AUSTRALIAN TRANSPORT SAFETY BUREAU

AVIATION SAFETY INVESTIGATION REPORT

BO/200105769

# Raytheon Beech 200C, VH-FMN


Mount Gambier, SA

10 December 2001

COMMONWEALTH DEPARTMENT OF TRANSPORT AND REGIONAL SERVICES

**Department of Transport and Regional Services**

**Australian Transport Safety Bureau**

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# INTRODUCTION

The Australian Transport Safety Bureau (ATSB) is an operationally independent multi-modal Bureau within the Commonwealth Department of Transport and Regional Services. ATSB investigations are independent of regulatory, operator or other external bodies.

In terms of aviation, the ATSB is responsible for investigating accidents, serious incidents, incidents and safety deficiencies involving civil aircraft operations in Australia, as well as participating in overseas investigations of accidents and serious incidents involving Australian registered aircraft. The ATSB also conducts investigations and studies of the aviation system to identify underlying factors and trends that have the potential to adversely affect safety. A primary concern is the safety of commercial air transport, with particular regard to fare-paying passenger operations.

The ATSB, and prior to 1 July 1999, the Bureau of Air Safety Investigation (BASI), is a corporate member of the Flight Safety Foundation and the International Society of Air Safety Investigators.

The ATSB performs its aviation functions in accordance with the provisions of the *Air Navigation Act 1920*, Part 2A. Section 19CA of the Act states that the object of an investigation is to determine the circumstances surrounding any accident, serious incident, incident or safety deficiency to prevent the occurrence of other similar events. The results of these determinations form the basis for safety recommendations and advisory notices, statistical analyses, research, safety studies and ultimately accident prevention programs. Similar to equivalent overseas organisations, the ATSB has no power to implement its recommendations.

It is not the object of an investigation to determine blame or liability. However, it should be recognised that an investigation report must include factual material of sufficient weight to support the analysis and conclusions reached. That material will at times contain information reflecting on the performance of individuals and organisations, and how their actions may have contributed to the outcomes of the matter under investigation. At all times the ATSB endeavours to balance the use of material that could imply adverse comment, with the need to properly explain what happened, and why, in a fair and unbiased manner.

This report is written in harmony with the International Standards and Recommended Practices promulgated in International Civil Aviation Organization (ICAO) Annex 13 to the Convention on International Civil Aviation. Section 1, *Factual Information*, contains the known facts relevant to the occurrence. Issues raised in Section 1 are addressed in Section 2, *Analysis*.

# 1 FACTUAL INFORMATION

## 1.1 History of the flight

The Raytheon Beech 200C Super King Air, registered VH-FMN, departed Adelaide at 2240 hours Central Summer Time (CSuT)[1] under the Instrument Flight Rules for Mount Gambier, South Australia. The ambulance aircraft was being positioned from Adelaide to Mount Gambier to transport a patient from Mount Gambier to Sydney for a medical procedure, for which time constraints applied. The pilot intended to refuel the aircraft at Mount Gambier. The planned flight time to Mount Gambier was 52 minutes. On board were the pilot and one medical crewmember. The medical crewmember was seated in a rear-facing seat behind the pilot.

On departure from Adelaide, the pilot climbed the aircraft to an altitude of 21,000 ft above mean sea level for the flight to Mount Gambier. At approximately 2308, the pilot requested and received from Air Traffic Services (ATS) the latest weather report for Mount Gambier aerodrome, including the altimeter sub-scale pressure reading of 1012 millibars. At approximately 2312, the pilot commenced descent to Mount Gambier. At approximately 2324, the aircraft descended through about 8,200 ft and below ATS radar coverage.

At approximately 2326, the pilot made a radio transmission on the Mount Gambier Mandatory Broadcast Zone (MBZ) frequency advising that the aircraft was 26 NM north, inbound, had left 5,000 ft on descent and was estimating the Mount Gambier circuit at 2335. At about 2327, the pilot started a series of radio transmissions to activate the Mount Gambier aerodrome pilot activated lighting (PAL).[2] At approximately 2329, the pilot made a radio transmission advising that the aircraft was 19 NM north and maintaining 4,000 ft. About 3 minutes later, he made another series of transmissions to activate the Mount Gambier PAL. At approximately 2333, the pilot reported to ATS that he was in the circuit at Mount Gambier and would report after landing. Witnesses located in the vicinity of the aircraft's flight path reported that the aircraft was flying lower than normal for aircraft arriving from the northwest.

At approximately 2336 (56 minutes after departure), the aircraft impacted the ground at a position 3.1 NM from the threshold of runway (RWY) 18. The pilot sustained fatal injuries and the medical crewmember sustained serious injuries, but egressed unaided.

The location of the accident site is depicted at fig. 1.

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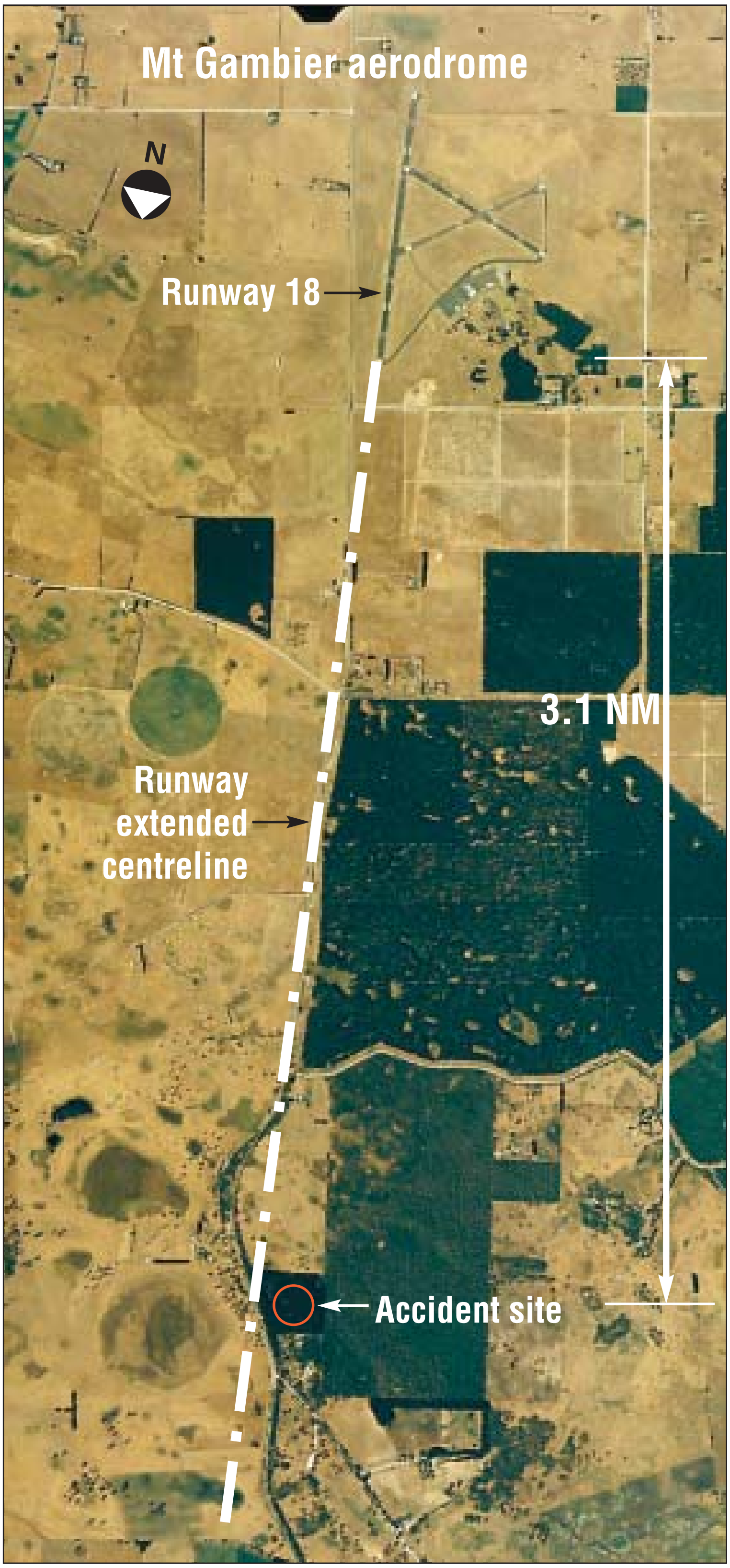
1 All times used in this report are stated in the 24-hour clock format and refer to Mount Gambier local time of day, Central Summer Time (CSuT). CSuT was Coordinated Universal Time (UTC) + 10½ hours.

2 Pilot activated lighting (PAL) will remain illuminated for 30 to 60 minutes, depending on the installation timer setting. The wind indicator light will flash continuously during the last 10 minutes of lighting illumination to warn users that the lights are about to extinguish. To maintain continuity of lighting, the activation sequence can be repeated. The Mount Gambier PAL was set to operate for 30 minutes.

Figure 1:
Location of accident site



## 1.2 Injuries to persons

| *Injuries* | *Crew* | *Medical crewmember* | *Others* | *Total* |
|---|---|---|---|---|
| Fatal | 1 | - | - | 1 |
| Serious | - | 1 | - | 1 |
| Minor | - | - | - | - |
| None | - | - | - | - |

## 1.3 Damage to aircraft

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

## 1.4 Other damage

Nil.

## 1.5 Personnel information

| | |
|---|---|
| Type of licence | Air Transport Pilot (Aeroplane) Licence |
| Instrument rating | Multi Engine Command |
| Medical certificate | Class 1, vision correction required |
| Flying experience (total hours) | 13,730.0 |
| Total command | 9,003.0 |
| Total night | 1,390.0 |
| Total on type | 372.0 |
| Total last 24 hours | 3.1 |
| Total last 30 days | 18.0 |
| Total last 90 days | 87.0 |
| Total on type last 90 days | 52.0 |
| Last flight check | 16 August 2001 (Line check) |

The pilot was familiar with the occurrence aircraft. A review of the pilot's previous flying experience indicated that he had a significant amount of experience conducting night approaches to remote locality airfields. As he was based at Port Augusta, the pilot did not fly to Mount Gambier often. A review of the pilot's flying logbook indicated that his last flight into Mount Gambier took place on 19 August 2001, and that flight was by day. The investigation could find no record of him having ever flown into Mount Gambier by night.

During the period 4–6 December 2001, the pilot was rostered on day shift. During the period 7–9 December 2001, he was rostered off duty. He then commenced a 4-day series of night-shift duties at 1800 hours on 10 December. Prior to the occurrence flight, the pilot had flown from Port Augusta to Adelaide via Whyalla on another air ambulance mission.

Based on interviews and a review of telephone records, the pilot obtained less than 7 hours sleep on each of the nights of 7 and 8 December. It could not be determined how much sleep the pilot had on 9 December. At about midday on 10 December, the pilot mentioned to an associate in a telephone conversation that he intended to have a sleep during the day. However, the maximum period of time between phone calls after this conversation, and prior to 1800, was just under two hours.

## 1.6 Aircraft information

| | |
|---|---|
| Manufacturer | Raytheon Beech |
| Model | Super King Air B200C |
| Serial number | BL-47 |
| Powerplants | Two Pratt & Whitney PT6A-42 |
| Registration | VH-FMN |
| Year of manufacture | 1982 |
| Total airframe hours | 10,907.7 |
| Date of last maintenance | 16/10/01 |
| Type of last maintenance | Phase 4 & 5 |
| Maintenance release | Dated 16/10/01, valid to 16/10/02 or 10,951.9 hours |

### 1.6.1 Ground proximity warning system

The aircraft was not fitted with a ground proximity warning system (GPWS), nor was it required by regulation.

### 1.6.2 Global Positioning System

The aircraft was fitted with a Bendix/King KLN-900 Global Positioning System (GPS) navigation system, which consisted of a panel mounted receiver/display unit and a GPS antenna. The system was designed to provide the pilot with navigation and position information from received satellite signals. Flight plans were entered into the receiver/display unit as a number of waypoints to be flown. Navigation data could also be displayed on a course deviation indicator (CDI) and a horizontal situation indicator (HSI). Steering information was also coupled to the autopilot in the NAV mode.

Manufacturer's literature stated that the system was designed to meet TSO-C129,[3] Class A1 specifications for non-precision instrument approaches, as well as for all enroute and terminal operations.

