FINAL REPORT

BOEING B777-200 REGISTRATION OE-LPC COLLISION WITH AN AEROBRIDGE AT SINGAPORE CHANGI AIRPORT ON 17 JANUARY 2006

AIB/AAI/CAS.031

Air Accident Investigation Bureau of Singapore
Ministry of Transport
Singapore

11 March 2009

The Air Accident Investigation Bureau of Singapore

The Air Accident Investigation Bureau (AAIB) is the air accidents and incidents investigation authority in Singapore responsible to the Ministry of Transport. Its mission is to promote aviation safety through the conduct of independent and objective investigations into air accidents and incidents.

The AAIB conducts the investigations in accordance with the Singapore Air Navigation (Investigation of Accidents and Incidents) Order 2003 and Annex 13 to the Convention on International Civil Aviation, which governs how member States of the International Civil Aviation Organization (ICAO) conduct aircraft accident investigations internationally.

In carrying out the investigations, the AAIB will adhere to ICAO's stated objective, which is as follows:

> "The sole objective of the investigation of an accident or incident shall be the prevention of accidents and incidents. It is not the purpose of this activity to apportion blame or liability."

Synopsis

On 17 January 2006 at 2315 hours local time, a Boeing 777-200 landed at Singapore Changi Airport from Melbourne, Australia. While parking at gate F58, the aircraft taxied beyond the designated stop line and its left hand engine cowling collided with the aerobridge. The aerobridge's automatic level sensor and the aircraft's left hand engine cowling were damaged as a result.

The occurrence was classified as an incident by the Air Accident Investigation Bureau of Singapore.

CONTENTS

1 FACTUAL INFORMATION

All times used in this report is Singapore time. Singapore time is eight hours ahead of Coordinated Universal Time (UTC).

1.1 History of Flight

1.1.1 On 17 January 2006, a Boeing 777-200 departed Melbourne, Australia for Singapore enroute to Austria. The flight to Singapore was uneventful up to the time of parking at bay F58 at Terminal 2 of Singapore Changi Airport.

1.1.2 This was the first time the flight crew of the aircraft was assigned a parking bay in this part of Terminal 2 where the Aircraft Docking and Guidance System (ADGS) used was Robert Louis Gaugenmaier (RLG) Type B, which had one pair of amber lights. The crew used to dock in another part of Terminal 2 where the ADGS used was RLG Type C, which was a newer type and had three pairs of amber lights. Information concerning the types of ADGS used at Terminal 2 was not available on board the aircraft.

1.1.3 The Pilot-in-command (PIC) performed the Pilot Flying (PF) duties and taxied the aircraft to park at bay F58. When the aircraft turned into bay F58 the PF used the airport's ADGS to park the aircraft.

1.1.4 During the interview with the investigators, the flight crew described what they were doing as the aircraft taxied into Bay F58. The actions of the flight crew appear to be consistent with normal operating procedures. The flight crew stated they were cognizant of the safety issues such as obstacles in the apron area and both flight crew's attention were focused on the task at hand.

1.1.5 The PF's taxi technique consisted of entering the aircraft bay at about 5 knots and applying the aircraft brakes gradually to slow the aircraft to about 1 knot by the time the ADGS amber lights illuminated.

1.1.6 The PF could not recall whether the ADGS' green lights were on when he turned into bay F58. Just prior to the amber indication on the ADGS the PF started commenting to the PNF that something was incorrect and that he was not happy with the indications. As he made the comments the PF observed that the lights turned to amber and then quickly to red. He applied full brakes when the lights turned red. The red lights then flickered and went off.

1.1.7 When approaching bay F58, the PNF remembered seeing the single pair of amber lights but was expecting three pairs of amber lights before a pair of red lights. To monitor the aircraft's approach into the bay, the PNF looked out the front and to the right-hand side. When he was looking out the right-hand window, he heard the PF's

comment on the operation of the ADGS indications and he looked back at the ADGS and saw the red lights flickering before they went off.

