSA, MEA, etc | 15 | ______ |
| • You have a trained flight safety officer who rides the jump-seat occasionally | 25 | ______ |
| • You have a flight safety periodicals that describe and analyse CFIT incidents | 10 | ______ |
| • You have an incident/exceedance review and reporting program | 20 | ______ |
| • Your organisation investigates every instance in which minimum terrain clearance is compromised | 20 | ______ |
| • You annually practice recoveries from terrain with GPWS in the simulator | 40 | ______ |
| • You train the way that you fly | 25 | ______ |

285-315 points	Tops in company culture
250-285 points	Good, no best
190-250 points	Improvement needed
Less than 190 points	High CFIT Risk

Hazard Awareness & Training Total (+) ______ *

Section 4 - Aircraft Equipment

Aircraft Includes:

	Value	Score
• Radio altimeter with cockpit display of full 2,500-foot range captain only	20	_____
• Radio altimeter with cockpit display of full 2,500-foot range copilot only	10	_____
• First generation GPWS	20	_____
• Second generation GPWS	30	_____
• GPWS with all approved modifications, data tables and service bulletins to reduce false warnings	10	_____
• Navigation display & FMS	10	_____
• Limited number of automated altitude callouts	10	_____
• Radio-altitude automated callouts for non-precision approach (not heard on ILS approach) and procedure	10	_____
• Preselected radio altitudes to provide automated callouts that would not be heard during normal non-precision approach	10	_____
• Barometric altitudes and radio altitudes to give automated "decision" or "minimums" callouts	10	_____
• An automated excessive "bank angle" callout	10	_____
• Auto flight/vertical speed mode	-10	_____
• Auto flight/vertical speed mode with no GPWS	-20	_____
• GPS or other long-range navigation equipment to supplement NDB only approach	15	_____
• Terrain-navigation display	20	_____
• Ground-mapping radar	10	_____

175-195 points	Excellent equipment to minimise CFIT risk
155-175 points	Good, but not best
115-155 points	Improvement needed
Less than 115 points	High CFIT Risk

Aircraft equipment Total (+) _______ *

Company Culture _______ + Flight Standards ______ + Hazard Awareness & Training _____

+ Aircraft Equipment _______ = CFIT Risk-reduction Factors Total (+) ______

***If any section in Part 2 scores less than "Good" a thorough review is warranted of that aspect of the company's operation.**

Part 3 Your CFIT Risk

Part 1 CFIT Risk Factors Total (-) ______ + Part 2 CFIT Risk-reduction Factors Total (+) _____

= CFIT Risk Score (+)(-) _________

A negative CFIT Risk Score indicates a significant threat; review the sections in Part 2 and determine what changes and improvements can be made to reduce CFIT risk.

KEY

PIC	Pilot in command
PAX	Passenger
CP	Co-pilot
BRIS	Brisbane Control
AJS	VH-AJS
MELB	Melbourne Control
JPW	VH-JPW
EAO	VH-EAO
ADL	Adelaide Control

