FINAL REPORT

WINGTIP COLLISION INCIDENT INVOLVING B777-200ER AIRCRAFT, REGISTRATION 9V-SVH AND 9V-SVO AT SINGAPORE CHANGI AIRPORT ON 4 AUGUST 2007

AIB/AAI/CAS.042

Air Accident Investigation Bureau of Singapore
Ministry of Transport
Singapore

8 July 2008

The Air Accident Investigation Bureau of Singapore

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> *"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."*

CONTENTS

		Page
	SYNOPSIS	3
	AIRCRAFT DETAILS	4
1	**FACTUAL INFORMATION**	5
1.1	History of Flights	5
1.2	Injuries to persons	7
1.3	Damage to aircraft	7
1.4	Personnel information	9
1.5	Aircraft information	11
1.6	Meteorological information	11
1.7	Aids to navigation	11
1.8	Flight recorders	11
1.9	Communications	12
1.10	Aerodrome and Air Traffic Control	12
1.11	Collision site information	13
1.12	Medical and pathological information	13
1.13	Fire	13
1.14	Other Information	13
2	**ANALYSIS**	16
2.1	Action of the 9V-SVO Crew	16
2.2	Action of the 9V-SVH Crew	16
2.3	Technique for Judging Wingtip Clearance	16
2.4	Action of Ground Controller	17
3	**CONCLUSIONS**	.18
3.1	Significant Factors	18
3.2	Others	18
4	**SAFETY ACTIONS**	19
5	**SAFETY RECOMMENDATIONS**	20

SYNOPSIS

Two Boeing 777-200ER aircraft were departing from Singapore Changi Airport in the early morning of 4 August 2007. 9V-SVH was taxiing along Taxiway C1 and 9V-SVO was being pushed back from Bay F37. When the crew of 9V-SVH saw 9V-SVO ahead of them and to their left, they stopped and queried Ground Control about their taxi clearance. They were told to continue to taxi past the other aircraft if they had sufficient clearance. The Pilot-in-Command (PIC) of 9V-SVH judged that they had sufficient clearance from the other aircraft and continued to taxi. However, their aircraft's left wing hit the right wing of 9V-SVO at about 0103 hrs.

The Air Accident Investigation Bureau of Singapore classified the occurrence as an incident and instituted an investigation.

AIRCRAFT DETAILS

BOEING 777-200

Aircraft Type	: Boeing 777–200 ER (Extended Range)
Registration	: 9V-SVH
Number and Type of Engines	: 2 x Rolls Royce Trent 892 series Turbofan
Place	: Singapore Changi Airport, Taxiway C1 / C2
Date & Time (Local Time)	: 4 August 2007 at 0103 hrs
Type of Flight	: Scheduled Passenger Flight
Persons on Board	: Crew - 15 Passengers - 152
Point of Departure	: Singapore
Destination	: Rome, Italy

BOEING 777-200

Aircraft Type	: Boeing 777–200 ER (Extended Range)
Registration	: 9V-SVO
Number and Type of Engines	: 2 x Rolls Royce Trent 892 series Turbofan
Place	: Singapore Changi Airport, Taxiway C1 / C2
Date & Time (Local Time)	: 4 August 2007 at 0103 hrs
Type of Flight	: Scheduled Passenger Flight
Persons on Board	: Crew - 15 Passengers - 282
Point of Departure	: Singapore
Destination	: Copenhagen, Denmark

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 the flights

9V-SVH

1.1.1 The crew arrived at their aircraft at the planned time and the aircraft was pushed back from Bay F58 of Changi Airport's Terminal 2 onto Taxiway C6 without delay. The crew received taxi instructions at 0101 hrs to follow the green taxiway guidance lights to the holding point of Runway 20C.

1.1.2 The Pilot-in-Command (PIC) taxied the aircraft and followed the guidance lights along Taxiway C6 and turned onto Taxiway C1. During this turn, the crew saw another B 777 aircraft (9V-SVO) which was being pushed back from Bay F37 and the PIC stopped their aircraft as 9V-SVO was visually assessed to be too close to Taxiway C1. They had not been informed by the Ground Controller of the pushback aircraft from F37. The Co-pilot contacted Ground Control for instructions and was given a clearance to continue taxiing if there was enough separation from the other aircraft.

