

FINAL REPORT

WING CLIPPING INVOLVING BOEING B787, REGISTRATION 9V-OJA AND AIRBUS A380, REGISTRATION A6-EUB AT SINGAPORE CHANGI AIRPORT ON 30 MARCH 2017

AIB/AAI/CAS.143

**Transport Safety Investigation Bureau
Ministry of Transport
Singapore**

19 March 2018

The Transport Safety Investigation Bureau

The Transport Safety Investigation Bureau (TSIB) is the air and marine accidents and incidents investigation authority in Singapore. Its mission is to promote aviation and marine safety through the conduct of independent investigations into air and marine accidents and incidents.

The TSIB conducts air safety 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.

The sole objective of TSIB's safety investigations is the prevention of aviation accidents and incidents. The safety investigations do not seek to apportion blame or liability. Accordingly, TSIB reports should not be used to assign blame or determine liability.

CONTENTS

	Page
GLOSSARY OF ABBREVIATIONS	3
SYNOPSIS	4
1 FACTUAL INFORMATION	5
1.1 History of the flight	5
1.2 Injuries to persons	8
1.3 Damage to aircraft	8
1.4 Personnel information	9
1.5 Meteorological information	10
1.6 Aerodrome information	10
1.7 Recorded data	10
1.8 Medical and pathological information	11
1.9 Additional information	11
2 DISCUSSION	14
2.1 Use of aircraft taxi guidance system	14
2.2 ATC verbalising the intended taxi route	15
2.3 Human perception challenges	16
2.4 Information presentation in advisory chart	16
2.5 Hazard identification	17
2.6 Preservation of recorders	18
3 SAFETY ACTIONS	19
4 SAFETY RECOMMENDATIONS	21

GLOSSARY OF ABBREVIATIONS

AGLCMS : Airfield Ground Lighting Control and Monitoring System

ATC : Air Traffic Control

ATSM : Air Traffic Services Manual

ATSP : Air Traffic Services Provider

CAAS : Civil Aviation Authority of Singapore

EAFR : Enhanced Airborne Flight Recorder

FO : First Officer

GMC : Ground Movement Controller

PIC : Pilot-in-command

SYNOPSIS

On 30 March 2017, at about 01:40 hours local time, the left wing of a B787 aircraft collided, while the aircraft was taxiing along Taxiway WA in Changi Airport, with the right wing of an A380 aircraft which was being pushed back from a parking bay in Terminal 1. There were damages at the wing areas of both aircraft.

There was no injury to any person.

The occurrence was classified as a serious incident.

AIRCRAFT DETAILS

Aircraft 1

Aircraft type	:	Boeing B787
Operator	:	Scot
Registration	:	9V-OJA
Engine details	:	2 x Rolls Royce Trent 1000
Type of flight	:	Scheduled passenger flight
Persons on board	:	314

Aircraft 2

Aircraft type	:	Airbus A380-861
Operator	:	Emirates
Registration	:	A6-EUB
Engine details	:	4 x Engine Alliance GP7270
Type of flight	:	Scheduled passenger flight
Persons on board	:	508

Date and time of occurrence	:	30 March 2017, 01:40 hours
Location of occurrence	:	Changi Airport, Singapore

1 FACTUAL INFORMATION

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

1.1 History of the flight

1.1.1 On 30 March 2017 at about 01:00 hours, two air traffic controllers started their shift of manning the ground movement control at Changi Tower. One of them was undergoing on-the-job ground movement controller (GMC) training (hereinafter referred to as the OJT trainee) under the supervision of the other, who was a qualified GMC (hereinafter referred to as the OJT trainer).

1.1.2 At about 01:33 hours, a B787 aircraft had completed pushback from parking bay E28 in Terminal 2. The OJT trainee instructed the flight crew of the B787 to “taxi on greens” and hold short of Taxiway WA. The taxi route comprised Taxilane A6 and Taxiway NC3. The OJT trainee did not verbalise the taxi route¹.

1.1.3 At that time, the green taxiway centreline lights² along A6, NC3 and WA towards the threshold of Runway 02L were illuminated (see **Figure 1**). The illuminated lights had been in that configuration as a few aircraft had taxied on WA in the past 30 minutes.

