



Australian Government

Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY REPORT

Aviation Occurrence Investigation – AO-2009-012

Preliminary

Tail Strike
Melbourne Airport, Vic.
20 March 2009
A6-ERG
Airbus A340-500



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Abstract

At 2231 Eastern Daylight-saving Time, an Airbus A340-500 aircraft, registered A6-ERG, commenced the take-off roll on runway 16 at Melbourne Airport on a scheduled, passenger flight to Dubai, United Arab Emirates with 257 passengers, 14 cabin crew and four flight crew. The takeoff was planned as a reduced-power takeoff and the first officer was the handling pilot for the departure.

At 2231:53, the captain called for the first officer to rotate. The first officer attempted to rotate the aircraft, but it did not respond immediately with a nose-up pitch. The captain again called 'rotate' and the first officer applied a greater nose-up command. The nose of the aircraft was raised and the tail made contact with the runway surface, but the aircraft did not begin to climb. The captain then selected TOGA on the thrust levers, the engines responded immediately, and the aircraft commenced a climb.

The crew notified air traffic control of the tail strike and that they would be returning to Melbourne. While reviewing the aircraft's performance documentation in preparation for landing, the crew noticed that a take-off weight, which was 100 tonnes below the actual take-off weight of the aircraft, had inadvertently been used when completing the take-off performance calculation. The result of that incorrect take-off weight was to produce a thrust setting and take-off reference speeds that were lower than those required for the actual aircraft weight.

The aircraft subsequently landed at Melbourne with no reported injuries. The tail strike resulted in substantial damage to the tail of the aircraft and damaged some airport lighting and the instrument landing system.

As a result of the accident, the aircraft operator has advised the Australian Transport Safety Bureau that it is reviewing a number of procedures including human factors involved in take-off performance data entry.

The investigation is continuing.

THE AUSTRALIAN TRANSPORT SAFETY BUREAU

The Australian Transport Safety Bureau (ATSB) is an operationally independent multi-modal bureau within the Australian Government Department of Infrastructure, Transport, Regional Development and Local Government. ATSB investigations are independent of regulatory, operator or other external organisations.

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 enhance safety. To reduce safety-related risk, ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated.

It is not the object of an investigation to determine blame or liability. However, 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 proactively initiate safety action rather than release formal recommendations. However, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation, a recommendation may be issued either during or at the end of an investigation.

The ATSB has decided that when safety recommendations are issued, they will focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on the method of corrective action. As with equivalent overseas organisations, the ATSB has no power to implement its recommendations. It is a matter for the body to which an ATSB recommendation is directed (for example the relevant regulator in consultation with industry) to assess the costs and benefits of any particular means of addressing a safety issue.

About ATSB investigation reports: How investigation reports are organised and definitions of terms used in ATSB reports, such as safety factor, contributing safety factor and safety issue, are provided on the ATSB web site www.atsb.gov.au

FACTUAL INFORMATION

The information contained in this preliminary report is derived from the initial investigation of the occurrence. Readers are cautioned that there is the possibility that new evidence may become available that alters the circumstances as depicted in the report.

History of the flight

At 2231 Eastern Daylight-saving Time¹ (1131 UTC) an Airbus A340-500 aircraft, registered A6-ERG, commenced the take-off roll on runway 16 at Melbourne Airport on a scheduled passenger flight to Dubai, United Arab Emirates. Onboard the aircraft were 257 passengers, 14 cabin crew and four flight crew² (captain, first officer, augmenting captain and augmenting first officer). The takeoff was planned as a reduced-power takeoff³ and the first officer was the handling pilot for the departure.

At 2231:53, the captain called for the first officer to rotate.⁴ The first officer attempted to rotate the aircraft, but it did not respond immediately with a nose-up pitch. The captain again called 'rotate' and the first officer applied a greater nose-up command. The nose of the aircraft was raised and the tail made contact with the runway surface, but the aircraft did not begin to climb. The captain then commanded and selected TOGA⁵ on the thrust levers, the engines responded immediately, and the aircraft commenced a climb.

After establishing a climb gradient, the crew noticed an ECAM⁶ message indicating that the aircraft had sustained a tail strike. The crew notified air traffic control (ATC) of the tail strike and that they would be returning the aircraft to Melbourne after dumping fuel. The aircraft was climbed to 7,000 ft and radar vectored by ATC for approximately 36 minutes over Port Phillip Bay while excess fuel was dumped to reduce the landing weight of the aircraft.

While reviewing the aircraft's performance documentation in preparation for landing, the crew noticed that a take-off weight, which was 100 tonnes below the actual take-off weight of the aircraft, had inadvertently been used when completing the take-off performance calculation. The result of that incorrect take-off weight

¹ The 24-hour clock is used in this report to describe the local time of day, Eastern Daylight-saving Time (EDT), as particular events occurred. Eastern Daylight-saving Time was Coordinated Universal Time (UTC) + 11 hours.

² The A340 was designed to be operated by two pilots (captain and first officer). For long duration sectors, a second 'augmenting' crew were carried on board the aircraft. The augmenting crew was normally resting in the crew rest station in the rear of the aircraft, but for take-off and landing the augmenting crew were stationed in the cockpit.

³ A reduced power takeoff is a takeoff carried out at less than maximum available engine thrust.

⁴ Raise the nose of the aircraft in order to become airborne.

⁵ TOGA: Take-off and go-around thrust setting, the maximum thrust that the engines will supply.

⁶ ECAM: Electronic Centralized Aircraft Monitoring. The ECAM provides information to the crew on the status of the aircraft and its systems.

was to produce a thrust setting and take-off reference speeds that were lower than those required for the aircraft's actual weight.

At 2327, after completing the fuel dump and while the crew were configuring the aircraft to land on runway 34, they received a report from cabin crew in the rear of the aircraft of smoke in the cabin. The crew requested an immediate landing from ATC and commenced the approach.

At 2336, the aircraft landed and rolled to the runway end. The aircraft was examined by the airport fire and rescue services for signs of immediate danger, none were evident and the crew were given a clearance to taxi the aircraft to the terminal where the passengers were disembarked.