1.1.3 The PIC judged that 9V-SVH would have enough clearance from 9V-SVO by referencing the wingtip of 9V-SVO to a screw on the side window pillar (the technique is further described in paragraph 1.14.2) and he pointed this out to his crew. He said during interview that he saw 9V-SVO was being pulled forward after the pushback was halted, and this gave him added confidence that the wingtip of 9V-SVH would be able to clear 9V-SVO. The Co-pilot and the additional crew member were uncomfortable with the proximity of the other aircraft but they accepted the PIC's decision to continue taxiing. The Co-pilot said during interview that he did not see 9V-SVO moving forward whereas the additional crew member of 9V-SVH said during interview that he saw 9V-SVO moving forward.

1.1.4 At 01:03:44 hrs, the left wingtip of 9V-SVH struck the right wingtip of 9V-SVO and the PIC of 9V-SVH informed ATC that his aircraft might have hit 9V-SVO. At 01:06:15 hrs, he informed the Ground Controller that his aircraft's wingtip needed to be checked by an engineer and he was asked if he wanted to taxi to somewhere else or preferred to hold at the present position for the damage check. The PIC asked Ground Control to allow his aircraft to taxi to a suitable location for the check and at 01:06:40 hrs, about three minutes after the collision, the aircraft received clearance to taxi towards Taxiway C7 and subsequently docked at Bay F58 at 0124 hrs.

9V-SVO

1.1.5 The aircraft was cleared for a standard pushback[1] from Bay F37. The crew released the park brakes at 01:00:47 hrs and soon after, ATC advised that there was traffic on Taxiway C1 and to push back with caution. This message was immediately relayed by the PIC to the ground crew operating the towbarless air tug vehicle.

1.1.6 During the pushback, this flight crew could not see 9V-SVH initially as it was approaching them from behind but the air tug crew reported that they saw it. The pilots continued looking for the aircraft and when they first saw it at 01:03:05 hrs, the PIC remarked that 9V-SVH was very close to 9V-SVO. The PIC immediately asked the air tug's headset man if their aircraft was clear of 9V-SVH. The headset man replied that 9V-SVH appeared to be stopping but soon after, at 01:03:44 hrs, the collision occurred. The crew stated that they did not feel their aircraft being towed forward at any time prior to the collision

1.1.7 At 01:05:59 hrs, the PIC informed Ground Control that he would most likely need his aircraft to be checked by an engineer. The aircraft was towed back to F37 by the same air tug and was chocked at 0111 hrs.

Air tug vehicle pushing back 9V-SVO

1.1.8 The towbarless air tug vehicle assigned to push back 9V-SVO was manned by a ground crew team of two (a headset man and a driver). The air tug driver was pushing back 9V-SVO from Bay F37 to Stopbar 4 on Taxiway C2 when he saw another B777 that he had been warned to lookout for, approaching along Taxiway C1 and then stopping. The headset man was seated on the driver's right side, facing 9V-SVO. Although his view of the other B777 was largely blocked by his aircraft, he too saw the other aircraft stopping. The headset man had been warned by the PIC of 9V-SVO to exercise caution with regard to the taxiing aircraft and had relayed this warning to the driver.

1.1.9 When the driver saw the other aircraft start moving again, he stopped the pushback and wanted to pull the aircraft forward in order to provide more clearance from the other aircraft. When he told the headset man of this intention, the headset man stopped him immediately as he wanted to first assess the relative positions of the wingtips. As he was preparing to walk from the air tug to the wingtip to check the clearance, the collision occurred. The PIC subsequently instructed the headset man to tow 9V-SVO back to Bay F37.

[1] A standard pushback means pushing back till the nosewheel is at Stopbar 4, marked as "END OF PUSHBACK" on the ground. See Figure 1.