Procedures for use of the system were contained in the company Flying Operations Manual. The GPS database was last updated on 28 November 2001 and was valid until 26 December 2001.

### 1.6.3 Altimeter

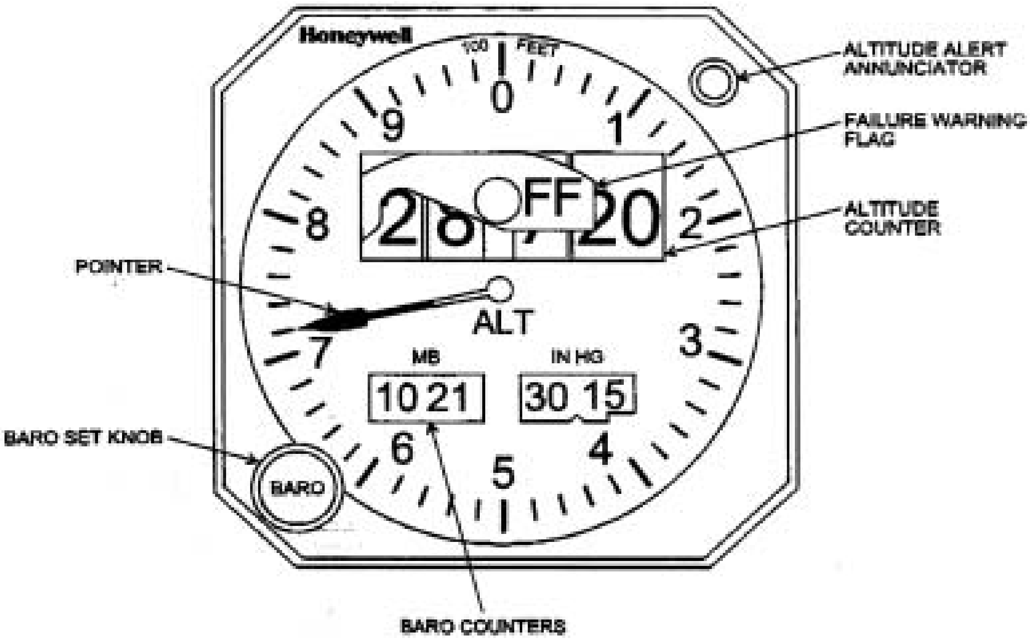
The aircraft was fitted with a Sperry BA-141 encoding altimeter. Manufacturer's literature stated that the BA-141 encoding altimeter provided the following displays:

- Counter drum display of altitude, marked in 20-foot increments.
- Pointer display of altitude between thousand-foot levels with 20-foot graduations.
- Altitudes below 10,000 feet are annunciated by a black and white crosshatch on the left-hand digit position of the counter display.
- Barometric pressure counter, set by means of the BARO knob, displays barometric pressure in inches of mercury and millibars.
- Failure warning flag.

[3] Technical Standard Order C129 (TSO-C129), *Airborne Supplemental Navigation Equipment using the Global Positioning System (GPS).*

The altimeter and pitot-static system was last inspected on 19 January 2001, with no anomalies noted. The BA-141 altimeter is depicted at fig. 2.

**FIGURE 2:**
**Sperry BA-141 encoding altimeter**




### 1.6.4 Radio altimeter

While a radio altimeter is standard fitment in many turbine-engine aircraft, there was no Australian regulatory requirement for such equipment to be fitted. However, FMN was fitted with a Sperry AA-300 radio altimeter. The pilot could select a height using the radio altimeter decision height knob, which would provide an advisory light on the attitude indicator and radio altimeter, when the aircraft descended below that height. The radio altimeter also provided input to the voice advisory system.

The company Flying Operations Manual stated that:

> The Radar Altimeter, if fitted, is to be set to 500 ft, except when conducting an instrument approach, where MDH or DH is to be set.[4]

### 1.6.5 Altitude alerting system

Paragraph 7.2 of Civil Aviation Order (CAO) 20.18 stated that:

> Pressurised turbine engined aircraft operating in controlled airspace under Instrument Flight Rules (except night VMC) shall be equipped with an altitude alerting system.

FMN was fitted with a Sperry SPI-500 Flight Director System which incorporated an AL-245 altitude alert controller. The altitude alert controller provided a means for setting the desired altitude reference for the altitude alerting and altitude preselect system, which provided input to the autopilot. Manufacturer's literature stated that as the aircraft approached a point 1,000 ft from a selected altitude, a warning light would illuminate on the altimeter and a single aural

[4] Minimum Descent Height or Decision Height.

alert would sound for 1 second. The light would remain on until the aircraft was 250 ft from the selected altitude. The autopilot would then capture the selected altitude. If the aircraft then deviated by 250 ft or more from the selected altitude, the light would again illuminate and a single aural alert would again sound. The light would remain on until the aircraft returned to within 250 ft or deviated more than 1,000 ft from the selected altitude. The nature of the aural alert was dependent upon pilot selection of a panel-mounted switch which would present the pilot with either a voice advisory alert (see paragraph 1.6.6) or altitude aural alert. Procedures for use of the system were contained in the company Flying Operations Manual. Those procedures included, in part:

- Descending OCTA [outside controlled airspace], in IMC [instrument meteorological conditions] or at night set the route LSALT [lowest safe altitude] or destination MSA [minimum sector altitude].
- During an instrument approach, the missed approach altitude normally should be set once the approach is commenced. This may be delayed if using the [Altitude Preselect] Controller in conjunction with the autopilot. Do not try to set limiting altitudes late in the approach, as this creates an unnecessary additional workload at a critical time, and in any case, many limiting altitudes cannot be set as they are not multiples of 100 ft.

The system did not permit the pilot to prevent activation of the altitude aural alert. In addition, no volume control was provided. No altitude aural alert was heard on the cockpit voice recorder (CVR) recording (see paragraph 1.11).

### 1.6.6 Voice advisory

FMN was fitted with a Sperry VA-100 Voice Advisory unit. Manufacturer's literature stated that the VA-100 was designed to:

> …advise the pilot by 'VOICE ADVISORY' (a digitised female voice) of absolute altitude during approaches to land, unsafe and changing conditions when in close proximity to the ground, and unsafe and changing conditions while enroute.

If the voice advisory system was activated, it provided voice advisories dependent upon the altitude selected on the altitude alert controller (that is, at 1,000 ft above the selected altitude and at 250 ft deviation from the selected altitude). It also provided voice advisories at various altitudes dependent on the height selected on the radio altimeter.

The unit could be inhibited by pilot selection of a panel-mounted switch. Manufacturer's literature stated that when switched to the 'OFF' position, the unit annunciated a single 'VOICE OFF'. The operator could not recall if the unit fitted to FMN provided that annunciation. No such annunciation was heard on the CVR recording.

Company pilots reported that the unit produced '…an excessive…' number of aural alerts. In particular, they reported '…six or more…' alerts within the last 1,000 ft during an approach to land, which was distracting and interfered with normal communications. They reported that it was common practice for pilots to inhibit the voice advisory due to that distraction. Notwithstanding, inhibition of the voice advisory would have been replaced by aural alerts from the altitude alerting system. A voice advisory was detected on the CVR recording when the aircraft was passing about 19,700 ft on descent to Mount Gambier. There were no subsequent voice advisories recorded.

FMN was one of three B200C aircraft purchased second-hand by the operator. Each of the three aircraft had different avionics packages fitted. The Flying Operations Manual provided standard procedures for the fleet of three B200C aircraft, but contained no information with respect to operation of the voice advisory as FMN was the only company aircraft fitted with the system.

There were no CASA or US Federal Aviation Administration Airworthiness Directives, Airworthiness Advisory Circulars or Airworthiness Bulletins pertaining to any failures of the GPS navigation system, altimeter, radio altimeter, altitude alerting system or voice advisory system fitted to the aircraft.

## 1.7 Meteorological information

During the flight, ATS advised the pilot in command of the latest Mount Gambier aerodrome forecast. That forecast included wind from 240 degrees at 6 to 10 kts, visibility 7 km, light drizzle, scattered cloud at 800 ft, broken cloud at 3,500 ft, temperature and dew point both 11 degrees Celsius, and QNH 1012 Hpa.

On descent into Mount Gambier, the pilot obtained the latest actual aerodrome weather conditions from an automatic broadcasting system at the aerodrome. That weather broadcast included wind from 230 degrees at 6 kts, humidity 96 per cent, nil rainfall in the last 10 minutes, temperature and dew point both 11 degrees Celsius, and QNH 1012 Hpa.

Reported weather conditions in the area at the time of impact included low cloud, rain showers, moderate winds and low visibility. At the time of the accident there was no visible moon and no other aircraft were operating in the vicinity.

## 1.8 Aids to navigation

Mount Gambier aerodrome radio navigation aids consisted of a VHF Omni-directional Radio Range (VOR) and Non Directional Radio Beacon (NDB). ATS radar data indicated that the aircraft was tracking from Adelaide to Mount Gambier aerodrome, probably with reference to the VOR. There was little or no ambient illumination in the area surrounding the aircraft's flight path during the latter stages of the descent to Mount Gambier. Company pilots reported that the aerodrome lighting could be '…difficult to see…' when flying from the direction of Adelaide, which was to the northwest of Mount Gambier, however, there were no reports that the lighting was difficult to see when on approach to the runway.

## 1.9 Communications

All communications between ATS and the pilot in command were recorded by ground-based automatic voice recording equipment for the duration of the flight. Radio transmissions made by the pilot on the Mount Gambier aerodrome frequency were recorded on the aerodrome automatic voice recording equipment. The quality of the aircraft's recorded transmissions was good. Radio transmissions from the aircraft did not indicate any aircraft anomalies.

Radio transmissions were also recorded on the aircraft CVR and are discussed at paragraph 1.11.

## 1.10 Aerodrome information

Mount Gambier aerodrome is situated 5 NM north of the township and is 212 ft above mean sea level. It is operated by the District Council of Grant and has three runways. RWY 18/36 was the preferred runway for regular public transport and Royal Flying Doctor Service operations. It was aligned 176/356 degrees M, was 1,524 m (5,000 ft) in length and had negligible slope. Witnesses who were in the vicinity of the aerodrome shortly after the accident advised that the aerodrome PAL was illuminated. Aerodrome operations personnel reported that post-accident testing of the PAL system indicated that it was functioning correctly. An Abbreviated ‘T’ Visual Approach Slope Indicator System (AT-VASIS) pilot-interpreted runway glideslope indication, set at 3 degrees to the horizontal, was provided for RWY 18/36.[5] The system was installed on the left side of RWY 18. The AT-VASIS was designed to illuminate coincident with activation of the PAL. Aerodrome operations personnel reported that post-accident testing of the AT-VASIS system indicated that it was functioning correctly. There was no evidence to indicate that the AT-VASIS was not illuminated at the time of the occurrence.

## 1.11 Flight recorder information

The aircraft was not fitted with a flight data recorder, nor was it required by regulation.

The aircraft was fitted with a Collins 642C-1 CVR, which was recovered in good condition. The CVR provided 33 minutes of good quality audio data of the flight, recorded on four separate channels. CVR data ceased at impact at approximately 2336. Engine and propeller noise was audible on the recording, and no anomalies were detected. In addition, there was no indication from the pilot that the aircraft was functioning abnormally. The recording revealed that the pilot had configured the aircraft for landing by extending the landing gear and increasing propeller RPM.[6] The last recording made by the pilot was about 2.5 minutes prior to impact. There was no indication on the CVR that the pilot saw the ground prior to impact. The only altitude alert on the CVR was a voice advisory at 19,700 ft on descent.

## 1.12 Wreckage information

The impact position was right of the RWY 18 extended centreline, with a deviation to the right of about 5 to 10 degrees (that is, about 185–190 degrees M). The aircraft impacted the ground slightly right wing low and in a nose-low attitude. The impact swathe extended approximately 240 metres and the aircraft came to rest upright and facing back towards the direction of flight. The tail section had separated and was lying inverted a short distance from the remainder of the aircraft. The cabin airstair door was open and had been used by the medical crewmember for egress. The emergency location transmitter (ELT) had activated on impact. Examination of the wreckage and impact swathe indicated that the aircraft's landing gear was extended and the flaps were in the approach configuration. The aircraft’s final position is depicted at figs. 3 and 4. The impact swathe is depicted at fig. 5.