Injuries to persons

There were no reports of injuries to any crew or passengers.

Damage to the aircraft

An initial inspection of the aircraft revealed that the rear of the fuselage was seriously damaged⁷. The lower skin panels were abraded by contact with the runway surface (Figure 1), and in some areas the skin had worn through the full thickness (Figure 2). A service panel had been dislodged (Figure 2) and was found by airport personnel at the end of the runway, along with numerous pieces of metal consistent with the abraded skin panels. Numerous fuselage frames and stringers in the region were deformed and several contained cracks (Figure 3). The rear pressure bulkhead⁸ contained cracks in the composite structure and deformation of the diaphragm support ring (Figure 4). There were also scrapes on the right side of the fuselage consistent with contact with external objects. One contact mark had an orange colouration and was located forward of the skin abrasion, immediately below the right, rear cargo door (Figure 5). The other contact mark was located adjacent to the skin abrasion and consisted of several, fine, divergent marks running rearwards and slightly upwards (Figure 6). There was also a contact mark on the left main landing gear, inboard rear tyre (Figure 7).

⁷ The Australian Transport Safety Bureau classified this event as an accident. Consistent with the ICAO definition outlined in Annex 13 to the Chicago Convention, an accident is defined in the *Transport Safety Investigation Act 2003* as an investigable matter involving a transport vehicle where the vehicle is destroyed or seriously damaged.

⁸ The rear pressure bulkhead is an airtight diaphragm that forms the rear pressure wall of the cabin.

