FINAL REPORT

BOEING B777-200, REGISTRATION 9V-SRP
CARGO CONTAINER INGESTION

19 DECEMBER 2013

AIB/AAI/CAS.100

Air Accident Investigation Bureau of Singapore
Ministry of Transport
Singapore

30 July 2015

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."*

Accordingly, it is inappropriate that AAIB Reports should be used to assign fault or blame or determine liability, since neither the safety investigation nor the reporting process has been undertaken for that purpose.

CONTENTS

GLOSSARY OF ABBREVIATIONS

ADGS	:	Aircraft Docking Guidance System
BT	:	Baggage Trailer
CCTV	:	Closed Circuit Television
CT	:	Certifying Technician
EO	:	Equipment Operator
ERA	:	Equipment Restraint Area
ESA	:	Equipment Staging Area
ETA	:	Estimated Time of Arrival
GSP	:	Ground Service Provider
LT	:	Lead Technician
PIC	:	Pilot-in-Command
PLB	:	Passenger Loading Bridge
SFO	:	Senior Flying Officer
SOP	:	Standard Operating Procedure

SYNOPSIS

At about 1645 hours on 19 December 2013, a Boeing B777-200 aircraft ingested an empty cargo container into its left engine while docking at Bay F37 at Changi Airport after arrival from Mumbai. The engine sustained serious damage and had to be replaced. There was no injury to any person.

The cargo container and two baggage trailers had been left in the equipment restraint area of bay F37 by an equipment operator who was preparing to service an arriving aircraft at the adjacent bay F42.

The Air Accident investigation Bureau of Singapore classified this occurrence as a serious incident.

AIRCRAFT DETAILS

Aircraft type :	Boeing 777-200
Operator :	Singapore Airlines
Registration :	9V-SRP
Number and type of engines :	2 x Rolls-Royce Trent 884
Type of flight :	Scheduled passenger flight

1 FACTUAL INFORMATION

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

Appendix A shows the various operational areas/zones in a typical aircraft parking bay.

1.1 Nature of the occurrence

1.1.1 On 19 December 2013 at about 1645 hours, the Boeing B777 aircraft (registration 9V-SRP) ingested an empty cargo container (which was sitting on a dolly[1]) into its left engine while docking at bay F37 at Changi Airport after arrival from Mumbai (see **Figure 1**). The engine sustained serious damage and had to be replaced. There was no injury to any person.

Figure 1: Empty dolly and surroundings after the incident

1.1.2 At the time of the occurrence, the cargo container and two baggage trailers (BTs) were left in the equipment restraint area (ERA)[2] of F37, just outside the red hatch lines of the passenger loading bridge (PLB) safety zone.

1.1.3 **Figure 2** shows a layout of F37. The bay's equipment staging area (ESA) is to the right of the docking aircraft. F37 is a bay at the far end of the Southeast Pier of Terminal 2 of the Changi Airport. The apron configuration is such that the ESA of the adjacent bay F42 is very close to the ERA of F37.

[1] Dollies are used to move cargo containers and/or pallets to load luggage, freight, and mail on aircraft.
[2] The ERA demarcates the area to be kept clear for the safe movement of an aircraft in/out of the aircraft bay.

