

Final Report

RUNWAY INCURSION AT CHANGI AIRPORT

5 FEBRUARY 2024

TIB/AAI/CAS.228

Transport Safety Investigation Bureau
Ministry of Transport
Singapore

8 November 2024

The Transport Safety Investigation Bureau of Singapore

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

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Table of Contents

SYNOPSIS	1
1 Factual information	2
1.1 History of the flight	2
1.2 Injuries to persons	4
1.3 Damage to aircraft	4
1.4 Personnel information	4
1.5 Meteorological information	6
1.6 Aerodrome information	6
1.7 Flight recorders	7
1.8 Medical and pathological information	7
1.9 Organisational and management information	7
2 Analysis	10
2.1 RWC's issuance of landing clearance to Aircraft B	10
2.2 RWC's decision not to cancel landing clearance for Aircraft B	11
3 Conclusions	13
4 Safety actions	14
5 Safety recommendations	15

ABBREVIATIONS

ATPL	Airline Transport Pilot Licence
ATSM	Air Traffic Services Manual
ATSP	Air Traffic Services Provider
FO	First Officer
GMC	Ground Movement Controller
JOC	Joint Operations Committee
PF	Pilot Flying
PIC	Pilot-in-Command
PM	Pilot Monitoring
RET	Rapid Exit Taxiway
RWC	Runway Controller
SAOC	Singapore Changi Airport Operations Committee
TSIB	Transport Safety Investigation Bureau of Singapore

SYNOPSIS

On 5 February 2024, a Boeing 787-9 (Aircraft A) landed on Runway 02C of Changi Airport at 0435 hrs. While Aircraft A was vacating the runway via Rapid Exit Taxiway (RET) T6, the Runway Controller (RWC) issued a landing clearance to another Boeing 787-9 (Aircraft B), in anticipation that Aircraft A would have soon vacated via RET T6 onto Taxiway T and be clear of the runway strip.

However, Aircraft A had not yet managed to vacate RET T6 when Aircraft B was about to land.

Although RET T6 was still occupied by Aircraft A, the RWC nevertheless did not cancel the landing clearance nor instruct Aircraft B to go around as the RWC saw that Aircraft B was already over the threshold of the runway and believed that it would be safer for Aircraft B to continue landing instead of going around. Aircraft B landed and passed a distance behind Aircraft A and exited the runway via another RET.

The Transport Safety Investigation Bureau of Singapore classified this runway incursion as an incident.

AIRCRAFT DETAILS

	Aircraft A	Aircraft B
Aircraft type	B787-9	B787-9
Operator	Korean Airlines	Scot
Aircraft registration	HL7209	9V-OJH
Date and time of incident	5 February 2024 0436 hrs (LT)	
Location of occurrence	Changi Airport Runway 02C, rapid exit taxiway T6	
Type of flight	Scheduled	Scheduled
Persons on board	106	354

1 FACTUAL INFORMATION

All times used in this report are Singapore Local Time (LT) unless otherwise stated. Singapore Local Time is eight hours ahead of Coordinated Universal Time (UTC).

1.1 History of the flight

1.1.1 On 5 February 2024, a Boeing 787-9 (Aircraft A) landed on Runway 02C of Changi Airport at 0435 hrs. The Pilot-in-command (PIC) was the pilot flying (PF) and the First Officer (FO) was the pilot monitoring (PM).

1.1.2 Aircraft A was instructed by the Runway Controller (RWC) to vacate via Rapid Exit Taxiway (RET) T6 and to turn left onto Taxiway T (see **Figure 1**).

