

FINAL REPORT

B747-400F, REGISTRATION 9V-SFL

AIRCRAFT VEERING OFF RUNWAY

CHANGI AIRPORT

2 DECEMBER 2011

AIB/AAI/CAS.081

**Air Accident Investigation Bureau of Singapore
Ministry of Transport
Singapore**

18 March 2013

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 Organisation (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 investigation nor the reporting process has been undertaken for that purpose.

Table of Contents

SYNOPSIS	3
1 FACTUAL INFORMATION	4
1.1 History of the flight	4
1.2 Damage to aircraft	5
1.3 Other damage	7
1.4 Personnel information	7
1.5 Medical and pathological information	7
1.6 Additional information.....	8
1.6.1 Runway friction coefficient.....	8
1.6.2 Nose wheel steering.....	8
2 DISCUSSION	9
2.1 Deactivation of auto-brakes	9
2.2 Attempt to vacate via W3	9
2.3 Nose wheel steering tiller operation	10
3 SAFETY ACTION	11
4 SAFETY RECOMMENDATION	11

SYNOPSIS

On 2 December 2011 at about 4.15 p.m., a Boeing B747-400F freighter aircraft landing on Runway 02L at Singapore Changi Airport veered to the right side of the runway when trying to vacate the rapid exit taxiway W3. The right wing gear, right body gear and the nose gear went onto the grass area momentarily.

The flight crew managed to steer the aircraft back to the runway and taxied to its parking bay.

Many wheels and part of the brake systems were damaged. Some mud was ingested into the No.3 engine and damaged one fan blade. Two runway edge lights and four threshold lights were damaged.

The Air Accident Investigation Bureau of Singapore classified this occurrence as an incident. The investigation revealed that the aircraft did not decelerate to a low enough speed for the aircraft to turn off at taxiway W3. And when, despite the relatively high speed, the nose gear steering tiller was applied, the aircraft did start to turn but the inertia of the aircraft also caused the aircraft to skid, resulting in the aircraft's excursion off the runway.

AIRCRAFT DETAILS

Aircraft type	: Boeing 747-400 Freighter
Operator	: Singapore Airlines Cargo
Registration	: 9V-SFL
Number and type of engines	: 4 x Pratt & Whitney PW4000
Type of flight	: Scheduled Freighter Flight

1 **FACTUAL INFORMATION**

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

1.1 History of the flight

1.1.1 The Boeing B747-400F aircraft was flying from Sharjah, UAE to Singapore Changi Airport and was cleared to land on Runway 02L.

1.1.2 The runway condition was damp and the aircraft was configured to land with flaps set to 25° and auto-brakes set to two¹. The First Officer (FO) was the pilot flying the aircraft while the Pilot-In-Command (PIC) was performing pilot monitoring duties.

1.1.3 The aircraft touched down about 120m beyond the touchdown marking (**Figure 1** point (a)) and the thrust reversers were activated. When the aircraft had decelerated to about 99 knots, the FO deactivated the auto-brakes by applying manual brakes² (**Figure 1** point (b)) momentarily, i.e. manual brakes were not maintained. Manual brakes were applied about five seconds later (**Figure 1** point (c)) (during these five seconds, the aircraft had travelled about 280m, as estimated from FDR data). While the manual brakes were being re-applied, the thrust reversers were stowed when the aircraft speed was about 68 knots.

1.1.4 When the aircraft was around rapid exit taxiway W4, the FO noted from his instruments that the speed of the aircraft was around 60 knots and felt that the aircraft was still decelerating. (Data from the Flight Data Recorder (FDR) indicated that the aircraft was decelerating and the speed was about 70 knots.) Thereafter, the FO's attention was focused outside the cockpit to look out for rapid exit taxiway W3 which was his intended exit.

1.1.5 Based on the visual cues, the FO felt that the aircraft had reached a speed which was safe to exit via W3. The FO said that he attempted to turn right towards W3 (**Figure 1** point (d)) by applying right rudder pedal input. (FDR data indicated that the speed was about 59 knots at this point.) However,

¹ Based on the weather and runway conditions, 25° flaps was the preferred flap setting, and auto-brakes selection two was the norm as per the operator's Operating Procedures.