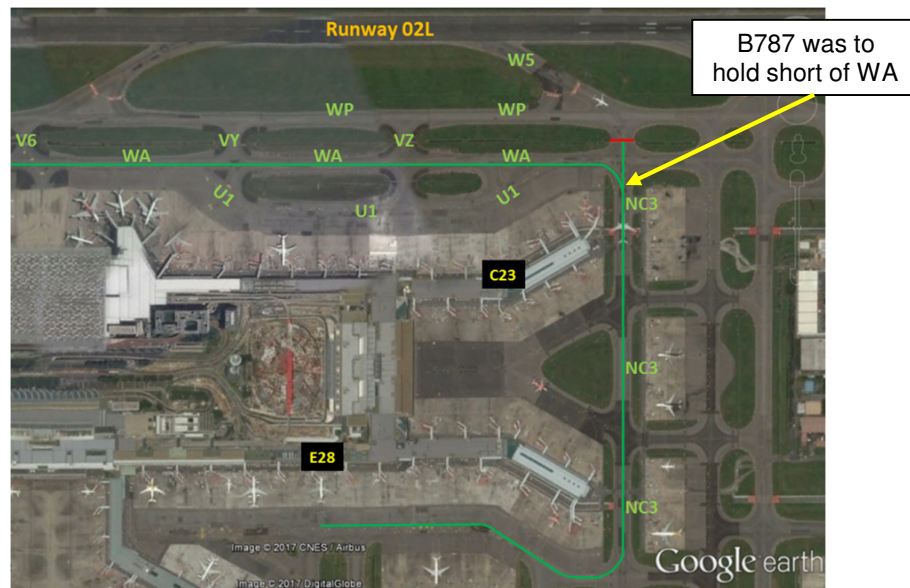


Figure 1: Green taxiway centreline lights configuration at the time of taxi instruction issuance

¹ Air traffic control operating procedures did not require verbalising of the exact taxi route.

² The taxiway lighting is part of the Airfield Ground Lighting Control and Monitoring System (AGLCMS) which enables the air traffic controllers to control the airfield lights to provide pilots with visual guidance while taxiing during night operations or during periods of poor visibility. More details provided in 1.6.1.

- 1.1.4 According to the OJT trainee, her plan was to have the B787 taxi on Taxiway WP after an arriving aircraft had landed and vacated Runway 02L via Rapid Exit Taxiway W5,. She would then switch off the green taxiway centreline lights leading to WA and switch on the green taxiway centerline lights leading to WP (which was parallel to WA) to guide the B787 onto WP, and to hold short of it at Taxilane V6 towards the runway holding position of Runway 02L (see **Figure 2**).

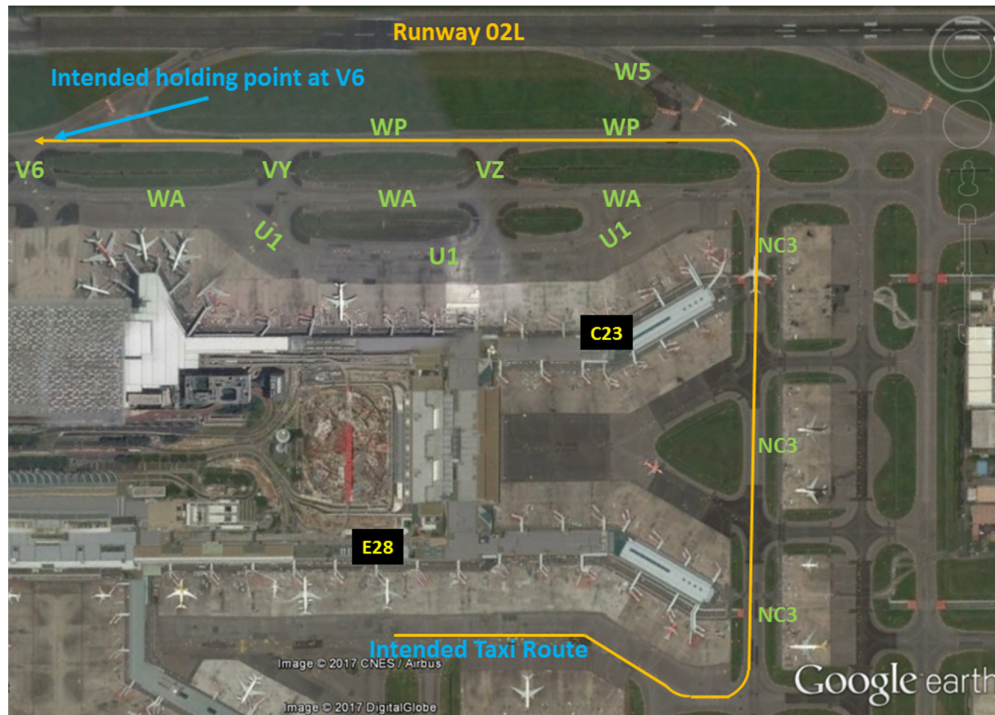


Figure 2: Intended taxi route for B787

- 1.1.5 The OJT trainee determined that she would be able to reconfigure the green taxiway centreline lights before the B787 arrived at the intersection of WA and NC3. Hence, she did not see the need to switch on the red stop bar light³ on NC3 short of WA.
- 1.1.6 The flight crew of the B787 read back to the OJT trainee her instruction to “taxi on green” and hold short of WA, and proceeded to taxi.
- 1.1.7 The OJT trainer did not interfere with the OJT trainee’s control.
- 1.1.8 At about 01:34 hours, the OJT trainee gave clearance to an A380 aircraft to commence pushback from parking bay C23 in Terminal 1. The pushback operation commenced at about 01:37 hours. The pushback involved pushing the aircraft tail-first and to the right onto Taxilane U1, with the aircraft ending up facing south (see **Figure 3**).