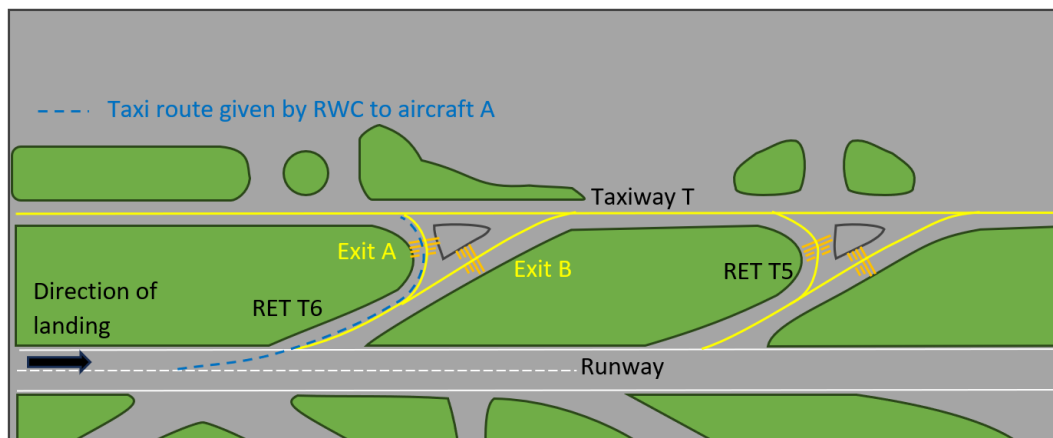


Figure 1: Taxi route given by the RWC to Aircraft A

(Note: The portions of Taxiway T6 used for turning to the left and right onto Taxiway T are labelled as “Exit A” and “Exit B” respectively. “Exit A” and “Exit B” are used solely for the purposes of this report. They are not used by the aerodrome operator or air traffic services provider.)

1.1.3 The PM read back the RWC’s instruction correctly. The RWC then instructed Aircraft A to contact the Ground Movement Controller (GMC) on the Changi Ground frequency.

1.1.4 While Aircraft A was taxiing on RET T6 after exiting the runway, the PM established contact with the GMC. The GMC provided taxi instructions to parking bay G18, which the PM read back correctly. According to both the PF and PM, they understood the taxi instruction to mean that they would need to turn onto Taxiway T via Exit A, which was in line with one of the three possible

taxi routes¹ to their eventual parking bay they had discussed during their pre-flight planning.

- 1.1.5 At 0435:47 hrs, after observing that Aircraft A had taxied onto RET T6 and was in contact with the GMC, the RWC issued clearance for another Boeing 787-9 (Aircraft B), which was about 2nm away from the runway threshold, to land on Runway 02C. At this point, Aircraft A was still in motion, taxiing on RET T6 and had yet to cross the runway holding position marking on RET T6 Exit A. The RWC issued the landing clearance to Aircraft B in anticipation that Aircraft A would soon have vacated from RET T6 onto Taxiway T (please see para 1.9.1.1 for the procedures of the air traffic services provider (ATSP))
- 1.1.6 At 0436:37 hrs, the RWC and GMC verbally mentioned that Aircraft A appeared to have stopped on RET T6 close to the runway holding position marking on RET T6 Exit B. According to the RWC, at that instant, Aircraft B was over the threshold of Runway 02C. According to the PF of Aircraft A, as the aircraft arrived at the Exit A and Exit B bifurcation, the PF heard the PM calling out for the aircraft to be stopped. The PM made the call after assessing that there was insufficient clearance (i.e. manoeuvre space) for the aircraft to turn into Exit A. The PF stopped the aircraft as per the PM's callout, in accordance with the operator's crew resource management policy.
- 1.1.7 Even though the RWC was aware that Aircraft A had come to a stop and was unable to vacate RET T6, the RWC did not cancel Aircraft B's landing clearance and instruct Aircraft B to go around. The RWC's considerations were as follows:
- The tail of Aircraft A was clear of the runway and there was no immediate obstruction that would interfere with Aircraft B's landing; and
 - Aircraft B was already over the threshold of Runway 02C and the RWC believed that it would be safer to allow Aircraft B to continue landing instead of instructing it to go around as it was in a critical operating phase for Aircraft B's flight crew which was documented as a note in the ATSM (please see para 1.9.1.5).
- 1.1.8 After Aircraft B had landed, the RWC instructed Aircraft B to vacate the runway via RET T4 (see **Figure 2**).