Ground vegetation consisted of a cleared pine plantation, with some secondary growth to a height of about 5 metres. Damage to trees in the approach path indicated an aircraft approach angle of about 10 to 13 degrees. The operator estimated that such an approach angle would

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5 An AT-VASIS consists of 10 light units arranged on one side of the runway, in the form of a single wing bar of four light units, with a bisecting longitudinal line of six lights. The red ‘fly up’ indication is designed to be visual to ground level. The Airservices Australia Aeronautical Information Publication stated that the AT-VASIS:

> …standard installation aims to provide an obstacle clearance of at least 11M above a 1.9 degree slope, within the azimuth splay of 7.5 degree either side of the runway centre line for a distance of 5 NM from the threshold…When the installation differs from the standard, details are promulgated in the aerodrome documentation.

Mount Gambier aerodrome documentation did not publish advice of a difference to the standard installation. Paragraph 7.6 of Chapter 12 of the Civil Aviation Safety Authority Document Rules and Practices for Aerodromes, current at the time of the occurrence, stated that:

> The beam of light produced by the units is to be such that in clear weather the effective visual range of the indicator is to be at least 4 nautical miles over the angle of 1½ degrees above and 1 degree below the correct approach slope, both by day and by night, and in azimuth over 10 degrees by day and 30 degrees by night. The light units are to have as great an intensity as possible from ground level to 6 degrees in elevation.

6 Propeller RPM is increased to allow the aircraft engines to develop maximum horsepower if required, and is conducted as part of the aircraft checklist procedures on final or short final approach.

have required an aircraft attitude of about 5 degrees nose-down on the aircraft attitude indicator and a rate of descent of about 1,500 to 2,800 ft per minute, dependant upon indicated airspeed and wind effect. The aircraft's approach path is depicted at fig. 6. Due to impact and fire damage, no information was able to be obtained from cockpit instruments and flight control positions.

Following discussions with Mount Gambier Police, and in accordance with the provisions of the *Air Navigation Act 1920*, Part 2A, Section 19FM, the aircraft wreckage was released to the owner on 13 December 2001.

**FIGURE 3:**
**Final wreckage position**

FIGURE 4:
Extent of fire damage to cockpit area

FIGURE 5:
Impact swathe viewed from point of initial impact to final position

FIGURE 6:
Approximate aircraft approach path, looking back along flight path


## 1.13 Medical information

A review of the pilot's medical records, investigation interviews, results of the post-mortem examinations and toxicological testing, found no evidence of pre-existing medical conditions that may have influenced his performance. His civil aviation medical certificate carried the restriction 'vision correction required'. The medical crewmember reported that the pilot was complying with that restriction at the time of the accident.

The pilot's colleagues reported that they were unaware of him having any significant medical problems and that he did not consume alcohol. A week before the accident, the pilot had seen a medical practitioner for a cold, and he received a prescription for the antibiotic Rulide. Post-occurrence specialist medical advice suggested that that medication would have had no adverse effects on the pilot's performance. The medical crewmember reported that the pilot did not display any apparent effects of the cold that could have adversely affected his performance.

During his visit to the medical practitioner, the pilot also reported that he was having difficulty sleeping during the day between or before night shifts, and he received a prescription for Temazepam.[7] The extent to which he used the prescribed medication could not be determined. Toxicological analysis of the pilot's blood at post mortem did not detect benzodiazepines.

## 1.14 Fire

There was no evidence of an in-flight fire. The aircraft was largely consumed by post-impact fire, which was initiated during the impact sequence.

7 Temazepam is a benzodiazepine derivative, which hastens the onset of sleep and increases total sleep time in short-term use.

## 1.15 Survival aspects

The medical crewmember was seated behind the pilot, in a rear-facing standard Beech executive seat, and was restrained by a lap and shoulder sash restraint harness. Despite an intense fire and partial aircraft break-up during the impact sequence, the medical crewmember was able to evacuate through the cabin airstair door unaided, and walk away from the aircraft.

Post-mortem examination indicated that the pilot survived the initial impact, however, did not survive the accident. That examination also indicated head trauma and inhalation of trace gases consistent with combustion. The pilot remained in his seat. Although the seat belt assembly was destroyed by the post-impact fire, the position of the pilot in the wreckage indicated that his shoulder and lap restraint harness was secure at the time of impact.

## 1.16 Operational information

### 1.16.1 Mount Gambier instrument approaches

At the time of the accident, published instrument approaches for Mount Gambier included VOR RWY 18, NDB RWY 18, Global Positioning System (GPS) RWY 18, GPS RWY 36 approaches and GPS Arrival procedure.

A VOR RWY 18 or NDB RWY 18 instrument approach, or a circling approach[8] would have required the aircraft to fly overhead the aerodrome. Witnesses located in the vicinity of the aerodrome at the time of the accident reported that the aircraft did not fly overhead.

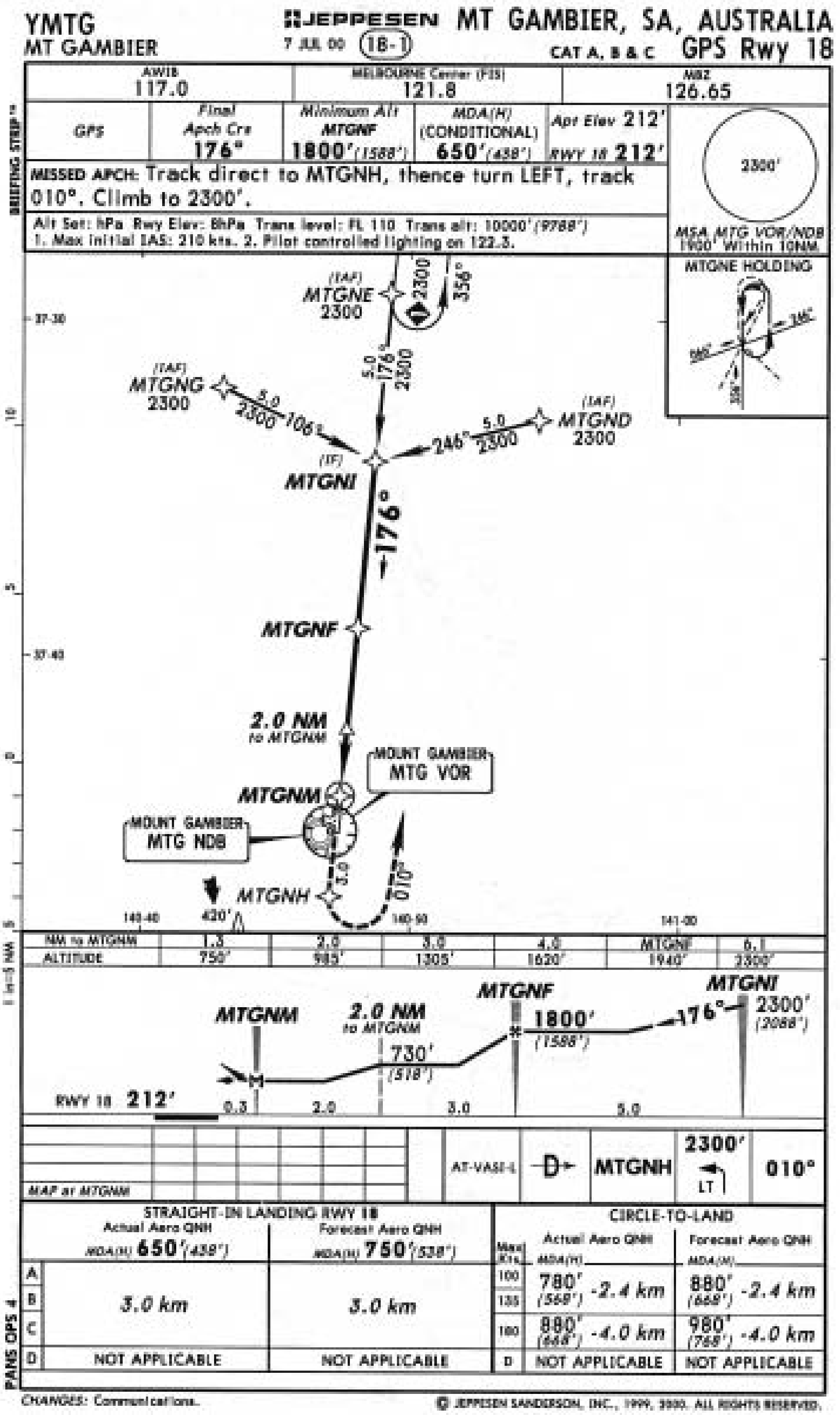
Based on the times of the pilot's position reports at 26 and 19 NM, and the estimated ground speed of the aircraft, the aircraft would have overflown the aerodrome at about 2338. The investigation calculated that a circling approach would have taken about an additional 3 minutes to arrive at the accident site (2341). The time of impact was about 2336.

### 1.16.2 GPS RWY 18 Approach

The pilot was reported to have used Jeppesen Sanderson, Inc. (Jeppesen) instrument approach charts. The Jeppesen Mount Gambier GPS RWY 18 Approach, current at the time of the occurrence, is depicted at fig.7. CASA had approved the use of GPS as a non-precision approach navigation aid, in Australian domestic airspace, under the Instrument Flight Rules. The operator reported that FMN was not certified to conduct GPS non-precision approaches, and company pilots were not trained to, and therefore not permitted to, conduct GPS non-precision approaches.

8 A circling approach is an extension of an instrument approach procedure, which provides for visual circling of the aerodrome prior to landing.

**FIGURE 7:**
**Jeppesen Mount Gambier GPS RWY 18 Approach**

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Witnesses located under the GPS RWY 18 Approach path, and to the south of the GPS waypoint MTGNF (5.3 NM north of the threshold RWY 18), reported that they heard the occurrence aircraft some distance to the west of them, and that it did not overfly their location. Witnesses located to the south and west of MTGNF, reported that the occurrence aircraft overflew their location.

### 1.16.3 GPS Arrival procedure

The Jeppesen Mount Gambier GPS Arrival procedure, current at the time of the occurrence, is depicted at fig. 8. A GPS Arrival procedure provides descent guidance from either a controlled airspace step or an enroute or sector lowest safe altitude in uncontrolled airspace, to the visual circling area of an aerodrome. Azimuth guidance is required from the radio navigation aid specified in the procedure. Azimuth guidance for the Mount Gambier GPS Arrival procedure was provided with reference to the Mount Gambier VOR.