³ An illuminated red stop bar light will indicate to all aircraft and vehicles to stop and not proceed beyond the associated holding point.

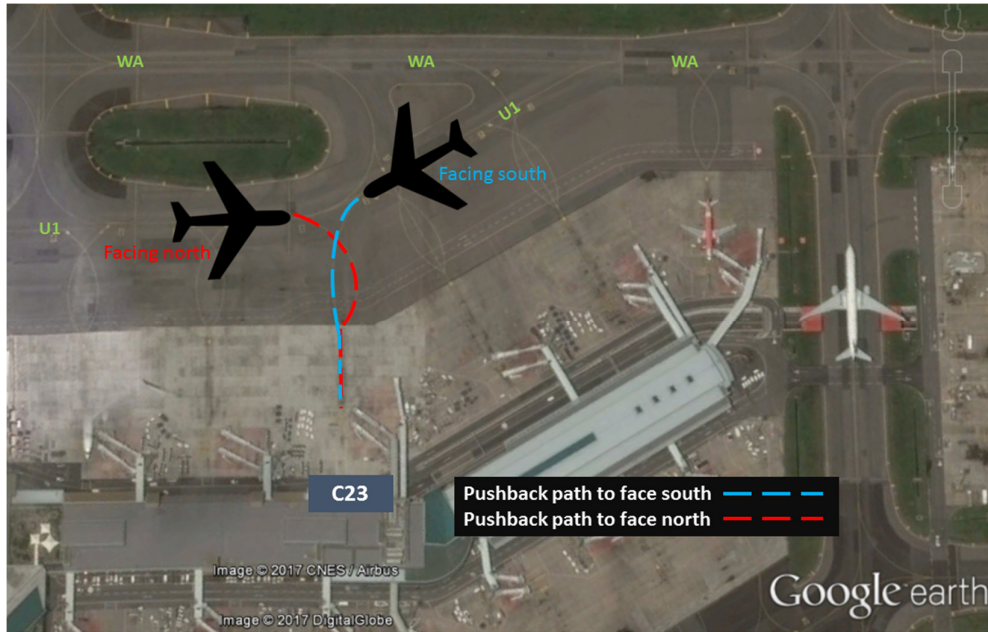


Figure 3: Pushing back of A380 from parking bay C23

- 1.1.9 At 01:38 hours, the flight crew of the B787 informed Air Traffic Control (ATC) that they were approaching the intersection of WA and NC3. The OJT trainee instructed the B787 to "...continue on the greens and hold short V6"⁴ (see Figure 2).
- 1.1.10 After this, the OJT trainee and trainer turned their attention away from the B787 to manage four departing aircraft near the holding position of Runway 02L.
- 1.1.11 In the meantime, the B787 continued to taxi along NC3. As the aircraft approached the intersection of WA and NC3, the flight crew observed that there was a continuous path of green lights leading from NC3 to WA on the left. The flight crew also observed that, on the remaining section of NC3 beyond the intersection, there were no green taxiway centreline lights and there were illuminated red stop bar lights. Thus, the flight crew adhered to the instruction of "taxi on greens" and turned left onto WA.
- 1.1.12 After turning onto WA, both the Pilot-in-command (PIC) and First Officer (FO) of the B787 saw the A380 on U1. The FO, who was taxiing the B787, slowed the aircraft significantly as the nose of the B787 came up abeam the A380's vertical stabiliser. Both the PIC and FO visually judged that there was enough clearance between the two aircraft for them to continue taxiing along WA.
- 1.1.13 Meanwhile, the A380 had been pushed out of C23 onto U1. The tow tug driver saw the B787 approaching. He stopped the tow tug as he was unsure if there was sufficient clearance.

⁴ As mentioned in paragraph 1.1.4, the OJT trainee had intended for the B787 to taxi on WP.

- 1.1.14 While passing the A380 at about 01:40 hours, the left wing of the B787 came into contact with the right winglet of the A380. The tow tug driver heard a scrapping sound. However, the flight crew of the B787 felt only a slight jerk and they thought the aircraft had taxied over some uneven ground on the taxiway and they continued the taxiing.
- 1.1.15 After managing the four departing aircraft near Runway 02L, the OJT trainee and trainer turned their attention back to the B787 at about 01:41 hours. They then realised that the B787 was taxiing on WA instead of WP. At that time, the B787 was approaching Taxiway VZ. The OJT trainee was not aware of anything untoward, and instructed the B787 to taxi to WP via V6 for departure on Runway 02L.
- 1.1.16 At about 01:42 hours, the flight crew of the A380 requested to return to the parking bay C23 after they had learnt from the towing crew that the A380's right wing was damaged. ATC approved the request.
- 1.1.17 The flight crew of the B787 overheard the transmission from the A380 and stopped taxiing on WA. The PIC instructed the cabin crew to visually inspect the left wing for any anomaly. After being informed that the navigational light on the left wing appeared to be detached and hanging freely, the flight crew requested to return to a parking bay.