Figure 1: Skin abrasion

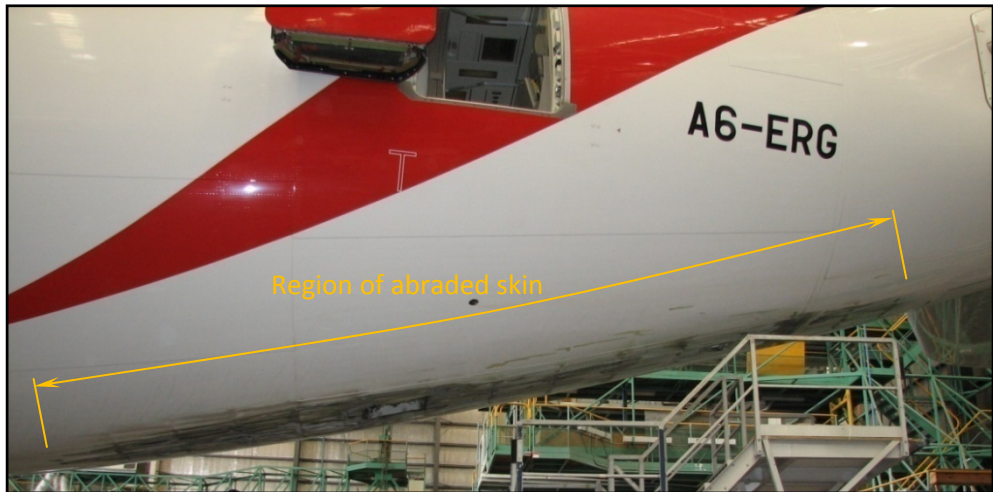


Figure 2: Skin abrasion detail

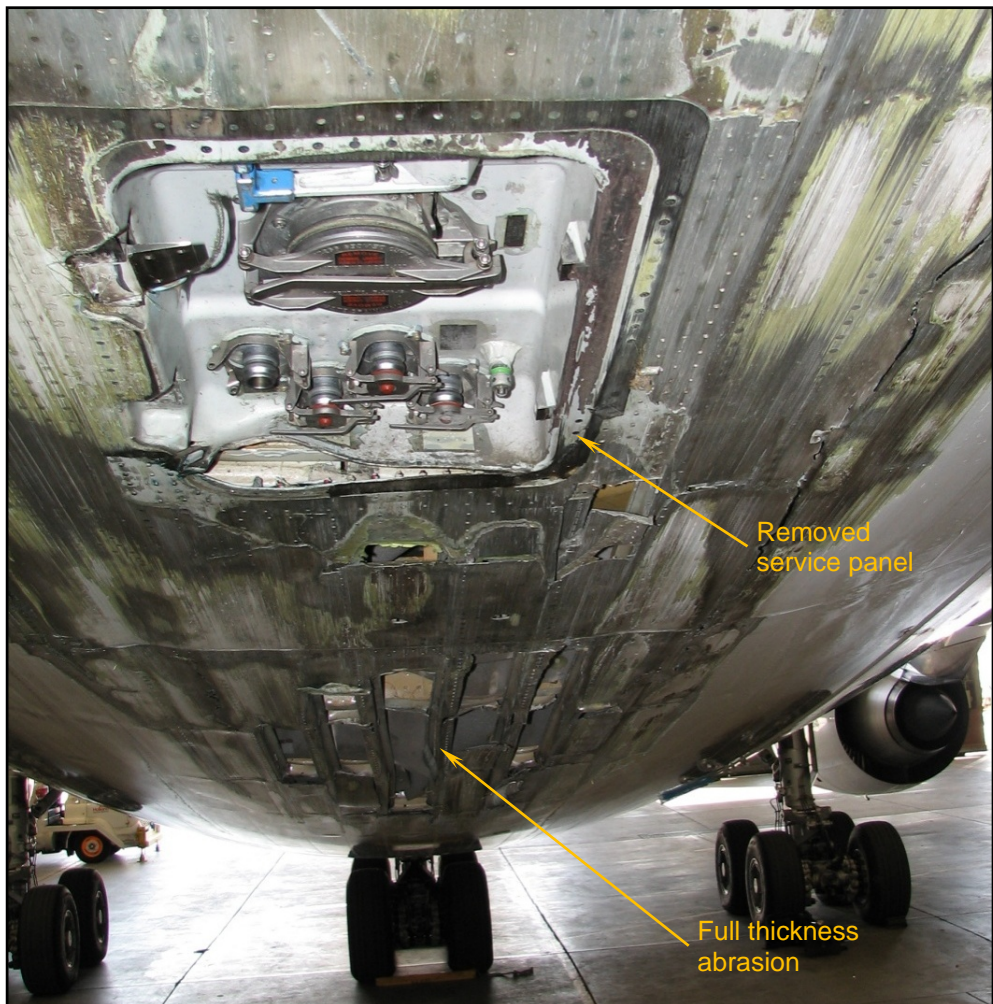


Figure 3: Example of frame deformation and cracking



Figure 4: Example of rear pressure bulkhead damage

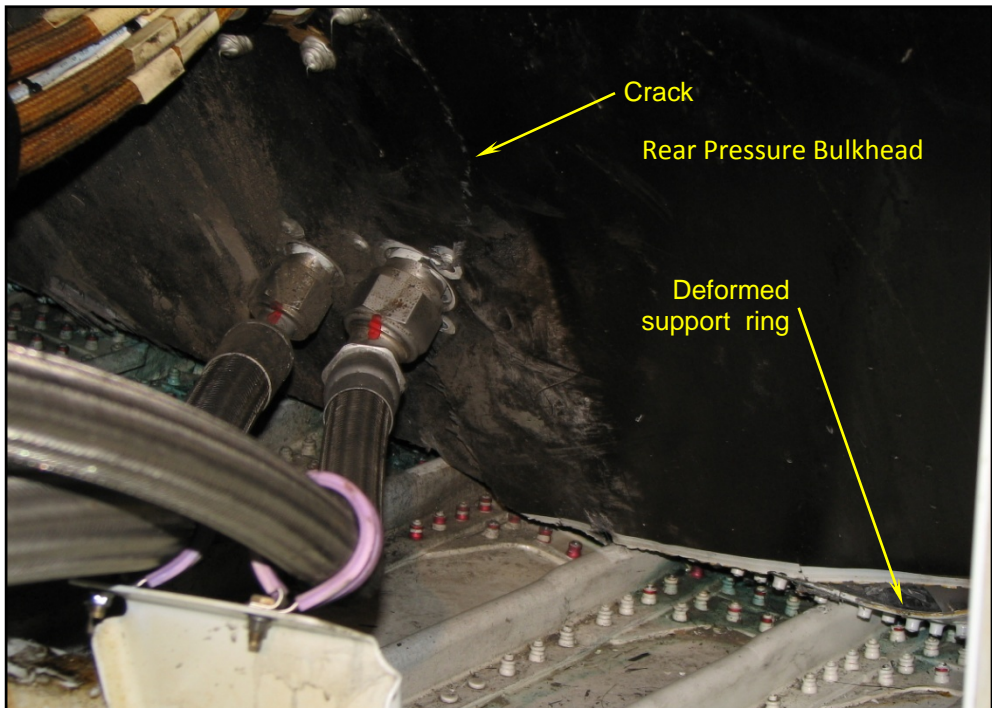


Figure 5: Contact mark below right, rear cargo door



Figure 6: Contact marks adjacent to skin abrasion



Figure 7: Contact mark on left main landing gear, inboard rear tyre



Other damage

An inspection of the runway and overrun areas identified multiple contact marks (Figure 8). The tail of the aircraft made contact with the runway at three locations, each starting at the positions indicated by ① ② and ③ in Figure 8. After leaving the stopway, two contact marks were identified in the grassed area, indicated by ④ and ⑤ in Figure 8. Figure 9 shows typical ground contact marks. The aircraft also made contact with ground infrastructure; a runway 34 high-intensity approach lighting centreline strobe light (Figure 10), and the runway 16 localiser monitor antenna (Figure 11). The runway 16 localiser antenna (Figure 12) was contacted by the left main landing gear inboard-rear tyre. The damage to the localiser antenna disabled the localiser function.

Figure 8: Ground contact marks



Figure 9: Typical contact marks on runway, stopway and grassed areas



Figure 10: Strobe light

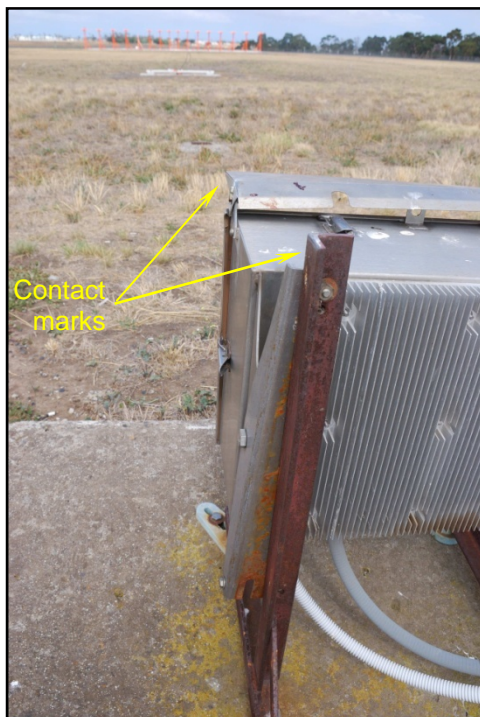


Figure 11: Localiser monitor antenna



Figure 12: Localiser antenna array



Personnel information

Table 1 summarises the operational qualifications and experience of the flight crew at the time of the occurrence.

Table 1: Flight crew qualifications and experience

	Captain	First Officer
Licence Category	ATPL	ATPL
Date of last medical	15 Oct 2008	06 Aug 2008
Date of last recurrent check	07 Oct 2008	05 Feb 2009
Total flying hours	8,195	8,316
Total on A340	1,978	612
Total on A340-500	1,372	425
Total last 30 days	98.9	89.7
Total last 90 days	229.3	199.2

Aircraft information

General information

Aircraft type:	Airbus A340-541
Serial number:	0608
Year of manufacture:	2004
Nationality:	United Arab Emirates
Registration:	A6-ERG
Certificate of Registration:	30 Nov 2004
Certificate of Airworthiness:	Valid: 30 November 2008 to 29 November 2009
Last 'A' maintenance check:	11 March 2009

Weight and Balance

Maximum Take-Off Weight:	372,000 kg
Maximum Landing Weight:	243,000 kg
Zero fuel weight on flight plan:	226,600 kg
Take-off weight on flight plan:	362,900 kg
Approximate landing weight:	280,000 kg

Meteorological information

Melbourne Airport automatic terminal information service (ATIS) 'uniform', current at the time of the accident, included information that the wind direction and speed at ground level was 250 degrees at 5 kts, QNH⁹ was 1015 hectopascals and the temperature was 17° C. Although it was night, the visibility was greater than 10 km. There were no reports of significant weather at the time of the accident.