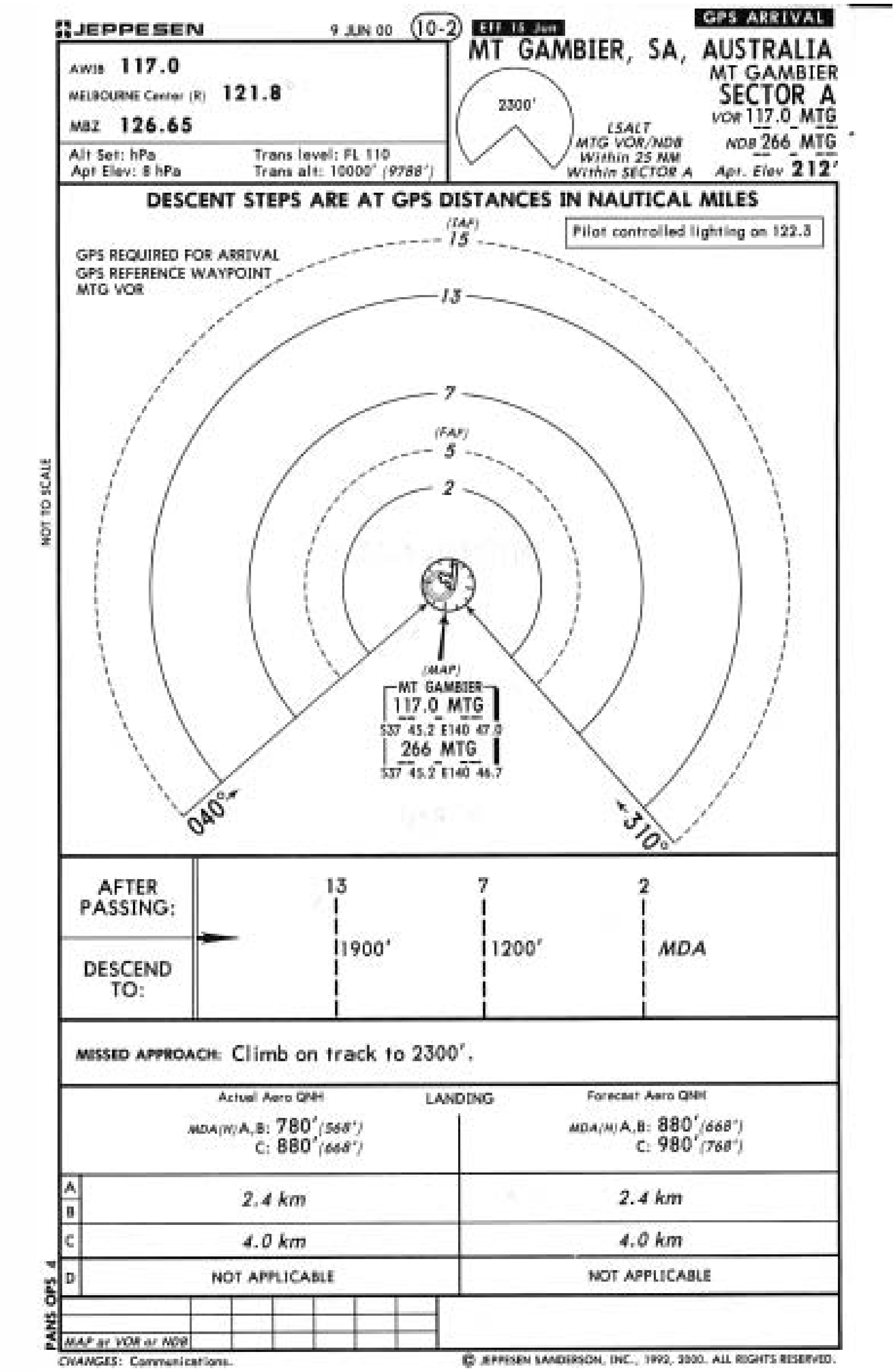
GPS Arrival procedures, and procedures for discontinuing the approach, were published in Airservices Australia and Jeppesen aeronautical information publications. Those procedures do not imply a requirement to adopt a stepped descent profile. Descents may be conducted at any suitable rate unless specified by ATS. The descent from cruise to Mount Gambier is discussed at paragraph 1.16.4.1.

GPS Arrivals may be conducted via a straight-in or circling approach. Procedures detailing the requirements for straight-in approaches were published in Airservices Australia and Jeppesen aeronautical information publications. Those procedures included a requirement for the pilot in command to broadcast that intention on the MBZ frequency '…as close as practicable to 15NM from the aerodrome...' and again '… as close as practicable to 5 NM from the intended landing runway threshold…'. The occurrence pilot did not broadcast that intention in either instance.

The minimum altitudes specified for the Mount Gambier GPS Arrival procedure, as shown at fig. 8, were 1,900 ft above mean sea level (AMSL) from 13 NM to 7 NM and 1,200 ft from 7 NM to 2 NM. The minimum descent altitude (MDA) for the procedure, at less than 2 NM, was 780 ft[9]. At MDA, the procedure specified a flight visibility requirement of 2.4 km. The missed approach point was the VOR. Descent below MDA is discussed at paragraph 1.16.4.2. The initial approach fix was at 15 NM and the final approach fix was at 5 NM, with reference to the Mount Gambier VOR.

9 FMN was a Category B aircraft. The MDA for the approach was 780 ft, which was 100 ft lower than the 880 ft depicted on the chart. That was permitted in accordance with the provisions of the Aeronautical Information Publication because an actual aerodrome QNH was available to the pilot.

**FIGURE 8:**
**Jeppesen Mount Gambier GPS Arrival procedure**

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### 1.16.4 Descent to Mount Gambier

#### 1.16.4.1 Descent from cruise

ATS recorded radar data at fig. 9, indicated that the aircraft commenced descent to Mount Gambier, from cruise altitude, at about 2312 and was about 89 NM from Mount Gambier at that time. The initial rate of descent was about 440 ft per minute for about 5 minutes, until about 67 NM from Mount Gambier, indicating a descent profile of about 6 NM per 1,000 ft. The aircraft then descended at a rate of 1,350 ft per minute for about 8 minutes, until radar contact was lost at an altitude of about 8,200 ft AMSL and 34 NM from Mount Gambier. That indicated a descent profile of about 3 NM per 1,000 ft. Aircraft groundspeed during the descent varied between 237 and 269 kts.

A plan view depicting pilot position reports and radar data is at fig.10.

#### 1.16.4.2 Descent below the published minimum descent altitude

Requirements for discontinuing an instrument approach or procedure, and therefore descent below GPS Arrival procedure steps or MDA, by night, were published in Airservices Australia and Jeppesen aeronautical information publications. Those requirements included, in part, establishing and maintaining the aircraft:

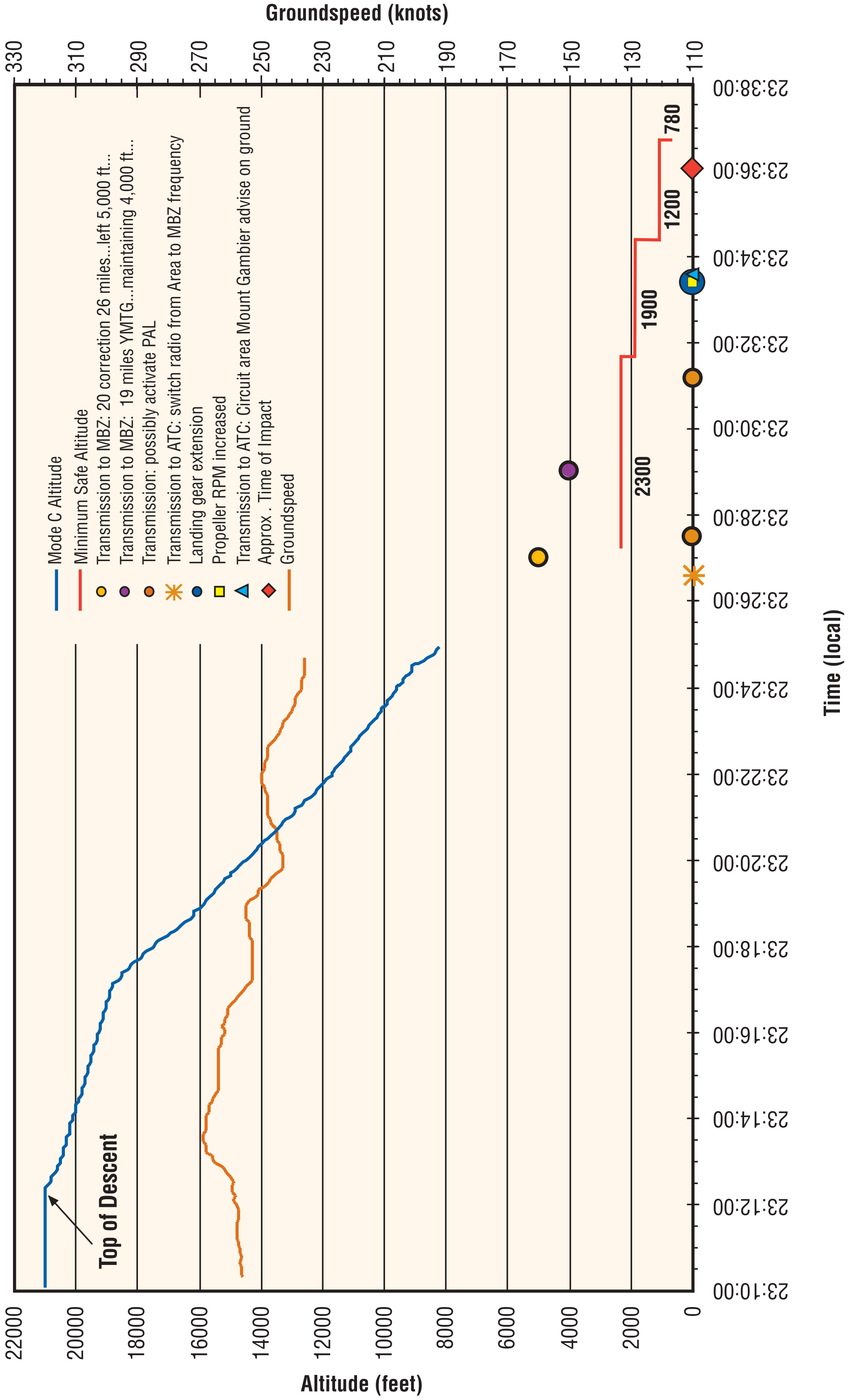
- clear of cloud
- in sight of ground or water
- with a flight visibility not less than 5,000M
- within 5NM… of that aerodrome aligned with the runway centreline and established not below 'on slope' on the T-VASIS…

In addition, when conducting a straight-in approach, a pilot in command was required to broadcast on the MBZ frequency at 5 NM, that the aircraft was established on final approach at that distance and identifying the runway to be used. There was no evidence on recorded information that the occurrence pilot broadcast that intention.

#### 1.16.4.3 Flight planning information

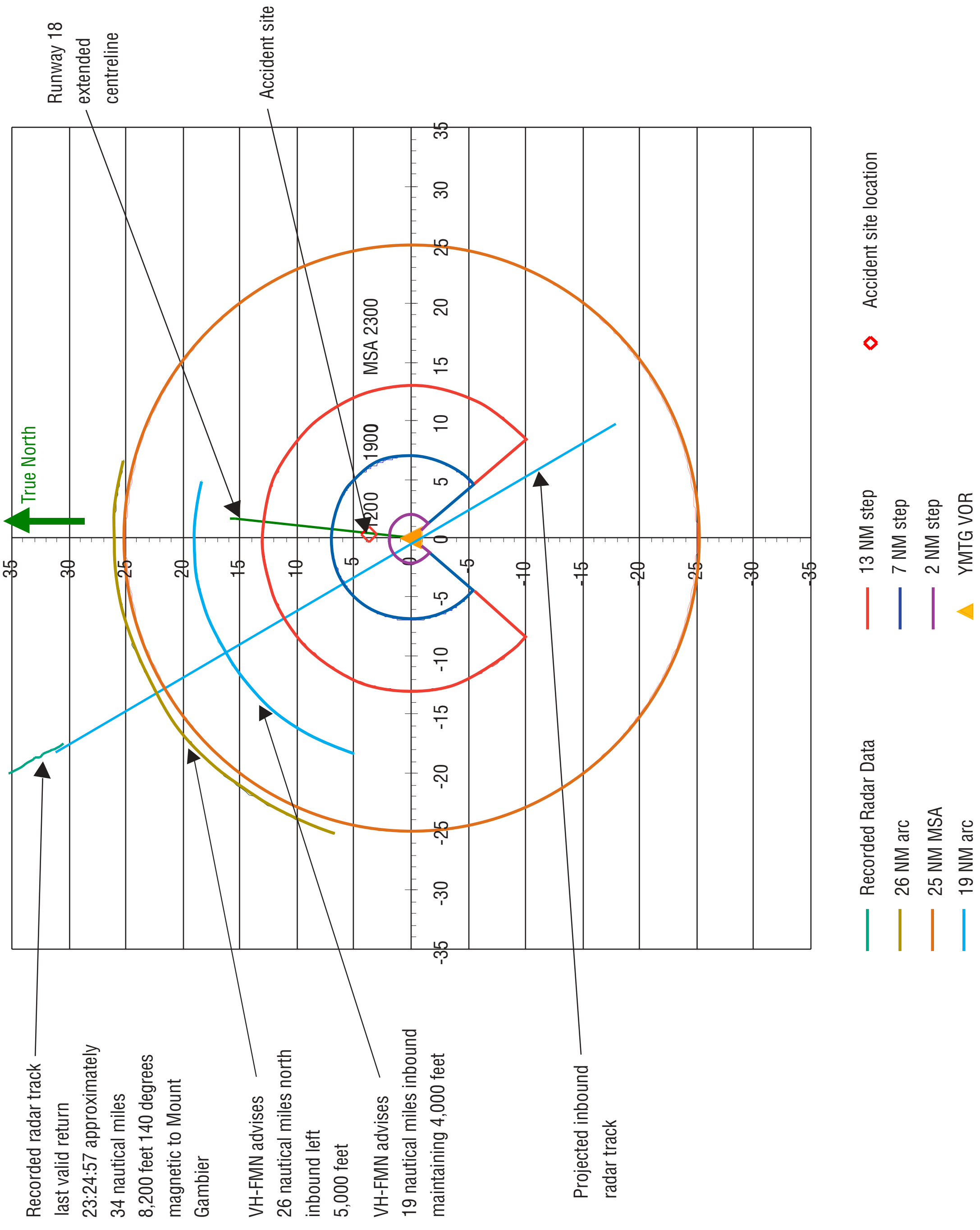
The aircraft took off from Adelaide with full fuel tanks. The operator reported that the pilot intended to refuel at Mount Gambier.