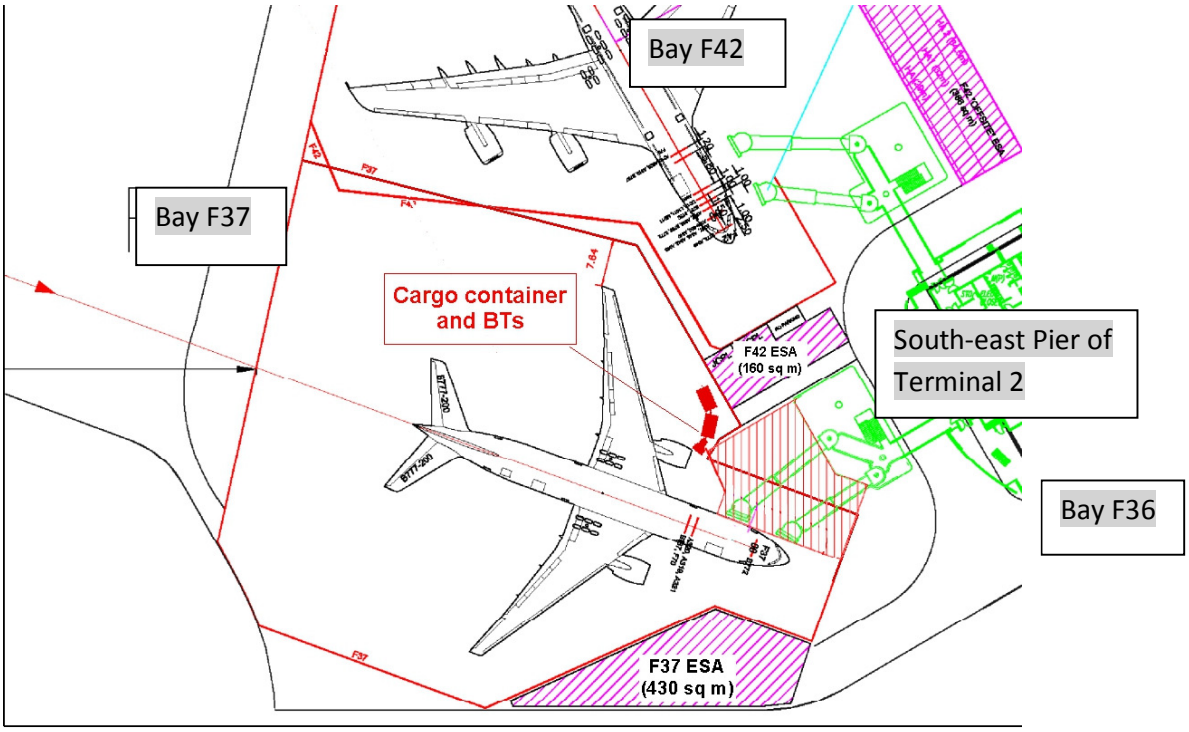

Figure 2: Layout of bay F37

1.2 Cargo container and baggage trailers

1.2.1 Below is the sequence of events leading to the cargo container and the BTs being left in the ERA:

(a) The aircraft's estimated time of arrival (ETA) was 1634 hours. At about 1610 hours, an arrival crew from the ground service provider (hereinafter referred to as GSP1) came to bay F37 to prepare for the arrival of the aircraft[3]. The arrival crew comprised a certifying technician (CT1) and a lead technician (LT), the former being the crew's leader. LT was understudying CT1 with a view to qualifying himself as a certifying technician.

(b) As part of the preparation for the aircraft's arrival, CT1 operated the operator panel of the Aircraft Docking Guidance System (ADGS) and confirmed that the ADGS was working. LT inspected the ERA to ensure that it was clear of obstructions and equipment. They completed these tasks in about 10 minutes. Thereafter, they waited below the aerobridge near the pillars for the aircraft to arrive. No

[3] The GSP1 required its arrival crew to be at the arrival bay at least 20 minutes before the ETA.

further inspection of the area was carried out as it was not required by GSP1.

(c) Another certifying technician (CT2) of GSP1, who started his shift at 1600 hours, joined the arrival crew at the bay at about 1630 hours. He was told by CT1 that the pre-arrival checks were completed and was assigned by CT1 to be the chock bearer[4].

(d) Meanwhile, on the adjacent bay F42, there was a departing A320. The bay was to receive an A330 later (ETA 1653 hours). At about 1635 hours, an equipment operator (EO) from another ground service provider (hereinafter referred to as GSP2) drove a tractor to bring in two BTs to the area. The BTs were meant for the arriving A330. EO intended to park them at the ESA of F42. But the ESA was already full, so EO decided to leave the BTs in the ERA of F37, near the edge of bay F42 ESA, and not far from but outside F37's PLB safety zone. There was an off-site ESA for F42 next to bay F41, but EO did not check if there was any space there for his equipment.

(e) EO then drove off and, two minutes later, brought in an empty cargo container on a dolly, also meant for the arriving A330. He hooked the cargo container dolly up with the BTs. The cargo container and the BTs were thus all in the ERA.