² Auto-brakes are automatically deactivated when the pilot applies manual brakes.

according to the FDR, very negligible right rudder input was applied.

- 1.1.6 The FO noticed that the aircraft was not turning right despite his right rudder pedal input and he applied some tiller input³.
- 1.1.7 The aircraft started to turn right but the FO and PIC felt the aircraft skidding towards the left (**Figure 1** point (e)). The FO immediately tried to steer the aircraft back towards the runway centreline in order to proceed on the runway to vacate via the next exit taxiway W2. The PIC took over control and also attempted to steer the aircraft towards the runway centreline.
- 1.1.8 Despite their efforts, the right wing gear, right body gear and the nose gear exited the paved runway momentarily and went onto the grass area.
- 1.1.9 The Control Tower saw the aircraft going into the grass area and alerted the Airport Emergency Service (AES).
- 1.1.10 The aircraft rolled towards the end of the runway after it had returned to the centre of the runway. It vacated the runway via the taxiway W2 and taxied to and stopped at the intersection of taxiways V3 and WP (**Figure 1** point (f)) where the AES, responding to the alert by the Control Tower, approached the aircraft. **Figure 1** shows the ground path of the aircraft.
- 1.1.11 While the aircraft was holding on the taxiway, the flight crew checked the aircraft's systems for abnormalities. There were no abnormalities observed. During this time, the ground engineer arrived at the aircraft and informed the flight crew that mud had been ingested into the No. 3 engine. Although all the engine parameters appeared normal, the flight crew shut down the No.3 engine as a precaution and taxied the aircraft to Parking Bay 505.
- 1.2 Damage to aircraft
 - 1.2.1 All the wheels of the aircraft other than wheel No.4 and all the brake assemblies of the right wing gear and right body gear were damaged and had to be replaced (**Figure 2**). One of the fan blades of the No.3 engine was also damaged by mud that was ingested.

³ Tiller input was not a parameter recorded by the FDR. Therefore, the amount of tiller input by the FO could not be assessed. However, the FO said that he used the tiller cautiously and at a rate slower than he would use to taxi the aircraft normally.