TIME (CST)	FROM	TO	TEXT
1927.25	PIC	CP	ALICE ALL AROUND ON THE AIDS WHEN YOU'VE GOT A MINUTE PLEASE
1928.33	PIC	CP	WHERE'S JPW IN FRONT OF US
1929.23	CP	PIC	GETTING ALONG
1929.37	CP	PIC	OK TRIMS DONE THROUGH TO ADELAIDE
1929.41	MELB	JPW/AJS	JULIET PAPA WHISKEY AND ALPHA JULIET SIERRA REPORT IN TURN DISTANCE ALICE SPRINGS
1929.46	JPW	MELB	JULIET PAPA WHISKEY ONE TWO SIX
1929.49	AJS	MELB	ALPHA JULIET SIERRA ONE SEVEN ZERO
1929.52	MELB	JPW/AJS	JULIET PAPA WHISKY ALPHA JULIET SIERRA THANKS
1929.55	CP	PIC	HE'S IN FRONT HEH HEH HEH
1929.58	CP	PAX	DID YOU GET IT
1929.59	PAX	PIC	WHAT'S THAT
1930.00	CP	PAX	THAT TEMPERATURE RISE
1930.02	PAX	PIC	OH I JUST APPLIED IT TO THE MACH NUMBER AND GOT THE TAS
1930.09	PIC	CP	OK CAN I HAVE AN RNAV FOR A 11 MILE FINAL RUNWAY ONE TWO
1930.19	CP	PIC	YEP
1930.25	PIC	CP	I ONLY WANT IT PREED UP
1930.27	CP	PIC	OK YEP
1930.30	CP		AND IT'S NINE
1930.35	CP	PIC	DO YOU WANT IT AH ELEVATION OF THRESHOLD OR JUST THE AERODROME
1930.40	PIC	CP	AERODROME SAME DIFFERENCE
1930.50	CP	PIC	WELL ACTUALLY WE'LL HAVE TO MAKE IT EIGHTEEN THERE (TWO NINE TWO AND)
			(non-pertinent radio transmissions)
1931.15	CP	PIC	IT WAS RUNWAY ONE TWO YOU'RE GONNA USE WEREN'T YOU DO YOU (TWO NINE TWO TWO NINE TWO)
1931.28	PIC	CP	SURE IT'S NOT TWO NINE SIX OK THAT'LL DO I ACTUALLY WANTED THE THE RUNWAY WELL ALL RIGHT THAT'LL DO
1931.41	CP	PIC	NOT AS PER THE APPROACH OR
1931.43	PIC	CP	NO THAT'S CLOSE ENOUGH

TIME (CST)	FROM	TO	TEXT
1931.45	CP	PIC`	AND IT’S SEVEN MILES SEVEN MILE FINAL
1931.48	PIC	CP	NO ELEVEN
1931.49	CP	PIC	ELEVEN
1931.55	PIC	CP	THAT’S THE SHOT
1931.59	PIC	CP	OK WE’LL HAVE A BIT OF A FIDDLE WITH THIS
1932.06	MELB	JPW	JULIET PAPA WHISKEY WHEN READY LEAVE CONTROL AREA ON DESCENT
1932.09	JPW	MELB	JULIET PAPA WHISKEY
1932.15	CP	PIC	THE ONLY PROBLEM WE MIGHT GET IS IF THEY LEAVE BEFORE US THEY MIGHT DEPART ON ONE TWO
1932.23	PIC	CP	THEY CAN’T WE’VE GOT THEIR FREIGHT
1932.26	CP	PIC	OH THAT’S RIGHT
1932.35 NDB	PIC	CP	OK ON NUMBER ONE I WANT AH ALICE
1932.43	CP	PIC	RIGHT
1932.47	PIC	CP	NUMBER TWO I WANT THAT ONE SO WE WANT THAT AND THAT AND THAT ONE PREED
1932.52	EAO	MELB	MELBOURNE CONTROL GOOD EVENING ECHO ALPHA OSCAR POSITION QUEBEC TWO THREE BRAVO ONE ZERO ZERO TWO MAINTAINING FLIGHT LEVEL THREE FIVE QUEBEC TWO THREE CHARLIE TWO SEVEN
1932.55	PIC	CP	THAT’S IN NUMBER ONE AND THAT’S IN NUMBER TWO
1933.02	CP	PIC	OK
1933.04	MELB	EAO	ECHO ALPHA OSCAR MELBOURNE CONTROL GOOD EVENING
1933.07	CP	PIC	ALICE NUMBER ONE
1933.09	PIC	CP	YEAH ALICE IN NUMBER ONE
1933.11	CP	PIC	YEP
1933.13	CP	PIC	SIMPSON’S GAP ON NUMBER TWO
1933.15	PIC	CP	SIMPSON’S GAP ON NUMBER TWO
1933.20	PIC	CP	AND TEMPLE BAR PREED UP BECAUSE AS SOON AS WE GET TO THERE I’LL GET YOU TO PRE THAT UP BECAUSE I CAN’T GO BELOW 3450 UNTIL WE GET TO IT
1933.50	CP	PIC	OK SO
			(non-pertinent transmissions)