¹ None of the taxi routes would require the aircraft to vacate the runway via RET T6 Exit B.

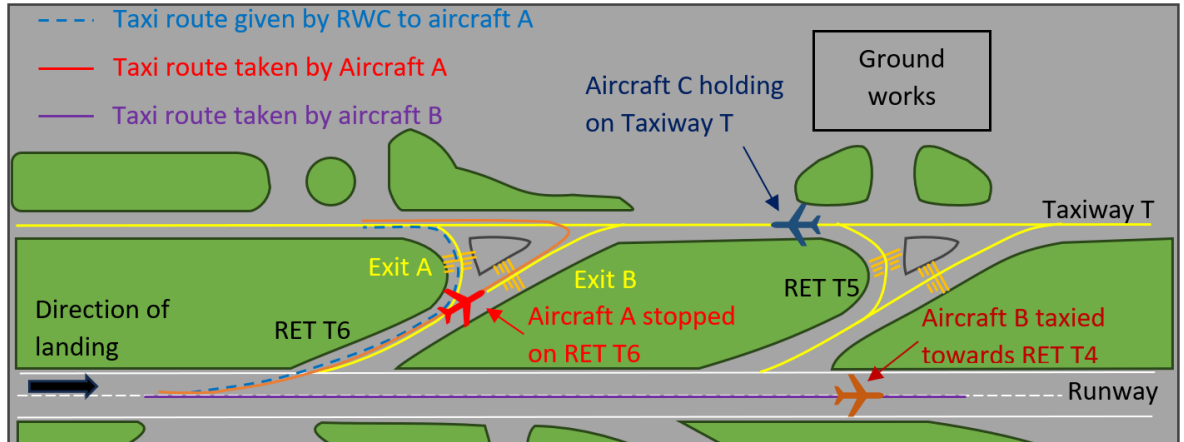


Figure 2: Movements of Aircraft A and Aircraft B

1.1.9 The GMC informed the flight crew of Aircraft A that there was another aircraft (Aircraft C) holding on Taxiway T near RET T5. The flight crew discussed and proposed to the GMC that Aircraft A taxi towards Exit B and vacate RET T6 by making a sharp left turn onto Taxiway T. The GMC assessed the overall traffic condition and acceded to the pilot's proposal. Aircraft A executed the sharp left turn onto Taxiway T and proceeded to parking bay G18.

1.2 Injuries to persons

1.2.1 There was no injury to any person.

1.3 Damage to aircraft

1.3.1 There was no damage to Aircraft A or Aircraft B.

1.4 Personnel information

1.4.1 PIC of Aircraft A

Age	54
Licence type	Airline transport pilot licence (ATPL)
Issuing authority	Korea Transportation Safety Authority
Licence validity date	Valid till 30 June 2024
Medical certificate	Class 1

Medical certificate validity	Valid till 30 June 2024
Medical operational proviso	None
Last Base Check date	14 June 2023
Last Line Check date	9 August 2023
Total flying hours	7,193 hr
Aircraft types flown	AB6, B787, B777, B737
Total hours on type	2,256 hr
Flying in last 90 days	151 hr
Flying in last 7 days	22 hr
Flying in last 24 hours	0
Duty time in last 48 hours	0
Rest period in last 48 hours	48 hr

1.4.2 FO of Aircraft A

Age	32
Licence type	Commercial pilot licence
Issuing authority	Korea Transportation Safety Authority
Licence validity date	Valid till 31 January 2025
Medical certificate	Class 1
Medical certificate validity	Valid till 31 January 2025
Medical operational proviso	Must wear corrective glasses and carry spare glasses on duty
Last Base Check date	19 January 2024
Last Line Check date	11 October 2023
Total flying hours	2,673 hr
Aircraft types flown	B787, B737
Total hours on type	1,991 hr
Flying in last 90 days	182 hr
Flying in last 7 days	23 hr
Flying in last 24 hours	0
Duty time in last 48 hours	0
Rest period in last 48 hours	48 hr