Tracks of 9V-SVH and 9V-SVO

1.1.10 The tracks of 9V-SVH and 9V-SVO are as shown in **Figure 1**.

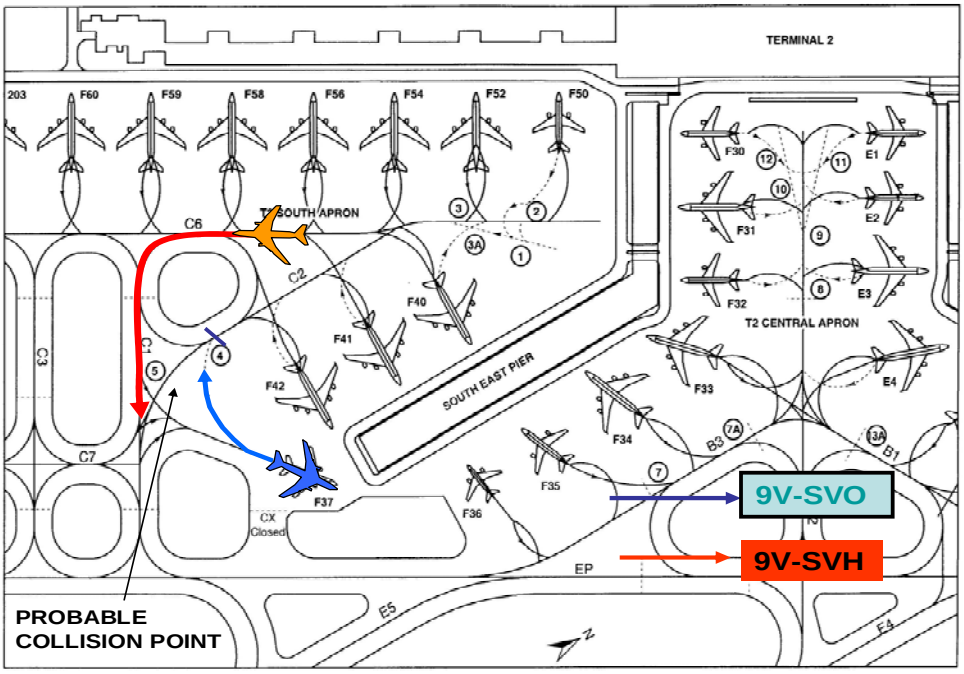

Figure1. Tracks of 9V-SVH and 9V-SVO, prior to collision.

1.2 **Injuries to persons**

Nil.

1.3 **Damage to aircraft**

1.3.1 **9V-SVH** - The left hand wingtip was damaged. The surrounding fibreglass panels were broken and the No.1 leading edge slat was damaged. Wing fibreglass panels below the leading edge slat were also damaged. See **Figure 2**.

1.3.2 **9V-SVO** - The right hand wingtip leading edge was damaged. The trailing edge fibreglass honeycomb was broken, with about 100 sq cm of material missing. The right hand aileron was damaged at the outboard edge with about 130 sq cm missing. The honeycomb material on the lower surface was crushed. See **Figure 3**.

Figure 2. 9V-SVH damage at top of left wingtip area. View from front / above

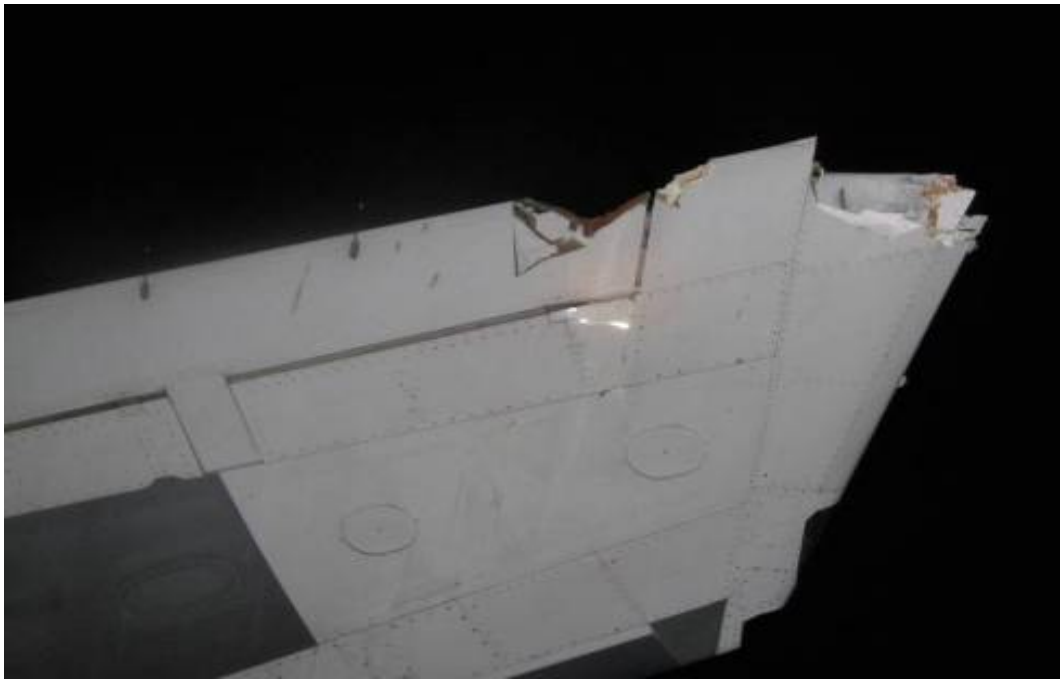

Figure 3. 9V-SVO damage at right wingtip and aileron. View from rear / below.

