Australian Government
Australian Transport Safety Bureau

Descent below the minimum permitted altitude, Airbus A320 VH-VNC

15 km SSE of Avalon Airport, Vic | 30 June 2011

Investigation

ATSB Transport Safety Report
Aviation Occurrence Investigation
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Addendum

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Safety summary

What happened

At 2302 Eastern Standard Time on 30 June 2011, an Airbus A320 aircraft, registered VH-VNC and operated by Tiger Airways Australia Pty Ltd (Tiger Airways) on a regular public transport flight, conducted a go-around procedure after an unsuccessful approach to land on runway 18 at Avalon Airport, Victoria. The flight crew contacted air traffic control (ATC) and were directed to climb to 3,000 ft and, after further discussion, to visually position as required for return and landing on Avalon runway 36. During that re-positioning, the flight crew descended below the assigned altitude without clearance. After a brief discussion with ATC, the flight crew were cleared for a conditional visual approach. In continuing the approach, the aircraft descended to 1,600 ft at a point where the minimum permitted altitude was 2,000 ft. The aircraft subsequently landed on runway 36.

What the ATSB found

The ATSB found that the flight crew, despite recognising the potential that a go-around may be required, did not plan for a return to runway 36 before commencing their first approach. The workload associated with the execution of the go-around prevented them from planning the return to land until levelling at 3,000 ft. The flight crew's comprehension of the aircraft's position during the second approach was probably influenced by the workload associated with the approach. Similarly, this high workload may have resulted in their not recognising the ramifications of descending to 1,600 ft.

The ATSB also found that the controller did not provide the flight crew with the required minimum vector altitude as part of the visual approach clearance, which resulted in a missed opportunity for the flight crew to identify the lowest altitude to which the aircraft could be descended. In addition, despite the controller identifying that the aircraft had descended below the minimum permitted altitude and querying the flight crew, a safety alert was not issued. This meant that the aircraft remained at heightened risk for an extended period of time.

Finally a number of discrepancies in the operational and air traffic services documentation relating to night visual approaches and Avalon airspace were identified.

What's been done as a result

Tiger Airways advised that they have implemented a process to identify and manage the risks associated with any organisational change. This process will apply to any future changes to operational documentation.

Airservices Australia has completed a review of the Manual of Air Traffic Services and incorporated a number of amendments to improve its readability.

Safety message

This incident highlights the importance of preparation by flight crew in order to avoid the adverse effects of high workload. The potential safety benefit of intervention by air traffic controllers is also highlighted.

Contents

The occurrence

On the evening of 30 June 2011, a Tiger Airways Australia Pty Ltd (Tiger Airways) Airbus A320 (A320) aircraft, registered VH-VNC, and operating as Go Cat 6207 was conducting an approach to Avalon Airport, Victoria. The flight was a scheduled passenger service from Sydney, New South Wales to Avalon. The flight crew consisted of the captain, who was designated as the pilot flying (PF) and the first officer (FO), who was designated as the pilot monitoring (PM).[1]

Events prior to the occurrence

Before descent, the flight crew obtained the latest automated weather for Avalon, which indicated clear conditions and a wind at 030º of 7 kt. This represented a downwind component of up to 7 kt for a landing on runway 18, which was below the aircraft's maximum permitted tailwind limit of 10 kt. The PF prepared for the approach and landing by entering the expected arrival procedure and approach type into the primary route of the aircraft's Flight Management Guidance System (FMGS)[2] through his Multipurpose Control and Display Unit (MCDU).[3] The expected approach to runway 18[4] was via the instrument landing system (ILS).[5] The PF also loaded that same arrival and approach into the secondary route of the FMGS, but with an amended arrival procedure that reflected expected track shortening during the descent.

The flight crew conducted an approach and landing briefing that included the intention to activate the secondary route should track shortening be approved by air traffic control (ATC). The briefing also included an intention to assess the tailwind at 100 ft and, if it exceeded the aircraft's limit, to conduct a missed approach and return to land on runway 36. The briefing did not include a discussion on how the return to runway 36 would be conducted; however, Tiger Airways did not permit the crew to conduct a circling approach off the ILS to land on runway 36. The briefing did include a review of the *ALAR Risk Assessment Checklist* (see the section titled *Approach preparation and briefing*). This review did not identify an unacceptable level of risk but did prompt the crew to reinforce that it was 'ok to go-around'[6] if they were unhappy with the approach.

Immediately prior to descent the crew obtained the latest automated weather from Avalon, which indicated a wind of 020º at 8 kt. This initiated a discussion on whether to change the landing to runway 36, as well as other factors relating to low-level windshear commonly encountered at Avalon. The crew decided to continue with the planned landing on runway 18 and monitor the wind during the descent with the intention of again assessing it before commencing the approach. That assessment was not conducted.

During the descent the expected track shortening was approved by ATC and the crew activated the FMGS secondary route, which meant the primary route could be reprogrammed for an approach return to runway 36. However due to other activities at the time, the crew did not reprogram the FMGS in case of that contingency.

At 2256 Eastern Standard Time,[7] Melbourne Approach (ML-APP)[8] cleared the aircraft to leave controlled airspace on the ILS approach to runway 18 (Point A in Figure 1). At 200 ft, the crew

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1 The PF does most of the flying, except in defined circumstances, such as during the planning and preparation for descent, approach and landing. PM duties include crosschecking the actions of the PF, monitoring the aircraft's progress and conducting the radio communications.

2 The FMGS provides aircraft navigation, lateral and vertical guidance and aircraft performance functions along a pre-planned route.

3 The MCDU is used by the flight crew to enter flight planning details into the FMGS and also can display various flight navigation information.

4 See *Appendix A - Avalon instrument approach charts* for details of the ILS approach to runway 18.

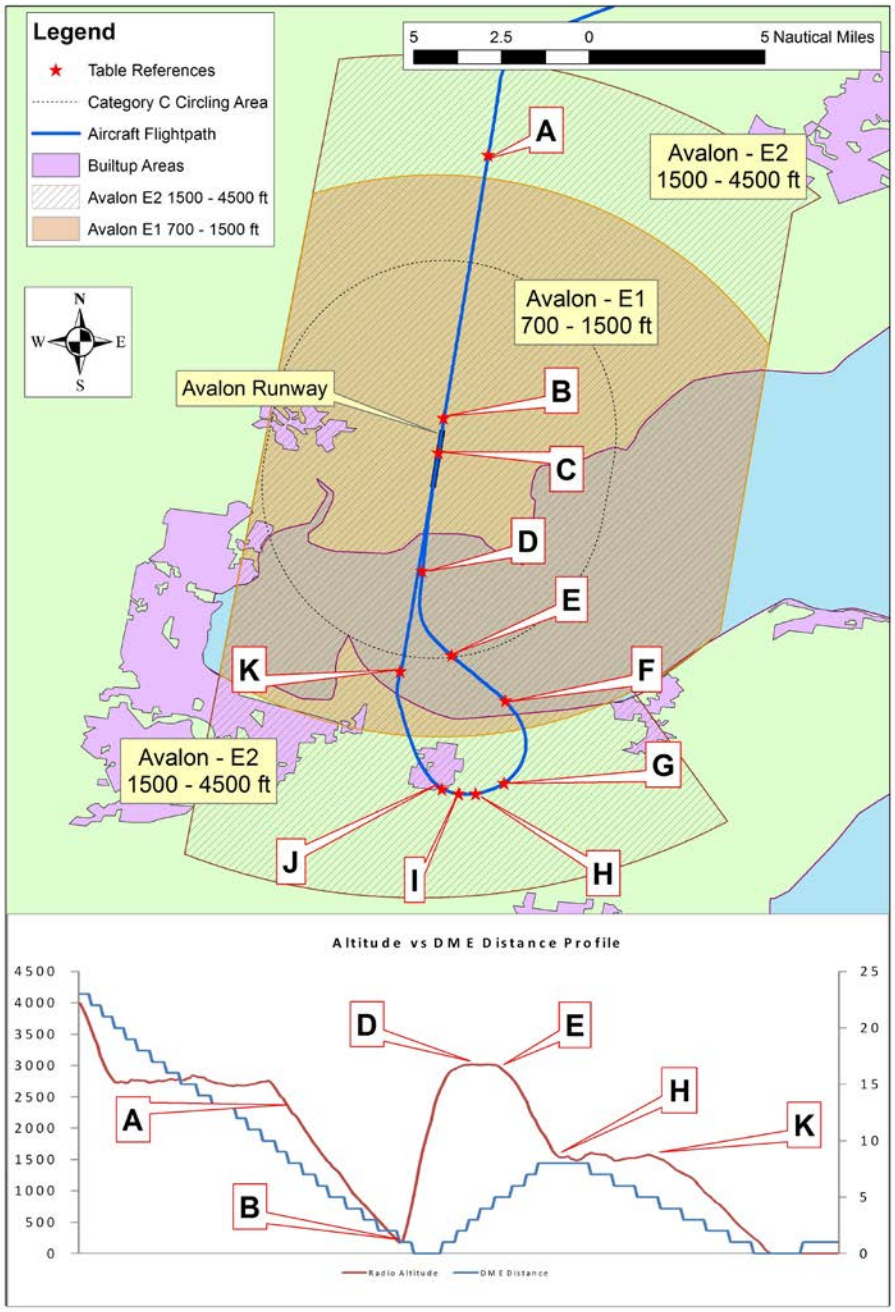
5 A standard ground aid to landing, comprising two directional radio transmitters: the localizer, which provides direction in the horizontal plane; and the glideslope, for vertical plane direction, usually at an inclination of 3°.