1.2 Injuries to persons

- 1.2.1 There were no injuries in this occurrence.

1.3 Damage to aircraft

- 1.3.1 The left wing of the B787 was damaged. The damage included the following:

- Delamination and scuffing of multiple composite panels
- Multiple bent and abraded skin panels
- Cracked wing tip light lenses
- Severed static discharger wicks

- 1.3.2 The right wing of the A380 was damaged. The damage included the following:

- Delamination, cracks and perforation of multiple skin panels
- Scratches on wing leading edge and slats
- Cracked ribs and spars
- Severed static discharger wicks

1.4 Personnel information

1.4.1 B787 pilots' information

1.4.1.1 Pilot-in-command (PIC)

Gender	Male
Age	58
License	Air Transport Pilot Licence
Total Flying Experience	17,000 hours
Total on type	314 hours
Flying in last 24 hours	0
Flying in last 7 days	17 hours
Flying in last 28 days	75 hours
Flying in last 90 days	239 hours

1.4.1.2 First Officer (FO)

Gender	Male
Age	35
License	Commercial Pilot Licence
Total Flying Experience	2570 hours
Total on type	1270 hours
Flying in last 24 hours	0
Flying in last 7 days	19 hours
Flying in last 28 days	78 hours
Flying in last 90 days	230 hours

1.4.2 Air traffic controllers' information

1.4.2.1 OJT trainer

Gender	Female
Age	26
Years of experience in Changi Aerodrome	4 years 5 months

1.4.2.2 OJT trainee

Gender	Female
Age	27
Years in service	4 years 7 months
Date of obtaining rating for Seletar Aerodrome	29 August 2013
OJT practical training to obtain rating for Changi Aerodrome	Completed 5 months at the time of occurrence and deemed by the OJT trainer to be competent to manage traffic independently

- 1.5 Meteorological information
 - 1.5.1 At the time of the occurrence, the taxiways/taxilanes were dry and the visibility was 10km.
- 1.6 Aerodrome information
 - 1.6.1 Aircraft taxi guidance system
 - 1.6.1.1 The airport had an aircraft taxi guidance system consisting of stop bars and selectable segments of green taxiway centreline lights. The system was designed to provide pilots with visual route guidance for taxiing during night operations and periods of low visibility. It was controlled by the GMC at Changi Tower using the Airfield Ground Lighting Control and Monitoring System (AGLCMS). The GMC would switch on the green taxiway centreline lights corresponding to the assigned taxi route and instruct flight crews to “taxi on the greens”.
 - 1.6.1.2 ATC’s operating procedure did not require air traffic controllers to verbalise the taxiway designators when pilots were instructed to “taxi on the greens”. However, ATC would verbalise the taxiway designators if requested by the flight crew.
 - 1.6.1.3 According to ATC, this system would reduce radio communication over the air regarding the taxi route, provide flight crews with a clearer direction, and reduce the risk of making wrong turns.
- 1.7 Recorded data
 - 1.7.1 The B787 was equipped with two GE Enhanced Airborne Flight Recorders (EAFRs). Flight data and cockpit voice recordings were downloaded from each EAFR.
 - 1.7.2 The EAFR had 25 hours of flight data recording. The flight data downloaded was of good quality and flight data around the time of the occurrence was available.
 - 1.7.3 The EAFR had two hours of cockpit voice recording. However, the recording around the time of the occurrence was not available. This was because the EAFRs were not deactivated immediately after the B787 had returned to the parking bay. Thus, the cockpit voice recording around the time of the occurrence was overwritten.
 - 1.7.4 The operator of the B787 required that the EAFRs be deactivated following a significant occurrence. However, the flight crew of the B787 did not deactivate the EAFRs nor did they ask the engineering staff to effectuate the deactivation.

- 1.7.5 ATC recordings and data from the AGLCMS around the time of the occurrence were made available to the investigation team. They provided useful information about the taxiway centreline lighting configuration and positions of the aircraft on the manoeuvring area around the time of the occurrence.

- 1.8 Medical and pathological information
 - 1.8.1 The OJT trainee and trainer underwent medical examinations and toxicological tests after the occurrence. There was no evidence of any medical or toxicological factors that could have affected their performance.