TIME (CST)	FROM	TO	TEXT
1934.05	PIC	CP	WE'LL GO DOWN TO FORTY-THREE HUNDRED TO THERE AND IF YOU CAN WIND IN THIRTY-FOUR FIFTY AND WHEN WE WHEN WE GET OVER THERE WIND IN TWENTY-SEVEN EIGHTY THAT'LL BE THE MINIMUM WE'LL SEE HOW IT LOOKS JUST FOR A GIGGLE AND YOU CAN PUT THE STEPS IN NOW TOO IF YOU WOULDN'T MIND BUT YOU ONLY NEED TO PUT THE STEPS IN BELOW THE LOWEST SAFE
			(non-pertinent transmissions)
1935.32	CP	PIC	YOU GOT A DME PLATE THERE OR ARE YOU QUITE HAPPY TO GO ALONG WITH WHAT WE'VE COPIED OFF HERE WHICH IS
1935.37	PIC	CP	NAH THEY'RE ALL RIGHT
1935.39	CP	PIC	OK ALL RIGHT BELOW THE LOWEST SAFE SO TWENTY-NINE
1935.43	PIC	CP	DOWN TO FIVE EIGHT DOWN TO SEVEN - TWENTY-NINE TO FIVE - EIGHT TO THIRTY-SEVEN THAT'S WHAT (unintelligible) IN ACTUAL FACT WE'RE ONLY GOING TO FIVE CAUSE UM WON'T BE ON THE INBOUND TRACK
			(Melbourne comms with VH-JPW)
1936.12	CP	PIC	WHO'S THAT FLYING
193616	PIC	CP	THAT'S SPIKE
1936.26	PAX	PIC	ARE THEY IN FRONT ARE THEY
1936.28	PIC	PAX	YEAH A FAIR WAY
1936.52	PIC	PAX	HARD TO READ AFTER THE CAA ONES AREN'T THEY
1937.15	PIC	CP	AH CAN YOU PUT AH SIMPSON'S GAP IN NUMBER TWO NOW
1938.15	CP	?	WE GOT THERE ONE TWO ONE TWO THREE IS TWENTY-SIX FIVE FIVE FIVE
1939.12	MELB	AJS	ALPHA JULIET SIERRA WHEN READY LEAVE CONTROL AREA ON DESCENT CONTACT ADELAIDE NOW ONE ONE NINE DECIMAL EIGHT
1939.19	CP	MELB	ALPHA JULIET SIERRA (BEEP SOUND)
			(BEEP SOUND)
1939.20	CP	PIC	OK RIGHT TO TWENTY
1939.25	?		CHECKED

TIME (CST)	FROM	TO	TEXT
1939.42	CP	PIC	CAN YOU MONITOR NUMBER ONE FOR ME FOR A SEC
1939.47	PIC	CP	HE SAID TO CALL ADELAIDE NOW DIDN'T HE
1939.49	CP	PIC	YEAH
1939.50	PIC	CP	WELL YOU CAN GO OFF GO OFF THAT
1940.05	CP	ADL	ADELAIDE GOOD DAY ALPHA JULIET SIERRA'S MAINTAINING FLIGHT LEVEL THREE THREE ZERO AND SHORTLY ON DESCENT AND ESTIMATING THE CIRCUIT AREA ALICE TWO ONE
1940.19	CP	ADL	ADELAIDE GOOD DAY ALPHA JULIET SIERRA'S MAINTAINING FLIGHT LEVEL THREE THREE ZERO SHORTLY ON DESCENT AND ESTIMATING THE CIRCUIT AREA ALICE TWO ONE
1940.30	ADL	AJS	ALPHA JULIET SIERRA GOOD EVENING IFR TRAFFIC IS JULIET PAPA WHISKEY WESTWIND INBOUND FROM DARWIN BE ON DESCENT FROM FLIGHT LEVEL 370 ESTIMATING ALICE SPRINGS AT ONE EIGHT
1940.40	CP		ADL ALPHA JULIET SIERRA ROGER, REQUEST SURFACE CONDITIONS AT ALICE
1940.43	ADL	AJS	ALPHA JULIET SIERRA WIND ONE HUNDRED DEGREES FIVE KNOTS QNH ONE ZERO TWO ONE TEMPERATURE ONE EIGHT
1940.50	CP	ADL	ALPHA JULIET SIERRA
1940.54	CP	PIC	COPY THAT RUNWAY ONE TWO (IS FIVE FIVE)
1941.19	JPW		JULIET PAPA WHISKEY'S GOING MTAF
1941.24	ADL	JPW	JULIET PAPA WHISKEY
1941.28	JPW		ALL STATIONS ALICE SPRINGS JULIET PAPA WHISKEY AN IFR WESTWIND IS ON THE THREE FOUR ZERO RADIAL AH THREE ZERO DME AND PASSING SEVENTEEN THOUSAND ON DESCENT TO ALICE SPRINGS TO JOIN FIVE MILE FINAL FOR RUNWAY ONE TWO AND WE ESTIMATE IN THE CIRCUIT AT ONE SEVEN
1941.51	PIC	CP	OK WE'LL BE ARE YOU GOING TO CALL ME THAT YOU'VE GOT A HEADING FLAG
1941.58	CP	PIC	NOW
1941.59	PIC	CP	EH
1942.00	CP	PIC	NOW I AM
1942.02	PIC	CP	YEAH OK IT'S BEEN THERE ABOUT TEN MINUTES ACTUALLY
1942.04	CP	PIC	I'VE BEEN DOING PAPERWORK