1.4.3 Runway Controller (RWC)

Age	31
ATCO licence validity	Valid till 31 May 2027
Ratings	Changi Aerodrome
Total experience	3.5 years

Experience in position manned	3 months
Duty time in last 48 hours	Morning shift on 2 and 3 February 2024, 0800–1730 hrs
Rest period in last 48 hours	29 hr since end of shift on 3 February 2024

1.4.4 Ground Movement Controller (GMC)

Age	31
ATCO licence validity	Valid till 31 August 2027
Ratings	Changi Aerodrome and Seletar Aerodrome
Total experience	7 years
Experience in position manned	7 years
Duty time in last 48 hours	Morning shift on 3 February 2024, 0800-1730 hrs
Rest period in last 48 hours	32 hr since end of shift on 3 February 2024

1.5 Meteorological information

1.5.1 The occurrence took place during hours of darkness. There was no precipitation and visibility was 10km.

1.6 Aerodrome information

1.6.1 The runway strip is a defined area including the runway and stopway, if provided, intended to reduce the risk of damage to aircraft running off a runway, and to protect aircraft flying over it during take-off or landing operations.

1.6.2 For Runway 02C/20C, the defined area (see **Figure 3**) comprises²:

- (a) An area that extends 140m laterally from the centreline of the runway
- (b) An area that extends 60m from the ends of the two stopways

² The runway strip dimensions for Runway 02C are in accordance with the requirements of the International Civil Aviation Organization.

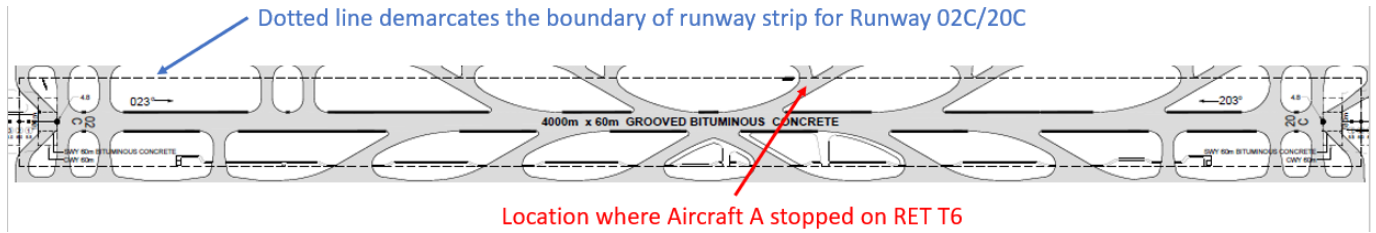


Figure 3: Runway strip area of Runway 02C/20C

1.7 Flight recorders

1.7.1 Aircraft A's flight recorders were not obtained by the Transport Safety Investigation Bureau of Singapore (TSIB) as the aircraft had departed Singapore when the occurrence was reported to the TSIB.

1.7.2 The data from Aircraft B's Enhanced Airborne Flight Recorder was downloaded and available for analysis.

1.8 Medical and pathological information

1.8.1 Medical and toxicological examinations of the flight crews were not conducted.

1.9 Organisational and management information

1.9.1 Issuance of landing clearance

1.9.1.1 According to the Air Traffic Services Manual (ATSM) of the ATSP, the requirements³ for the issuance of landing clearance are as follows:

- (a) A landing aircraft will not normally be permitted to cross the runway threshold until all preceding landing aircraft are clear of the runway-in-use.
- (b) An aircraft may be cleared to land when there is reasonable assurance that the necessary separation will exist when the aircraft crosses the runway threshold.

³ These requirements are in accordance with the International Civil Aviation Organization's Procedures for Air Navigation Services – Air Traffic Management (PANS-ATM).

1.9.1.2 The ATSP indicated that, to meet the above requirements, when an air traffic controller has reasonable assurance that the preceding aircraft is in a continuous motion vacating the runway and will clear the runway (the term runway refers to the runway strip as described in para 1.6) in time for the succeeding arrival, the landing clearance for the succeeding arrival aircraft can be issued.