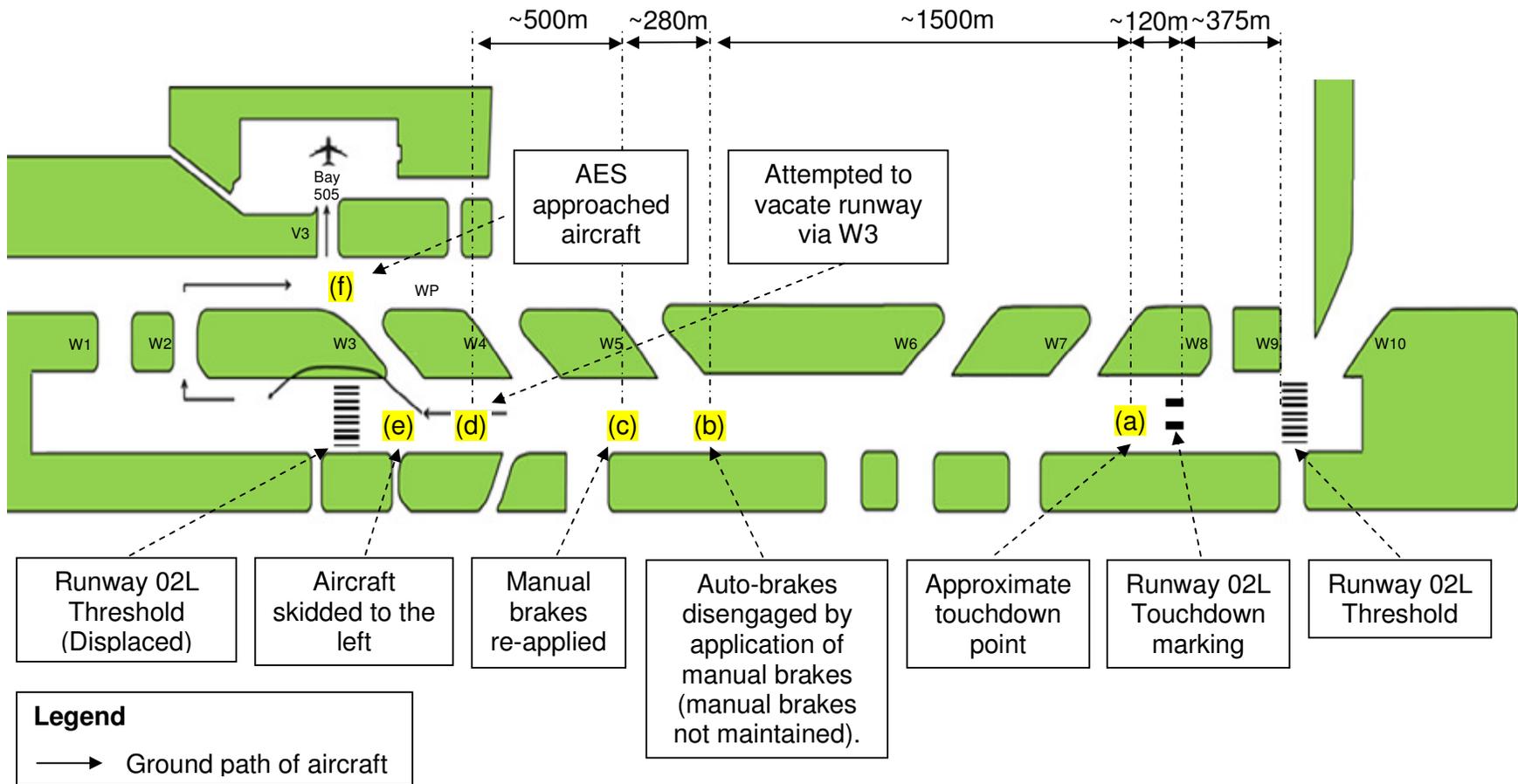


Figure 1: Ground path of the aircraft (Not drawn to scale)

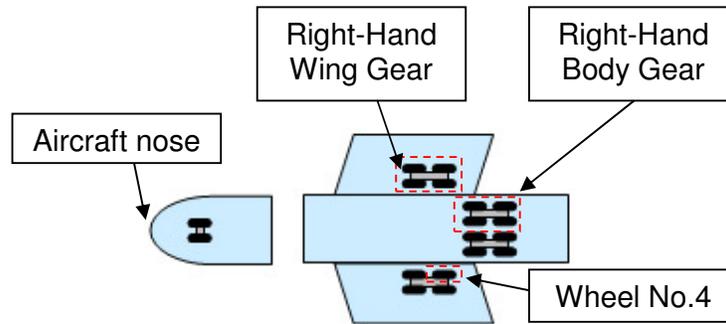


Figure 2: Landing gears of B744F (plan view)

1.3 Other damage

1.3.1 Four threshold lights (of Runway 20R) and two elevated runway edge lights between taxiways W2 and W3 were damaged.

1.4 Personnel information

	PIC	FO
Age	40	34
Gender	Male	Male
Type of licence	Airline Transport Pilot Licence issued by CAAS	Airline Transport Pilot Licence issued by CAAS
Valid till	31 May 2012	31 January 2012
Aircraft rating	B747-400	B747-400
Total flying time	9,095 hours	3,440 hours
Total on this type	3,624 hours	3,173 hours
Total last 90 days	131 hours 25 minutes	118 hours 15 minutes
Total last 28 days	39 hours 07 minutes	46 hours 31 minutes
Total last 24 hours	3 hours 42 minutes	3 hours 42 minutes
Rest period before flight (Company's policy minimum 12 hours)	18 hours 14 minutes	18 hours 14 minutes
Medical class	One	One
Medical limitation	Nil	Nil