**FIGURE 9:**
**Aircraft descent profile**[10]




10 Altitudes shown in Figs. 9 and 10 are in feet above mean sea level (AMSL). Mount Gambier aerodrome is 212 ft AMSL.

**FIGURE 10:**
**Plan view depicting pilot position reports and radar data**[11]




11 Radar data was obtained from Airservices Australia.

## 1.17 Tests and research[12]

### 1.17.1 Controlled flight into terrain and approach and landing accident reduction

Research conducted by an industry task force, under the auspices of the International Civil Aviation Organization (ICAO), attributed 80 per cent of fatalities in commercial transport-aircraft accidents, throughout the world, to controlled flight into terrain (CFIT) accidents, and accidents occurring during the approach-and-landing phase. CFIT occurs when an airworthy aircraft, under the control of the flight crew, is flown unintentionally into terrain, obstacles or water, usually with no prior awareness by the crew. This type of accident can occur during most phases of flight, but CFIT is more common during the approach-and-landing phase. This phase begins when an airworthy aircraft under the control of the flight crew descends below 5,000 feet above ground level (AGL), with the intention to conduct an approach. It ends when the landing is complete or the flight crew flies the aircraft above 5,000 feet AGL enroute to another aerodrome.

In late 1992, in response to a high CFIT accident rate worldwide, the Flight Safety Foundation (FSF) formed a CFIT and Approach and Landing Task Force. By mid-1993, ICAO and FSF had agreed to a cooperative 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 ATS training and procedures. From the work of these teams, a number of issues were highlighted. Those relevant to this accident include:

- Ground proximity warning systems (GPWS)

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

- 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 that are not equipped with GPWS. The task force recommended that procedures should be developed to make greater use of radio altimeters to increase crews' awareness of their aircraft's vertical position.

- CFIT and Approach-and-Landing Accident Reduction (ALAR) awareness material

  The FSF CFIT task force developed a complete CFIT education and prevention package for all members of the aviation community worldwide. The package consisted of a number of safety awareness products including a CFIT Safety Alert, CFIT Checklist and a number of educational video productions. The checklist was designed to assist aircraft operators in evaluating the CFIT risk for a particular route or flight. It was also useful in highlighting aspects of company operations, which might be contributing to CFIT risk. A copy of the checklist is included at Attachment B. In addition, ICAO produced a CD-ROM entitled 'CFIT Education and Training Aid'. The FSF task force also produced an ALAR tool kit, which consists of an 'Approach-and-landing Risk Reduction Guide'. A copy of the guide is included at Attachment C. The education and training packages were distributed to the worldwide civil aviation industry by the FSF and by ICAO to its Contracting States.[13]

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[12] Information contained in this section was sourced from the ICAO and FSF internet web-sites. Australia is an active member state within ICAO and the ATSB is a member of the FSF.

[13] Copies of the education and training programs, including video programs, are available in CD-ROM format and can be obtained directly from the FSF (www.flightsafety.org) or through aviation retail outlets.

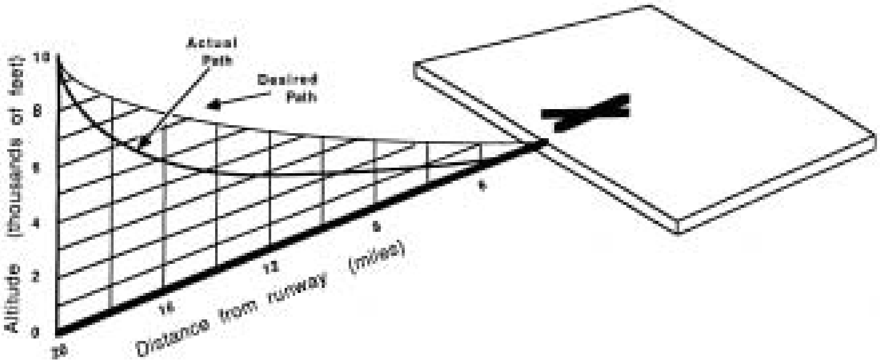
In addition to the production of education and training programs, the FSF made a number of recommendations to ICAO concerning the use of GPWS and design and presentation of non-precision instrument approach procedures.

### 1.17.2 Dark night approaches

Research conducted by Transport Canada indicates that approach-and-landing accident risk increases significantly during approaches in 'black hole' conditions. The term 'black hole' is generally used to describe aerodromes isolated from sources of significant ground lighting. On a dark night, those aerodromes necessitate an approach to the runway over dark and generally unlit terrain and can contribute to the pilot experiencing various visual and other sensory illusions.

The latter stages of the occurrence flight were flown over dark, unlit terrain towards lights, in conditions of low cloud, rain showers and the lack of a defined horizon. Flying a visual approach in those conditions has been associated with less reliable pilot control of approach path angle due to the lack of visual cues. On occasions, pilots have experienced difficulty judging rates of descent and closure rates, resulting in them overestimating approach path angle and flying a shallow approach, sometimes resulting in ground impact short of the lit area. The same conditions can also produce high approaches, however low approaches have been shown to be more likely. In those instances of low approaches, a comparison of the approach path flown by pilots during a night visual approach, with the desired altitudes, is depicted at fig. 11.

**FIGURE 11:**
**Comparison of the approach path flown by pilots during a night visual approach with the desired altitudes**[14]




The hazards of black hole situations have been widely publicised throughout the aviation community since the late 1960s. Research conducted at Boeing suggested in part that pilots in command:

- supplement outside visual reference to the runway with airport approach slope indicators or glide path information from navigation instruments
- use distance measuring equipment to fly a 3 degree approach angle
- overfly an unfamiliar aerodrome before commencing the approach to landing

[14] Illustration reproduced from Human Factors in Aviation, Earl Weiner and David Nagel, 1988

## 1.18 Additional information

### 1.18.1 Previous occurrences

As a result of the investigation into the CFIT accident involving Westwind VH-AJS near Alice Springs on 27 April 1996, the then Bureau of Air Safety Investigation (BASI)[15] made two recommendations. One of those recommendations referred to the fitment of GPWS to aircraft engaged in regular public transport or charter category operations[16]. As FMN was engaged in aerial work category operations, the recommendations do not directly apply to this occurrence. However, GPWS issues are further examined at paragraph 1.18.2.

A search of the ATSB air safety occurrence database identified a number of previous night CFIT aircraft accidents that have occurred in Australia, including, but not limited to:

- Chieftain VH-NDU, at Young, NSW, on 11 June 1993 (ATSB occurrence number 199301743)
- Aero Commander VH-BSS, near Sydney, NSW, on 14 January 1994 (ATSB occurrence number 199400096)
- Chieftain VH-KIJ, near King Island, TAS, on 8 February 1996 ((ATSB occurrence number 199600399)
- Cessna 210 VH-SJP, at Osborne Mine, QLD, on 26 February 1998 (ATSB occurrence number 199800604)

However, those occurrences displayed a number of differences from the circumstances of the occurrence involving FMN.

### 1.18.2 Ground proximity warning systems

GPWS provides flight crew with aural and visual alerts when one of the following thresholds are exceeded between 50 and 2,450 ft radio altitude:

- excessive descent rate
- excessive terrain closure rate
- altitude loss after take-off or go-around
- unsafe terrain clearance while not in the landing configuration
- below glide slope deviation

Subsection 9 of Civil Aviation Order (CAO) 20.18, current at the time of the accident, detailed the Australian regulatory requirements concerning GPWS. The order applies only to turbine-engine aircraft with a take-off weight in excess of 15,000 kg or that are carrying 10 or more passengers and engaged in regular public transport or charter operations. FMN had a maximum certificated take-off weight of 5,670 kg, and was engaged in aerial work category operations. In addition, at the time of the accident, FMN was configured for ambulance operations. In that configuration, FMN was certified under Civil Aviation Regulation (CAR) 35 to carry up to six adult persons. Consequently, there was no regulatory requirement for FMN to be fitted with a GPWS.

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15 BASI became part of the new ATSB on 1 July 1999.

16 Recommendation R19960040 states:

> 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.

ICAO standards and recommended practices with respect to fitment of GPWS are contained in Annex 6, Operation of Aircraft. However, Annex 6 does not apply to aircraft engaged in aerial work category operations. Consequently, there was no ICAO requirement to fit GPWS to FMN.

In January 2001, CASA circulated to industry Discussion Paper DP 01010S. That paper concerned a proposed Part 137 of the Civil Aviation Safety Regulations (CASRs), entitled Aerial Work Operations. The CASR part number was subsequently revised to Part 136. The paper did not address fitment of GPWS to aircraft engaged in aerial work operations.

### 1.18.3 Organisational information

The operator had established a training and checking organisation in accordance with CAR 217 (1), as a result of CASA direction to do so. The organisation consisted of:

- a training cell consisting of the Aviation Manager and Assistant Aviation manager
- selected pilots approved for specific supervisory, training and/or checking duties, as secondary functions to their primary duties

The structure, duties and responsibilities of the organisation, including training and proficiency programs, were outlined in the company Flying Operations Manual.

The operator reported that company pilots underwent four training and checking flights plus a Command Multi-Engine Instrument Rating renewal per year. It reported satisfaction with the occurrence pilot's flying performance. The operator also reported that there were two basic variations used by company pilots for conducting instrument approaches:

- flying a considered descent rate and levelling at the steps
- aiming for the 300 ft per NM profile

The operator also reported that, as all company operations are conducted single pilot, the method of flying an instrument descent profile was seen as personal preference. As long as it was compliant and safe, an individual pilot could use the method that they had been taught, had consolidated, and were comfortable with.

The company Flying Operations Manual contained information about CFIT awareness, and procedures for using altitude awareness systems fitted to company aircraft. The manual stated that:

> Part of the rationale behind these requirements is to provide a measure of protection against controlled flight into terrain, which is now the international leading accident cause. Not surprisingly, 80% of these accidents have occurred within 15 nm of an airfield. What is surprising, though, is that half of these have occurred through descent into relatively flat terrain. The above procedures are aimed at providing appropriate warnings to the pilot.

### 1.18.4 Classification of aircraft operations

In September 2001, the ATSB recommended that CASA:

> …consider proposing an increase in the operations' classification, and/or the minimum safety standards required, for organisations that transport their own employees and similar personnel (for example contractors, personnel from related organisations, or prisoners, but not fare-paying passengers) on a regular basis. This recommendation applies to all such operations, regardless of the take-off weight of the aircraft involved.

As a result of that recommendation, and following a consultative process, CASA has proposed the issue of a Notice of Proposed Rule Making, regarding classification of aircraft operations, in 2003.

# 2 ANALYSIS

## 2.1 Instrument approach methods

Calculated flight parameters and witness evidence indicated that the aircraft did not fly overhead the aerodrome. It is therefore unlikely that the pilot was attempting to conduct a VOR RWY 18 or an NDB RWY 18 approach, for which he held qualifications. Witness evidence also indicated that the pilot was not attempting to conduct a GPS RWY 18 non-precision approach. Additionally, the aircraft was not certified to conduct GPS non-precision approaches and the pilot was not qualified to conduct GPS non-precision approaches.

Therefore, it was more likely that the pilot was attempting to conduct a GPS Arrival procedure, for which he held a qualification. That procedure presented a pilot in command with two options in accordance with the published instrument approach procedures:

- fly overhead the aerodrome and/or the navigation aid and, if visual, conduct a circling approach
- conduct a straight-in approach by tracking to intercept the 360 degree M radial inbound before the final approach fix (5 NM from the VOR). In this case, the pilot should not descend below 1,200 ft, until within 5 NM, established on the runway centreline, and visually established not below the AT-VASIS glideslope indication.