Flight recorders

Overview

The aircraft was equipped with three flight recorders:

- a flight data recorder (FDR)
- a cockpit voice recorder (CVR)
- a digital ACMS¹⁰ recorder (DAR)¹¹.

The FDR and CVR were mandatory fitment recorders for this aircraft, with the recorded flight data stored within crash-protected memory modules located near the tail of the aircraft. The FDR recorded aircraft parameters defined by regulatory requirements.

The DAR is utilised by the operator for flight data and aircraft system monitoring activities. The aircraft flight parameters recorded by the DAR included most of the FDR parameters, with additional parameters as configured by the operator. The information recorded on the DAR was not crash-protected, but instead stored on a removable PC-card.

Recording system operation

FDR system

The FDR fitted to A6-ERG was a Honeywell Solid State Memory Flight Data Recorder (Part Number 980-4700-042). The FDR was required to store the last 25 hours of recorded flight data, capturing at least from engine start to 5 minutes after engine shutdown for each flight. The FDR installed in A6-ERG recorded approximately 1,200 aircraft parameters.

CVR system

The CVR fitted to A6-ERG was a Honeywell Solid State Memory Cockpit Voice Recorder, (Part Number 980-6022-001). The CVR was installed to record the cockpit audio environment, including crew conversation, radio transmissions, aural

⁹ QNH is local barometric air pressure.

¹⁰ ACMS is an abbreviation for aircraft condition monitoring system.

¹¹ The DAR is the airline configurable data from the flight data interface and management unit (FDIMU) output to a memory card.

alarms, control movements, switch activations, engine noise and airflow noise. The CVR installed in A6-ERG was required to retain the last 2 hours of audio information.

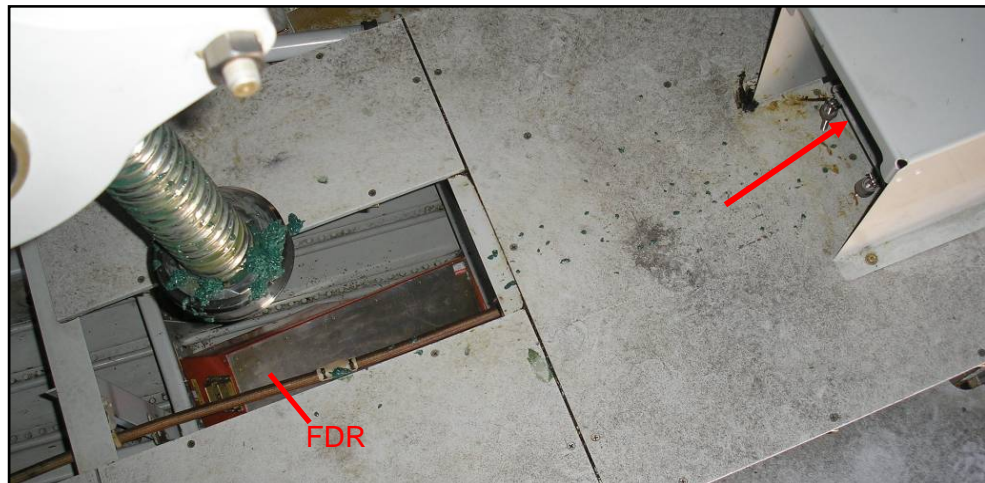
DAR system

The DAR recorded flight data on a PC card as part of the aircraft's flight data interface and management unit (FDIMU). The DAR retained several days of aircraft flight data.

Flight recorder retrieval

The examination and retrieval of the flight recorders was undertaken under Australian Transport Safety Bureau (ATSB) supervision on 21 March 2009. The FDR had separated from its mounting rack and was located in a small compartment directly to the rear of the mounting rack and adjacent to the tail lower skin.

Figure 13: Location of FDR as found with FDR mounting rack in view (arrowed)



The FDR mounting rack displayed evidence of deformation with part of one securing nut found to have also separated from the rack.

The CVR and PC-Card were in their correct locations and undamaged. The aircraft operator and manufacturer were provided with a copy of the recorded DAR data for use in their own analysis.

Flight recorder download

FDR

The FDR was found to contain 27 hours of flight data, which comprised four previous flights and the start of the accident flight. The accident flight data commenced at 2156 (1056:00 UTC) but ended as the aircraft passed over the threshold at the southern end of runway 16 during the tail strike.

CVR

The CVR was found to contain 125 minutes of good quality audio data. The audio included the entire accident flight and commenced while the flight crew were carrying out their pre-flight checks with the aircraft at the gate.

DAR

The DAR PC-card was found to contain flight data from three previous flights and the entire accident flight. The DAR parameters and FDR data compared favourably up to the point of FDR data stoppage. The DAR flight data was consequently used in the preparation of a sequence of events for the accident flight. A graphical representation of the DAR data during the takeoff is presented in Appendix A.

Key event snapshots of the take-off roll are shown at Appendix B.

Sequence of events

Table 2 provides a sequence of events prepared from data from the flight recorders. Times are based on UTC. Local time is UTC plus 11 hours.

Table 2: A6-ERG accident flight sequence of events

Time (UTC) (hh:mm:ss)	Event Description	Distance from RWY 16 end (m) ¹² (Note runway length = 3657m)
10:53:14	Start of CVR recording.	N/A
10:56:00	Start of FDR recording	N/A
11:18:28	Push back from gate.	N/A
11:19:31	Engines started.	N/A
11:21:20	Start of DAR recording.	N/A
11:30:48	Aircraft lined up on runway 16.	3540
11:30:49	Brakes released.	3537
11:30:51	Ground speed begins to increase.	3536
11:30:55	Thrust levers set to FLX/MCT thrust lever detent, engine pressure ratio (EPR) = 1.14.	3529

¹² Calculated from groundspeed recorded on DAR.