1.4 Personnel information

9V-SVH

1.4.1 Pilot-in-Command

Age	:	42 years (Male)
Licence	:	Airline Transport Pilot Licence (Aeroplanes), issued by the Civil Aviation Authority of Singapore
Licence expiry date	:	30 November 2007 Subject to: The holder to wear lenses which correct for near and distant vision while exercising the privileges of the licence
Total flying experience	:	7665 hrs
Flying experience on type	:	1414 hrs
Last medical check	:	2 November 2006
Medical certificate expiry	:	30 November 2007

1.4.2 Co-pilot

Age	:	32 years (Male)
Licence	:	Airline Transport Pilot Licence (Aeroplanes), issued by the Civil Aviation Authority of Singapore
Licence expiry date	:	31 December 2007
Total flying experience	:	2999 hrs
Flying experience on type	:	2999 hrs
Last medical check	:	29 November 2006
Medical certificate expiry	:	31 December 2007

1.4.3 Additional crew member (Observer Seat)

Age	:	27 years (Male)
Licence	:	Airline Transport Pilot Licence (Aeroplanes), issued by the Civil Aviation Authority of Singapore
Licence expiry date	:	30 June 2008 Subject to: The holder to wear lenses which correct for distant vision while exercising the privileges of the licence
Total flying experience	:	1202 hrs
Flying experience on type	:	1202 hrs
Last medical check	:	22 May 2007
Medical certificate expiry	:	30 June 2008

9V-SVO

1.4.4 **Pilot-in-Command**

Age	:	34 years (Male)
License	:	Airline Transport Pilot Licence (Aeroplanes), issued by the Civil Aviation Authority of Singapore
Licence expiry date	:	31 December 2008
Total flying experience	:	9551 hrs
Flying experience on type	:	5501 hrs
Last medical check	:	3 December 2006
Medical certificate expiry	:	31 December 2007

1.4.5 **Co-pilot**

Age	:	35 years (Male)
Licence	:	Airline Transport Pilot Licence (Aeroplanes), issued by the Civil Aviation Authority of Singapore.
Licence expiry date	:	30 June 2008
Total flying experience	:	2220 hrs
Flying experience on type	:	2220 hrs
Last medical check	:	7 June 2007
Medical certificate expiry	:	30 June 2008

Air Traffic Control

1.4.6 **Ground Controller**

Age	: 37 (Male)
Licence	: Air Traffic Controller Licence, issued by the Civil Aviation Authority of Singapore.
Licence expiry date	: 22 May 2008
Experience	: 14 years
Work scheduled	: 12-hour shift. 2000 hrs 3 August 2007 to 0800 hrs 4 August 2007
Last Proficiency Check	: Aerodrome - 15 February 2007 Approach - 10 May 2007
Last Medical Check	: 23 April 2004 (valid for 4 years)

Air Tug Vehicle

1.4.7 **Headset man**

Age	:	49 (Male)
Licence	:	Certifying Technician on B744
Experience	:	30 years
Work schedule	:	1500 hrs 3 August 2007 to 0200 hrs 4 August 2007

1.4.8 **Driver**

Age	:	45 years (Male)
Experience	:	15 years
Work Schedule	:	1500 hrs 3 August 2007 to 0200 hrs 4 August 2007

1.5 **Aircraft information**

1.5.1 Both 9V-SVH and 9V-SVO had valid Certificates of Airworthiness.

1.5.2 9V-SVH had a deferred defect on the right bleed pressure sensor.

1.5.3 9V-SVO had no deferred defects.

1.6 **Meteorological information**

1.6.1 The incident occurred at night and the lighting at the area where the incident occurred was dim. At the time of the incident, the weather condition was clear, with no precipitation. Visibility was reported as more than 10 km and wind from south at 4 knots.

1.7 **Aids to navigation**

1.7.1 Taxiway markings and signs around the incident location were in good condition. The taxiways had a yellow painted centreline, blue edge lights and green centreline lights for operations at night or in poor weather. These green lights are selectively controlled by the Ground Controller, to guide aircraft to and from the runways.