- 1.9 Additional information
 - 1.9.1 Previous occurrences
 - 1.9.1.1 In the course of its investigation, the investigation team became aware of two earlier occurrences involving an aircraft taxiing on WA while another aircraft was being pushed back from C23, one on 25 June 2016 and one on 19 January 2017.
 - 1.9.2 Occurrence on 25 June 2016
 - 1.9.2.1 An A380 was being pushed back from C23 to face south on U1. The GMC instructed another aircraft (aircraft type information not available) to taxi by following the greens. The intention was for the aircraft to taxi on WP. However, the taxiing aircraft turned onto WA as the path of the lit green taxiway centreline lights was leading to WA.
 - 1.9.2.2 The GMC saw the aircraft taxiing onto WA. He was not sure whether there would be enough wing tip clearance between the taxiing aircraft and the A380. He made a prudent decision to instruct the taxiing aircraft to stop.
 - 1.9.2.3 The Air Traffic Services Provider (ATSP) was aware of the GMC's action. However, there was no follow-up on the part of the ATSP with regard to the potential hazard of the GMC not ensuring that the illuminated taxiway centreline lights tallies with his intended taxi route.

- 1.9.3 Occurrence on 19 January 2017
 - 1.9.3.1 An A380 was being pushed back from C23 to face south on U1. An A330 aircraft was following the greens and taxiing on WA as instructed by ATC. The flight crew of the A330 saw the A380. They assessed that there would not be sufficient clearance for taxiing past the A380. They stopped and alerted the GMC about the hazard.

1.9.4 Pushback procedure

- 1.9.4.1 The Singapore Aeronautical Information Publication (AIP) included an advisory⁵ (see **Figure 4**) since 15 January 2009 that aircraft taxiing on WA were not clear of aircraft that were being pushed back from parking bays C24, C25 or C26. The OJT trainee and trainer and the flight crew of the B787 were aware of this advisory. However, C23 was not a subject of the advisory. The ATSP was unable to advise if there had been a risk assessment that concluded that there would not be clearance problem with C23.

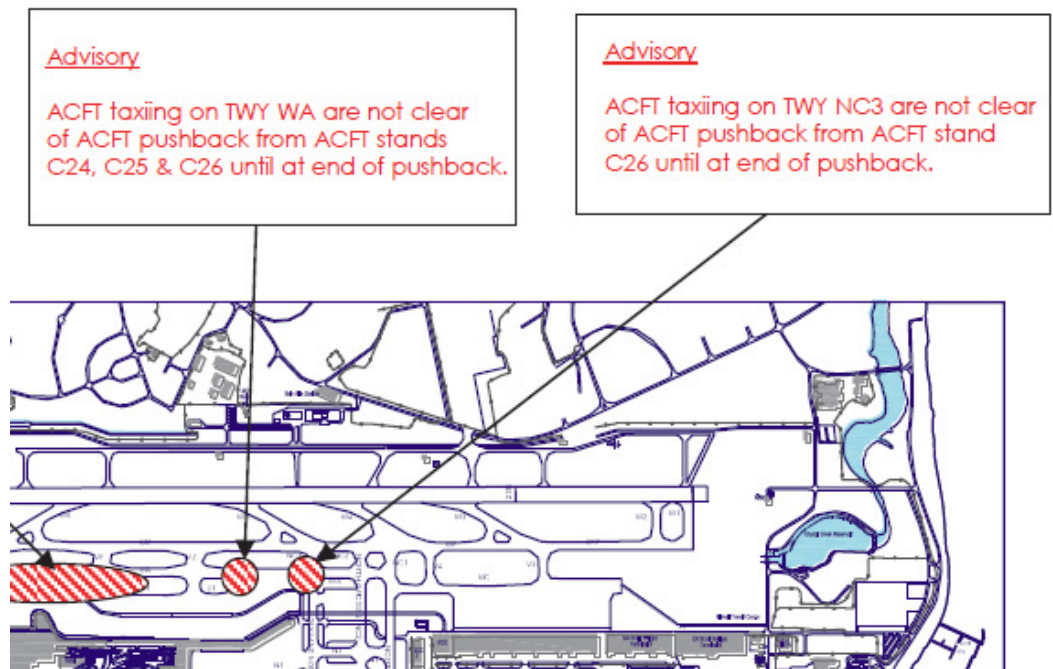


Figure 4: Excerpt of Aerodrome Advisory Chart AD-2-WSSS-ADC-3 in the Aeronautical Information Publication

- 1.9.4.2 Arising from the 19 January 2017 occurrence, the ATSP initiated a review of the pushback procedure in its Air Traffic Services Manual (ATSM). The ATSP also requested the aerodrome operator to conduct a review of the pushback operations at the aerodrome, including a determination of possible hotspots within the aerodrome where there would not be sufficient clearance between an aircraft on pushback and an aircraft on taxi. The aerodrome operator agreed to undertake the review but had not completed the review by the time of the occurrence on 30 March 2017.
- 1.9.4.3 Also arising from the 19 January 2017 occurrence, the ATSP instructed the supervisory controllers on 25 January 2017 via e-mail that they brief their air traffic controllers that there would not be sufficient clearance between an aircraft taxiing along WA and an aircraft being pushed back from C23 to face south. The ATSP intended to incorporate this instruction into the ATSM

⁵ Ref. Aerodrome Advisory Chart AD-2-WSSS-ADC-3

together with any new or revised instructions that may arise after the aerodrome operator had completed its review.