1.1.8 The parking bay was manned by two ground personnel. One was the ADGS operator. The other was an assistant whose duty was to assist the ADGS operator by indicating to him with hands signals the progress of the docking aircraft, and to insert the chocks when the aircraft had stopped. Both persons opined that the aircraft was taxiing in at a higher than normal taxi speed. However, the aircraft's speed as recorded by the aircraft's Quick Access Recorder was 5 knots during the turn into the bay.

1.1.9 The ADGS operator stated that he operated the ADGS in the Manual mode, which was the normal mode. He said he rotated the switch to the amber detent when the aircraft was about 6m from the stop line. Upon noticing that the aircraft was apparently not slowing down, he turned the switch to Red when the aircraft was 3m from the stop line. As the aircraft was apparently still not slowing down, he released the deadman's switch to initiate an emergency stop.

1.1.10 The aircraft came to a stop 6m beyond the stop line with its left engine in contact with one of the aerobridges connected to gate F58. The ADGS operator then approached the aircraft and plugged in the headset. He then used the interphone to call the cockpit and inform the flight crew that the left engine had contacted the aerobridge.

1.2 Injuries to Persons

There were no injuries in this incident.

1.3 Damage to Aircraft

1.3.1 The left engine cowl suffered a puncture at the one o'clock position from making contact with the aerobridge (Figures 1 and 2).

Figure 1. Left engine cowling damage location at 1 o'clock position

Figure 2. Damage to left engine cowling (close-up view)

1.4 Other Damage

1.4.1 The aerobridge's automatic level sensor was damaged (Figure 3).

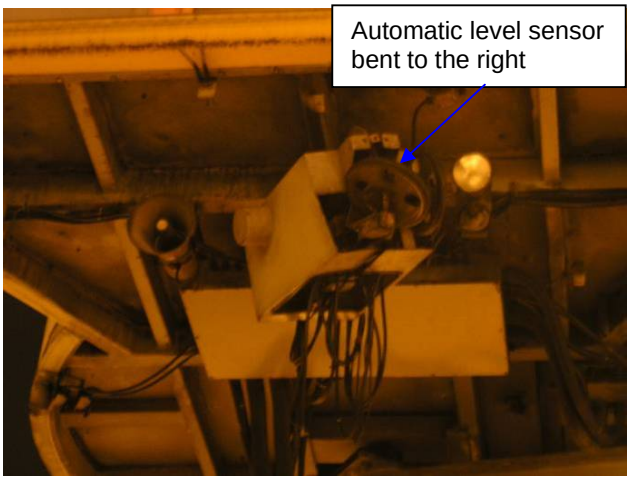

Figure 3. Damage to aerobridge automatic level sensor

1.5 Personnel Information

1.5.1 Pilot-in-command

Age	:	58 years (Male)
Licence	:	Airline Transport Pilot's Licence, issued by Austro Control Gmbh of the Republic of Austria
Aircraft rating	:	B777
Licence expiry date	:	26 March 2006
Total flying experience	:	19,012 hours
Flying experience on type	:	4,576 hours
Last Base Check date	:	11 August 2005
Last Instrument rating date	:	11 August 2005
Last medical check	:	8 September 2005
Medical certificate expiry	:	26 March 2006
Flight time (Prior 24 hrs)	:	7.45 hrs
Flight time (Last 30 days)	:	26 hrs
Flight time (Last 90 days)	:	131 hrs

1.5.2 Co-pilot

Age	:	28 years (Male)
Licence	:	Airline Transport Pilot's Licence, issued by Austro Control Gmbh of the Republic of Austria
Aircraft rating	:	B777
Licence expiry date	:	4 July 2006
Total flying experience	:	4,592 hours
Flying experience on type	:	546 hours
Last base check date	:	6 November 2005
Last instrument rating date	:	6 November 2005
Last medical check	:	8 November 2005
Medical certificate expiry	:	4 July 2006
Flight time (Prior 24 hrs)	:	7.45 hrs
Flight time (Last 30 days)	:	84 hrs
Flight time (Last 90 days)	:	193 hrs

1.6 Aircraft Information

Aircraft Type	:	Boeing 777-200
Aircraft Serial Number	:	29313
Registration	:	OE-LPC
Number and Type of Engines	:	Two GE 90

1.7 Aids to Navigation

1.7.1 Not applicable.

1.8 Communications

1.8.1 Communications between ATC and the flight crew were normal.

1.8.2 Communications between the ground crew and flight crew over the aircraft's interphone system after the aircraft had stopped were normal.