6 A manoeuvre in which the flight crew discontinues the approach, increases power and reconfigures the aircraft to climb.

7 Eastern Standard Time (EST) was Coordinated Universal Time (UTC) + 10 hours.

checked the tailwind, which was 15 kt and as such, a go-around was executed and the crew conducted the missed approach procedure for the runway 18 ILS (Point B in Figure 1).

Figure 1: Aircraft track and descent profile with airspace dimensions



Source: ATSB

The aircraft re-entered controlled airspace during the climb and at 2302:03 the PM called ML-APP and reported 'going around' and climbing on runway heading to an altitude of 2,500 ft (Point C in Figure 1). ML-APP replied that the aircraft was still identified and, as such, was receiving an air traffic service (ATS) surveillance service (see the section titled *ATS surveillance service*). The crew were instructed to climb to 3,000 ft; the controller reported that this was to facilitate another

[8] The ATC service that was responsible for the Avalon area at the time of the occurrence.

instrument approach. The PM acknowledged the new altitude requirement and the target altitude for the climb was changed to 3,000 ft on the Flight Control Unit (FCU).[9]

At 2302:50, while the aircraft was still climbing, ML-APP asked the crew to report, when ready, how they intended to return for landing. The flight crew did not respond to this initial call as they were reconfiguring the aircraft and carrying out other procedures associated with the go-around. As the aircraft was passing about 2,800 ft the PM offered to make a public address (PA) announcement to the passengers, to which the PF agreed. At the same time ML-APP called and again requested the crew's intentions for the return. The PF advised the PM that he intended to return via a teardrop manoeuvre, to which the PM agreed and again confirmed that the PF was happy for him to conduct the PA. The PF then took over the radio communications while the PM made a PA to the passengers.

As the aircraft levelled at 3,000 ft the following radio communications were conducted between the PF and ML-APP (Point D in Figure 1):

> PF: Approach, Go Cat 6207, we had a bit of a downwind there on the landing, are we okay to make a teardrop for landing, left turn out but a right turn back to land?
>
> ATC: Go Cat 6207, affirm, so is that to come back visually or by the VOR?
>
> PF: No, no, we are visual, we are happy just to make a left hand teardrop to turn back into a right hand pattern.
>
> ATC: Go Cat 6207, that's approved.
>
> PF: Thank you.

That exchange ended at 2303:47 and coincided with the PM completing the PA announcement to passengers and returning his attention to the flight deck. The PF reported that from this communication he understood that ATC had cleared the aircraft to conduct a visual approach, which was permitted under Tiger Airways procedures.

Observation:

Aeronautical Information Publication Australia (AIP)[10] ENR 1.1 paragraph 12.8.5 detailed the minimum altitude requirements that the pilot of an instrument flight rules (IFR)[11] aircraft must meet when conducting a night visual approach. These included that the aircraft must not descend below the route segment lowest safe altitude (LSALT),[12] the minimum sector altitude (MSA),[13] or the appropriate step of the distance measuring equipment (DME)[14] arrival procedure. In addition, if in receipt of an ATS surveillance service, an aircraft was not to be operated below the last assigned altitude.

In this instance, the MSA was 2,500 ft, the relevant step of the DME arrival procedure was 2,000 ft and the aircraft was assigned 3,000 ft by ML-APP while receiving an ATS surveillance service.[15] This service could assign a minimum vector altitude (MVA) that was based on radar terrain clearance charts. The MVA at the time of the occurrence

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9 The FCU is located on the glareshield in front of the flight crew and allows the crew to make inputs into the FMGS.

10 A package of documents that provides the operational information necessary for the safe and efficient conduct of national (civil) and international air navigation throughout Australia and its Territories.

11 Instrument flight rules permit an aircraft to operate in instrument meteorological conditions (IMC), which have much lower weather minimums than visual flight rules. Procedures and training are significantly more complex as a pilot must demonstrate competency in IMC conditions, while controlling the aircraft solely by reference to instruments. IFR-capable aircraft have greater equipment and maintenance requirements.

12 The lowest altitude which will provide safe terrain clearance at a given place.

13 The lowest altitude in an area contained within a sector of a circle of 25 NM (46 km) or 10 NM (19 km) based on a radio navigation aid.

14 A ground-based transponder station that uses a signal from the aircraft to the ground station to calculate the aircraft's distance from the ground station.

15 See the section titled *ATS surveillance service.*

was 2,000 ft (see the subsequent discussion titled *Visual approach – Requirements of the MATS*). The lowest altitude that provided adequate separation from terrain when the aircraft descended from 3,000 ft was 2,000 ft (the minimum permitted altitude).

Immediately following the completion of the radio exchange, the PF commenced a left turn to start the teardrop manoeuvre and checked that the PM was happy with that manoeuvre. The PM agreed, and later reported that his understanding of the communications with ML-APP was that the aircraft had been cleared for a visual approach.

The crew then started a checklist associated with the go-around, and at the same time, ML-APP called the aircraft with an instruction to report turning inbound for descent. The PM acknowledged that instruction and returned to the checklist. About 5 seconds later, the PF stated that he was commencing a descent to 1,500 ft. The PF later reported that this height was selected based on his understanding of the surrounding airspace and a desire to remain outside controlled airspace. The PM corrected this to 1,600 ft, which is the required circuit altitude for an A320 at Avalon, and again returned to the checklist. About 5 seconds later, at 2304:15, the target altitude of 1,600 ft was set on the FCU and the aircraft commenced a descent from 3,000 ft (Point E in Figure 1). The 1,600 ft target altitude was below the minimum permitted altitude of 2,000 ft and the descent was commenced without the required clearance from ML-APP. The PF later reported that he understood the airspace was uncontrolled.

Following completion of the interrupted checklist, the PM commenced programming the FMGS through the MCDU to provide guidance to runway 36. Shortly after, and about 15 seconds after the start of the descent, the PF observed that the aircraft was 6 NM (11 km) from Avalon. At that time the aircraft's DME was reading 5 NM (9 km) and the crew later confirmed that the MCDU had the progress page displayed and was showing the distance to destination. That observation was almost immediately interrupted by a discussion concerning the PM's difficulties in entering the required data into the FMGS.

At 2304:40, as the aircraft descended through 2,800 ft, the ML-APP controller received a Clearance Level Adherence Monitoring (CLAM)[16] warning, identifying that VH-VNC had left its current assigned altitude. In response to the CLAM, the following radio communications took place between the PF and ML-APP as the aircraft was passing 2,600 ft (Point F in Figure 1):

> ATC: Go Cat 6207, Confirm you will be maintaining 3,000 [ft] until back on final?
>
> PM: Go Cat 6207, we are leaving 3,000 [ft] now for the teardrop turn right base for runway 36.
>
> ATC: Go Cat 6207, understood, established on the PAPI[17] or [in the] circling area[18] cleared visual approach for runway 36 the wind still trending about 030/8 kt.
>
> PM: Go Cat 6206 [sic] Roger, 6207.

This communications sequence was completed at 2305:12, as the aircraft passed through about 2,200 ft.

The occurrence event

The aircraft descended through the minimum permitted altitude of 2,000 ft at 2305:25 as the PM was programming the FMGS. At that time the aircraft was 8 NM (15 km) to the south-south-east of runway 36, passing through a southerly heading as it turned back in to the runway. Towards the end of the attempts by the PM to enter the runway 36 guidance into the FMGS, the PF requested the PM to return his attention to support duties due to the aircraft's proximity to the ground. Those duties included configuring the aircraft for landing and providing the PF with guidance to the runway.

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16 For an explanation of the CLAM warning, see the section titled *Altitude alerting*.

17 The precision approach path indicator, a runway approach lighting system that aids the pilot to identify the correct glidepath to the runway.

18 See the section titled *The circling area.*

As the aircraft was turning back towards the runway, the PF asked the PM if he had it in sight. The PM responded at 2305:38 that the runway was in sight, as the aircraft was descending through 1,760 ft (Point G in Figure 1). Ten seconds later, the aircraft's automation captured the target altitude of 1,600 ft (Point H in Figure 1). At 2305:55 the ML-APP controller identified that the aircraft was below the MVA in that area and initiated the following radio communications (Point I in Figure 1):

> ATC: Go Cat 6207, are you happy with the terrain there, you are showing one thousand six hundred?
>
> PM: Yeah, Go Cat, affirm, we are visual.
>
> ATC: Go Cat 6207, okay thanks.

The PF stated that during this communication he had visual contact with the runway. In later interviews both crew members stated that, as a result of the ML-APP enquiry about their altitude, they checked their radio altimeter and assessed that the aircraft was clear of terrain.

As the aircraft was lined up on the runway centreline and approaching the required final glideslope from below, the glideslope indications from the PAPI and the T-VASIS[19] varied slightly (Point K on Figure 1). In response the PM checked the DME and noted that it indicated just over 5 NM (9 km). The flight crew continued the approach and landed at 2310:40. The initial approach to runway 18, the go-around and the return to runway 36 were flown via the autopilot and the final approach to runway 36 was manually flown.