- 1.9.4.4 The OJT trainee and trainer said they had been briefed by their supervisors and were mindful of the clearance limitation when they were on duty on 30 March 2017. This was the reason the OJT trainee had in mind for the B787 to taxi on WP.

2 DISCUSSION

The investigation looked into the following:

- (a) Use of aircraft taxi guidance system
- (b) ATC verbalising the intended taxi route
- (c) Human perception challenges
- (d) Information presentation in advisory chart
- (e) Hazard identification
- (f) Preservation of recorders

2.1 Use of aircraft taxi guidance system

2.1.1 The OJT trainee's plan was for the B787 to taxi along NC3 onto WP, with an intermediate holding short of WA, and hold short of V6. She was mindful of the ATSP instruction that there would not be sufficient clearance between an aircraft taxiing along WA and an aircraft being pushed back from C23 to face south.

2.1.2 Although there were red stop bar lights on NC3 short of WA, the OJT trainee did not turn on these lights to complement her instruction to the flight crew to hold short of WA. Her reason for not turning on the red stop bar lights was that she would be able to reconfigure the aircraft taxi guidance system appropriate before the B787 arrived at the intersection of WA and NC3. However, the reconfiguration was not performed as OJT trainee and trainer had turned their attention to managing four aircraft that were making preparations for departure.

2.1.3 When the flight crew of the B787 informed ATC that they were approaching the intersection of WA and NC3, the OJT trainee instructed the B787 to "...continue on the greens and hold short V6". This instruction superseded her earlier instruction of holding short at WA.

2.1.4 Thus, seeing that the green taxiway centreline lights on WA were illuminated, and having been instructed to proceed to V6, and not having been told that they were to taxi on WP, the flight crew quite naturally followed the greens on WA.

2.1.5 The B787 could have been prevented from taxiing onto WA if at least one of the following actions had been taken:

- Switching off the green taxiway centreline lights on WA
- Verbalising the intended taxi route
- Switching on the red stop bar lights at the holding position on NC3 short of WA

2.1.6 This occurrence shows that if an air traffic controller intends to rely solely on the aircraft taxi guidance system to guide an aircraft, the benefits of this

system as mentioned in paragraph 1.6.1.2 can only be realised if the light system is configured properly to reflect the intended taxi route.

2.1.7 The repeated instances where an air traffic controller's intended taxi route differs from the configuration of the aircraft taxi guidance system suggests a need for the ATSP to review the use of the AGLCMS to ensure that the way in which the green taxiway centreline lights are configured do not create situations where pilots inadvertently taxi along unintended routes.

2.2 ATC verbalising the intended taxi route

2.2.1 One of the benefits of the "taxi on the greens" system was said to be a reduction of the possibility of making wrong turn during taxiing (see paragraph 1.6.1.2). This occurrence suggests that the benefit was not always realised.

2.2.2 There may be merit in ATC verbalising the taxi route. Any inconsistency between the verbalised taxi route and the illuminated green lights could alert the flight crew to seek clarification from ATC.

2.2.3 In its report on an attempted take-off on a taxiway on 12 July 2015, the then Air Accident Investigation Bureau of Singapore made the following safety recommendation:

It is recommended that the ATC consider verbalising the main taxi route in addition to the instruction to "taxi on the greens" in the taxi clearance. [AAIB Recommendation R-2016-005]

2.2.4 The ATSP considered the safety recommendation and assessed that verbalising the main taxi route in addition to the instruction to "taxi on the greens" when issuing taxi instruction would carry its own hazard. The ATSP's risk assessment included the following considerations:

- (a) The lighting up of the green centreline lights along a specific designated route is to provide pilots with a clear guidance without them having to receive long verbal instructions. Verbalising the taxi route in addition to the green centreline lights would create a double layer of instructions which could complicate operations leading to safety hazard.
- (b) Duplicating the taxi instructions would create congestion on the radio, and increase the workload in the Tower and the cockpit to process and corroborate the two sets of instructions (verbal and green centreline lights). This radio congestion would create a safety hazard as it could block out calls from pilots or other controllers if they need to take urgent action.