(f) EO told the investigators that his intention was to re-position them in the ESA of F42 once the A320 had departed, as some of the service and handling equipment serving the A320 would be vacated from the ESA, thus freeing up some ESA space.

(g) EO waited in the area for about 10 minutes. While waiting, he tried to fix the headlamp of the tractor which was faulty. When he could not rectify the fault and the A320 on F42 had still yet to be pushed back, he decided that he should go to the ESA next to bay F36 to re-arrange the equipment there to create space, with a view to bringing some equipment from the ESA of F42 over, so that he could position the cargo container and the BTs correctly in the ESA of F42. He left the area leaving the cargo container and the BTs behind, just as the incident aircraft was coming into F37.

(h) EO told the investigators that he was not aware that F37 was being prepared to receive an aircraft, and that he did not see or hear the aircraft arriving as he was focused on completing his own tasks.

[4] Chock bearers will place one chock near the stop line for the aircraft type concerned prior to aircraft arrival and other chocks at the aircraft wheels after the aircraft had parked.

1.3 Aircraft docking at bay F37

1.3.1 LT operated the ADGS operator panel after the aircraft was sighted. However, the ADGS display unit did not activate properly and CT1 took over the operator panel from LT[5]. In the meantime, the pilot-in-command (PIC) of the aircraft could see F37's ADGS display unit as he was approaching the bay on Taxiway C7, but noticed that the display appeared to be not working properly. When the aircraft had reached the outskirt of F37, PIC decided to stop taxiing, as there was no ADGS display to guide the aircraft. PIC asked his co-pilot, a Senior First Officer (SFO), to report the ADGS problem to air traffic control. The ADGS display returned to normal about 20 seconds later and PIC resumed taxiing into F37.

1.3.2 After about 25 seconds, the aircraft was established on the centreline of F37. At this moment, EO drove away, but without removing the cargo container and the BTs, which remained within the ERA (see paragraph 1.2.1(g)).

1.3.3 When the aircraft was established on the centreline of F37, the SFO announced "right side is clear," meaning that there were no obstructions on the right side of F37 as seen from his position in the cockpit. PIC, however, did not make any pronouncement although he told the investigators that he had done a visual sweep of the area from his position and did not notice any obstructions.

1.3.4 LT walked slowly towards the aircraft as the aircraft was coming to a stop to prepare for the chocking process. It was only then that he noticed the cargo container and the BTs. He called out to CT1 to try to get him to stop the aircraft through the ADGS, but the engine noise drowned out his voice. The cargo container was sucked into the left engine by the time the aircraft reached the stop line.

1.4 Personnel information

1.4.1 CT1 joined GSP1 in June 1998. He had been given arrival crew leader assignments since 2008. He last attended the ADGS and manual marshalling briefing in October 2012, and was not due for another refresher training until October 2014.

1.4.2 LT joined GSP1 in July 1996. At the time of the incident, LT was understudying CT1 with a view to qualifying himself as a certifying technician. He had already spent nine months undergoing certifying technician training. The training did not include any module on the ADGS,

[5] LT did not attend any formal training on ADGS and he learnt to operate the ADGS through on-the-job training (see paragraph 1.4.2). In this incident, he initially had just pressed the deadman switch and did not select the aircraft type on the operator panel. The ADGS worked only after he made the aircraft type selection.

but he learnt how to operate the ADGS during his on-the-job attachment training with CT1, which began in October 2013. He had operated the ADGS about 10 times before the ingestion incident.

1.4.3 EO joined GSP2 in March 2013. The GSP2's training records showed that EO had successfully completed the necessary equipment operator training.

1.4.4 CT2 joined the GSP1 in August 1989 as a technician. He last attended the ADGS and manual marshalling briefing in August 2013.

1.4.5 The flight crew members were licensed by the Civil Aviation Authority of Singapore.

1.5 Aircraft Docking Guidance System (ADGS)

1.5.1 The operator panel of the ADGS installed at the airport is of either the 30-key or 54-key type (see **Figure 3**). That at F37 is of the 30-key type[6].