1.5 Medical and pathological information

1.5.1 The PIC and FO underwent medical and toxicological tests after the occurrence. The tests revealed no abnormality.

- 1.6 Additional information
 - 1.6.1 Runway friction coefficient
 - 1.6.1.1 Following the incident, a runway friction test was conducted. The runway friction coefficient was found to be within limits.
 - 1.6.2 Nose wheel steering
 - 1.6.2.1 The aircraft could be steered on ground by using rudder pedals (for up to $\pm 7^\circ$ of nose gear deflection) or nose wheel steering tiller (for up to $\pm 70^\circ$ of nose gear deflection).
 - 1.6.2.2 Tiller steering has precedence over steering using rudder pedals. For example, if one pilot uses rudder pedals to steer the aircraft left while the other pilot uses the tiller to steer the aircraft right, the aircraft will respond to the tiller steering to the right in a way that is proportional to the tiller input.
 - 1.6.2.3 According to the operator's flight manual, the nose wheel steering tiller should be used only when the aircraft is travelling at the normal taxi speed (normally less than 30 knots). In fact, the procedure required that flight crews should not have their hands on the tiller when aircraft is taxiing above the normal taxi speed.

- 2 **DISCUSSION**
- 2.1 Deactivation of auto-brakes
- 2.1.1 According to the operator's Operations Manual Volume A Gen/Basic (OMV A), auto-brakes should normally be deactivated when the aircraft has decelerated to between 60 and 30 knots (the latter being the typical taxi speed). The operator's Flight Crew Training Manual (FCTM) also stated that the speed at which to deactivate auto-brakes would depend on such factors as deceleration rate, runway conditions, etc. This implies that flight crews could deactivate auto-brakes above 60 knots if they judged that the aircraft would be able to slow down and vacate the runway safely.
- 2.1.2 The FO was aware of the guidance stipulated in the OMV A, and FCTM. According to him, he deactivated the auto-brakes at 99 knots because he wanted to vacate the runway as expeditiously as possible. He believed that the aircraft would occupy less time on the runway by having it rolling down the runway at a higher speed and moderating the brakes to control the aircraft's speed down to the safe level for exit via W3. He believed that retaining the auto-brakes until the aircraft had decelerated to 60 knots before deactivating them would result in the aircraft staying longer on the runway.
- 2.2 Attempt to vacate via W3
- 2.2.1 The FO intended to exit via W3. He did not check his speed just before he attempted to vacate the runway via W3. Moments earlier when the aircraft was abeam W4, the FO noted that his speed was about 60 knots and decelerating. He then focused his attention outside the cockpit for his intended exit W3 and did not check his speed again before attempting to vacate the runway via W3. Based on visual cues, he perceived that the speed had decelerated to a safe level to turn off at W3.
- 2.2.2 The FO had deactivated the auto-brakes by applying manual brakes but he did not maintain the manual brakes. He only applied manual brakes again about five seconds later. Had he maintained manual brakes, the aircraft would have had further decelerated through a distance of 280m and would have reached the turning point for W3 at a speed lower than 59 knots. It was possible that the aircraft could have safely vacated the runway via W3, despite early deactivation of the auto-brakes.

- 2.3 Nose wheel steering tiller operation
 - 2.3.1 Although the FO said that he applied right rudder pedal input, the FDR data indicated that only very negligible right rudder pedal input was applied. As a result, the aircraft continued on a relatively straight path along the runway instead of turning right towards W3.
 - 2.3.2 As the FO felt that the aircraft was not turning right, he used the nose wheel steering tiller to try to turn the aircraft.
 - 2.3.3 Tiller for nose wheel may be used when the aircraft is at or below typical taxi speed. The FO was looking outside the cockpit as he attempted to vacate the runway. Although he felt (based on the visual cues) that the aircraft was at a speed which was safe to vacate via W3 and for tiller operation, the aircraft's speed was actually about 59 knots, which was higher than the typical taxi speed.
 - 2.3.4 Thus, while the use of the tiller managed to get the aircraft to start turning to the right, the inertia of the aircraft also caused the aircraft to skid, resulting in the aircraft's excursion off the runway.

3 **SAFETY ACTION**

3.1 Following the incident, the operator took the following safety actions:

- (a) Emphasising to all the flight crews the criteria for releasing auto-brakes during the landing roll.
- (b) Enhancing flight crews' awareness of the need to decelerate the aircraft to a safe taxi speed, especially after landing, before making a turn.

4 **SAFETY RECOMMENDATION**

4.1 In view of the safety actions taken by the operator, no safety recommendation is proposed.