TIME (CST)	FROM	TO	TEXT
1942.06	PIC	CP	AH
1942.07	CP	PIC	CAN'T DO EVERYTHING
1942.09	PIC	CP	UMM WELL YOU'RE EXPECTED TO
1942.12	CP	PIC	ERR
1942.14	PIC	CP	UMM I DON'T KNOW HOW WE'RE GONNA GET RID OF THAT I GUESS ALL YOU CAN DO IF IT DOESN'T GO AWAY IS AH PUT MY INFORMATION ON YOUR SIDE IT'S NO GOOD THE WAY IT IS
1942.32	PIC	CP	IN FACT IT'S A FAIR WAY OUT ISN'T IT
1943.04	PIC	CP	THERE YOU GO THAT'S GOT RID OF IT FOR A WHILE ANYWAY
1943.04	PIC	CP	OK WE'RE GONNA DO THIS FOR A BIT OF A GIGGLE UMM ELEVATIONS EIGHTEEN HUNDRED FEET WE'VE GOT ENOUGH FUEL TO HOLD FOR ONE POINT FOUR HOURS IF NEED BE AND AH WE GOT A VEE REF FOR ONE TWENTY SET ON THE LEFT
1943.23	CP	PIC	SET ON THE RIGHT
1943.24	PIC	CP	KEEP GOING
1943.28	PIC	CP	KEEP GOING CHECKS THANKS
1943.29	CP	PIC	OK VEE REF ONE TWENTY SET - FUEL BALANCE
1943.32	PIC	CP	IT'S WITHIN LIMITS
1943.34	CP	PIC	FUEL INTERCONNECT
1943.35	PIC	CP	IT'S CLOSED
1943.36	CP	PIC	FLAP UNBALANCED CHECKED
1943.37	CP	PIC	THRUST REVERSERS
1943.44	CP	PIC	THRUST REVERSERS
1943.47	CP	PIC	CHECKED (CHUCKLE)
1943.48	CP	PIC	ANTI-ICE
1943.49	PIC	CP	IT'S OFF
1943.50	CP	PIC	PRESSURISATION
1943.51	PIC	CP	EIGHTEEN HUNDRED SET FOR... ALICE SPRINGS
1944.08	CP	PIC	OK COMPLETE TO PRELANDING