As discussed above, the available evidence indicates that the pilot did not fly overhead the aerodrome or VOR. It is therefore considered likely that he was intending to position the aircraft for a straight-in approach, backed up with circling if a visual landing could not be assured.

The investigation noted the following aspects of the pilot's approach method:

- The pilot did not broadcast an intention on the MBZ frequency to conduct a straight-in approach at 15 NM and at 5 NM. It is possible that he did not do so because he was not expecting to be able to complete a straight-in approach due to the previously advised prevailing weather conditions at Mount Gambier.
- Based on witness evidence, the aircraft was not aligned with the runway centreline at 5 NM from the VOR.
- The aircraft was not in a position for the pilot to be visually established on the AT-VASIS glideslope after descending below 1,200 ft. The intersection of a 3 degree glideslope from the runway threshold/aimpoint with 1,200 ft was at 3.2 NM from the threshold. The aircraft impacted the ground at 3.1 NM from the threshold. Had the pilot not visually acquired the AT-VASIS, he should have remained at 1,200 ft until he was at 2 NM. The investigation was unable to determine whether the pilot had visually acquired the AT-VASIS.
- The aircraft rate of descent at the point of impact was in excess of the 3 degree AT-VASIS glideslope. Damage to trees in the approach path indicated an aircraft approach angle of about 10 to 13 degrees. The operator estimated that such an approach angle would have required an aircraft attitude of about 5 degrees nose-down on the aircraft attitude indicator and a rate of descent of about 1,500 to 2,800 ft per minute, dependant upon indicated airspeed, wind effect and other factors. It is possible that the pilot remained at 1,200 ft or above until 5 NM from the VOR.

There was no conclusive evidence to indicate why the pilot deviated from published instrument approach procedures. In addition, the combination of aircraft attitude and rate of descent during the latter stages of the approach to land could not be explained.

## 2.2 Altitude warning systems

The circumstances of the accident appear to be consistent with controlled flight into terrain. Regardless of why the pilot deviated from published instrument approach procedures, he could have still detected and corrected this situation had he been using defences which should have been available to him if they were serviceable. FMN was fitted with altitude warning and alerting systems. The company Flying Operations Manual contained procedures for use of the aircraft radio altimeter and altitude alerting system, in particular, setting of the decision heights for each system. Due to the extent of fire damage, the height settings at impact could not be determined.

It was common practice amongst company pilots to inhibit the voice advisory system due to the reported distractions the system produced in the final stages of approach, due to input from the radar altimeter. However, if the system was inhibited, the altitude alerting system should have sounded an aural alert when the aircraft descended below 1,000 ft above the height set on the altitude alert controller. No altitude aural alerts were heard on the CVR, and no voice advisories were heard after the aircraft had passed through 19,700 ft. In addition, the radio altimeter should have been set to 780 ft, in accordance with the requirements of the company Flying Operations Manual. In order to prevent radio altimeter input to the altitude aural alerting system, the radio altimeter must be set to zero, however, to do so was not in accordance with standard operating procedures. It is possible that the pilot had not inhibited the voice advisory system, in which case, the absence of recorded voice alerts could indicate failure of the system. Due to the extent of fire damage, the serviceability of the system could not be determined. If the pilot had left the altitude selection on the altitude alert controller at the cruise altitude setting, the design of the system was such that, as the aircraft descended more than 1,000 ft below that selection, there would be no further altitude alerts. However, the altitude selection on the altitude alert controller also provided input to the autopilot. Accordingly, the investigation considers it unlikely that the pilot would have left the altitude selection at the cruise altitude setting, as this would mean that he would not be able to use the autopilot to fly the aircraft to, and level the aircraft at, a selected altitude during the descent. The absence of recorded altitude aural or voice alerts, subsequent to the voice advisory at 19,700 ft, could not be explained.

The aircraft was not fitted with a GPWS, nor was it required by regulation. The function of such systems is to prevent CFIT accidents. A GPWS may have provided the pilot with a more salient warning to enable him to take corrective action in time to avoid ground contact.

## 2.3 Aircraft serviceability

Information from the CVR indicated that the aircraft was in controlled flight at impact. Engine and propeller noise was audible on the recording, and no anomalies were detected. In addition, there was no indication from the pilot that the aircraft was functioning abnormally. The aircraft was in the approach configuration at the time of impact. In addition, radio transmissions made by the pilot did not indicate any aircraft anomalies during the last 33 minutes of the flight. Due to impact and fire damage, the investigation was not able to examine the cockpit instrumentation. However, apart from possible altitude alerting system failure as discussed at paragraph 2.2, there were no indications, prior to, or during the flight, of any problems with any of the aircraft systems that may have contributed to the circumstances of the accident. In summary, the investigation considered that the aircraft was capable of normal flight prior to impact.

## 2.4 Lighting and weather conditions

RWY 18 was equipped with an AT-VASIS, which provided a pilot with visual glideslope guidance when the aircraft was aligned with the runway centreline. Had the pilot complied with the published instrument approach procedures, he would have been able to effectively use the guidance provided by the AT-VASIS and the runway lights. The red 'fly-up' light indication was designed to be visual from ground level, within an azimuth of 30 degrees (15 degrees either side of the runway centreline). The pilot should have been able to see the red 'fly-up' indication. Aerodrome operations personnel reported that post-accident testing of the AT-VASIS system indicated that it was functioning correctly. There was no evidence to indicate that the AT-VASIS was not functioning at the time of the occurrence.

Weather conditions prevailing in the Mount Gambier area included low cloud, low visibility and rain showers. There was no visible moon or other ambient illumination, or ground lighting in the area surrounding the aircraft's flight path and to the north of the runway. That combination would have made it difficult for the pilot to visually acquire the ground or other terrain features. There was no indication that the pilot saw the ground during the latter part of the approach.

Information from the CVR recording indicated that the pilot attempted to activate the aerodrome lighting more than once. The investigation considered that action was probably due to the pilot not sighting, or being able to sight, the aerodrome lighting, at least during periods of the descent.

## 2.5 Other issues

The pilot broadcast on the MBZ frequency an estimated arrival time in the circuit area (about 3 NM from the aerodrome reference point) of 2335. He then reported to ATS as having arrived in the circuit area at 2333. Based upon estimations of the aircraft's groundspeed, it was likely that he was still about 9 NM from Mount Gambier. There was no evidence to indicate why the pilot made this radio transmission at this position.

The pilot intended to refuel the aircraft at Mount Gambier. He was aware that time constraints applied to the transport of the patient from Mount Gambier to Sydney, but he did not express any concerns about time pressures on the CVR recording.

The aircraft was fitted with a Sperry BA-141 encoding altimeter that displayed altitude on a counter drum in addition to a pointer. Both the counter and pointer were calibrated in 20-ft increments. Failure warning was indicated by a large warning flag that obscured the counter drum when activated. The design of some older altimeters that used different altitude display methods, had been misread by pilots in previous occurrences. The BA-141 altimeter fitted to the occurrence aircraft did not use those display methods. Additionally, the pilot was familiar with the occurrence aircraft. The investigation therefore considered that it was unlikely that the pilot misread the altimeter fitted to the aircraft.

It is possible that the pilot was incapacitated in the period just prior to the accident. However, there was no evidence to indicate any pre-existing medical condition that could have led to incapacitation. The pilot had been suffering the effects of a cold, for which he received medical advice and antibiotic medication. Post-accident medical advice indicated that it was unlikely that his cold and the medication had any adverse influence on his performance.

The accident occurred at approximately 2336, and the pilot had received less than the generally recommended 7.5 to 8 hours of sleep[17] in the third and second nights prior to the accident. The pilot had also reported that he was experiencing difficulty sleeping during the day before and after night shifts, and had obtained prescribed medication for this problem. The extent to which he was using this medication could not be determined, however, toxicological analysis of the pilot's blood at post mortem did not detect benzodiazepines. Overall, it is possible that the pilot may have been experiencing a level of fatigue at the time of the accident, but there was insufficient information to make any conclusions regarding the extent of fatigue, or the extent to which it may have contributed to the accident.

The conduct of non-precision approaches can be a relatively high workload task for a single pilot operation in dark night conditions and reduced visibility. This workload can be managed and an appropriate level of safety assurance generally established for such tasks with sound preparation for the approach, compliance with published procedures, and the effective use of altitude alerting systems. The use of two pilot operations is a means of providing greater safety assurance in such conditions, as long as appropriate procedures and training for multi-crew operations is put in place. However, the cost of implementing such a defence can be prohibitive for small operators. In addition, there was no regulatory requirement for the occurrence flight to be crewed by two pilots. Further, the FSF ALAR tool kit places more emphasis on the fitment of radio altimeters and GPWS than crewing by two pilots.

Medical advice indicated that the pilot survived the impact, but did not survive the accident. The reason for his non-survival could not be conclusively established. It is likely that the medical crewmember's survival was attributable, at least in part, to the fact that the seat was rear facing and there was a large amount of habitable space surrounding that seat area.

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17 Battelle Memorial Institute, *An Overview of the Scientific Literature Concerning Fatigue, Sleep, and the Circadian Cycle,* 1998. (Report prepared for the Office of the Chief Scientific and Technical Adviser for Human Factors, Federal Aviation Administration, USA.)

# 3 CONCLUSIONS

## 3.1 Findings

1. The pilot held a valid pilot's licence, endorsed for the Raytheon Beech 200C aircraft.
2. The pilot held a valid command multi-engine instrument rating.
3. The aircraft was operating under a valid maintenance release at the time of the accident.
4. Apart from possible altitude alerting system failure, there were no indications, prior to, or during the flight, of any problems with any of the aircraft systems that may have contributed to the circumstances of the accident.
5. Mount Gambier aerodrome lighting was observed by witnesses to be illuminated at the time of the occurrence.
6. Mount Gambier aerodrome AT-VASIS, radio-navigation aids and PAL were tested post-accident and found to be capable of operating normally.
7. Dark night conditions existed in the area surrounding the approach path of the aircraft, due to low cloud, low visibility and rain showers.
8. The aircraft was in the approach configuration at the time of impact.
9. For reasons which could not be ascertained, the pilot did not comply with the requirements of the published instrument approach procedures.

## 3.2 Significant factors

1. Dark night conditions existed in the area surrounding the approach path of the aircraft.
2. For reasons which could not be ascertained, the pilot did not comply with the requirements of the published instrument approach procedures.
3. The aircraft was flown at an altitude insufficient to ensure terrain clearance.

# 4 SAFETY ACTION

As a result of this occurrence, the Australian Transport Safety Bureau again highlights the importance of good CFIT/ALAR awareness to operators and includes the FSF CFIT checklist and ALAR risk reduction guide at Attachments B and C of this report.

The Civil Aviation Safety Authority (CASA) has encouraged use of the FSF CFIT awareness material and has included CFIT awareness modules in its safety and promotional activities for some time. During 2002, the module was included in eight Flight Safety Forums and four Roadshows. CASA report that 2,600 and 165 people attended these events, respectively. During 2003, CASA has planned seven Roadshows in regional locations and has reported that CFIT will continue to remain one of their core safety promotional activities.

In addition, the Aviation Safety Foundation of Australia has conducted FSF ALAR courses.

Prior to the occurrence, the operator had acquired new aircraft fitted with Enhanced GPWS, despite no regulatory requirement to do so.

The investigation noted that amendment 92 to the Airservices Australia Aeronautical Information Publication, Departure and Approach Procedures (West), dated 17 April 2003, included an amended GPS Arrival chart for Mount Gambier. That amendment revised the Minimum Descent Altitude (MDA) step from 2 NM to 4 NM. The revision permits an aircraft to descend to MDA 2 NM earlier that previously, which will permit a pilot in command more time to achieve a more stable descent profile to the runway.