Time (UTC) (hh:mm:ss)	Event Description	Distance from RWY 16 end (m) ¹² (Note runway length = 3657m)
11:31:31	Aircraft computed airspeed (CAS) = 100 knots. Groundspeed (GS) = 104 knots.	2474
11:31:52	Aircraft CAS 143 knots corresponding to V1 GS = 149 knots.	1118
11:31:54	First officer commences nose-up pitch command on sidestick. CAS = 147 knots. GS = 152 knots.	964
11:31:55	Aircraft started to rotate. CAS 152 knots, GS = 158 knots. FO pitch command = -16 degrees.	886
11:31:57	Nose gear uncompressed.	727
11:32:03	<i>Initial tail contact with runway, pitch angle = 9.8°, right and left main gear still compressed¹³. CAS = 156 knots GS 167= knots</i> Captain commanded TOGA	229
11:32:05	Thrust levers moved to the TOGA detent, aircraft passes end of runway 16. TRA = 85 degrees. CAS = 157 knots, GS = 169 knots, FDR recording ends.	0
11:32:07	Pitch increased to 13.7 degrees. Right and left main gear uncompressed. CAS = 161 knots, GS = 172 knots.	-115
11:32:09	Positive rate of climb established.	-292
11:32:46	Landing gear retracted.	N/A
11:35:45	Aircraft reached 5,000 feet.	N/A
11:40:18	Aircraft reached 7,000 feet.	N/A
11:46:19	PAN call to ATC made.	N/A
11:49:35	Fuel dump commenced	N/A
12:25:35	Fuel dump completed	N/A
12:26:11	Descent clearance given	N/A
12:27:47	First officer requested immediate approach due to report of smoke in cabin.	N/A
12:36:29	Touchdown at Melbourne airport on runway 34.	N/A

¹³ 9.5° is the geometry limit for the A340-500 with landing gear fully compressed.

Other information

Aircraft performance calculation

The operator utilised the Airbus Less Paper Cockpit (LPC) system. The LPC system replaced the majority of the aircraft's operating documentation with a laptop computer-based system. The aircraft carried two laptops containing the LPC system. One was used during operation; the second was used as a backup in case of the failure of one laptop.

The LPC system contained a section for calculating take-off performance. The take-off performance calculation required input of various parameters, including the take-off weight, environmental parameters (temperature, air pressure, and wind), the runway being used and the status of aircraft systems that affect performance. Information regarding the runway (for example the length), contained in a database in the LPC system, was obtained by selecting the appropriate airport and runway. The computer then calculated the take-off reference speeds, aircraft configuration and Flex¹⁴ temperature.

The results of the take-off performance calculation were then manually entered into the aircraft's flight management and guidance computer.

¹⁴ Flex, for flexible take-off thrust, used for reduced power take-off.

ONGOING INVESTIGATION ACTIVITIES

The investigation is ongoing and will include examination of:

- human performance and organisational risk controls, including:
 - data entry
 - a review of similar accidents and incidents
 - organisational risk controls
 - systems and processes relating to performance calculations
- computer-based flight performance planning, including:
 - the effectiveness of the human interface of computer based planning tools.
- reduced power takeoffs, including:
 - the risks associated with reduced power takeoffs and how they are managed
 - crew ability to reconcile aircraft performance with required takeoff performance, and the associated decision making of the flight crew
 - preventative methods, especially technological advancements.

SAFETY ACTION

Aircraft operator

On 17 April 2009, the aircraft operator informed the Australian Transport Safety Bureau that based on their internal investigation the following areas were under review:

- human factors – including review of current pre-departure, runway performance calculation and cross-check procedures; to determine if additional enhancement is feasible and desirable, with particular regard to error tolerance and human factors issues.
- training – including review of the initial and recurrent training in relation to mixed fleet flying and human factors.
- fleet technical and procedures – including introduction of a performance calculation and verification system which will protect against single data source entry error by allowing at least two independent calculations.
- hardware and software technology – including liaising with technology providers regarding systems for detecting abnormal take-off performance.