1.9.1.3 In the ATSM, a runway incursion is defined as an occurrence involving the incorrect presence of an aircraft, vehicle or person on the protected area of a surface (the term “protected runway” refers to the runway strip as described in Section 1.6) designated for the landing and take-off of aircraft.

1.9.1.4 The ATSM provides that:

In the event the air traffic controller, after a take-off clearance or landing clearance has been issued, becomes aware of runway incursion or the imminent occurrence thereof, or the existence of any obstruction on or in close proximity to the runway likely to impair the safety of an aircraft taking off or landing, appropriate action shall be taken as follows:

- (a) *cancel the take-off clearance for a departing aircraft;*
- (b) *instruct a landing aircraft to execute a go-around or missed approach;*
- (c) *in all cases inform the aircraft of the runway incursion or obstruction and its location in relation to the runway.*

1.9.1.5 There is also a note in the ATSM, for the air traffic controllers’ awareness, indicating that:

An aborted take-off or a go-around executed after touchdown may expose the aeroplane to the risk of overrunning the runway. Moreover, a low altitude missed approach may expose the aeroplane to the risk of a tail strike. Pilots may, therefore, have to exercise their judgement in accordance with Annex 2, 2.4⁴, concerning the authority of the pilot-in-command of an aircraft.

⁴ ICAO Annex 2, 2.4 states that the pilot-in-command of an aircraft shall have final authority as to the disposition of the aircraft while in command.

- 1.9.2 Change management of ground works at the aerodrome
- 1.9.2.1 When there is a planned prolonged closure of a runway or taxiway in Changi Airport, the potential hazards, impact on safe movement of aircraft and possible mitigating measures will be discussed at the following forums:
- (a) Joint Operations Committee (JOC) which comprises the aerodrome operator and ATSP.
 - (b) Singapore Changi Airport Operations Committee (SAOC) which comprises the aerodrome operator, ATSP and other stakeholders such as air operators.
- 1.9.2.2 At the SAOC meeting scheduled on 12 December 2023, one of the items discussed was how aircraft movements would be affected by construction works at the Terminal 2 apron area adjacent to Taxiway T (see Figure 2 above). According to the notes of the meeting, the SAOC identified six parking stands in Terminal 2 where aircraft pushback operation could affect aircraft movement on Taxiway T and arrival aircraft vacating Runway 2 via Taxiway T. The ATSP and aerodrome operator developed additional procedures for pushback operation at these six parking stands to ensure that there is sufficient clearance between the aircraft being pushed back and the aircraft taxiing on Taxiway T.
- 1.9.2.3 According to the ATSP, potential hazards of any unexpected stoppage of aircraft movements on the RETs of Runway 02C/20C were already sufficiently addressed in the ATSM (see paragraph 1.9.1.4). As long as air traffic controllers adhered to the procedure, the risk of a loss of separation between two aircraft would be mitigated.

2 ANALYSIS

Aircraft B was landing on Runway 02C when Aircraft A was still on RET T6 at the Exit A and Exit B bifurcation. This constituted a runway incursion - incorrect presence of Aircraft A within the runway strip which should be free of aircraft or existence of any obstruction when Aircraft B was landing.

The investigation looked into the following:

- (a) RWC's issuance of landing clearance to Aircraft B
- (b) RWC's decision not to cancel landing clearance for Aircraft B

2.1 RWC's issuance of landing clearance to Aircraft B

2.1.1 Ideally, when an air traffic controller issues a landing clearance for an aircraft, the entire runway strip should be clear of any traffic until the aircraft touches down.

2.1.2 However, in aerodromes where there is high traffic volume, ICAO's provisions⁵ allow an ATSP to conduct safety assessment to determine an acceptable level of safety and to develop procedures for scenarios where there is reduced runway separation between a landing aircraft and the preceding landing aircraft. This allows a more practical approach for ATSPs to handle a higher volume of traffic more efficiently while maintaining an acceptable level of safety.