# 5 ATTACHMENTS

## Attachment A: Terms and abbreviations

| | |
|---|---|
| AGL | Above Ground Level |
| ALAR | Approach-and-Landing Accident Reduction |
| ATS | Air Traffic Services |
| AT-VASIS | Abbreviated ‘T’ Visual Approach Slope Indicator System |
| BASI | Bureau of Air Safety Investigation |
| CAO | Civil Aviation Order |
| CAR | Civil Aviation Regulation |
| CASA | Civil Aviation Safety Authority |
| CASRs | Civil Aviation Safety Regulations |
| CFIT | Ccontrolled flight into terrain |
| CVR | Cockpit Voice Recorder |
| DH | Decision Height |
| ELT | Emergency Location Transmitter |
| FSF | Flight Safety Foundation |
| ft | Feet |
| GPS | Global Positioning System |
| GPWS | Ground Proximity Warning System |
| Hpa | Hectopascals |
| ICAO | International Civil Aviation Organisation |
| IFR | Instrument Flight Rules |
| kg | Kilograms |
| km | Kilometres |
| kts | Knots |
| M | Magnetic |
| MBZ | Mandatory Broadcast Zone |
| NDB | Non Directional radio Beacon |
| MDH | Minimum Descent Height |
| NM | Nautical Miles |
| PAL | Pilot Activated Lighting |
| QNH | An altimeter sub-scale setting to show height above mean sea level |
| VHF | Very High Frequency |
| VMC | Visual Meteorological Conditions |
| VOR | VHF Omni-directional Radio range |

## Attachment B: FSF CFIT Checklist Risk Reduction Guide

Flight Safety Foundation

# CFIT Checklist

## Evaluate the Risk and Take Action

Flight Safety Foundation (FSF) designed this controlled-flight-into-terrain (CFIT) risk-assessment safety tool as part of its international program to reduce CFIT accidents, which present the greatest risks to aircraft, crews and passengers. The FSF CFIT Checklist is likely to undergo further developments, but the Foundation believes that the checklist is sufficiently developed to warrant distribution to the worldwide aviation community.

Use the checklist to evaluate specific flight operations and to enhance pilot awareness of the CFIT risk. The checklist is divided into three parts. In each part, numerical values are assigned to a variety of factors that the pilot/operator will use to score his/her own situation and to calculate a numerical total.

In *Part I: CFIT Risk Assessment*, the level of CFIT risk is calculated for each flight, sector or leg. In *Part II: CFIT Risk-reduction Factors*, Company Culture, Flight Standards, Hazard Awareness and Training, and Aircraft Equipment are factors, which are calculated in separate sections. In *Part III: Your CFIT Risk*, the totals of the four sections in *Part II* are combined into a single value (a positive number) and compared with the total (a negative number) in *Part I: CFIT Risk Assessment* to determine your CFIT Risk Score. To score the checklist, use a nonpermanent marker (do not use a ballpoint pen or pencil) and erase with a soft cloth.

### *Part I: CFIT Risk Assessment*

| Section 1 – Destination CFIT Risk Factors | Value | Score |
|---|---|---|
| **Airport and Approach Control Capabilities:** | | |
| ATC approach radar with MSAWS | 0 | _____ |
| ATC minimum radar vectoring charts | 0 | _____ |
| ATC radar only | -10 | _____ |
| ATC radar coverage 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 mountainous terrain | -20 | _____ |
| ILS | 0 | _____ |
| VOR/DME | -15 | _____ |
| Nonprecision approach with the approach slope from the FAF to the airport TD shallower than 2 ¾ 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:** | | |
| Controllers and pilots speak different primary languages | -20 | _____ |
| Controllers' spoken English or ICAO phraseology poor | -20 | _____ |
| Pilots' spoken English poor | -20 | _____ |
| **Departure:** | | |
| No published departure procedure | -10 | _____ |

**Destination CFIT Risk Factors Total (–) _____**

1 CFIT Checklist (Rev. 2.3/1,000/r)

**Section 2 – Risk Multiplier**

| | Value | Score |
|---|---|---|
| **Your Company's Type of Operation** (select only one 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 | ____ |
| Southeast Asia | 3.0 | ____ |
| Euro-Asia (Eastern Europe and Commonwealth of Independent States) | 3.0 | ____ |
| South America/Caribbean | 5.0 | ____ |
| Africa | 8.0 | ____ |
| **Weather/Night Conditions** (select only one value): | | |
| Night — no moon | 2.0 | ____ |
| IMC | 3.0 | ____ |
| Night and IMC | 5.0 | ____ |
| **Crew** (select only one value): | | |
| Single-pilot flight crew | 1.5 | ____ |
| Flight crew duty day at maximum and ending with a 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 × Risk Multiplier Total = CFIT Risk Factors Total (−) ____**

## *Part II: 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 centralized 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 |
| 80-105 points | Improvement needed |
| Less than 80 points | High CFIT risk |

**Company Culture Total (+) ____ ***

Flight Safety Foundation 2

## Section 2 – Flight Standards

**Specific procedures are written for:**

| | Value | Score |
|---|---|---|
| Reviewing approach or departure procedures charts | 10 | _____ |
| Reviewing significant terrain along intended approach or departure course | 20 | _____ |
| Maximizing 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 checklist is complete before initiation of approach | 10 | _____ |
| Abbreviated checklist for missed approach | 10 | _____ |
| Briefing and observing MSA circles on approach charts as part of plate review | 10 | _____ |
| Checking crossing altitudes at IAF positions | 10 | _____ |
| Checking crossing altitudes at FAF and glideslope centering | 10 | _____ |
| Independent verification by PNF of minimum altitude during stepdown DME (VOR/DME or LOC/DME) approach | 20 | _____ |
| Requiring approach/departure procedure charts with terrain in color, shaded contour formats | 20 | _____ |
| Radio-altitude setting and light-aural (below MDA) for backup on approach | 10 | _____ |
| Independent charts for both pilots, with adequate lighting and 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 and familiarization checks for new pilots | | |
| Domestic | 10 | _____ |
| International | 20 | _____ |
| Airport familiarization aids, such as audiovisual aids | 10 | _____ |
| First officer to fly night or IMC approaches and the captain to monitor the approach | 20 | _____ |
| Jump-seat pilot (or engineer or mechanic) to help monitor 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 |
| 200-270 points | Improvement needed |
| Less than 200 | High CFIT risk |

**Flight Standards Total** (+) _____ *

## Section 3 – Hazard Awareness and Training

| | 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 and examples of how the procedures can detect a CFIT "trap" | 30 | _____ |
| Recent and 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 flight safety periodicals that describe and analyze CFIT incidents | 10 | _____ |
| You have an incident/exceedance review and reporting program | 20 | _____ |
| Your organization investigates every instance in which minimum terrain clearance has been 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 CFIT training | |
| 250-285 points | Good, but not the best | **Hazard Awareness and Training Total (+) ____ *** |
| 190-250 points | Improvement needed | |
| Less than 190 | High CFIT risk | |

**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 | 10 | ____ |
| First-generation GPWS | 20 | ____ |
| Second-generation GPWS or better | 30 | ____ |
| GPWS with all approved modifications, data tables and service bulletins to reduce false warnings | 10 | ____ |
| Navigation display and FMS | 10 | ____ |
| Limited number of automated altitude callouts | 10 | ____ |
| Radio-altitude automated callouts for nonprecision approach (not heard on ILS approach) and procedure | 10 | ____ |
| Preselected radio altitudes to provide automated callouts that would not be heard during normal nonprecision 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 minimize CFIT risk | |
| 155-175 points | Good, but not the best | **Aircraft Equipment Total (+) ____ *** |
| 115-155 points | Improvement needed | |
| Less than 115 | High CFIT risk | |

**Company Culture ________ + Flight Standards ________ + Hazard Awareness and Training ________**
**+ Aircraft Equipment ________ = CFIT Risk-reduction Factors Total (+) ________**

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

## *Part III: Your CFIT Risk*

**Part I CFIT Risk Factors Total (−) ____ + Part II CFIT Risk-reduction Factors Total (+) ____**

**= CFIT Risk Score (±) _____**

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

In the interest of aviation safety, this checklist may be reprinted in whole or in part, but credit must be given to Flight Safety Foundation. To request more information or to offer comments about the FSF CFIT Checklist, contact Robert H. Vandel, director of technical projects, Flight Safety Foundation, 601 Madison Street, Suite 300, Alexandria, VA 22314 U.S., Telephone: +1 (703) 739-6700 • Fax: +1 (703) 739-6708.

## Attachment C: FSF Approach-and-Landing

Flight Safety Foundation

**ALAR**

Approach-and-landing Accident Reduction

**Tool Kit**

# Approach-and-landing Risk Reduction Guide

The Flight Safety Foundation (FSF) Approach-and-landing Accident Reduction (ALAR) Task Force designed this guide as part of the *FSF ALAR Tool Kit*, which is designed to help prevent ALAs, including those involving controlled flight into terrain. This guide should be used to evaluate specific flight operations and to improve crew awareness of associated risks. This guide is intended for use as a strategic tool (i.e., for long-term planning).

Part 1 of this guide should be used by the chief pilot to review flight operations policies and training. Part 2 should be used by dispatchers and schedulers. The chief pilot should provide Part 3 to flight crews for evaluating pilot understanding of company training objectives and policies. Part 4 should be used by the chief pilot and line pilots.

This guide is presented as a "check-the-box" questionnaire; boxes that are not checked may represent shortcomings and should prompt further assessment.

## Part 1 — Operations: Policies and Training

Check the boxes below that apply to your specific flight operations.

### Approach

#### Crew Resource Management

- ❑ Is risk management taught in initial training and recurrent training?
- ❑ Are crew resource management (CRM) roles defined for each crewmember?
- ❑ Are CRM roles defined for each crewmember for emergencies and/or system malfunctions?
- ❑ Are standard operating procedures (SOPs) provided for "sterile-cockpit"[1] operations?
- ❑ Are differences between domestic operations and international operations explained in CRM training?
- ❑ Is decision making taught in CRM training?

#### Approach Procedures

- ❑ Do detailed and mandatory approach-briefing requirements exist? (See Part 4 below.)
- ❑ Are approach risks among the required briefing items?
- ❑ Are standard calls defined for approach deviations?
- ❑ Are limits defined for approach gate[2] at 1,000 feet in instrument meteorological conditions (IMC) or at 500 feet in visual meteorological conditions (VMC).
- ❑ Is a missed approach/go-around recommended when stabilized approach criteria (Table 1) are exceeded?
- ❑ Is a "no fault" go-around policy established? If so, is it emphasized during training?
- ❑ Does the checklist policy require challenge-and-response for specified items?
- ❑ Does the checklist policy provide for interruptions/distractions?
- ❑ Is a go-around recommended when the appropriate checklist is not completed before reaching the approach gate?

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**Table 1**
**Recommended Elements of a Stabilized Approach**

All flights must be stabilized by 1,000 feet above airport elevation in instrument meteorological conditions (IMC) and by 500 feet above airport elevation in visual meteorological conditions (VMC). *An approach is stabilized when all of the following criteria are met:*

1. The aircraft is on the correct flight path;
2. Only small changes in heading/pitch are required to maintain the correct flight path;
3. The aircraft speed is not more than $V_{REF}$ + 20 knots indicated airspeed and not less than $V_{REF}$;
4. The aircraft is in the correct landing configuration;
5. Sink rate is no greater than 1,000 feet per minute; if an approach requires a sink rate greater than 1,000 feet per minute, a special briefing should be conducted;
6. Power setting is appropriate for the aircraft configuration and is not below the minimum power for approach as defined by the aircraft operating manual;
7. All briefings and checklists have been conducted;
8. Specific types of approaches are stabilized if they also fulfill the following: instrument landing system (ILS) approaches must be flown within one dot of the glideslope and localizer; a Category II or Category III ILS approach must be flown within the expanded localizer band; during a circling approach, wings should be level on final when the aircraft reaches 300 feet above airport elevation; and,
9. Unique approach procedures or abnormal conditions requiring a deviation from the above elements of a stabilized approach require a special briefing.

*An approach that becomes unstabilized below 1,000 feet above airport elevation in IMC or below 500 feet above airport elevation in VMC requires an immediate go-around.*

Source: Flight Safety Foundation Approach-and-landing Accident Reduction (ALAR) Task Force (V1.1 November 2000)

- ❑ Are captain/first officer weather limits provided for approach (e.g., visibility, winds and runway conditions)?
- ❑ Are crewmember roles defined for approach (e.g., crewmember assigned pilot flying duties, crewmember monitoring and conducting checklist, crewmember who decides to land or go around, crewmember landing aircraft, exchange of aircraft control)?