Note: There is no means to communicate verbally until the aircraft has stopped and the headset is connected to the aircraft.

1.9 Aerodrome Information

1.9.1 At the time of the incident, Singapore Changi Airport had two passenger terminals, Terminal 1 and Terminal 2. One of three types of ADGS was installed at each parking bay to assist in the docking of aircraft. Terminal 1 used a laser-based automatic ADGS, whereas Terminal 2 used one of two types of manually operated ADGS. These two types of manually operated ADGS were installed in Terminal 2 at different times.

1.9.2 The ADGS in Terminal 1 was upgraded to the laser-based system in September 2004. The laser-based system could recognise the type of aircraft that is docking and measure the closure rate of the gap between the aircraft and the stop line. At the time of the incident, Changi Airport was in the process of upgrading the two ADGS in Terminal 2 to a similar laser system. The Terminal 1 ADGS consists of a lead-in line azimuth indicator, a digital count down of the distance from the stop line, and a closing rate field (Figure 4). The lead-in line azimuth indicator will display arrows to the left or right of the lead-in line to guide the aircraft back to the centre line. The closing rate field is a bar that decreases in length as the aircraft approaches the stop line, the digital count down also provides information to the flight crew as to the distance remaining to the stop line. When the aircraft reaches the stop line the digital count down is change to a 'stop' indication and the closing rate field will disappear.

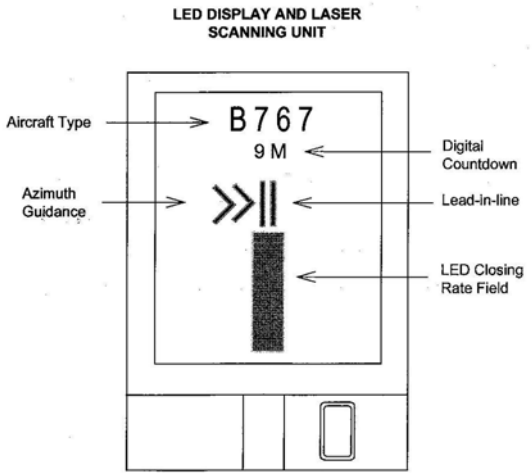

Figure 4. T1 ADGS indications

1.9.2 The manual types of ADGS used in Terminal 2 were Robert Louis Gaugenmaier (RLG) Type B (Figure 5a) and RLG Type C (Figure 5b). RLG Type B had one pair each of green, amber and red lights. RLG Type C was similar to Type B except that it had three pairs of amber lights instead of just one. Correspondingly, on Type B's console panel, the rotary knob used to select the lights had one amber light detent whereas on Type C's control panel, the rotary knob had three amber detents (for selecting one, two or three pairs of amber lights).