1.7.2 The taxiway navigation lights described above were serviceable at the time of the incident.

1.8 **Flight recorders**

1.8.1 **9V-SVH** - The 25-hour solid state flight data recorder (FDR) L3 FA2100, PN:2100-4043-00, SN:000297838 and 2-hour cockpit voice recorder (CVR) Honeywell PN:980-6022-0001, SN:CVR120-04982 were downloaded and transcribed at the AAIB Singapore. Both recorders operated normally and had recorded information before and after the incident.

1.8.2 **9V-SVO** - The 25-hour FDR L3 FA2100, PN2100-4043-00, SN 000190785 did not record any data pertaining to this incident as aircraft power is only supplied to the FDR after an engine is started. The engines of the aircraft had not been started yet during the pushback. The 2-hour CVR L3 FA2100, PN:2100-1020-00, SN238674 operated

normally and had recorded information before and after the incident. The CVR was transcribed at the AAIB Singapore.

1.9 Communications

1.9.1 ATC communications between both aircraft and Changi Tower on Ground Frequency were normal.

1.9.2 The communications between the flight crew of 9V-SVO and the air tug headset man were also normal.

1.10 Aerodrome and Air Traffic Control

1.10.1 Although Bay F37 had been designed to accommodate large aircraft, it had previously been restricted to B737, A320 and other smaller aircraft because of its limited equipment staging area. To upgrade this bay to handle the larger B777 aircraft, the boundary line for the equipment staging area was redrawn and an off-site equipment staging area was provided. A NOTAM was issued on 25 July 2007 to announce the use of F37 for B777-200 / 200ER after this upgrade was completed. The aerodrome operator stated that a safety assessment was done prior to this change and that pushback of larger aircraft was discussed. However, the investigation team was unable to validate this as the aerodrome operator did not keep a record of the safety assessment.

1.10.2 The Ground Controller would normally assign aircraft on Taxiway C6 to proceed to Runway 20C via Taxiways C3 and EP when an aircraft is pushed back from Bay F37. At the time of the incident, sections of Taxiway EP and Taxiway C3 were closed for maintenance works (Ref. Fig 1). Aircraft on Taxiway C6 had to use Taxiway C1 to reach Runway 20C because of this closure.

1.10.3 The Air Traffic Services Manual (ATSM) contained instructions for the pushback from Bay F37. The instructions, applicable to all types of aircraft being pushed back from Bay F37, highlighted that during the pushback from F37 the aircraft is not clear of Taxiway C1. The ATSM and these instructions are only available to Air Traffic Control Officers (ATCO), hence this information was not known to flight crews.

1.10.4 The Ground Controller was aware of the ATSM pushback instructions mentioned above and knew that clearance was assured between 9V-SVH and 9V-SVO only when 9V-SVO had reached the “END OF PUSHBACK” position.

1.10.5 Notwithstanding this, the Ground Controller gave the clearance to 9V-SVH to taxi past 9V-SVO along Taxiway C1 at the crew’s discretion. During interview, he said that this was to minimise any delay to the taxiing of a number of aircraft under his control because these aircraft had take-off times to meet. If these aircraft did not take off before the expiry of their flight clearance, their flights would be delayed as they had

to wait for another clearance. The Ground Controller believed that pilots should be able to judge their aircraft's clearance from obstacles.

1.10.6 The air traffic services provider at Changi Airport indicated to the investigation team that the Ground Controller's instructions to 9V-SVH to taxi past 9V-SVO at the crew's discretion constituted a conditional clearance. It said that the issuance of such clearances is an accepted practice and air traffic controllers are trained in their use.

1.11 Collision Site information

1.11.1 When the AAIB investigators arrived at the incident site, both aircraft had been removed. The fallen debris from the two aircraft had also been cleared from the junction of Taxiways C1 and C2 by the Airfield Safety Inspection Team of the aerodrome operator, on instructions from Changi Tower. The team placed a cone marker at the location where dislodged aircraft parts had been recovered. No measurements or photographs were taken of the site before the debris was cleared.

1.12 Medical and pathological information

1.12.1 The pilots of 9V-SVH and 9V-SVO went for medical examinations immediately after the incident. The test results were all normal.