### Fuel

- ❑ Are fuel minimums defined for proceeding to the alternate airport, contingency fuel, dump-fuel limits?
- ❑ Are crews aware of when to declare "minimum fuel" or an emergency?
- ❑ When declaring an emergency for low fuel, is International Civil Aviation Organization (ICAO) phraseology required (e.g., "Mayday, Mayday, Mayday for low fuel")?

### Approach Type

- ❑ Is your risk exposure greatest during precision, nonprecision, circling or visual approaches? Is the training provided appropriate for the risk?
- ❑ Are SOPs provided for constant-angle nonprecision approaches (CANPAs) using rate of descent or angle?

### Environment

- ❑ Is training provided for visual illusions on approach (e.g., "black hole effect,"[3] sloping terrain, etc.)?
- ❑ Is training provided for minimum-safe-altitude awareness?
- ❑ Does a policy exist to use the radio altimeter as a terrain-awareness tool?
- ❑ Are crews required to adjust altitudes during approach for lower than international standard atmosphere (ISA) standard temperatures?

- ❑ Are crews aware that most approach-and-landing accidents occur with multiple conditions present (e.g., rain and darkness, rain and crosswind)?

### Airport and Air Traffic Control (ATC) Services

- ❑ Are crews aware of the increased risk at airports without radar service, approach control service or tower service?
- ❑ Is training provided for unfamiliar airports using a route check or a video?
- ❑ Is potential complacency at very familiar airports discussed?
- ❑ Are crews provided current weather at destination airfields via automatic terminal information service (ATIS), airborne communications addressing and reporting system (ACARS) and/or routine weather broadcasts for aircraft in flight (VOLMET)?

### Aircraft Equipment

- ❑ Are procedures established to evaluate the accuracy and reliability of navigation/terrain databases?
- ❑ Are mechanical checklists or electronic checklists installed?
- ❑ Is a radio altimeter installed in the pilot's normal scan pattern?
- ❑ Does the radio altimeter provide visual/audio alerting?
- ❑ Is a wind shear alert system (either predictive or reactive) installed?
- ❑ Is a ground-proximity warning system (GPWS) or a terrain awareness and warning system (TAWS)[4] installed?
- ❑ Is a traffic-alert and collision avoidance system (TCAS) installed?
- ❑ Are head-up displays (HUDs) installed with a velocity-vector indicators?
- ❑ Are angle-of-attack indicators installed?
- ❑ For aircraft with a flight management system (FMS), are lateral navigation/vertical navigation (LNAV/VNAV) approach procedures database-selected?
- ❑ Are pilots prevented from modifying specified FMS data points on approach?
- ❑ Is the FMS system "sole-means-of-navigation" capable?
- ❑ Is there a policy for appropriate automation use (e.g., "full up for Category III instrument landing system, okay to turn automation off for a daylight visual approach")?
- ❑ Is there a policy requiring standard calls by the pilot not flying for mode changes and annunciations on the mode control panel?
- ❑ Is training provided and are policies established for the use of all the equipment installed on all aircraft?
- ❑ Are current and regulator-approved navigation charts provided for each flight crewmember?

### Flight Crew

- ❑ Is there a crew-pairing policy established for new captain/new first officer based on flight time or a minimum number of trip segments?
- ❑ Is the check airmen/training captain program monitored for feedback from pilots? Are additional training needs, failure rates and complaints about pilots from line operations tracked? Is it possible to trace these issues to the check airmen/training captain who trained specific pilots?
- ❑ Is there a hazard reporting system such as a captain's report? Are policies established to identify and to correct problems? Is a system set up to provide feedback to the person who reports a hazard?

### Safety Programs

- ❑ Is a nonpunitive safety reporting system established?
- ❑ Is a proactive safety monitoring program such as a flight operational quality assurance (FOQA) program or an aviation safety action program (ASAP) established?

### Landing

- ❑ Is training provided and are policies established for the use of visual landing aids?
- ❑ Is it recommended that crews use all available vertical guidance for approaches, especially at night?
- ❑ Is training provided and are policies established for landing on contaminated runways with adverse winds?
- ❑ Are crews knowledgeable of the differences in braking deceleration on contaminated runways and dry runways?
- ❑ Does training include performance considerations for items such as critical touchdown area, braking required, land-and-hold-short operation (LAHSO), engine-out go-around, and full-flaps/gear-extended go-around?
- ❑ Does the aircraft operating manual (AOM)/quick reference handbook (QRH) provide crosswind limitations?
- ❑ Is a policy in effect to ensure speed brake deployment and autobrake awareness?
- ❑ Does policy prohibit a go-around after reverse thrust is selected?

## Part 2 — Dispatcher/Scheduler

Check the boxes below that apply to your specific flight operations.

- ❑ Does the company have a dispatch system to provide information to assist flight crews in evaluating approach-and-landing risks?

### Approach and Landing

- ❑ Are dispatchers and captains familiar with each other's authority, accountability and responsibility?
- ❑ Are crews monitored for route qualifications and appropriate crew pairing?
- ❑ Are crew rest requirements defined adequately?
- ❑ Does the company monitor and provide suitable crew rest as defined by requirements?
- ❑ Are crews provided with timely and accurate aircraft performance data?
- ❑ Are crews assisted in dealing with minimum equipment list(MEL)/dispatch deviation guide (DDG)/configuration deviation list (CDL) items?
- ❑ Do dispatch-pilot communications exist for monitoring and advising crews en route about changing conditions?
- ❑ Are updates provided on weather conditions (e.g., icing, turbulence, wind shear, severe weather)?
- ❑ Are updates provided on field conditions (e.g., runway/taxiway conditions, braking-action reports)?
- ❑ Is there coordination with the captain to determine appropriate loads and fuel required for the effects of ATC flow control, weather and alternates?
- ❑ Are all the appropriate charts provided for routing and approaches to destinations and alternates?
- ❑ Is a current notice to airmen (NOTAM) file maintained for all of your operations and is the appropriate information provided to crews?

## Part 3 — Flight Crew

Check the boxes below that apply to your specific flight operations.

- ❑ Do you believe that you have appropriate written guidance, training and procedures to evaluate and reduce approach-and-landing risks?

### Approach

- ❑ Is the Flight Safety Foundation *Approach-and-landing Risk Awareness Tool (RAT)* provided to flight crews, and is its use required before every approach?
- ❑ Does the approach briefing consist of more than the "briefing strip" minimum? (See Part 4 below.)

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- ❑ Do briefings include information about visual illusions during approach and methods to counteract them?
- ❑ Are the following briefed: setup of the FMS, autopilot, HUD, navigation radios and missed approach procedures?
- ❑ Is a discussion of missed approach/go-around details required during every approach briefing?
- ❑ Are performance minimums briefed for the approach gate?
- ❑ Are standard calls required for deviations from a stabilized approach?
- ❑ Does the briefing include execution of a missed approach/go-around if criteria for the approach gate are not met?
- ❑ Are stabilized approach criteria defined? Is a go-around recommended in the event that these criteria are not met?
- ❑ Does your company practice a no-fault go-around policy?
- ❑ Are you required to write a report to the chief pilot if you conduct a missed approach/go-around?
- ❑ Do you back up the flight plan top-of-descent point with your own calculation to monitor descent profile?
- ❑ Are approach charts current and readily available for reference during approach?
- ❑ Are policies established to determine which crewmember is assigned pilot flying duties, which crewmember is assigned checklist duties, which crewmember will land the aircraft and how to exchange aircraft control? Do these policies change based on prevailing weather?
- ❑ Do terrain-awareness procedures exist (e.g., calling "radio altimeter alive," checking radio altimeter altitudes during approach to confirm that the aircraft is above required obstacle clearance heights)?
- ❑ Do altitude-deviation-prevention policies exist (e.g., assigned altitude, minimum descent altitude/height [MDA(H)], decision altitude/height [DA(H)])?
- ❑ Are you familiar with the required obstacle clearance criteria for charting design?
- ❑ Do altimeter-setting procedures and cross-check procedures exist?
- ❑ Do temperature-compensation procedures exist for temperatures lower than ISA at the destination airport?
- ❑ Are you aware of the increased risk during night/low-visibility approaches when approach lighting/visual approach slope indicator/precision approach path indicator aids are not available? How do you compensate for these deficiencies? For example, are runways with vertical guidance requested in those conditions?
- ❑ Are you aware of the increased risk associated with nonprecision approaches compared with precision approaches?
- ❑ Is a CANPA policy established at your company? Are you aware of the increased risk associated with step-down approaches compared with constant-angle approaches?
- ❑ Is a policy established for maintaining visual look-out, and is there a requirement to call "head-down"?
- ❑ Does a look-out policy exist for approach and landing in visual flight rules (VFR) conditions?

## Part 4 — Recommended Approach-and-landing Briefing Items

For the approach-risk briefing, refer to top-of-descent use of the *FSF Approach-and-landing RAT*.

In addition to the briefing strip items (e.g., chart date, runway, approach type, glideslope angle, check altitudes), which of following items are briefed, as appropriate?

- ❑ Automation setup and usage
- ❑ Navigation equipment setup and monitoring
- ❑ Rate of descent/angle of descent

- ❑ Intermediate altitudes and standard calls
- ❑ Altitude-alert setting and acknowledgment
- ❑ MDA(H)/DA(H) calls (e.g., "landing, continue, go-around"); runway environment expected to see (offsets); lighting
- ❑ Radio-altimeter setting in the DH window, calls required (e.g., "radio altimeter alive" and "below 1,000 feet" prior to an intermediate approach fix; "below 500 feet" prior to the final approach fix [FAF]; "go around" after the FAF if "minimums" is called [with radio altimeter at 200 feet] and if visual contact with the required references is not acquired or the aircraft is not in position for a normal landing)
- ❑ Aircraft configuration
- ❑ Airspeeds
- ❑ Checklists complete
- ❑ ATC clearance
- ❑ Uncontrolled airport procedures
- ❑ Manual landing or autoland
- ❑ Missed approach procedure/go-around
- ❑ Performance data
- ❑ Contaminated runway/braking action and autobrakes
- ❑ Illusions/hazards or other airport-specific items
- ❑ Abnormals (e.g., aircraft equipment/ground facilities unserviceable, MEL/DDG items, glideslope out)
- ❑ Runway (e.g., length, width, lighting, LAHSO, planned taxiway exit)
- ❑ Procedure for simultaneous approaches (as applicable)

## References

1. The *sterile cockpit rule* refers to U.S. Federal Aviation Regulations Part 121.542, which states: "No flight crewmember may engage in, nor may any pilot-in-command permit, any activity during a critical phase of flight which could distract any flight crewmember from the performance of his or her duties or which could interfere in any way with the proper conduct of those duties. Activities such as eating meals, engaging in nonessential conversations within the cockpit and nonessential communications between the cabin and cockpit crews, and reading publications not related to the proper conduct of the flight are not required for the safe operation of the aircraft. For the purposes of this section, critical phases of flight include all ground operations involving taxi, takeoff and landing, and all other flight operations below 10,000 feet, except cruise flight." [The FSF ALAR Task Force says that "10,000 feet" should be height above ground level during flight operations over high terrain.]
2. The Flight Safety Foundation Approach-and-landing Accident Reduction (ALAR) Task Force defines *approach gate* as "a point in space (1,000 feet above airport elevation in instrument meteorological conditions or 500 feet above airport elevation in visual meteorological conditions) at which a go-around is required if the aircraft does not meet defined stabilized approach criteria."
3. The *black-hole effect* typically occurs during a visual approach conducted on a moonless or overcast night, over water or over dark, featureless terrain where the only visual stimuli are lights on and/or near the airport. The absence of visual references in the pilot's near vision affect depth perception and cause the illusion that the airport is closer than it actually is and, thus, that the aircraft is too high. The pilot may respond to this illusion by conducting an approach below the correct flight path (i.e., a low approach).
4. Terrain awareness and warning system (TAWS) is the term used by the European Joint Aviation Authorities and the U.S. Federal Aviation Administration to describe equipment meeting International Civil Aviation Organization standards and recommendations for ground-proximity warning system (GPWS) equipment that provides predictive terrain-hazard warnings. "Enhanced GPWS" and "ground collision avoidance system" are other terms used to describe TAWS equipment.


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