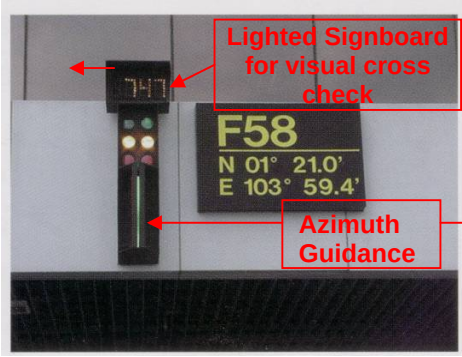

Figure 5a. RLG Type B

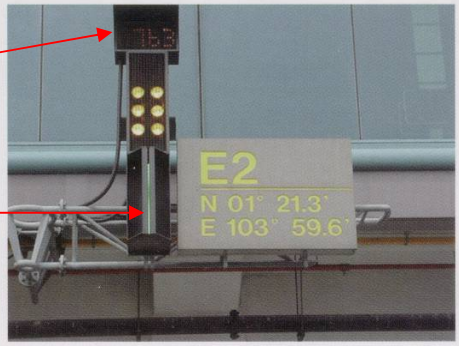

Figure 5b. RLG Type C

1.9.3 Azimuth guidance for both types of RLG was provided by three vertical light bars. The centre light was green in colour indicating the aircraft is centred. Two red light bars located either side of the green centre light bar would indicate on which side the aircraft was off centre and the pilot would have to steer the aircraft accordingly. The azimuth guidance indicator was calibrated for the left hand seat pilot's view. As such, the azimuth guidance information could only be of use to the left hand seat pilot.

1.9.4 The console panels of all the RLG ADGS installed in Terminal 2 contained a toggle switch for manual or auto selection. However,

the RLG ADGS was to be operated in the manual mode only and this toggle switch must be kept in the manual position[1].

1.9.5 In the manual mode, the operator had to judge the speed and closure rate of the aircraft with reference to ground markings. The operator had to manually turn the rotary knob to the corresponding detent to change the colour of the ADGS lights. (Figure 6).

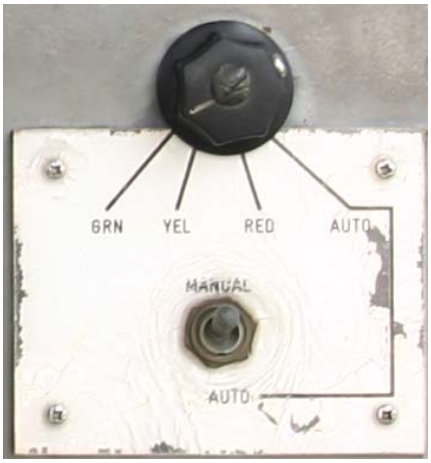

Figure 6. Type B rotary knob

1.9.6 All three types of ADGS required the operator to manually enter the aircraft type into the control panel. The aircraft type information would be displayed on the lighted sign board above the azimuth indications. The pilots of a docking aircraft would be able to see the aircraft type information and verify its correctness. The laser-based ADGS in Terminal 1 used buttons to select the aircraft type, whereas the RLG ADGS in Terminal 2 used a rotary knob to select the aircraft type (Figure 7).

Figure 7. RLG types B and C aircraft type selector knob

[1] The ADGS system involved the use of electromagnetic sensors which were embedded in the ground and which detected the movement of the wheels of taxiing aircraft. Technology advances had resulted in aircraft using wheels with newer alloys and which could not be detected by the sensors, and the auto mode would not be reliable and its use was stopped.

1.9.7 All three types of ADGS were equipped with a deadman's switch. In order for the ADGS to work and provide guidance instructions the ADGS operator had to keep the deadman's switch depressed at all times. If the deadman's switch was released the ADGS would give an emergency stop indication to the flight crew.

1.9.8 The normal stop indication was a steady red light which was turned on when the aircraft had reached the correct parking position. The emergency stop indication was identical to the normal stop indication.