TIME (CST)	FROM	TO	TEXT
1944.10	PIC	CP	OK WE'RE CLEARED DOWN WE KNOW THE TRAFFIC SO YOU CAN SET OUR STEPS UP THANKS
1944.15	CP	PIC	OK
1944.18	CP	PIC	ARE WE HAPPY TO SET AH FIVE THOUSAND TO START WITH TILL WE GET AH FURTHER CLOSE INBOUND
1944.22	PIC	CP	YEAH WELL JUST SET THE MINIMUM SAFE ALTITUDE WHICH IS FIVE THOUSAND
1944.26	CP	PIC	RIGHT
1944.31	PIC	PAX	YOU DON'T HAVE TO STRAP IN TILL WE'RE ON FINAL IF YOU DON'T WANT TO
1944.32	CP	ADL	ADELAIDE ALPHA JULIET SIERRA LEFT FLIGHT LEVEL THREE THREE ZERO ON DESCENT
1944.38	ADL	AJS	ALPHA JULIET SIERRA
1944.47	PIC	CP	OK IF YOU COULD PUT THE RNAV UP THANKS
1944.51	PIC	CP	WHOOH - DO THAT FIRST BRING EM BOTH OUT OK
1945.01	CP	PIC	RIGHT OH
1945.44	PIC	CP	AH HAVE YOU GOT THE ILS PREED UP THERE JUST IN CASE
1946.08	PIC	CP	THANKS
1946.40	PIC	CP	ARE YOU HAPPY THAT QNH IS CORRECT
1946.58	CP	PIC	YEP
1946.59	PIC	CP	THANK YOU
1947.04	PIC	CP	OK THIRTY MILES WE'RE TRACKING TO THE RNAV POSITION TO START THE APPROACH
1947.08	CP	PIC	OK
1947.09	PIC	CP	SO YOU CAN PUT THE INBOUND COURSE UP THERE
1947.32	PIC	CP	THANK YOU
1947.38			(VH-JPW transmission) 5 mile final rwy 12
1947.47	PIC	CP	OK TRANSITIONS THANKS
1947.49	CP	PIC	OK ONE ZERO TWO ONE
1947.53	PIC	CP	GIVES ME SIXTEEN THOUSAND NOW
1947.56	CP	PIC	OK I'M A HUNDRED AND FIFTY FEET LOW MY SIDE

TIME (CST)	FROM	TO	TEXT
1947.59	PIC	CP	OK
1948.03	CP	PIC	LANDING LIGHT - TAXI LIGHTS - ON
1948.08	CP	PIC	TIP TANKS
1948.09	PIC	CP	THEY'RE OUT
1948.10	CP	PIC	SPEED BRAKES
1948.11	PIC	CP	RETRACTED
1948.12	CP	PIC	COMPLETE TO FLAPS
1948.14	PIC	CP	OK YOU TOLD HIM WE'RE GOING TO MTAF
1948.16	CP	PIC	YEP
1948.19	CP	ADL	ADELAIDE AH ALPHA JULIET SIERRA'S CHANGING TO THE ALICE MTAF
1948.26	ADL	AJS	ALPHA JULIET SIERRA
1948.33	CP	PIC	SO WE'RE INBOUND FOR A TWIN LOCATOR RUNWAY ONE TWO
1948.38	CP		ALL STATIONS ALICE SPRINGS MTAF ALPHA JULIET SIERRA IFR WESTWIND IS CURRENTLY TWO FOUR MILES TO THE NOR NOR WEST WILL BE TRACKING FOR A TWIN LOCATOR APPROACH RUNWAY ONE TWO
1949.24	PIC	CP	TRY AND HAVE YOUR LIGHT AS DIM AS YOU CAN WORK IN - IT'S VERY DISTRACTING - THAT'S THE WAY THANKS
1949.41	PIC	CP	OK WE'RE ASSUMING WE'VE GOT THE AH THE IDENT ON ALL THE TIME OK IF YOU JUST IDENTIFY 'EM AND THEN TURN'EM OFF
1949.53			Navaid morse idents
1950.08	CP	PIC	OK SIMPSON'S GAP IDENTIFIED ON TWO ALICE IS IDENTIFIED ON ONE
1950.12	PIC	CP	THANK YOU
1950.13	PIC	CP	WELL THE MINUTE WE GET CLOSE TO SIMPSON GAP THE MINUTE WE GET HERE YOU CAN YOU READ WHAT WE GOT TO BE AT FORTY-THREE
1950.19	CP	PIC	YEP
1950.20	PIC	CP	OK
1950.21	CP	PIC	FORTY-THREE AT ELEVEN MILES - ONE TO GO TO THERE
1950.25	PIC	CP	THAT'S CHECKED
1950.33	CP	PIC	OK (AT FORTY) SET FORTY-THREE
1950.35	PIC	CP	OK SET FORTY-THREE