1.13 Fire

1.13.1 There was no fire.

1.13.2 The Airport Emergency Service was not activated to respond to this incident.

1.14 Other information

1.14.1 Air Navigation Order (ANO)

Paragraph 33(2) of the Eleventh Schedule of the ANO - Rules of the Air and Traffic Control - Part VII, states under the Heading "Right of Way on the Ground", that:

"Not withstanding any air traffic control clearance –

(a) the pilot in command of a taxiing aircraft shall ensure that the aircraft does not collide with any other aircraft or with any vehicle or obstacle while the aircraft is taxiing; and
(b) the leader of the towing crew shall ensure that the aircraft does not collide with any other aircraft or with any vehicle or obstacle while the aircraft is being towed".

1.14.2 Technique for judging wingtip clearance

1.14.2.1 The PIC of 9V-SVH said during interview that he used a technique to judge wingtip clearance that had been taught to him by some instructors during his B777 aircraft training and that he had used the technique successfully several times before. This technique consisted of determining whether the wingtip of a B777 was clear of a nearby object by determining whether the object was seen to be above or below the level of the middle screw on the side window post on the same side of the aircraft as the pilot seat (see **Figure 4**). According to the PIC, if an object was sighted above this middle screw, it would be judged to be clear of the wingtip on that side. The pilot said that he looked at the right wingtip of 9V-SVO and saw that it was clearly above this reference screw. He decided therefore that there was sufficient clearance and proceeded to taxi forward slowly. However, the wingtips still ended up colliding with each other.

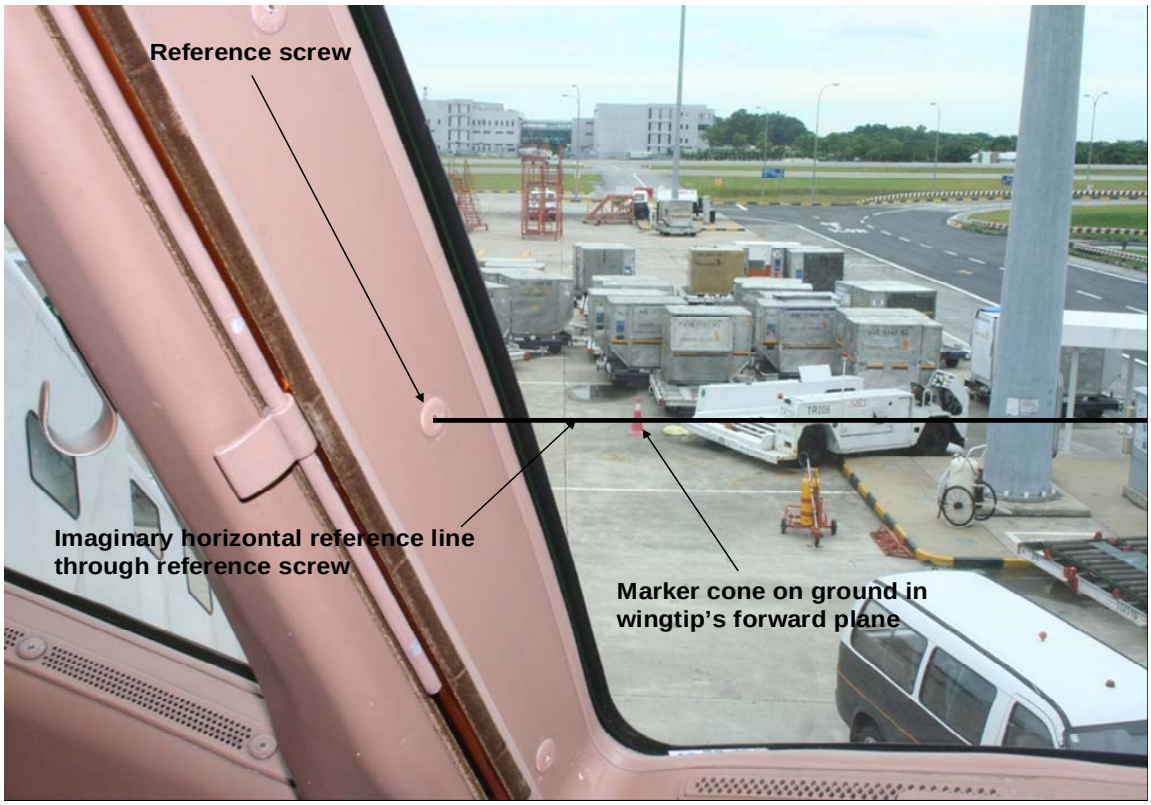

Figure 4 – Side view from pilot's (left) seat, using a screw located on a window frame as a reference to judge wingtip clearance.