1.9.9 Bay F58 was equipped with a RLG Type B ADGS. The ADGS console panel at F58 is shown below (Figure 8).

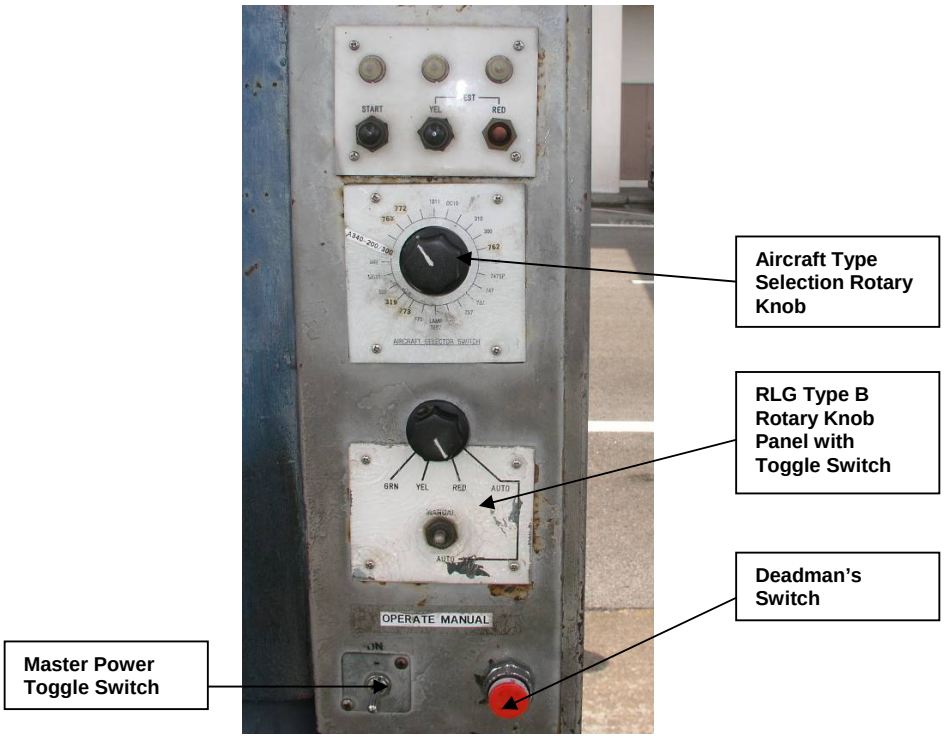

Figure 8. Bay F58 ADGS control panel

1.9.10 To ensure that the ADGS was kept in the manual position, an "Operate Manual" warning label was placed close to the toggle switch. The investigation team noted that at a number of bays, some of the "Operate Manual" labels as well as some other labels on the toggle switch section of the control panels were missing or partially painted over (Figures 9, 10 and 11).