Events post the occurrence

While taxiing to the terminal, the PM raised the ML-APP controller's apparent concern about how far south the aircraft had tracked during the approach. The PF initially responded with a belief that the controller's concern was linked to a potential airspace breach. The PM clarified that he felt the controller's concern related to the aircraft's proximity to terrain, to which the PF responded that the aircraft had remained within the circling area, before asking how far south the aircraft went. The PM advised the PF that the aircraft had exited the circling area during the approach.

Post-flight recorded telephone conversation with ATC

Following the taxi to the terminal, ATC requested that the aircraft captain contact them via telephone to discuss the approach. During that phone call, ATC enquired why the crew had commenced a descent when they were required to maintain 3,000 ft in accordance with their clearance. The captain advised that he was conducting a visual approach, that the airspace was uncontrolled and that they were aware of the aircraft's position the whole time. ATC highlighted that the airspace was actually Class E (see the section titled *Airspace classification*) and therefore controlled. ATC further advised that the aircraft had tracked 8 NM (15 km) south of the airport and had descended below the MVA of 2,000 ft.

[19] 'T' Visual Approach Slope Indicator, a runway approach lighting system that aids the pilot to identify the correct glide path to the runway.

Context

Personnel information

The captain held an Air Transport Pilot (Aeroplane) Licence (ATP(A)L) and had accumulated about 15,500 hours of aeronautical experience. Of these, approximately 10,000 hours were in command and about 300 hours were on the A320.

The FO held an ATP(A)L and had accumulated about 7,500 hours of aeronautical experience. Of these, approximately 380 hours were on the A320.

Both pilots held current Class 1 Aviation Medical Certificates and were appropriately qualified to conduct the flight. The pilots' training files showed that they had completed all relevant training and met the company requirements to conduct line flights.

There was no evidence that fatigue or other physiological issues affected the pilots' performance during the flight. The crew commenced duty at Avalon at 1355 and both crew members recalled that they were adequately rested before commencing duty. The flight was the final sector of four that were conducted within the same time zone. An assessment of the likelihood that the crew's performance was adversely affected by fatigue found that, while both crew members reported that they were tired following a long four-sector day, there was no evidence they were affected by fatigue.

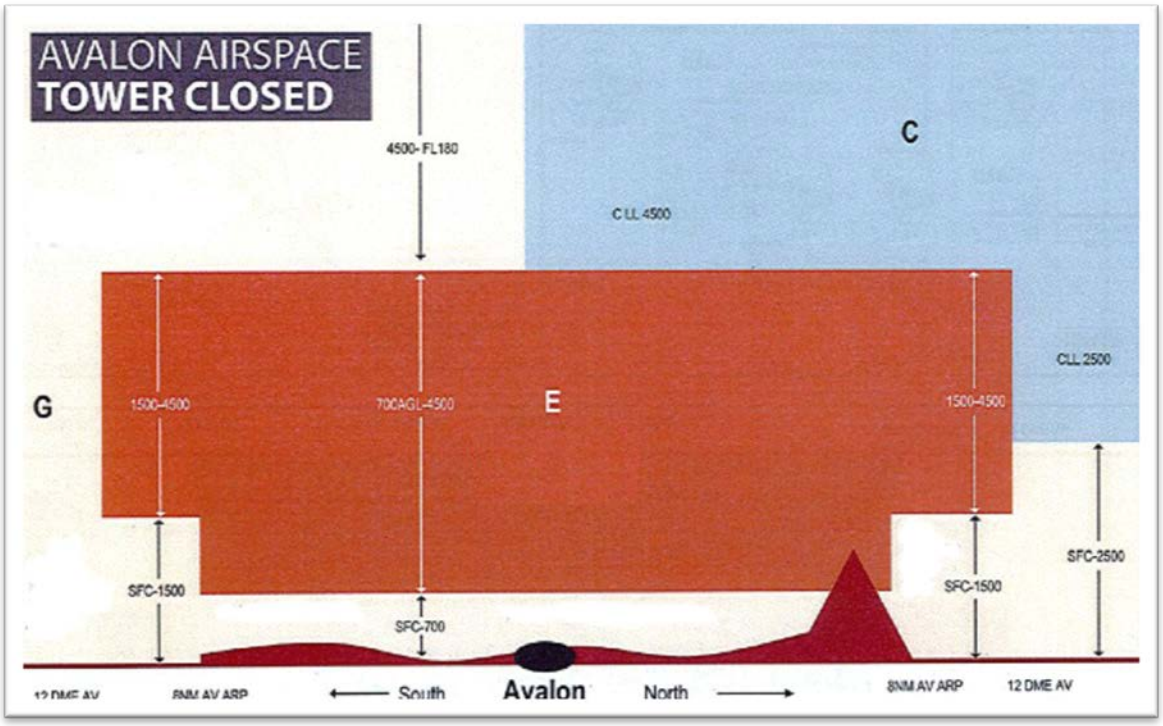
Airport information

Airspace classification

Avalon Tower operated daily from 0700 until 2000 and was closed outside of these hours. The closure of the control tower meant that the airspace immediately above Avalon to a height of 700 ft and within 8 NM (15 km) was re-classified as Class G (uncontrolled) (see Figure 1 and Figure 2). From 700 ft to 1,500 ft the airspace was Class E (Avalon-E1), and above that was additional Class E airspace (Avalon-E2) that extended from 1,500 ft to 4,500 ft.

Class E airspace was controlled airspace for which air traffic services were provided to IFR flights. Those services included separation from other IFR flights and, where practicable, the provision of traffic information to IFR flights about visual flight rules (VFR) flights in the same area. Further, in Class E airspace IFR aircraft were required to operate with an ATC clearance, whereas VFR aircraft were not.

Figure 2: Avalon airspace, tower closed configuration



Source: Airservices Australia

Paragraph 3.12 of ENR 1.1 *Air Traffic Clearances and Instructions* of the Aeronautical Information Publication Australia (AIP) stated that, in order to retain the protection of controlled airspace during climb or descent, pilots should maintain a height at least 500 ft above the lower limit of the control area (CTA) steps. At the time of the occurrence, this reference incorrectly stated that this procedure applied only to Class C and D (controlled) airspace. Class E airspace was not included despite also being controlled airspace. Later advice from the Civil Aviation Safety Authority (CASA) stated that the procedure also applied to Class E airspace. The AIP was subsequently modified to reflect that advice.

The Australian Terminal Area Chart (TAC) for Melbourne (TAC-3), dated 2 June 2011, depicted the Avalon airspace in the 'during the hours of tower operations' configuration. A caution box immediately adjacent to this airspace identified that Class E airspace was established and directed the reader to the En Route Supplement Australia for the times of activation. The corresponding Jeppesen chart, as used by Tiger Airways Australia Pty Ltd (Tiger Airways) flight crew, did not have an equivalent note. However, the Jeppesen Airways Airport Directory, which was carried in the aircraft, contained the correct information concerning the structure of the Avalon airspace.

Aids to navigation

The navigation aids at Avalon provided the means for the flight crew to establish their position, and therefore the relevant minimum permitted altitude. The applicable 25 NM (46 km) minimum sector altitude (MSA) of 2,500 ft was published on the runway 18 instrument landing system chart (appendix A). In addition, the flight crew could have identified a minimum permitted altitude of 2,000 ft by reference to the appropriate DME/GPS[20] arrival procedure (also appendix A).

[20] The Global Positioning System (GPS) is a space-based global navigation satellite system (GNSS) that provides location and time information in all weather, anywhere on or near the Earth, where there is an unobstructed line of sight to four or more GPS satellites.

Operational information

The circling area

The conduct of a visual approach required the pilot to be aware of the circling area for the intended airport. The dimensions of the circling area varied for different aircraft types. For an A320, the circling area at Avalon was defined by an arc radius of 4.2 NM (7.8 km) from each runway threshold and joined by tangents (depicted by the black dotted line in Figure 1). This excluded the western sector due to the high terrain in that area (appendix A). An aircraft was guaranteed obstacle clearance when it was within the circling area at an altitude not below the appropriate minimum altitude for circling, which in this case was 800 ft.

ATS surveillance service

The provision of an air traffic surveillance service was predicated on aircraft identification using a number of surveillance system options, including radar. Paragraph 2.1 of ENR 1.6 *ATS Surveillance Services and Procedures* of the AIP stated that an ATS surveillance service would only be provided once an aircraft was positively identified, but that control services would not be provided until the aircraft was within controlled airspace.

The Manual of Air Traffic Services (MATS) clause 9-45-110 stated that the ATS surveillance system procedures, services and functions were to:

> … g. maintain flight path monitoring of air traffic and/or
>
> h. maintain a watch on the progress of air traffic in order to provide:
>
> 1. improved position information regarding aircraft under control;
> 2. supplementary information regarding other traffic; and
> 3. information regarding any significant deviations, by aircraft from the terms of their respective clearances.