2.1.3 In line with ICAO's provisions, the ATSP involved in this incident had developed a procedure where its air traffic controllers may issue a landing clearance to an aircraft when there is reasonable assurance that the preceding aircraft will clear the runway in time for the succeeding arrival.

2.1.4 In this occurrence, the RWC had issued a landing clearance to Aircraft B in line with the ATSP's procedures as Aircraft A had already established contact with the GMC and was in a continuous motion and was vacating the runway via RET T6. The RWC had expected that Aircraft A would have crossed the runway holding line position markings, and been clear of the runway strip, by the time Aircraft B crossed the runway threshold.

⁵ Refer to paragraph 7.11 "Reduced runway separation minima between aircraft using the same runway" of ICAO Doc 4444 Procedures for Air Navigation Services – Air Traffic Management (PANS-ATM).

- 2.2 RWC's decision not to cancel landing clearance for Aircraft B
- 2.2.1 At about 0435:47 hrs the RWC issued landing clearance to Aircraft B. At 0436:37 hrs (about 50 seconds later), the RWC and GMC verbally mentioned that Aircraft A appeared to have stopped on RET T6 close to the runway holding position marking on RET T6 Exit B. According to the RWC, at that instant, Aircraft B was over the threshold of Runway 02C.
- 2.2.2 Given that Aircraft A had not yet vacated the runway strip, this situation constituted a runway incursion. In this situation where a runway incursion occurred after a landing clearance had been issued, the appropriate actions to be taken as stated in the ATSM are:
- (a) To instruct the landing aircraft to execute a go-around or missed approach; and
 - (b) To inform the landing aircraft of the runway incursion or obstruction and its location in relation to the runway.
- 2.2.3 Even though Aircraft B was close to touchdown, it was still possible for Aircraft B to go around as the aircraft was still airborne. The RWC's decision not to cancel the landing clearance for Aircraft B was based on his personal assessment that it was safer for Aircraft B to continue the landing than for him to instruct Aircraft B to go around, taking into consideration that the tail of Aircraft A was clear of the runway and was not obstructing Aircraft B. However, this decision was not in line with the ATSM procedures.
- 2.2.4 The investigation team opined that the safety margin had been reduced when the RWC did not cancel the landing clearance for Aircraft B. Had Aircraft B experienced a runway excursion during the landing and veered off the left edge of the runway, the presence of Aircraft A on the runway strip would constitute a hazard.
- 2.2.5 While it is not common for a landing aircraft to overshoot, undershoot or veer off the runway, the landing phase for an aircraft carries the highest risk in an aircraft's flight operation. The landing aircraft may take on an unintended path. Therefore, it is important for air traffic controllers to keep in mind that the main purpose of having a runway strip that is free of other aircraft and any other obstacles is to reduce the risk of damage should an aircraft undershoot, overrun or veer off the runway.

2.2.6 The ATSM includes a note for its air traffic controllers to be aware of increased risks associated with a low level missed approach or go-around. This note does not imply that an air traffic controller should be discouraged or not issue a go-around instruction when an aircraft is close to touchdown if other safety risks arise, such as the runway incursion in this occurrence.

3 **CONCLUSIONS**

From the information gathered, the following findings are made. These findings should not be read as apportioning blame or liability to any particular organisation or individual.

- 3.1 The RWC's issuance of landing clearance to Aircraft B was in line with the ATSP's procedures.
- 3.2 The RWC did not cancel the landing clearance for Aircraft B despite the runway incursion. This was not in line with the ATSM procedures.

4 SAFETY ACTIONS

Arising from discussions with the investigation team, the organisation(s) has/have taken the following safety action.

4.1 Between 6 and 9 Feb 24, the ATSP conducted briefing sessions for all its air traffic controllers to:

- (a) review the occurrence and share the lessons learnt; and
- (b) remind them to instruct a landing aircraft to go around whenever there is doubt as to whether the preceding landing aircraft had fully vacated the runway.

5 **SAFETY RECOMMENDATIONS**

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