APPENDIX A: GRAPHICAL REPRESENTATION OF FLIGHT DATA

Figure A1: Selected DAR parameters for entire take-off roll

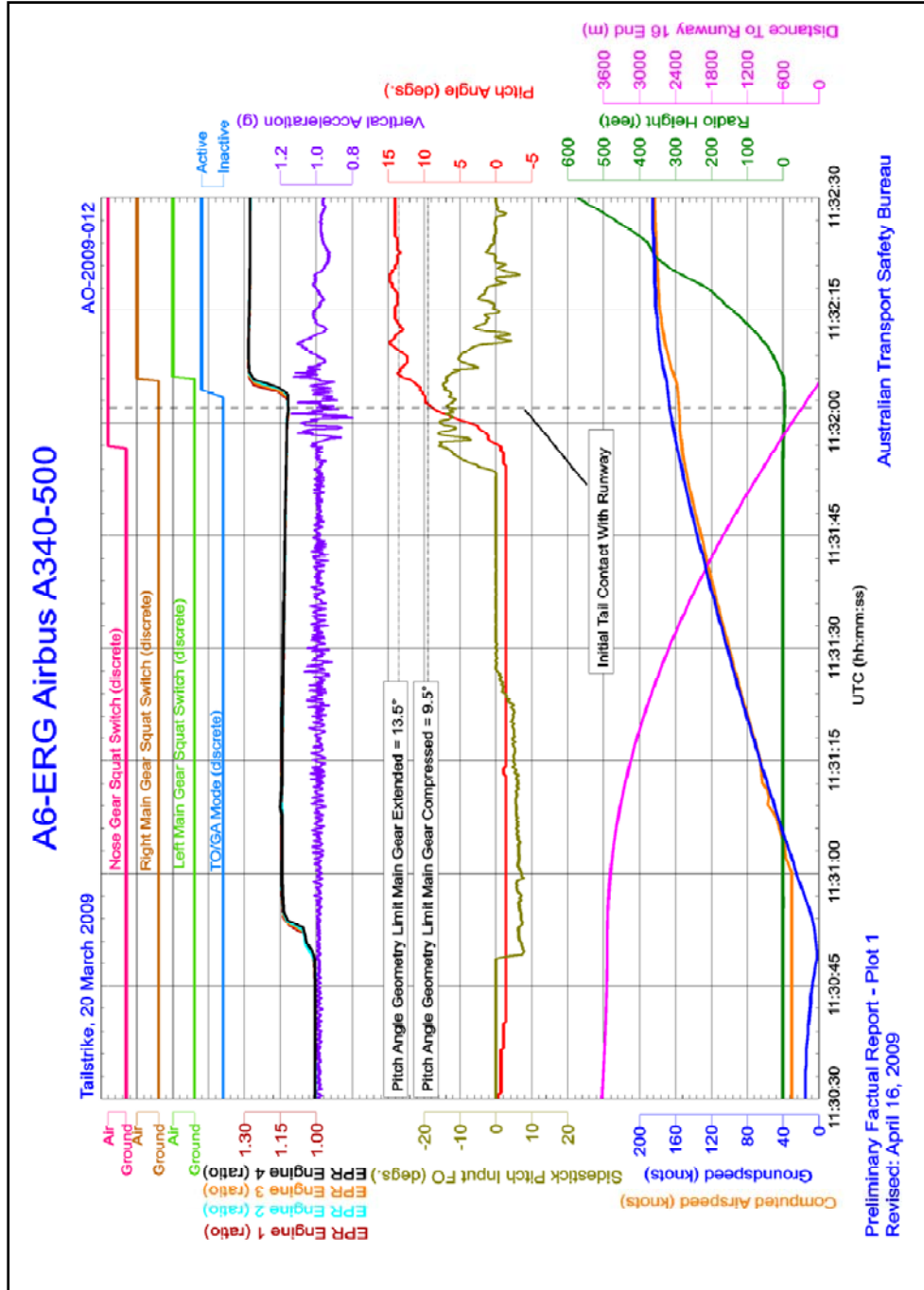
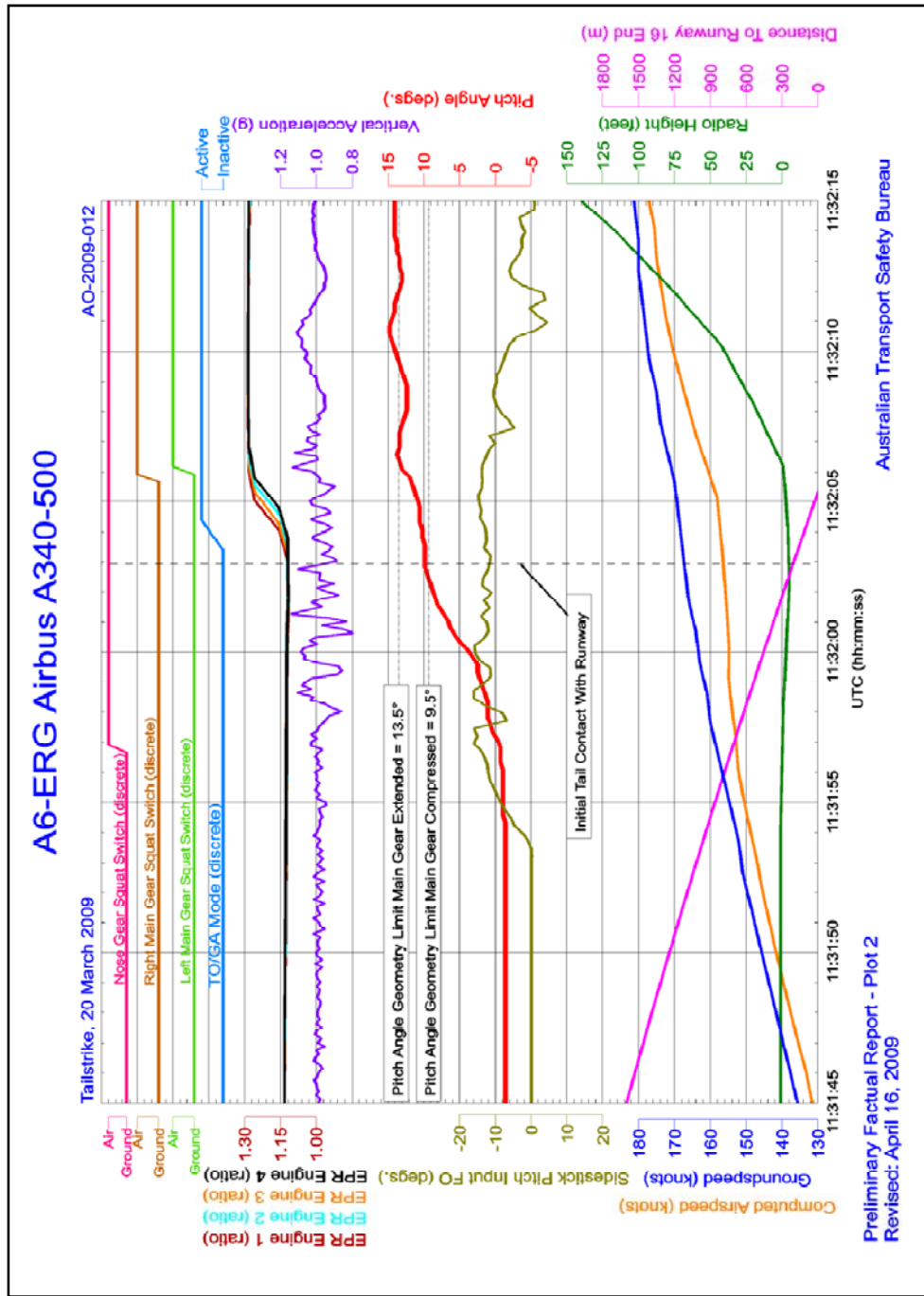


Figure A2: Selected DAR parameters for 30 seconds surrounding take-off



APPENDIX B: KEY EVENT SNAPSHOTS

Figure B1: Aircraft attains computed airspeed of 143 knots corresponding to the V1 used by the crew during the take-off