Visual approach

AIP requirements

AIP ENR 1.1 section 12.8 *Visual Approach* described the requirements for the conduct of a visual approach. The criteria under which ATC could clear an IFR aircraft for a visual approach at night were:

- the pilot had established and could continue flight to the aerodrome with continuous visual reference to the ground or water; and
- visibility along the flight path was not less than 5,000 m; and
- the aircraft was within 30 NM (56 km) of the aerodrome; or
- when the aircraft was being provided with an ATS surveillance service, the flight had been assigned a minimum vector altitude (MVA) and given heading or tracking instructions to intercept final or a position within the aerodrome circling area.

The flight crew met the criteria to be assigned a visual approach. During the go-around, ATC advised the crew that they were still radar identified. As such, they were being provided with an ATS surveillance service.

The AIP also identified specific minimum altitude requirements for an IFR aircraft when cleared for a night visual approach. These included:

- the aircraft must descend as necessary to maintain an altitude not less than the MSA or the appropriate step of the DME or GPS arrival procedure, or 500 ft above the lower limit of the control area, whichever was higher; or
- if receiving an ATS surveillance service, not below the last assigned altitude.

The minimum altitude requirements were to be observed until specific criteria were met. For an approach to runway 36 at Avalon, the minimum altitude was to be maintained until the aircraft was:

- within the prescribed circling area and with the aerodrome in sight, or
- within 5 NM (9 km) of the aerodrome, aligned with the runway centreline and established not below 'on slope' on the 'T' visual approach slope indicator (T-VASIS) or precision approach path indicator (PAPI).

As the flight crew were in receipt of a surveillance service, during a visual approach they were required to maintain the last assigned level of 3,000 ft until within the circling area or 5 NM (9 km) of Avalon, aligned with the runway and satisfying the 'on slope' requirements. The flight crew had the option of requesting a descent to a lower altitude prior to establishing either of these criteria. ATC could clear the aircraft to descend to a lower altitude provided that clearance took into account the required terrain clearance.

Requirements of the MATS

At night, ATC could clear an aircraft for a visual approach when a pilot reported 'visual', but was required to make that clearance dependent on the aircraft first establishing itself inside the circling area or, in this instance, within 5 NM (9 km) of the destination airport, aligned with the runway and 'on slope' before the approach could be commenced. In accepting a clearance for a visual approach, pilots were still required to meet the minimum altitude requirements as stated above. In this instance, the flight crew advised ATC that they were visual during the radio transmissions advising of their intentions following the missed approach.

MATS clause 11-10-1310 provided guidance on when a controller could issue a visual approach as follows:

> When a flight … is within 30 NM of an aerodrome, a visual approach may be authorised by day or night for:
>
> a. VFR flight
>
> b. an IFR flight when:
>
> 1. the pilot has established and can continue flight to the aerodrome with continuous visual reference to the ground or water
>
> 2. the visibility along the flight path is not less than 5000 m (or by day, the aerodrome is in sight).

Further, with respect to an IFR aircraft being assigned a night visual approach when being provided with an ATS surveillance service, MATS clause 11-10-1340 stated:

> At night, you may assign an IFR aircraft receiving an ATS surveillance service … a visual approach at any distance from an aerodrome if:
>
> a. the aircraft had been assigned the MVA [and]
>
> b. the aircraft is given heading or tracking instructions to intercept final or to position the aircraft within the circling area of the aerodrome.

and required the following phraseology to assign the visual approach:

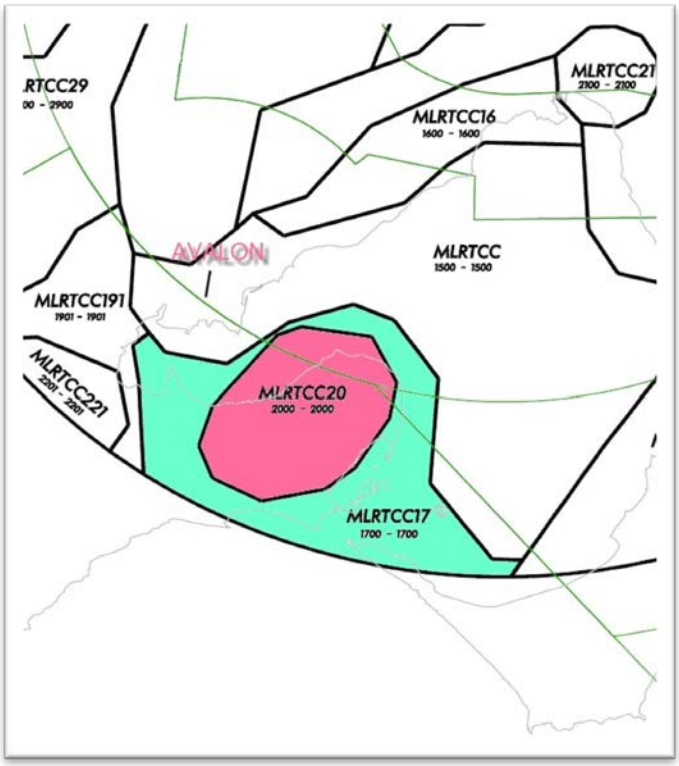
> ATC: "WHEN ESTABLISHED IN THE CIRCLING AREA, CLEARED VISUAL APPROACH"
>
> ATC: "WHEN ESTABLISHED ON THE T-VASI (or PAPI) (or GLIDEPATH) CLEARED VISUAL APPROACH".

In this occurrence, the controller used a combination of these two recommended phraseologies to assign the visual approach; however, no MVA was assigned.

Controllers can identify the relevant MVA by using radar terrain clearance charts (RTCC), which can be selected for display on the radar controller's air situation display. With respect to the Avalon area, and in particular the area to the south of the airfield including the Bellarine Peninsula, the applicable MVAs were 2,000 ft and 1,700 ft, as depicted by areas MLRTCC20 and

MLRTCC17 in Figure 3. The initial descent below the minimum permitted altitude of 2,000 ft occurred while the aircraft was in MLRTCC20. The controller queried the aircraft's altitude as the aircraft was about to exit MLRTCC20 and enter MLRTCC17. Closer to but still south of Avalon, an MVA of 1,500 ft was possible.

Figure 3: Melbourne RTCC chart



Source: Airservices Australia, modified by the ATSB

Air traffic services

Altitude alerting

The Australian Advanced Air Traffic System (TAAATS) included a number of systems that alerted controllers to a hazardous situation involving aircraft proximity to terrain or other aircraft. The alert system triggered in this occurrence was the clearance level adherence monitoring (CLAM). This alert informs a controller when an aircraft deviates from its cleared flight level (CFL) by more than 200 ft, but only if the controller has entered the CFL into TAAATS and the aircraft has reached that flight level.

During the missed approach, the controller cleared the aircraft to climb to 3,000 ft and set the CFL to that level. When the aircraft descended through 2,800 ft without clearance, the CLAM activated. The controller responded to that alert appropriately by querying the flight crew's intentions.

The procedures on the use of the CFL function required the CFL to be set to zero when an aircraft was cleared for an approach, which disabled all altitude alerts from that point.

Safety alerting

In the event that a controller was concerned about the position of an aircraft, MATS clause 9-10-610 stated that they could issue a safety alert as follows:

> Unless the pilot has already advised action is being taken to resolve the situation or has reported the other aircraft in sight, issue a Safety Alert to the aircraft as a priority, when you become aware that the aircraft is in a situation that is considered to place it in unsafe proximity to terrain, obstructions, active restricted areas or other aircraft.

Manual of standards

The content of MATS was based on rules published by CASA in the *CASR Part 172 – Manual of Standards* (MOS), the International Civil Aviation Organization's standards and practices, and rules specified by Airservices Australia (Airservices).[21] The MOS listed the following requirements in respect of assigning IFR aircraft night visual approaches:

> When being vectored at night, an IFR aircraft… may be assigned a visual approach at any distance from an aerodrome, if:
>
> (a) the aircraft has been assigned the minimum vector altitude; and
>
> (b) the aircraft has been given heading instructions to intercept final or to position the aircraft within the circling area of the aerodrome; and
>
> (c) the following phraseology is used to assign the visual approach:
>
> (i) —WHEN ESTABLISHED ON THE VASIS/GLIDEPATH CLEARED VISUAL APPROACH; or
>
> (ii) —WHEN ESTABLISHED IN THE CIRCLING AREA CLEARED VISUAL APPROACH.

As stated in the section titled *Visual approach*, the AIP and MATS reflected this overarching requirement from the MOS and initially the three documents had identical wording. However, at the time of the occurrence MATS did not include the use of 'and' between the requirement to assign an MVA and the requirement to issue tracking instructions.

In the March 2013 amendment to the MATS, clause 2-10-430, titled *List point relationships*, was included in Chapter 2-10 *Maintaining MATS: What's in MATS?* This clause stated:

> The relationship between list points is as follows:
>
> a) The relationship may be 'and' or 'or;'
>
> b) 'And' is not shown at the end of a list point but is implied in the absence of a descriptor
>
> c) 'And' and 'or' relationships are not used within the same list.

In addition, both the MATS and AIP replaced 'When being vectored at night…' with the more general stipulation that the affected aircraft was 'receiving ATS surveillance service'.

Organisational and management information

Tiger Airways

Approach preparation and briefing

The Tiger Airways procedures in preparation for an approach and landing, including the relevant briefings, were contained in the operations manual. This contained a section on Threat and Error Management (TEM) and included a brief discussion on the use of the Approach and Landing Accident Reduction (ALAR) checklist to identify any threats, and the resultant risk, expected during the approach.