- 2.2.5 In view of the occurrences on 25 June 2016, 19 January 2017 and this 30 March 2017 occurrence, it would be desirable for the ATSP to review its risk assessment and to see if verbalisation of the taxi route could at least be invoked in a limited set of circumstances.
- 2.3 Human perception challenges
- 2.3.1 The B787 pilots would not have had to make the judgment of clearance between their aircraft and the A380, had they not been wrongly guided to turn onto WA by following the greens.
- 2.3.2 The B787 pilots slowed their aircraft as it was approaching the A380 as they were aware of the potential lack of clearance posed by the positioning of the A380.
- 2.3.3 Both the B787 pilots saw the right wing tip of the A380 and determined that it was clear of their aircraft. They also identified the vertical stabiliser of the A380 as the hazard closest to their own aircraft. As such, they had the confidence to continue taxiing on WA after they had taxied past the vertical stabiliser of the A380.
- 2.3.4 Studies⁶ have suggested that the human visual perception can be affected by external factors⁷, in terms of one's ability to make accurate visual judgment. As such, it is important for pilots to recognise the limitations on human visual perception and all the more so, in low visibility situations where the lack of visual cues makes it even more challenging to make an accurate judgment.
- 2.3.5 One of the primary objectives of an air traffic controller is to prevent collision between aircraft on the aerodrome manoeuvring area. This occurrence highlights the importance for air traffic controllers to ensure sufficient clearance between traffic to avoid placing pilots in situations where they are required to exercise their judgment based purely on visual perception.
- 2.3.6 Pilots should also be mindful that in situations where they determine a potential lack of clearance between their aircraft, it would be prudent to hold position and seek clarification from ATC.
- 2.3.7 Instead of relying on pilots to visually judge wing tip clearance, it should be possible to harness modern technology to help pilots make the judgment. Proximity sensors or cameras installed at the wing tips should be able to complement pilots' vision for the judgment of wing tip clearance.

⁶ See publication titled "Night Vision: Current Research and Future Directions, Symposium Proceedings" authored by Working Group on Night Vision, Committee on Vision, Commission on Behavioral and Social Sciences and Education.

⁷ For this occurrence, the ambient lighting, contrast between the brightly lit vertical stabiliser of the A380 and its dark right wing tip, and relative position of both aircraft were factors that could have affected the pilots' visual perception.

- 2.4 Information presentation in advisory chart
- 2.4.1 The Aerodrome Advisory Chart was published for the purpose of providing advisory to air traffic controllers and pilots when operating in the aerodrome. The majority of the information in the advisory was to indicate areas of the aerodrome where there was insufficient clearance for a taxiing aircraft in the vicinity of another aircraft on pushback.
- 2.4.2 It was stated in Aerodrome Advisory Chart AD-2-WSSS-ADC-3 that “ACFT taxiing on TWY WA are not clear of ACFT pushback from ACFT stands C24, C25 & C26 until at the end of pushback.” This piece of information was useful for the air traffic controllers as this would make them avoid instructing another aircraft to taxi on WA when they are aware that an aircraft was being pushed back from C24, C25 or C26.
- 2.4.3 However, the way this piece of information is written could give the impression that the advisory is relevant only when there is a pushback. If a pilot taxiing on WA sees an aircraft already on the angled portion of U1 (as shown in Figure 3), it might not occur to the pilot that the aircraft had been pushed back from C24, C25 or C25 and, thus, the pilot might not think that the advisory is of relevance, thereby missing the implication therein – that the taxiing aircraft would not be clear from any aircraft on the angled portion of U1, regardless of whether this latter aircraft was stationary, taxiing or being pushed back. To better ensure that pilots seize the significance of Aerodrome Advisory Chart AD-2-WSSS-ADC-3, perhaps the advisory could be reworded as “ACFT taxiing on TWY WA are not clear of any aircraft occupying the angled section of U1”, or similar wording to the same effect.
- 2.5 Hazard identification
- 2.5.1 An organisation’s safety management system⁸ would entail reviewing occurrences and identifying potential hazards and the corresponding mitigating measures.
- 2.5.2 While the ATSP was aware of the GMC’s action in the 25 June 2016 occurrence, there was no evidence that the ATSP reviewed the occurrence which had resulted from a non-alignment of green taxiway centreline lights with the GMC’s intended taxi route.
- 2.5.3 The occurrence would have provided an opportunity for the ATSP to identify the following two safety issues:
- (a) The insufficient clearance between an aircraft taxiing on WA and an aircraft being pushed back from C23 to face south; and

⁸ Safety management system is a systematic approach to managing safety, which includes the identification of safety hazards and implementing remedial action.

- (b) The non-alignment of green taxiway centreline lights with a GMC's intended taxi route.
- 2.5.4 Had the first of the above two safety issues been identified, the 19 January 2017 occurrence could have been avoided.
- 2.5.5 Likewise, had the second of the above two safety issues been identified, the 30 March 2017 occurrence could also have been avoided.
- 2.6 Preservation of recorders
 - 2.6.1 The airline operator of the B787 required that the EAFRs be deactivated following a significant occurrence. However, the flight crew of the B787 did not deactivate the EAFRs after the wing clipping, nor did they ask the engineering staff to effectuate the deactivation. As a result, no cockpit voice recording was available to the investigation team for analysis.
 - 2.6.2 The importance of airline operators ensuring a robust procedure to prevent flight recordings from being overwritten cannot be overemphasised.