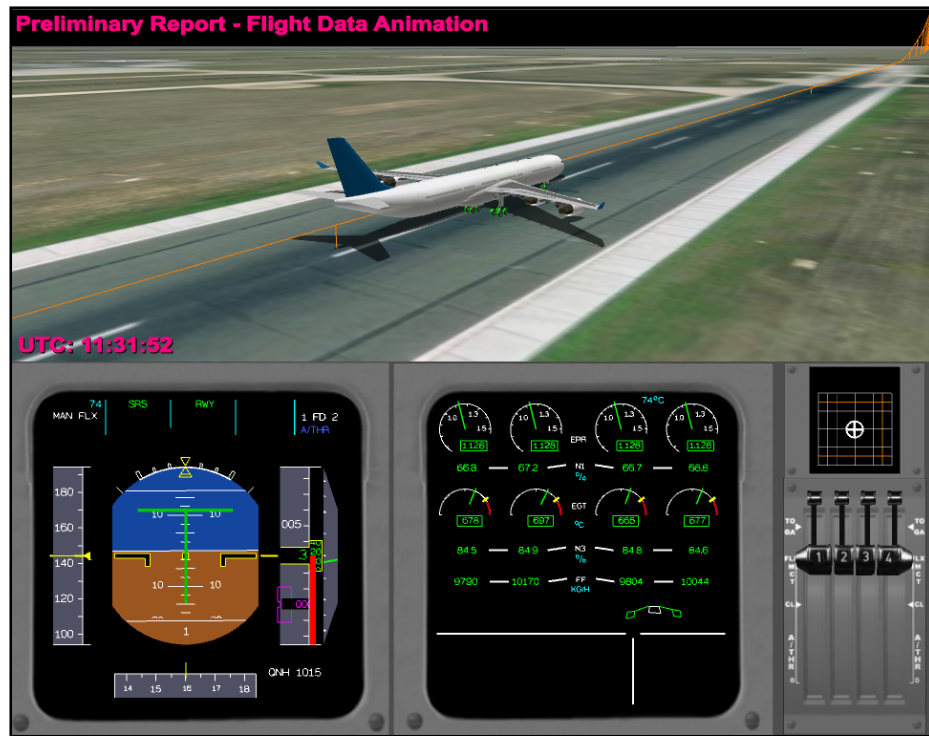


Figure B2: Initial tail contact with runway



Figure B3: Final tail ground contact witness mark

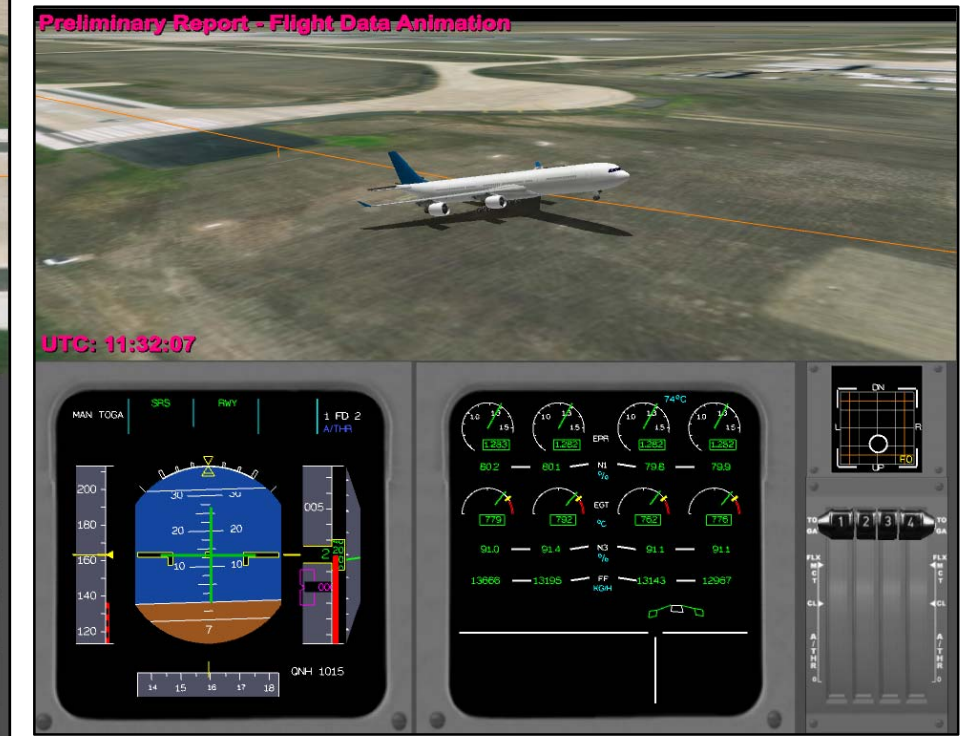
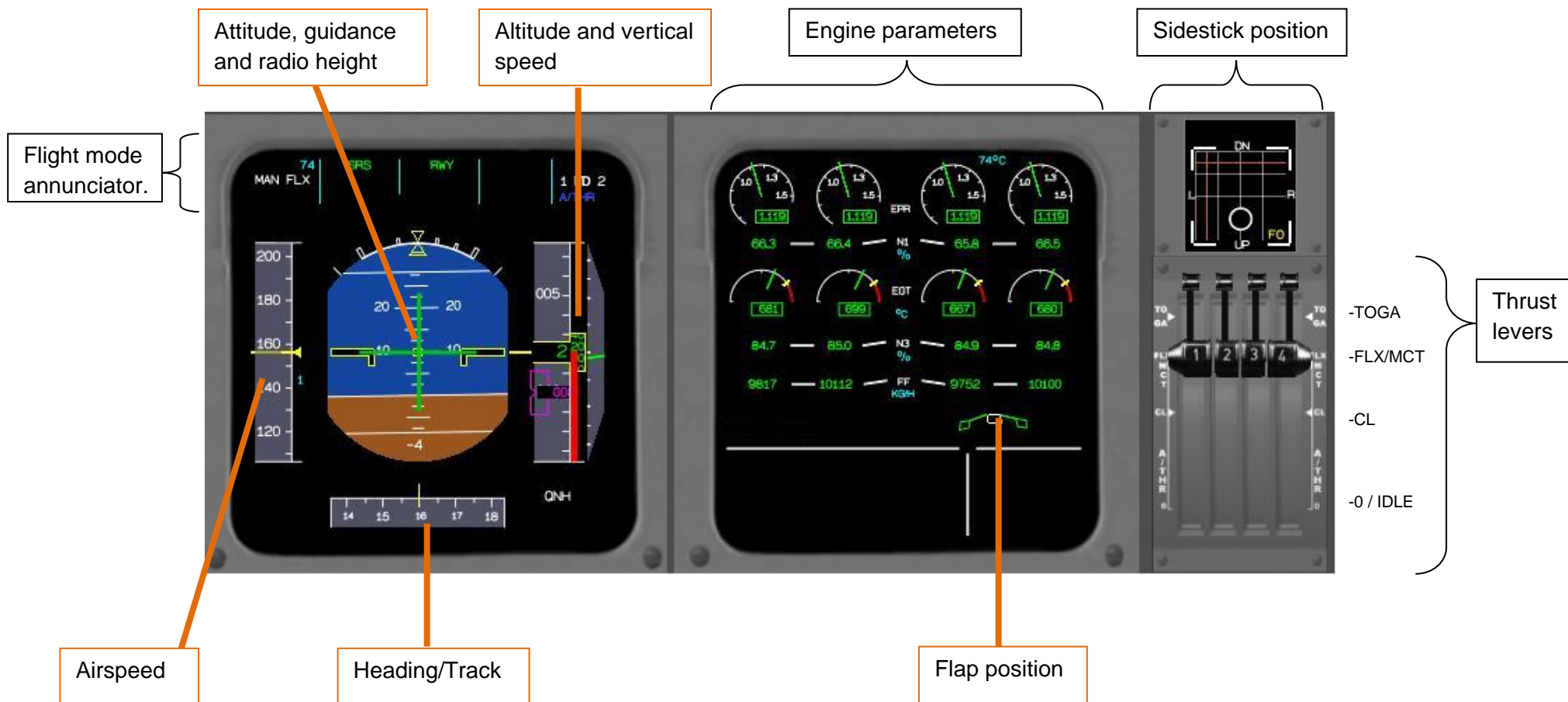