The go-around briefing, which was to be completed in conjunction with the approach briefing, required the review of these procedures and specific flight crew actions. That briefing was to be completed on the first sector of a sequence of flights, but could be omitted on subsequent sectors if the crew remained unchanged.

Guidance from Airbus and the Flight Safety Foundation recommended that the go-around briefing contain a discussion of a flight crew's intentions following a go-around, including the type of return approach envisaged (for example, the intended runway and/or type of approach). Neither the briefing procedure nor the example provided in the operations manual included the requirement for the crew to identify and discuss their intentions following a go-around. However, guidance was provided on the use of the secondary flight plan function of the flight management guidance

[21] MATS clause 2-15-210.

system. This guidance recommended that, if there was the strong possibility of a late runway change, the secondary flight plan function should be set up for an approach to an alternate runway.

The descent preparation procedure also included the requirement for the ALAR checklist to be used for all approach briefings to assess the risk associated with the approach and landing. The flight crew used this checklist during the approach briefing and did not identify any unacceptable risk for the landing. However, it did prompt the crew to reinforce that it was 'ok to go-around'.

Night visual approach requirements

The operations manual repeated the night visual approach requirements as detailed in the AIP. However, it omitted the requirement that '… if receiving an ATS surveillance service, operate not below the last assigned altitude'.

Operations notices and guidance on operations at Avalon

Tiger Airways had promulgated two operations notices detailing the structure of the Avalon airspace. The first, operations notice 57 (Ops 57) with an effective date of May 2010, was originally issued to highlight a change in the Avalon airspace. Ops 57 described the Avalon Class D airspace and its contiguous Class E airspace as reverting to uncontrolled Class G airspace 'outside of tower hours of operation'. The notice included a self-cancelling date of November 2010 and was superseded by operations notice 101 (Ops 101), which had an effective date of October 2010. Ops 101 contained the relevant, and significantly different, information on the Avalon airspace structure at the time of the occurrence.

Despite the operations manual requirement for operations notices to be cancelled as soon as they were no longer relevant, Ops 57 still appeared in the operations notice index at the time of the occurrence. This had the potential to create confusion among flight crew regarding the Avalon airspace structure.

The operations manual categorised Tiger Airways ports according to the level of complexity associated with operations at those locations (including departure, arrival and terrain considerations). The category assigned to Avalon required completion of a self-briefing package not more than 14 days prior to the captain first operating into that airport. Subsequent requalification for operations into Avalon required crews to '…complete the briefing qualifications as for initial qualification within thirty five days immediately prior to the flight.' Tiger Airways did not keep records of when flight crews completed their initial or requalification requirements.

The self-briefing package for Avalon contained information on the structure of the airspace that reflected the correct airspace configuration, but included information that incorrectly indicated that Avalon Class E airspace was uncontrolled. The material also identified Ops 57 and 101 as reference material and required flight crews to be 'cognisant of BOTH these documents' despite these operations notices presenting differing information on Avalon's airspace. The FO reported that he had notified Tiger Airways of the errors in the briefing package shortly before the occurrence.

Tiger Airways training system and documentation

The operations manual detailed checking and training policies including the specific content and forms to be used for the various checking and training cycles. The forms included a 'Phased Line Training Checklist' (PLTC) that identified over 200 proficiencies and discussion topics to be signed off by the check and training pilots during a pilot's line training. Both pilots had a completed PLTC in their training file.

There were no specific night visual approach training or checking requirements in the operations manual, listed in the PLTC, or included in any simulator training sequence. However, the PLTC did include a number of topics associated with the approach phase of flight that could have included a discussion on the requirements for a night visual approach. Tiger Airways advised that night visual approach requirements, while not stipulated, were addressed as part of these topics.

Civil Aviation Safety Authority

The Civil Aviation Safety Authority (CASA) suspended operations by Tiger Airways with effect 2 July 2011. In detailing the reasons for the suspension, CASA issued a media release, which stated:

> The suspension of Tiger Airways Australia follows the issue of a show cause notice to the airline in March 2011. Taking Tiger Airways Australia's response to this show cause notice into account, CASA subsequently imposed a number of conditions on the airline's air operator's certificate. These conditions required actions to improve the proficiency of Tiger Airways Australia's pilots, improvements to pilot training and checking processes, changes to fatigue management, improvements to maintenance control and ongoing airworthiness systems and ensuring appropriately qualified people fill management and operational positions.

On 10 August 2011, CASA issued another media release announcing they had lifted the suspension of the Tiger Airways air operator's certificate (AOC), placed conditions on the AOC for on-going operations and would continue to conduct surveillance and spot checks on the airline.

As a result of the action taken by CASA, the Australian Transport Safety Bureau (ATSB) examined CASA's surveillance that culminated in the issue of the show cause notice in March 2011. CASA's surveillance following this occurrence resulted in a number of Requests for Corrective Action, all of which were closed by the end of 2011 after appropriate action by Tiger Airways.

Human performance

Workload

Workload has been defined as 'reflecting the interaction between a specific individual and the demands imposed by a particular task. Workload represents the cost incurred by the human operator in achieving a particular level of performance.[22] The available resources are finite and will vary depending on the experience and training of the individual as well as the level of stress and fatigue experienced. Workload is managed by balancing task demands such that, when workload is low, tasks are added and when workload becomes excessive, tasks are shed.

Tasks, such as internal and external communication, can be shed in an efficient manner by eliminating low priority tasks or they can be shed inefficiently by abandoning important tasks.[23] The task demands can be influenced by the mental and physical requirements of the task, as well as the time available.[24]

Workload and time pressure can lead to a reduction in the number of information sources an individual may access, and the frequency or duration of time these sources are checked.[25] A high workload can result in individuals not perceiving relevant information, or not understanding the implications of the information they are presented with.

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22 Orlady, H.W., & Orlady, L.M. (1999). *Human factors in multi-crew flight operations*. Ashgate: Aldershot, UK, p.203.

23 Wickens, C.D. & Hollands, J.G. (2000). *Engineering psychology and human performance*, 3rd Edition. Prentice Hall: New Jersey.

24 Lee, Y-H., & Liu, B-S. (2003). Inflight workload assessment: Comparison of subjective and physiological measurements. *Aviation, Space and Environmental Medicine*, *74,* pp. 1078-1084.
Hart, S.G. & Staveland, L.E. (1988). Development of NASA-TLX (Task Load Index): Results of empirical and theoretical research. In P. A. Hancock and N. Meshkati (Eds.) *Human Mental Workload*. Amsterdam: North Holland Press.

25 Staal, M. (2004). *Stress, cognition, and human performance: A literature review and conceptual framework*, NASA/TM-2004-212824.

Related occurrences

A review of the ATSB database identified a number of previous occurrences involving descent below the minimum permitted altitude by a number of operators. However, none were similar to this occurrence.

Safety analysis

Introduction

During a return for landing to runway 36 at Avalon Airport following a go-around, the flight crew of VH-VNC initiated a descent without clearance to an altitude that was below the minimum permitted altitude. This analysis will examine the operational factors that led to those events, as well as a number of discrepancies between operational and air traffic control documents.

The initial approach to runway 18

During the briefing conducted prior to the descent into Avalon, the flight crew identified that the tailwind on runway 18 could exceed the limit for landing. If that occurred, a go-around, and subsequent approach to runway 36, would be required as circling off the runway 18 approach was not permitted by Tiger Airways Australia Pty Ltd (Tiger Airways) crews. The flight crew decided to monitor the tailwind during the approach with the aim of conducting a go-around if the limit was exceeded during the last 100-200 ft of the approach. Despite recognising the potential that a go-around may be required, the flight crew did not plan for a possible return to runway 36.

As the aircraft reached 200 ft above the ground, the flight crew identified that the tailwind exceeded the limit for landing and commenced a go-around. The lack of prior planning for a return to runway 36 meant that the crew had to develop their response after initiating the go-around.

The go-around and approach to runway 36

The go-around

The workload associated with the go-around prevented the flight crew from planning the return to land until they reached the cleared level of 3,000 ft. This workload included a number of aircraft configuration changes and performance monitoring as well as communication with air traffic control (ATC). All of these actions impacted on the time available for the flight crew to discuss their subsequent actions until the aircraft was established at 3,000 ft.

The flight crew had the option to return to runway 36 via another instrument approach or, as the weather was fine, conduct a visual approach. The intention of ATC when clearing the flight crew to 3,000 ft was to enable an instrument approach return. In addition, the flight crew could have requested radar vectors to the commencement point of an instrument approach or to a position where the aircraft was aligned for a final approach, which would have reduced their workload.

Manoeuvring for the approach

The pilot flying (PF) decided to conduct a visual approach using a teardrop manoeuvre to return to runway 36 and commenced manoeuvring shortly after reaching 3,000 ft. This rapid decision and action resulted in less time for the crew to complete the required actions and tasks for the approach, further elevating the associated workload. It also impacted on communications both within the cockpit and with ATC. By conducting the return as a visual teardrop manoeuvre, the flight crew were responsible for conducting the approach in accordance with the tracking and altitude requirements of a night visual approach and as such, were required to maintain their own terrain and obstacle clearance. Furthermore, as the flight crew were receiving an air traffic service (ATS) surveillance service, unless otherwise cleared, they were required to maintain the previously cleared 3,000 ft.