1.14.2.2 The operator and the manufacturer of the aircraft had no documented process or method for judging B777 wingtip clearance from the cockpit. The operator's training videos did not provide any guidance for judging wingtip clearance and the operator said during this investigation that it did not endorse the technique of using the window frame screw for wingtip clearance reference.

1.14.2.3 Feedback from pilots flying this and other types of aircraft in the operator involved indicated that pilots would stop the aircraft if there was any doubt about the clearance available and request for marshallers and wing walkers to guide them.

2 ANALYSIS

The analysis covered the following areas:

- Action of the 9V-SVH crew
- Action of the 9V-SVO crew
- Technique for judging wing clearance
- Action of the Ground Controller

2.1 Action of the 9V-SVH crew

2.1.1 Although the Co-pilot and the additional crew member were uncomfortable with the proximity of 9V-SVO to their aircraft, they accepted the PIC's judgment regarding the wingtip clearance as he was in the best position to see the other aircraft and to judge the clearance. From their positions, they could not verify the wingtip clearance by using the technique mentioned by the PIC. Although the PIC and the additional crew member of 9V-SVH said they saw 9V-SVO being pulled forward after the pushback was halted, the accounts of the Co-pilot of 9V-SVH and the crew of 9V-SVO and the crew of the air tug vehicle suggest that what they perceived as a forward movement was likely an illusion.

2.1.2 After the collision, the crew decided that engineers would have to inspect the damage and the aircraft was taxied back to Bay F58 to accomplish this. The possible hazards that could develop from the damage were not discussed. It would have been prudent to request for a safety assessment of their aircraft's damage prior to any further movement. At the time of the incident, the operator did not have a standing instruction for the crew to have their aircraft's damage assessed after a ground collision.

2.2 Action of the 9V-SVO crew

2.2.1 During the pushback from F37, ATC had cautioned the crew of 9V-SVO that 9V-SVH was taxiing on Taxiway C1 and the crew immediately reminded the headset man at the air tug vehicle to exercise caution as traffic was coming through. The crew was looking out for the other aircraft and they took reasonable precautions to reduce the risk of a collision by reminding the air tug crew to be careful.

2.2.2 After the collision, the crew decided to return to their gate and informed Ground Control that they would instruct their air tug to tow the aircraft back to Bay F37. It would have been prudent to arrange for a safety assessment of their aircraft's damage before the aircraft was moved.

2.3 Technique for judging wingtip clearance

2.3.1 The technique used by the PIC of 9V-SVH to judge the wingtip clearance of his aircraft was flawed. The technique appears unsuitable for judging

clearance from objects not lying on the ground. If the object is in mid air, the technique would require the pilot to estimate the position of the object's ground shadow position in relation to the reference screw. For example, if the white box in **Figure 5** represents a mid-air object within the wingspan distance from the cockpit, it will be wrong to conclude that it is outside the span of the wing just because it appears above the reference screw. The decision by the PIC of 9V-SVH to proceed with the taxiing was based on his seeing that the wingtip of the 9V-SVO was clearly above the reference screw, but he did not assess the ground shadow position of the wingtip, relative to the reference screw.