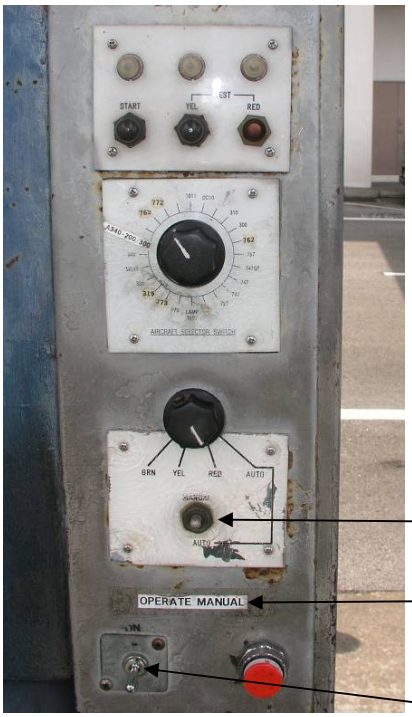

Figure 9. Bay F58 ADGS control panel

Figure 10. Bay F54 ADGS control panel

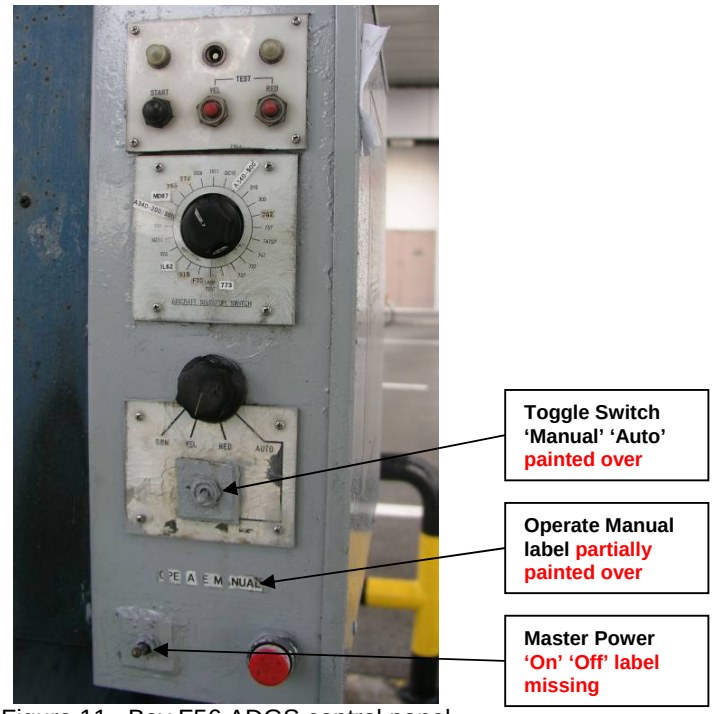

Figure 11. Bay F56 ADGS control panel

1.9.11 The Singapore Aeronautical Information Publication (AIP) contained information as to the type of ADGS available at each parking bay and the light indications provided by the ADGS at each bay.

1.10 Flight Recorders

1.10.1 The aircraft was equipped with the following recorders:

Honeywell Solid State CVR
Part number: 980-6022-001
Serial number: 0751

Honeywell Solid State FDR
Part number: 980-4700-042
Serial Number: 08410

1.10.2 The Flight Data Recorder (FDR) and Cockpit Voice Recorder (CVR) were removed for investigation by the AAIB.

1.10.3 The CVR was successfully read out. The CVR had a good quality recording.

1.10.4 The operator was unable to provide the investigation team with the parameter allocation and conversion documentation for the FDR.

Note: The parameter allocation and conversion file is a document that describes the parameter allocation as well as equations for converting raw data to engineering data. ICAO Annex 6 Attachment A "Flight Recorders (Supplement to 6.10)" states:

> 1.3.3 *Documentation concerning parameter allocation, conversion equations, periodic calibration and other serviceability/maintenance information should be maintained by the operator. The documentation must be sufficient to ensure that accident investigation authorities have the necessary information to read out the data in engineering units.*

1.10.5 The FDR was sent back to Austria and was successfully downloaded and read out with the assistance of the Accident Investigation Branch of the Austrian Federal Office of Transport. The FDR data was also read out successfully in Singapore after AAIB Singapore set up its recorder readout facility.

1.10.6 The operator was able to provide data from the aircraft's Quick Access Recorder (QAR).

1.11 Medical and Pathological Information

1.11.1 The flight crew were brought to the medical centre at the airport for medical examinations. The examination results were all normal.

1.12 Tests and Research

1.12.1 On the night of the incident, while the flight crew were still on board the aircraft the investigation team attempted to replicate the observations of the crew in the cockpit of the aircraft by having the ground personnel operate manually the ADGS control switches. After trying various combinations of the ADGS rotary and deadman's switch, the indications as observed by the flight crew could not be replicated. The flight crew stated that the intensity of the lights during the attempted replication exercise appeared to be much brighter than when they were taxiing in. The investigation team could not determine if the ADGS had worked properly during the aircraft's approach or if it had failed.

1.12.2 The maintenance of the ADGS was contracted out by the Changi Airport operator to a third party. The maintenance contractor conducted an ADGS test after the incident and the attempt to replicate the indications by the investigation team. No anomalies were detected.

1.13 Additional Information

1.13.1 The ADGS console at all the bays was located on the support pillar of the aerobridge at every bay. From this position the ADGS operator could only see half of the ADGS lights as the other half are obscured by the ADGS light housing. Another person had to stand in front of the ADGS indications to verify that all the lights are working before each aircraft arrival.