When ATC queried the flight crew's intention following the completion of the go-around, the PF advised that they would be conducting a visual teardrop manoeuvre to runway 36. The intent of the controller's response of 'that's approved' was ambiguous, and could have been interpreted to mean that the flight crew were cleared to descend as per a visual approach clearance. However, a

short time later the controller advised the flight crew to '…report turning inbound for descent', indicating that the controller was expecting the aircraft to remain at 3,000 ft. The pilot monitoring (PM) acknowledged that instruction.

About 30 seconds later, as the aircraft departed the circling area while outbound in the teardrop manoeuvre, the PF commenced a descent from 3,000 ft to 1,600 ft without a clearance from ATC. The PF incorrectly believed that the aircraft was operating outside of controlled airspace and was within the circling area at that time, contributing to the misunderstanding that there was no requirement to obtain a descent clearance and that the aircraft was descending to a safe altitude. Descent to 1,600 ft was permitted within the circling area, but to ensure adequate separation from terrain, the aircraft was required to operate no lower than 2,000 ft once outside the circling area unless established on the runway 36 centreline, not below 'on slope' on the precision approach path indicator (PAPI) or 'T' visual approach indicator system (T-VASIS) and within 5 NM (9 km) of the aerodrome.

It is possible the ambiguity with the operations notices and training package relating to Avalon airspace influenced the PF's understanding of the airspace classification. In addition, his comprehension of the aircraft's position in relation to the circling area was probably influenced by the workload associated with the teardrop manoeuvre and approach.

While the PM acknowledged the requirement to report ready for descent, the recorded data identified that at the time the descent was commenced, his workload was high in preparing the aircraft for the approach and landing. This increased the risk that he would inadvertently miss that requirement and may also explain his not recognising the ramifications of descending to 1,600 ft while outside the circling area - if he was aware of the aircraft's position at that stage.

Conditional clearance for the visual approach

Following receipt of a cleared level adherence monitoring (CLAM) alert relating to the aircraft's descent, the controller asked the crew to confirm that they would be maintaining the cleared 3,000 ft until established on final approach for runway 36. The PF advised that they were leaving 3,000 ft for the teardrop turn and, in response, the controller issued a conditional clearance that once the aircraft was established on the PAPI/T-VASIS or inside the circling area, they were cleared for a visual approach.

As the flight crew were receiving an ATS surveillance service, based on the content of Manual of Air Traffic Services (MATS) clause 11-10-1340 as well as the phraseology used by the controller in the conditional visual approach clearance, a minimum vector altitude (MVA) should have been included in that clearance. Although the crew were responsible for clearance from terrain during the visual approach, had they been instructed to descend not below the MVA altitude of 2,000 ft until established on the PAPI/T-VASIS or within the circling area, it is possible that they would not have descended below that altitude. Equally, had the crew advised the controller that they were on descent to 1,600 ft, the controller would have been alerted to the intended descent below the minimum permitted altitude.

Following the conditional visual approach clearance, the crew continued the descent and passed below the minimum permitted altitude of 2,000 ft at about 15 km from the airport before levelling the aircraft at 1,600 ft - about 1,500 ft above the ground. On observing the aircraft's position, the controller queried the crew on the aircraft's altitude with respect to the surrounding terrain and, based on the crew's advice that they were 'visual', did not issue a safety alert with respect to their proximity to terrain. At that time the aircraft was about 16 km from the runway 36 threshold, outside of the circling area and not aligned with the runway. The aircraft remained at 1,600 ft until established on the runway centreline, when the flight crew commenced the final approach and landing. The aircraft transited a number of zones with progressively lower MVAs, and therefore safety altitudes, and issuing a safety alert was at the controller's discretion. However, the decision not to issue an alert on this occasion meant that an opportunity to warn the flight crew of their

being below the minimum permitted altitude, and therefore minimise the time below that altitude, was lost.

Operational documentation

Tiger Airways documentation

The ATSB identified that the operations notices and briefing package relating to Avalon airspace contained incorrect material regarding the airspace structure. In addition, having two operations notices with conflicting information in circulation and incorrect training material could create confusion and misunderstanding among crews of the airspace structure. Moreover, while the Tiger Airways operations manual reflected the contents of the Aeronautical Information Publication Australia (AIP) with regard to the conduct of night visual approaches, it did not fully detail the minimum altitude requirements. Specifically, the omission of the requirement to operate not below the last assigned altitude when receiving an ATS surveillance service increased the risk that flight crews would not comply with the visual approach requirements of the AIP.

Air Traffic Services

During the investigation, the ATSB identified an omission within the AIP relating to the protection from collision afforded by operations in Classes C and D controlled airspace. The AIP did not include Class E airspace as also providing this protection, despite it also being controlled airspace. The AIP was subsequently amended to address this omission.

The ATSB also identified that the MATS was not in agreement with the Civil Aviation Safety Regulation Part 172 Manual of Standards (MOS) in respect of the requirements for issuing a night visual approach to an instrument flight rules aircraft. Specifically, whereas the word ‘and’ was used in the MOS to identify that two or more requirements had to be met when issuing a night visual approach, the word ‘and’ was removed from those requirements in the MATS. This increased the risk of controllers interpreting the requirements as being linked by the term ‘or’, incorrectly suggesting that certain requirements might be optional. Clarification on the interpretation of lists of requirements was provided in the March 2013 amendment of MATS.

The extent to which any variation between the documents may have influenced the controller’s actions on the night could not be determined.

Findings

From the evidence available, the following findings are made with respect to the descent below the minimum permitted altitude involving an Airbus A320, registered VH-VNC, which occurred 15 km south-south-east of Avalon Airport, Victoria on 30 June 2011. These findings should not be read as apportioning blame or liability to any particular organisation or individual.

Safety issues, or system problems, are highlighted in bold to emphasise their importance. A safety issue is an event or condition that increases safety risk and (a) can reasonably be regarded as having the potential to adversely affect the safety of future operations, and (b) is a characteristic of an organisation or a system, rather than a characteristic of a specific individual, or characteristic of an operating environment at a specific point in time.

Contributing factors

- The flight crew did not plan for a return to land on runway 36 at Avalon in the event that a go-around was required, which led to a rapid decision to conduct a visual approach and an elevated workload that impacted on the execution of the approach.
- The flight crew experienced a high workload environment that degraded their performance during the approach to runway 36 at Avalon and resulted in the aircraft descending below the minimum permitted altitude.

Other factors that increased risk

- During the return to runway 36 at Avalon, the pilot flying mistakenly believed that the aircraft was operating outside controlled airspace.
- The section in the Aeronautical Information Publication Australia on the protection from collision risk afforded to operations in Class C and D controlled airspace did not indicate that some of those protections were also available to instrument flight rules operations in Class E airspace, despite it also being controlled airspace.
- The omission by the controller to assign a minimum vector altitude as part of the visual approach clearance was a missed opportunity for the flight crew to identify the lowest safe altitude.
- The controller's decision not to issue a safety alert meant that an opportunity to warn the flight crew of their being below lowest safe altitude, and therefore minimise the time below that altitude, was lost.
- **The Tiger Airways Australia Pty Ltd documentation and training package relating to the Avalon airspace structure and night visual approach guidance contained incorrect material and omissions that increased the risk of confusion and misunderstanding by flight crews. [Safety issue]**
- **The Manual of Air Traffic Services differed from the Civil Aviation Safety Regulation Part 172 Manual of Standards concerning the requirements for issuing a night visual approach to an instrument flight rules aircraft, increasing the risk of ambiguity in the application of these requirements by controllers. [Safety issue]**

Other findings

- The controller identified that the aircraft had descended below the lowest safe altitude and queried the flight crew.

Safety issues and actions

The safety issues identified during this investigation are listed in the Findings and Safety issues and actions sections of this report. The Australian Transport Safety Bureau (ATSB) expects that all safety issues identified by the investigation should be addressed by the relevant organisation(s). In addressing those issues, the ATSB prefers to encourage relevant organisation(s) to proactively initiate safety action, rather than to issue formal safety recommendations or safety advisory notices.

All of the directly involved parties were provided with a draft report and invited to provide submissions. As part of that process, each organisation was asked to communicate what safety actions, if any, they had carried out or were planning to carry out in relation to each safety issue relevant to their organisation.

Tiger Airways Australia Pty Ltd documentation discrepancies

Number:	AO-2011-076-SI-01
Issue owner:	Tiger Airways Australia Pty Ltd
Operation affected:	Aviation – Air transport – Large aeroplanes
Who it affects:	Tiger Airways Australia flight crews

Safety issue description:

The Tiger Airways Australia Pty Ltd documentation and training package relating to the Avalon airspace structure and night visual approach guidance contained incorrect material and omissions that increased the risk of confusion and misunderstanding by flight crews.