3 SAFETY ACTIONS

During the course of the investigation and through discussions with the investigation team, the following safety actions were initiated.

Safety actions by ATSP

- 3.1 The ATSP shared the lessons learnt from the 30 March 2017 occurrence with its air traffic controllers in April 2017 to remind the air traffic controllers about the restriction of not allowing aircraft pushback from Bay C23 to face south.
- 3.2 The OJT trainee and trainer underwent refresher training on 25-26 April 2017. The training covered the basic competencies of an air traffic controller with emphasis on the area of maintaining separation between aircraft and obstacles. Both controllers underwent table top exercises and were assessed to have met the operational requirements before they resumed active air traffic control operations.
- 3.3 The ATSP is studying the feasibility of adding a detection algorithm to its detection and alerting equipment for alerting air traffic controllers of potential conflicts within the aerodrome manoeuvring areas.
- 3.4 The ATSP and aerodrome operator have jointly reviewed the pushback procedures for all parking bays and identified areas which would infringe the safe separation from any taxiing aircraft. Information and any associated mitigating actions regarding these areas will be included in the ATSP's procedures.

Safety action by aerodrome regulator

- 3.5 The Civil Aviation Authority of Singapore (CAAS) recommended to the ATSP to explore avenues to enhance the AGLCMS such that situations where pilots can inadvertently taxi onto unintended routes are eliminated. The ATSP has accepted the recommendation and is working towards the implementation of a system by 2020 where the green taxiway centreline lights are automatically switched on, just ahead of the taxi path of an aircraft and automatically switched off, once the aircraft has taxied past.

Safety actions by aerodrome operator

- 3.6 The aerodrome operator issued an Airside Operation Notice on 1 April 2017 to suspend pushback of aircraft from parking bay C23 if the aircraft would end up facing south. This suspension was lifted on 1 October 2017 when the ATSP incorporated pictorial information in the Air Traffic Services Manual to remind its controllers that WA, U1 and the adjacent parking bays

will be affected if an aircraft was allowed to face south, after a pushback from Bay C23.

- 3.7 The aerodrome operator issued an Airside Operations Notice on 3 April 2017 to remind maintenance ground crews to look out for obstructions, aircraft or vehicles in the pushback paths, including taxiways behind the parking bays and adjacent taxiways, during pushback operations. Copies of the notice were put up at every parking bay on 6 April 2017.

Safety actions by airline operator of B787

- 3.8 The operator issued an internal notice in April 2017 to remind its pilots to exercise caution during taxi when coming into close proximity of an obstacle and stop the aircraft when in doubt.
- 3.9 The operator issued an internal notice in April 2017 to remind its pilots of the requirement to deactivate the flight recorders after a significant event.
- 3.10 As part of its pilots' recurrent training cycle, the operator will include discussions, to be led by instructors, to remind its pilots of safe taxiing techniques.

Safety actions by civil aviation regulator

- 3.11 The CAAS issued an e-mail reminder on 8 August 2017 to all Singapore Air Operator Certificate holders to ensure strict compliance to the requirement of effecting the deactivation of flight recorders upon completion of a flight following an accident or a serious incident.

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.

It is recommended that:

- 4.1 The air traffic services provider consider verbalising the taxi route in addition to the instruction to “taxi on the greens” in the taxi clearance. [TSIB Recommendation RA-2018-004]
- 4.2 The Civil Aviation Authority of Singapore consider requiring the air traffic services provider to verbalise the taxi route in addition to the instruction to “taxi on the greens” in the taxi clearance. [TSIB Recommendation RA-2018-005]
- 4.3 The air traffic services provider ensure that its safety management system will identify and address safety hazards through the review of occurrences. [TSIB Recommendation RA-2018-006]
- 4.4 The Civil Aviation Authority of Singapore require the air traffic services provider to ensure that its safety management system will identify and address safety hazards through the review of occurrences. [TSIB Recommendation RA-2018-007]
- 4.5 The airline operator of the B787 review its procedures to ensure that flight recorders are deactivated at the end of a flight following a significant occurrence. [TSIB Recommendation RA-2018-008]
- 4.6 The Civil Aviation Authority of Singapore ensure that all the Singapore Air Operator Certificate holders have procedures that ensure the deactivation of flight recorders upon completion of a flight following an accident or a serious incident. [TSIB Recommendation RA-2018-009]
- 4.7 The Civil Aviation Authority of Singapore consider requiring commercial aircraft on Singapore’s register to install proximity sensors or cameras at the wing tips to assist pilots in making wing tip clearance decision. [TSIB Recommendation RA-2018-010]
- 4.8 The air traffic services provider consider revising the piece of information in the Aerodrome Advisory Chart AD-2-WSSS-ADC-3, viz. “ACFT taxiing on TWY WA are not clear of ACFT pushback from ACFT stands C24, C25 & C26 until at the end of pushback”, to ensure that pilots will not miss the information. [TSIB Recommendation RA-2018-011]