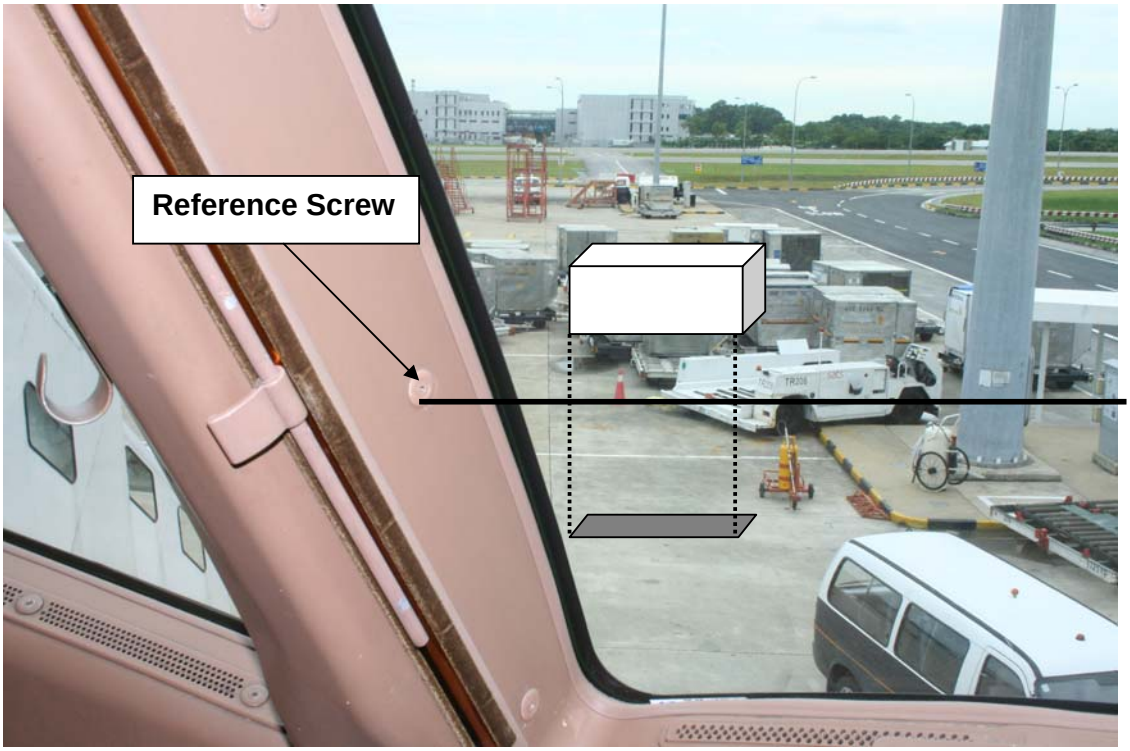

Figure 5 Mid-air object represented by the white box appears to be above reference screw.

2.4 Action of the Ground Controller

2.4.1 The Ground Controller authorised 9V-SVH to taxi past 9V-SVO along Taxiway C1 at the crew's discretion. The air traffic services provider at Changi Airport said that such a conditional clearance was acceptable. However, given that the instructions in the ATSM had specifically highlighted that during the pushback from F37 an aircraft was not clear of Taxiway C1, it would have been more prudent for the Ground Controller not to clear 9V-SVH to taxi past 9V-SVO.

3 CONCLUSIONS

3.1 Significant Factors

3.1.1 The Ground Controller was aware of the lack of clearance between aircraft being pushed back from Bay F37 and another aircraft taxiing along Taxiway C1 but nevertheless gave the clearance to 9V-SVH to continue its taxi past 9V-SVO.

3.1.2 The PIC of 9V-SVH used a technique of judging wingtip clearance that was flawed.

3.2 Others

3.2.1 The extent of damage sustained by both aircraft and the safety of the situation was not assessed before the aircraft were allowed to return to their bays.

4 SAFETY ACTIONS

Arising from discussions with the investigation team, the parties concerned have taken the following safety actions.

4.1 Three days after the incident, the air traffic services provider at Changi Airport issued instructions to all ground controllers that they must exercise positive control of aircraft manoeuvring around Bays F35, F36, F37, E6, E7, D38 and C19. These bays were identified as areas where the pushback manoeuvre of an aircraft would bring it into the path of taxiing traffic.

4.2 The operator involved in the incident conducted an internal investigation which highlighted the need to point out the following to the flight crews:

(a) The responsibility of crew to ensure aircraft separation at all times, and when in doubt, to stop.
(b) Crews should not determine wingtip clearance using solely non-documented processes.

The internal investigation also recommended that this collision and other recent taxi collisions be publicised to crews to highlight the lessons learnt from these incidents.

The operator acted accordingly by:

(a) briefing all B777 instructors on 17 August 2007;
(b) briefing all B777 crews on 25 September 2007;
(c) issuing on 25 October 2007 an Ops Tech Crew Circular with a summary of the operator's investigation and recommendations.

4.3 The operator's internal investigation also highlighted the need for the operator to implement procedures detailing post-collision actions.

The operator followed up by issuing a Tech Crew Circular on 1 November 2007 instructing all flight crews that "during an incident or accident, it is prudent, circumstances permitting, to request for Airfield Emergency Service (AES) via ATC or Engineering Services to assess the damage or any potential risk or hazard, before returning to bay or moving the aircraft further".

5 SAFETY RECOMMENDATIONS

5.1 It is recommended that the aerodrome operator establish procedures to preserve evidence and keep a detailed record of the incident scene prior to the removal of aircraft, vehicles or evidence from the site. Such evidence and records will be important if the relevant authorities decide later to carry out their investigations or if there are queries later regarding the incident. [AAIB Recommendation R-2008-001]