Response to safety issue and/or Proactive safety action taken by: Tiger Airways Australia Pty Ltd

Tiger Airways Australia Pty Ltd has advised that in response to this safety issue:

> The documentation and training packages relating to the Avalon airspace structure are no longer in use or circulation at Tigerair [Tiger Airways Australia Pty Ltd]. Additionally, although Tigerair does not currently operate scheduled services to Avalon, all flight crew have been required to complete an [Avalon] airspace training package to ensure that they are aware of the airspace structure and its associated complexities and implications. This has been incorporated into Flight Crew initial training to ensure that existing and new Flight Crew have the same level of familiarity.
>
> Since this event in 2011, the Tigerair process for the production, distribution and control of Operations Notices has changed substantially. Similarly, to support the introduction of organisational changes, whether due to internal or external factors, a process has been implemented that requires the risks associated with the change to be identified and managed. This process would apply for future changes to airspace that may introduce areas of risk to the Tigerair operation.

Action number: AO-2011-076-NSA-024

Current status of the safety issue:

Issue status: Adequately addressed.

Justification: The ATSB is satisfied that the action taken by Tigerair has adequately addressed the safety issue.

Air traffic services procedures

Number:	AO-2011-076-SI-02
Issue owner:	Airservices Australia
Operation affected:	Aviation – Air traffic control – All air traffic control
Who it affects:	Air traffic controllers

Safety issue description:

The Manual of Air Traffic Services differed from the Civil Aviation Safety Regulation Part 172 Manual of Standards concerning the requirements for issuing a night visual approach to an instrument flight rules aircraft, increasing the risk of ambiguity in the application of these requirements by controllers.

Response to safety issue and/or Proactive safety action taken by: Airservices Australia

Airservices Australia (Airservices) advised that it did not consider that there was a misalignment between the Manual of Air Traffic Services (MATS) and the Civil Aviation Safety Regulation Part 172 Manual of Standards concerning the requirements for issuing a night visual approach to an instrument flight rules aircraft. However, Airservices advised that, as part of its regular review of the MATS, amendments were incorporated to improve its readability. Specifically, the updated MATS effective February 2014 will ensure that linkage descriptors for list point requirements are explicitly stated.

Action number: AO-2011-076-NSA-063

Current status of the safety issue:

Issue status: Adequately addressed.

Justification: Although Airservices disagreed with the identified safety issue, the ATSB is satisfied that the action taken by Airservices has adequately addressed the safety issue.

General details

Occurrence details

Date and time:	30 June 2011 – 2245 EST
Occurrence category:	Incident
Primary occurrence type:	Operational non-compliance
Location:	15 km south-south-east of Avalon Airport, Victoria

Aircraft details

Manufacturer and model:	Airbus A320
Registration:	VH-VNC
Operator:	Tiger Airways Australia Pty Ltd
Serial number:	3275
Type of operation:	Air transport - high capacity

Sources and submissions

Sources of information

The sources of information during the investigation included:

- the flight crew of VH-VNC
- the aircraft's Cockpit Voice Recorder and Digital Flight Data Recorder
- Tiger Airways Australia Pty Ltd (Tiger Airways)
- Airservices Australia (Airservices)
- the Bureau of Meteorology.

References

Airbus. (2004). Conducting Effective Briefings. *Flight Operations Briefing Notes Reference: FLT OPS – SOP – SEQ06 – REV03 – JUNE 2004*. France: Airbus Customer Service.

Flight Safety Foundation. (2010). *FSF ALAR Tool Kit, Revision v.5.0 [DVD].* Alexandria, Virginia; Flight Safety Foundation.

Hutchins, E. (1995). How a cockpit remembers its speeds. *Cognitive Science*, *19,* pp. 265-288.

Lee, Y-H., & Liu, B-S. (2003). Inflight workload assessment: Comparison of subjective and physiological measurements. *Aviation, Space and Environmental Medicine*, *74,* pp. 1078-1084.

Hart, S.G. & Staveland, L.E. (1988). Development of NASA-TLX (Task Load Index): Results of empirical and theoretical research. In P. A. Hancock and N. Meshkati (Eds.) *Human Mental Workload*. Amsterdam: North Holland Press.

Orlady, H.W., & Orlady, L.M. (1999). *Human factors in multi-crew flight operations*. Ashgate: Aldershot, UK, p.203.

Staal, M. (2004). *Stress, cognition, and human performance: A literature review and conceptual framework*, NASA/TM 2004 212824.

Wickens, C.D. & Hollands, J.G. (2000). *Engineering psychology and human performance*, 3rd Edition. Prentice Hall: New Jersey.

Submissions

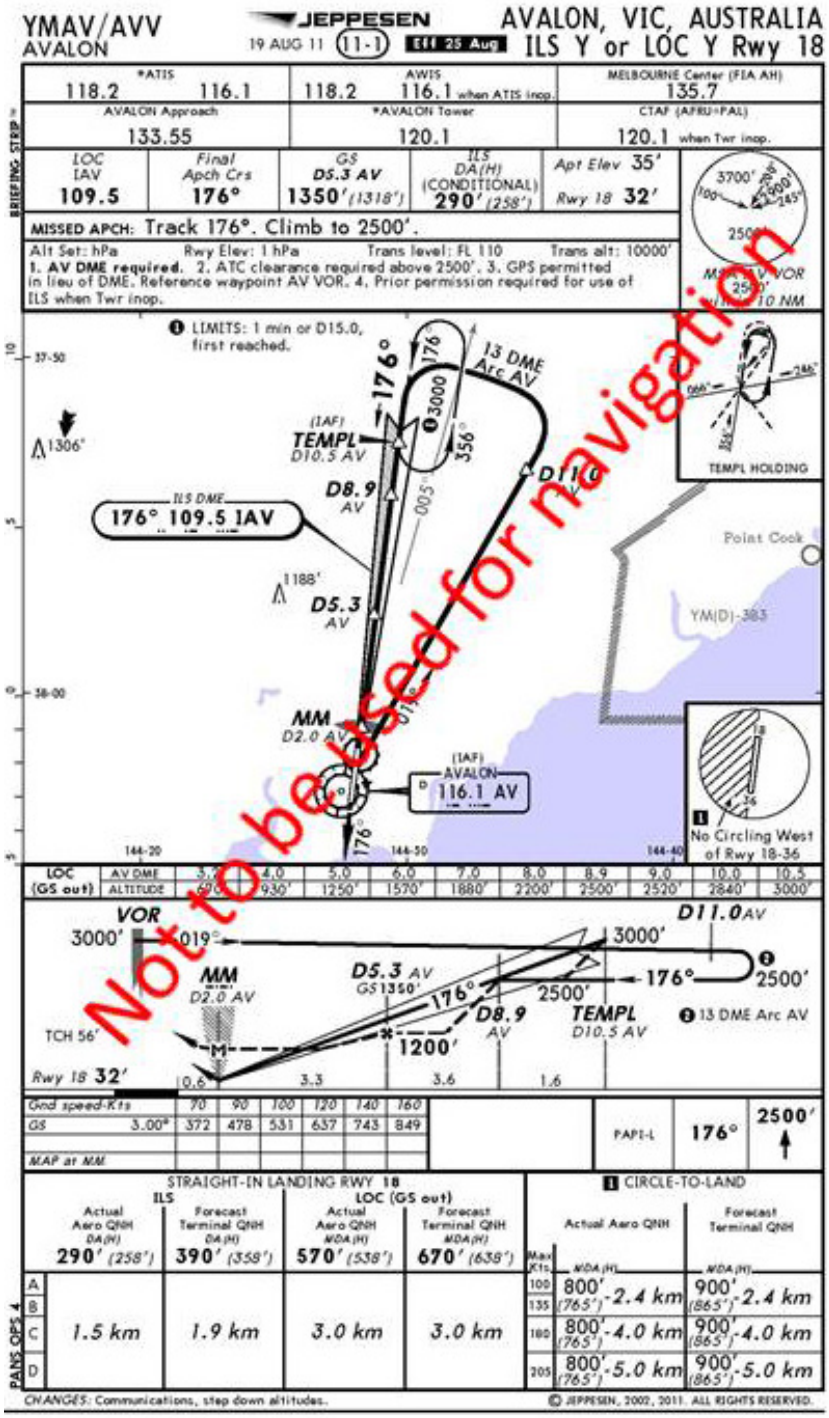
Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003* (the Act), the Australian Transport Safety Bureau (ATSB) may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. Section 26 (1) (a) of the Act allows a person receiving a draft report to make submissions to the ATSB about the draft report.