Figure 3: 30-key (L) and 54-key (R) operator panel

1.5.2 The difference in the operating procedures between the 30-key and 54-key panel is:

(a) 30-key panel – One needs to press and hold the deadman switch and then key in the aircraft type to activate the ADGS for the pre-arrival check and for the aircraft arrival.

(b) 54-key panel – One needs to key in the aircraft type and then press and hold the deadman switch to activate the ADGS for the pre-arrival check and for the aircraft arrival. If the aircraft arrives within 30 minutes after the pre-arrival check, one need not key in the aircraft type again and just needs to press and hold the deadman switch to operate the ADGS.

[6] The aerodrome operator had been changing progressively to the 54-key type.

1.6 Research

1.6.1 The investigators wished to determine whether the flight crew of the aircraft could have been aware that the cargo container and the BTs were in the ERA. A simulated docking at F37 was carried out on 23 December 2013, using a B777 on tow on the centreline of F37 and with a cargo container and two BTs positioned at the same location as on the incident day. The investigators were on board the B777 to assess the view of the bay from the cockpit. The findings from this simulation were:

(a) The investigators could have a reasonably good view of the equipment in the bay after turning into the bay.

(b) It was not easy to judge whether the cargo container and the two BTs were in, or not in, the ERA (see **Figure 4**). However, one could infer, from the fact that the PLB safety zone could not be seen, that the cargo container and the BTs were in the ERA obscuring the PLB safety zone.

(c) Likewise, one could infer, from the fact that the wheels of the aerobridge could not be seen, that the cargo container and the BTs were in the ERA.

Figure 4: View of the cargo container and the BTs in the simulated docking

2 DISCUSSION

2.1 The ingestion incident was the result of the following:

(a) The cargo container and the BTs having been placed in the ERA of F37.

(b) The GSP1's arrival crew not continuing to survey the ERA to ensure that it remained clear of obstructions and equipment, after they had done one round of inspection.

(c) The flight crew of the aircraft not detecting that there were equipment within the ERA.

2.2 The ingestion incident would probably not have happened had the cargo container and the BTs not been in the ERA of F37 in the first place. EO left the cargo container and the BTs in the ERA, because the ESA of F42 where he actually intended to bring them to was full. In the course of the investigation, the investigators received feedback that there were several other narrow and congested bays in the airport. The information was conveyed to the aerodrome operator for evaluation as ramp congestion could give rise to safety problems. Changes were initiated by the aerodrome operator (see paragraphs 3.3 and 3.4).

2.3 The GSP1's arrival crew came to F37 about 24 minutes before the ETA of the aircraft. They inspected the ERA to ensure that it was clear of obstructions and equipment. There was still some 15 minutes when the inspection was completed and before the aircraft arrived, but the arrival crew apparently did not continue to survey the ERA until the arrival of the aircraft and did not notice that EO had parked the cargo container and the BTs in the ERA. The ingestion incident would probably not have happened had such continual surveillance been performed. This incident suggests that more still need to be done in the area of safety culture and the promotion of a proactive mindset.

2.4 After waiting in vain for the A320 to depart F42 so that he could shift the cargo container and the BTs to the ESA of F42, EO decided to drive off to the area behind F36 to try to re-arrange the equipment at the ESA there. When he drove off, across F42, he was actually not aware that F37 was to receive the incident aircraft in a moment. In the course of the investigation, the investigators were told of a number of occasions where ground personnel was not aware even as an aircraft was about to enter or leave a bay. It seems that there is a need for a system that can clearly indicate to all working in the area the operational status of a bay.

2.5 The problem with the ADGS as perceived by PIC was due to LT's inexperience in operating the ADGS operator panel, i.e. failure to select the aircraft type, and not to any malfunction of the ADGS. LT might have mixed up the operational steps of the 30-key and 54-key operator panel of

the ADGS. As an understudy to CT1, LT was allowed by GSP1 to operate the ADGS even though he had not attended any formal ADGS training. He had operated the ADGS about 10 times before the ingestion incident. The GSP1 has since disallowed an understudy from operating the ADGS if this person has not completed the necessary training.