TIME (CST)	FROM	TO	TEXT
1950.37	CP	PIC	FORTY-THREE SET
1950.38			Warning horn ‘gear’
1950.48	PIC	CP	OK YOU CAN TAKE THE RNAV OUT THANKS JUST PUT ALICE UP
1950.51			Altitude alert BEEP
1951.09	PIC	CP	OK FLAP TWELVE
1951.10	CP	PIC	SPEED CHECK TWELVE SELECTED
1951.13	PIC	CP	FLAP TWENTY
1951.14	CP	SET	SET - SPEED CHECK - FLAP TWENTY SELECTED
			BEEP sound
1951.17	PIC	CP	OK WE’RE CLEARED TO FORTY-THREE
1951.19	CP	PIC	CHECKED PRESSURISATION
1951.22	PIC	CP	THAT’S YOURS
1951.23	CP	PIC	CHECKED - ON THE WAY DOWN - ANTI ICE
1951.28	PIC	CP	IT’S OFF
1951.29	CP	PIC	GEAR’S TO COME
1951.32	PIC	CP	OK
1951.41	PIC	CP	NOW THE MINUTE WE GO OVER SPRING HILL OR WHATEVER IT’S CALLED SIMP AH
1951.44	CP	PIC	SIMPSON’S GAP(ON TWOTHREE FIVE TWO)
1951.46	PIC	CP	SIMPSON’S IT’S CALLED YEAH UMM SET THE NEXT ALTITUDE UP AND THE NEXT NDB
1951.56			Transmission JPW
1952.01	PIC		BLEW IT
1952.02			Transmission JPW
1952.05			Faint BEEP sound
1952.15	CP		THIRTY FIVE
1952.17			BEEP BEEP BEEP
1952.56	CP	PIC	OK COMING UP - OVERHEAD SIMPSON’S GAP
1952.59	PIC	CP	RIGHTO
1953.01	PIC	CP	NEXT ONE AND THE (BEEP heard) ALTITUDE THANKS

TIME (CST)	FROM	TO	TEXT
1953.04	CP	PIC	THIRTY-FOUR FIFTY - I'LL PUT IN THIRTY-FIVE
1953.06	PIC	CP	YEP THAT'S FINE
1953.08	CP	PIC	AND
1953.12	PIC	CP	THEN WHEN WE GO OVER THAT NEXT NDB
1953.13	CP		(TWO OUT)
1953.15	PIC	CP	YOU CAN PUT IN THE MINIMA IN
1953.16	CP	PIC	OK
1953.25	PIC	CP	THIRTY-FIVE EH
1953.35	CP		TWO FOUR (UM)? THREE
1953.48	CP	PIC	OK THE RUNWAY SHOULD ACTUALLY BE OUT TO THE RIGHT
1953.50	PIC	CP	ALL RIGHT
1953.52	PIC	CP	OK THERE'S THIRTY FIVE HUNDRED
1953.54	CP	PIC	OK WE'RE COMING UP OVER THERE IT'S DOWN (beep, altitude alert?) TO TWENTY-THREE
1953.58	PIC	CP	TWENTY-THREE GEAR DOWN THANKS
1954.00	CP	PIC	OK SPEED CHECK GEAR SELECTED DOWN GEAR DOWN THREE GREENS CONFIRMED
1954.05	PIC	CP	CONFIRMED
1954.09	CP	PIC	OK HYDRAULIC PRESSURES CHECKED IN TWO - ANTI SKID (beep)
1954.13	PIC	CP	ONE TO RUN
1954.14	CP	PIC	THRUST REVERSERS CHECKED
1954.15	PIC	CP	ON - LIGHTS OUT
1954.16	CP	PIC	THRUST REVERSERS
1954.18	PIC	CP	ARMED THANKS
1954.19	CP	PIC	RADAR'S OFF - TRANSPONDER IS ON STANDBY - LANDING FLAP - RUNWAY'S CLEAR (OOOH)
1954.38	CP		(KAY)
1954.40	CP	PIC	THREE HUNDRED TO RUN TO MINIMA
1954.42	PIC	CP	THAT'S CHECKED
1954.48	CP	PIC	PULL UP. PULL UP!
1954.51	CP		XXXXXXX (BEEP sound)