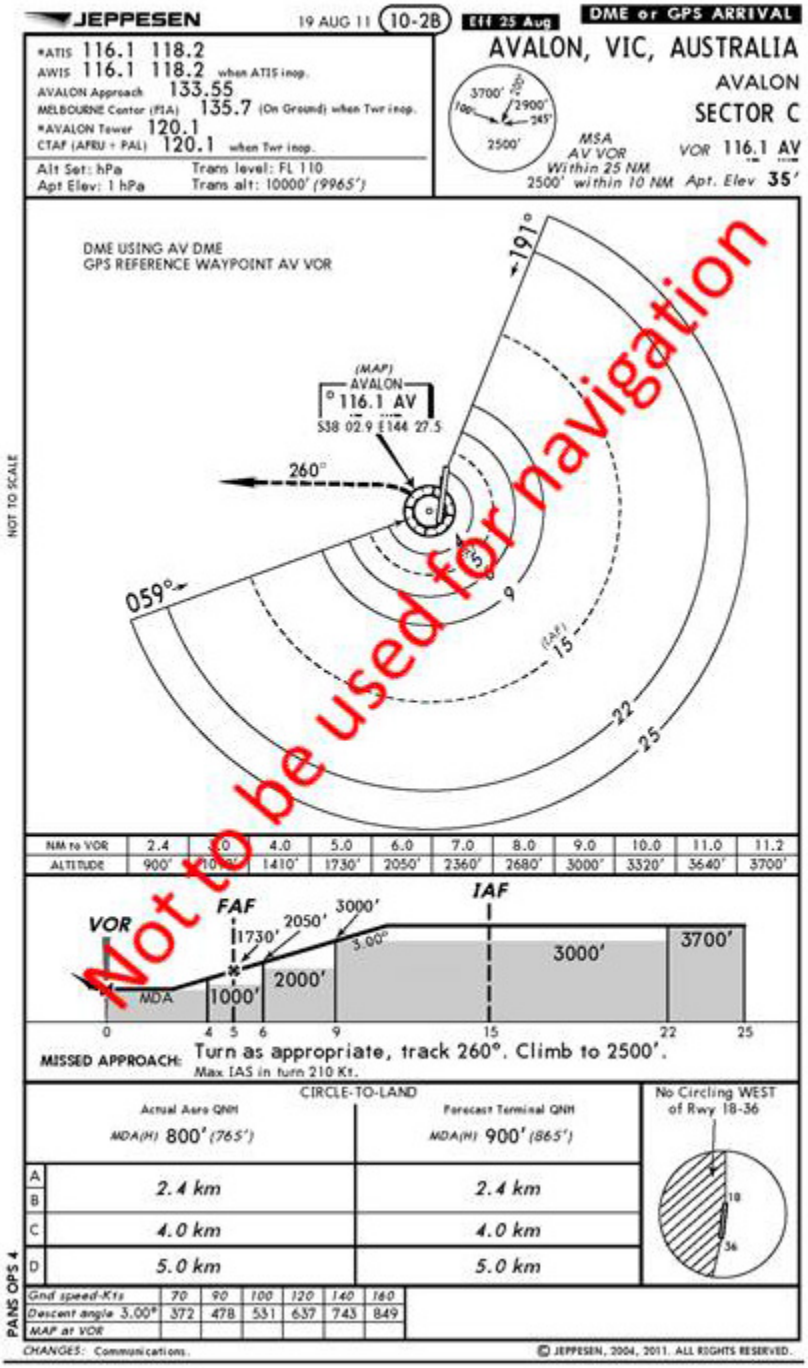
A draft of this report was provided to the flight crew of VH-VNC, Tiger Airways, the Civil Aviation Safety Authority (CASA) and Airservices.

Submissions were received from Tiger Airways, CASA and Airservices. The submissions were reviewed and where considered appropriate, the text of the report was amended accordingly.

Appendices

Appendix A - Avalon instrument approach charts





Appendix B - Transcript of events and radio communications[26]

Event Identifier[27]	Time	Event	Radio Call From	Radio Call To	Call	Response
	2256:10		ML-APP	Go Cat 6207[28]	Cleared to leave controlled airspace tracking via the 18 ILS approach, no reported IFR traffic.	Cleared to leave controlled airspace on the 18 ILS Avalon, Go Cat 6207.
	2257:04		Go Cat 6207	CTAF[29] Broadcast	Go Cat 6207, A320, is currently 15NM NE inbound for the ILS runway 18.	
	2258:06		ML-APP		Go Cat 6207, the wind is now showing 030/7, cleared to close this frequency. Confirming there is no reported IFR traffic, report on the ground clear of the runway on 133.55 to cancel SAR.	Report on the ground clear of the runway on this frequency, Go Cat 6207.
	2258:36		Go Cat 6207	CTAF Broadcast	Traffic Avalon, Go Cat 6207, Airbus A320 is now establishing on the ILS at 10 miles.	
A	2259:22	2,500 ft automated radio altitude (RA)[30] call.				
	2300:37	Aircraft configured for landing[31] as it passed 1,350 ft RA. The Flight Control Unit (FCU) was set to 128 kt and 2,500 ft for the go-around.				
B	2302:03	Go-around initiated.				
C	2302:26		Go Cat 6207	ML-APP	Melbourne Control, Go Cat 6207, going around, climbing runway heading to 2,500 [ft].	Go Cat 6207, still identified, climb to 3,000 [ft].

[26] The transcription is an incomplete representation of all of the events and actions recorded with respect to the occurrence flight.
[27] With reference to the track labels in Figure 1.
[28] Radio call-sign for the occurrence aircraft.
[29] Common Traffic Advisory Frequency.
[30] Altitude determined by radar altimeter.
[31] The landing configuration was landing gear down and locked and flaps set to Full.

Event Identifier[27]	Time	Event	Radio Call From	Radio Call To	Call	Response
	2302:31		Go Cat 6207	ML-APP	3,000 [ft], Go Cat 6207.	
	2302:40		ML-APP	Go Cat 6207	Go Cat 6207, when able advise intentions.	
	2303:10		ML-APP	Go Cat 6207	Go Cat 6207, what would you like to do now.	
	2303:20		Go Cat 6207	ML-APP	Approach Go Cat 6207, we had a bit of a downwind there on the landing, are we okay to make a teardrop for landing left turn out but a right turn back to land?	Go Cat 6207, affirm, so come back visual or by the VOR?
D	2303:31	Aircraft levels off at 3,000 ft.				
	2303:39		Go Cat 6207	ML-APP	No no, we are visual, we are happy just to make a left hand teardrop to turn back into a right hand pattern.	Go Cat 6207, that's approved.
	2303:47				Thank you.	
	2303:54		ML-APP	Go Cat 6207	Go Cat 6207, report turning inbound for descent.	Go Cat 6207, Wilco.
E	2304:15	Open descent selected, target 1,600 ft. Aircraft commenced descent.				
F	2304:50	Aircraft passing 2,600 ft.	ML-APP	Go Cat 6207	Go Cat 6207, Confirm you will be maintaining 3,000 [ft] until back on final?	Go Cat 6207, we are leaving 3,000 [ft] now for the teardrop turn right base for runway 36.
	2304:56		ML-APP	Go Cat 6207	Go Cat 6207, understood, established on the PAPI or circling area cleared visual approach for runway 36 the wind still trending about 030/8 kt.	Go Cat 6206 (sic) Roger, 6207.

Event Identifier[27]	Time	Event	Radio Call From	Radio Call To	Call	Response
G	2305:40	PM visually established contact with the runway.				
H	2305:50	Aircraft levels of at 1,600 ft. Flap 2 selected. Commencement of aircraft being reconfigured for the landing.				
I	2305:54		ML-APP	Go Cat 6207	Go Cat 6207, are you happy with the terrain there, you are showing one thousand six hundred?	Yeh, Go Cat, affirm, we are visual.
	2305:57		ML-APP	Go Cat 6207	Go Cat 6207, okay thanks.	
J	2306:11	Landing gear selected down.				
	2306:22		ML-APP	Go Cat 6207	Go Cat 6207, clear to close this frequency, confirm there is no reported IFR traffic and on the ground clear of the runway contact me 133.55 to cancel SAR.	Go Cat, will contact you on the ground clear of the runway.
K	2307:48	Aircraft commenced descent on final approach.				
	2310:41	The aircraft touched down on runway 36. Wind on touchdown was 7 kt headwind.				

Australian Transport Safety Bureau

The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory agency. The ATSB is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers. The ATSB's function is to improve safety and public confidence in the aviation, marine and rail modes of transport through excellence in: independent investigation of transport accidents and other safety occurrences; safety data recording, analysis and research; fostering safety awareness, knowledge and action.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within Commonwealth jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to fare-paying passenger operations.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and Regulations and, where applicable, relevant international agreements.

Purpose of safety investigations

The object of a safety investigation is to identify and reduce safety-related risk. ATSB investigations determine and communicate the factors related to the transport safety matter being investigated.

It is not a function of the ATSB to apportion blame or determine liability. At the same time, an investigation report must include factual material of sufficient weight to support the analysis and findings. 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.

Developing safety action

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. The ATSB prefers to encourage the relevant organisation(s) to initiate proactive safety action that addresses safety issues. Nevertheless, the ATSB may use its power to make a formal safety recommendation either during or at the end of an investigation, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation.

When safety recommendations are issued, they focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on a preferred method of corrective action. As with equivalent overseas organisations, the ATSB has no power to enforce the implementation of its recommendations. It is a matter for the body to which an ATSB recommendation is directed to assess the costs and benefits of any particular means of addressing a safety issue.

When the ATSB issues a safety recommendation to a person, organisation or agency, they must provide a written response within 90 days. That response must indicate whether they accept the recommendation, any reasons for not accepting part or all of the recommendation, and details of any proposed safety action to give effect to the recommendation.

The ATSB can also issue safety advisory notices suggesting that an organisation or an industry sector consider a safety issue and take action where it believes it appropriate. There is no requirement for a formal response to an advisory notice, although the ATSB will publish any response it receives.

Australian Transport Safety Bureau

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Investigation

ATSB Transport Safety Report
Aviation Occurrence Investigation

Descent below the minimum permitted altitude
Airbus A320, VH-VNC
15 km SSE of Avalon Airport, Vic, 30 June 2011

AO-2011-076
Final – 18 December 2013