1.13.2 In general, the primary focus of the operator of the Terminal 2 RLG ADGS was on the aircraft during the taxi in. At the same time he had to pay attention to the ADGS light indications as well as to his assistant, who would indicate to him via hand signal the progress of the docking aircraft. The ADGS operator looked at the ADGS lights to confirm a correct indication when he manually operated the switch. When the ADGS operator was standing in front of the control panel he was facing the terminal building. The approaching aircraft was at his back and his assistant stood abeam the aircraft stopping point within view of the ADGS operator. The ADGS operator and his assistant were required to judge the closure rate of the aircraft to the stop line painted on the ground. In order for the ADGS operator to provide guidance and indications to the parking aircraft he has to turn his body more than 90 degrees to have the aircraft in view. He has to move his head and body alternately to look at the ADGS lights, his assistant, and the aircraft.

2 Analysis

The analysis covered the following areas:

- Crew resource management
- Ramp operations
- Flight recorder read-out

2.1 Crew resource management

2.1.1 In the past the flight crew were assigned bays in another part of the airport where the ADGS had three pairs of amber lights. Thus, they were apparently surprised when they saw only one pair of amber lights at bay F58. Charts that describe the different ADGS systems at Changi airport were not provided onboard the aircraft. Had the charts been available, there was a chance that the crew would consult them and become aware that there was be only one pair of amber lights at bay F58.

2.1.2 The ADGS operator and his assistant perceived the aircraft as taxiing in at a higher than normal speed. The ADGS operator stated that he operated the ADGS based on the closure rate of the aircraft to the stop line. Data from the FDR and QAR showed the aircraft ground speed as 5 knots during the turn into the bay and gradual deceleration to a full stop. The speed at the time of the collision was estimated from the data to be below 1 knot. These speed data are consistent with the PIC's description of his docking technique.

2.2 Ramp operations

2.2.1 The position of the RLG Type B and Type C ADGS control panel was not conducive to the ADGS operator's task of monitoring the aircraft's taxi in and of ensuring that the correct indications were displayed on the ADGS. This was because the operator had to turn his body more than 90° to look at the aircraft and only half of the pairs of lights could be observed from the position of the ADGS control panel.

2.3 Flight recorder read-out

2.3.1 The investigation team was able to download the FDR data. The team needed information on flight recorder parameter allocation and conversion formula to interpret the FDR data. However, the operator was not able to provide the relevant documentation. This is not in line with ICAO standards and recommended practices. It is necessary for operators to compile and maintain the FDR

documentation for parameter allocation and conversion for their fleet of aircraft so that the information can be provided to investigation authorities when needed.

3 Findings

3.1 The aircraft was not travelling at excessive speed during the taxi into the parking bay.

3.2 The PF did not stop the aircraft before it made contact with the aerobridge as he was following the indications provided by the Aircraft Docking and Guidance System (ADGS).

3.3 The ADGS light indications described by the crew could not be replicated and a check of the ADGS shortly after the incident showed no anomalies.

3.4 The flight crew were not provided with the ADGS charts onboard the aircraft which would have provided useful information on the different types of ADGS.

3.5 The placement of the control panel of the ADGS at bays in Terminal 2 was not conducive to the ADGS operator's monitoring of aircraft's docking.

4 Safety Recommendations

4.1 The operator should provide charts to its flight crew that contain information on the ADGS systems used at the airports they operate into. [AAIB Recommendation R-2009-004]

4.2 The operator should compile and maintain the necessary FDR documentation for parameter allocation and conversion for their fleet of aircraft so that the information can be provided to investigation authorities quickly when needed.
[AAIB Recommendation R-2009-005]

5 Safety Action

5.1 The airport operator has changed the Aircraft Docking and Guidance Systems (ADGS) at all the bays in Terminal 2 to a laser-based system similar to the one used in Terminal 1. The ADGS control panels have been standardised for all parking bays at Terminal 2. However, the position of the ADGS console remains the same (i.e. facing the terminal building). Nevertheless, the ADGS operators' workload is reduced. The operators' attention is predominantly on watching the aircraft as it taxies into the bay.