2.6 The PIC worried about the reliability of the ADGS and thus focused more on the ADGS display during the docking, owing to the on-off-on display of the ADGS. This probably distracted him somewhat and resulted in a less effective visual scanning of the parking bay. He might also have not unreasonably assumed that, since the ADGS was active, the bay was clear of obstructions and equipment for the aircraft to proceed. Although the SFO announced "right side is clear" when the aircraft was established on the centreline of F37, there was no formal call-out procedure that would serve as a mutual verification by or reminder for the flight crew to check for presence of obstructions or equipment when docking at a bay.

2.7 It may be useful for flight crews to check for tell-tale signs that might suggest an abnormal situation in the ERA, for example, when the hatch lines of the PLB safety zone or the wheels of the aerobridge are not visible.

3 SAFETY ACTIONS

During the course of the investigation and through discussions with the investigation team, the following safety actions were initiated by the aerodrome operator and the ground service provider.

Surveillance of aircraft parking bays

3.1 The aerodrome operator has increased the frequency of airside inspections and safety audits on the GSPs. It has engaged auxiliary police officers to supplement its own aerodrome inspection teams to inspect the aircraft parking bays, and to be its extra pair of eyes to monitor infringement of the ERA via CCTV at the apron office.

3.2 The GSP1 has increased the number of spot checks and roving patrols by its Line Maintenance and Safety Team. Additional staff was stationed at its Integrated Ground Operations Centre to monitor the aircraft arrivals via CCTV.

Review of aircraft parking bay layout

3.3 The aerodrome operator has since limited the use of F37 to smaller aircraft, thus freeing up space to make for bigger ESAs for F37 and F42 as well as for better roadways for service vehicles in the area.

3.4 The aerodrome operator has engaged a consultant to undertake a review of the aircraft parking bay layout at Changi Airport. The review included the issue of adequacy of space for ground support equipment staging areas.

ADGS

3.5 The aerodrome operator has since replaced the remaining 30-key ADGS operator panel in all the three terminals of Changi Airport with the 54-key operator panel to standardise the ADGS operating procedure.

Safety awareness

3.6 The aerodrome operator and the ground service providers at the airport organised airside safety campaigns in the first half of 2014 to increase safety awareness and share learning points for all staff. One of the themes of the safety campaigns was “No parking in the ERA”.

3.7 The aerodrome operator issued on 15 January 2014 an Airside Safety Notice to all airside drivers to remind them of the following:

(a) To enter a bay only if they are required for ground operations of an aircraft.

(b) Not to make U-turns (for drivers who are not involved in ground operations) at occupied aircraft stands. (Such U-turns are only allowed at unoccupied aircraft stands, i.e. without any aircraft parked or arriving.)

(c) To park the vehicles in the ESA properly and neatly while waiting for the aircraft to arrive.

(d) To refrain from parking in the ERA at all times.

The aviation regulatory authority has also conducted its own investigation and has taken the following safety action.

Overall person-in-charge for ground handling activities

3.8 The aviation regulatory authority found that there was no one organisation or person who was overall in-charge and responsible for the various ground handling activities conducted by multiple parties at the bay. It has required the aerodrome operator to ensure that there is an overall person-in-charge of the operations at the bay for each arrival flight so as to ensure that the operations are carried out safely at the bay.

4 SAFETY RECOMMENDATIONS

A safety recommendation is for the purpose of preventive action and shall in no case create a presumption of blame or liability.

For the aerodrome operator

4.1 It is recommended that the aerodrome operator look into having a system that can clearly indicate to all working in the bay and adjacent areas the operational status of a bay. [AAIB Recommendation R-2015-005]

For the airline operator

4.2 It is recommended that the airline operator remind its flight crews that if the view of the hatch lines of the PLB safety zone or the wheels of the aerobridge was obscured, it could suggest an abnormal situation in the ERA. [AAIB Recommendation R-2015-006]

For the ground service provider

4.3 It is recommended that the GSP1 review its procedures to ensure that there will be continuous surveillance of the parking bays by its arrival crews until the aircraft arrive. [AAIB Recommendation R-2015-007]

Appendix A

Layout of Aircraft Parking Bay