Figure B4: Graphical representation of DAR data showing position of aircraft at a computed airspeed corresponding to V1 used by the crew, initial tail contact with ground, and final tail ground contact witness mark.

Figure B5: Diagram depicting parameters displayed on Figures B1 – B3



APPENDIX C: MEDIA RELEASE

Tail Strike Melbourne Airport 20 March 2009, Airbus A340-500 aircraft, registered A6-ERG.

Today the Australian Transport Safety Bureau (ATSB) is releasing its Preliminary Factual report into the tail strike involving Airbus A340-500, A6-ERG, during takeoff at Melbourne Airport at approximately 10:31 PM on the evening of 20 March 2009. The aircraft was being operated on a scheduled passenger flight from Melbourne to Dubai in the United Arab Emirates.

It is important to note that the information contained in the preliminary factual report, as the name suggests, is limited to preliminary factual information that has been established in the initial investigation of the accident. Caution should be exercised as there is the possibility that new evidence may become available that alters the circumstances as depicted in the report. Analysis of the factual information and findings as to the factors that contributed to the accident are subject to ongoing work and will be included in the final report.

The ATSB investigation, assisted by a number of other organisations and agencies, including the United Arab Emirates General Civil Aviation Authority (GCAA), the French Bureau d'Enquetes et d'Analyses (BEA), Emirates and Airbus, has determined that during the take-off roll on runway 16, the captain called for the first officer to rotate (lift off). However, when the aircraft was slow to respond, the captain commanded and applied maximum take-off thrust (TOGA). The aircraft's tail struck the runway and the aircraft lifted off shortly afterwards. During the take-off, the aircraft's tail contacted the ground beyond the end of the runway and a number of airport landing aids came into contact with the aircraft.

After becoming airborne, the flight crew received a cockpit message that a tail strike had occurred and so they contacted Air Traffic Control (ATC) and requested a return to Melbourne. The aircraft was radar vectored by ATC over Port Philip Bay to dump fuel to reduce the aircraft's weight for landing. While reviewing the aircraft's performance documentation in preparation for landing, the crew noticed that an incorrect weight had been inadvertently entered into the laptop when completing the take-off performance calculation prior to departure. The performance calculations were based on a take-off weight that was 100 tonnes below the actual take-off weight of the aircraft. The result of that incorrect take-off weight was to produce a thrust setting and take-off reference speeds that were lower than those required for the aircraft's actual weight.

During the return to land at Melbourne, a cabin crew member reported smoke in the cabin. The aircraft subsequently landed safely at 11:36 PM and was able to be taxied to the terminal where the passengers were disembarked. There were no reported injuries.

Damage to the aircraft included abraded skin to the rear, lower fuselage and damage to the rear pressure bulkhead. There was also damage to a fixed approach light, an instrument landing system (ILS) monitor antenna and the ILS localiser antenna.

The aircraft was fitted with a Flight Data Recorder (FDR), Cockpit Voice Recorder (CVR) and a Digital Aircraft Condition Monitoring System Recorder (DAR). The FDR was dislodged from its mounting in the rear of the aircraft during the tail strike and only recorded data up to that point. The CVR and DAR recorded data for the entire flight.

The investigation is continuing and will examine:

- human performance and organisational risk controls
- computer-based flight performance planning, including the effectiveness of the human interface of computer based planning tools.
- reduced power takeoffs, including the associated risks and how they are managed.

The aircraft operator has informed the ATSB that based on their internal investigation, the following areas are under review:

- human factors
- training
- fleet technical and procedures
- hardware and software technology.

The investigation is ongoing and the ATSB continues to work closely with representatives from the UAE GCAA, French BEA, Emirates and Airbus. While the investigation is likely to take some months, should any critical safety issues emerge that require urgent attention, the ATSB will immediately bring such issues to the attention of the relevant authorities who are best placed to take prompt action to address those issues.

Media Contact: 1800 020 616