

Final Report

B787-9, REGISTRATION 9V-OJD TURBULENCE EVENT

6 SEPTEMBER 2024

TIB/AAI/CAS.239

Transport Safety Investigation Bureau
Ministry of Transport
Singapore

4 October 2025

The Transport Safety Investigation Bureau of Singapore

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ABBREVIATIONS

ATC	Air Traffic Control
CAT	Clear Air Turbulence
CIC	Crew-in-Charge
CVR	Cockpit Voice Recorder
DFDR	Digital Flight Data Recorder
FCOM	Flight Crew Operating Manual
FIR	Flight Information Region
G	Gravitational Force
HKO	Hong Kong Observatory
PA	Passenger Address
PF	Pilot Flying
PM	Pilot Monitoring
PIC	Pilot-in-Command
PIREP	Pilot Report
OFP	Operational Flight Plan
OM	Operations Manual
VWS	Vertical Windshear
WXR	Weather Radar

SYNOPSIS

On 6 September 2024, a Boeing B787-9 passenger flight from Singapore to Baiyun International Airport in Guangzhou, China, encountered turbulence in the vicinity of waypoint TAMOT while on descent to Guangzhou. A passenger and a cabin crew sustained serious injuries.

The Transport Safety Investigation Bureau of Singapore classified this occurrence as an accident.

AIRCRAFT DETAILS

Aircraft type	:	Boeing B787-9
Operator	:	Scoot
Aircraft registration	:	9V-OJD
Date and time of incident	:	6 September 2024 at 0044 UTC
Location of occurrence	:	Hong Kong Flight Information Region, near waypoint TAMOT
Type of flight	:	Scheduled
Persons on board	:	339 passengers and 13 crew members

1 **FACTUAL INFORMATION**

All times used in this report are Coordinated Universal Time (UTC) unless otherwise stated.

1.1 History of the flight

1.1.1 On 5 September 2024, a Boeing B787-9 aircraft was to operate a scheduled flight from Changi Airport, Singapore to Baiyun International Airport, Guangzhou, China. The flight crew comprised a Pilot-in-Command (PIC) and a First Officer (FO). The PIC was the Pilot Flying (PF) and the FO the Pilot Monitoring (PM).

1.1.2 The PIC and the FO reviewed pre-flight briefing package¹ prepared by the flight dispatcher for the flight to Guangzhou, which included the weather prognostic chart. The weather forecast was as follows (see **Figure 1**):

- (a) Isolated embedded cumulonimbus clouds reaching an altitude of 48,000 feet over Ho Chi Minh Flight Information Region (FIR)
- (b) Occasional embedded cumulonimbus clouds reaching an altitude of 50,000 feet over the South China Sea
- (c) Super Typhoon Yagi (hereinafter referred to as Yagi) at the east of Hainan Island moving west
- (d) Moderate showers expected around the scheduled arrival time (0125hrs on 6 September 2024) in Guangzhou

¹ Pre-flight briefing package contains the Operational Flight Plan (OFP), Notice to Airmen (NOTAM), Internal Notice to Airmen (INTAM), weather prognostic chart, potential clear air turbulence (CAT) chart and forecasted weather satellite images.

- 1.1.6 At about 0003hrs on 6 September 2024, the aircraft entered Sanya FIR. The PIC observed that there was no weather return² on the weather radar (WXR) display along the aircraft's flight path. He also looked outside the cockpit windows and saw that there was no weather on the flight path. Considering that the flight was smooth at this point, the PIC decided to switch off the fasten-seat-belt signs to allow passengers to use the lavatories prior to the commencement of descent to Guangzhou.
- 1.1.7 Upon entering Hong Kong FIR, the PIC requested Hong Kong ATC for permission to deviate from weather up to 15nm to either the left or right of the flight path to circumnavigate some small isolated patches of weather. Hong Kong ATC approved their request. According to the flight crew, the actual deviations were less than 15nm.
- 1.1.8 About 20 minutes prior to reaching the top of descent and in anticipation of weather, the PIC reminded the passengers via the public address (PA) system that, if they wished, they could use the lavatories before he switched on the fasten-seat-belt signs again. Following the PA announcement, the cabin crew began preparing the cabin for landing.
- 1.1.9 At about 0029hrs, Hong Kong ATC instructed the flight crew to descend to 22,000 feet and proceed direct to waypoint TAMOT (see **Figure 1**), weather permitting.
- 1.1.10 According to the flight crew, during the descent to 22,000 feet, they observed that there was no weather return on the WXR display. The PIC also looked outside the cockpit windows and saw that there was no weather on the flight path. The flight crew proceeded to track direct to waypoint TAMOT.
- 1.1.11 At about 0041hrs, Hong Kong ATC instructed the flight crew to descend to 14,800 feet. The flight crew initiated the descent as instructed. According to the flight crew, the WXR display did not show any weather return along the flight path and showed only small green patches³ about 30nm to the left of the flight path. The aircraft was flying in and out of light clouds and did not experience any turbulence. The PIC assessed that the flight path ahead would be smooth and felt that he could let the passengers have more time to use the lavatories before switching on the fasten-seat-belt signs.

² A weather return is the depiction of precipitation on the weather radar display.

³ Green indicates light precipitation, yellow indicates moderate precipitation and red indicates heavy precipitation.

- 1.1.12 At about 0044hrs, when the aircraft was descending through 18,700 feet and approaching waypoint TAMOT, the aircraft encountered turbulence. Data from the digital flight data recorder (DFDR) showed that the vertical acceleration decreased from +1G to +0.71G in 0.99 seconds, then increased to +2.86G in 0.43 seconds (during which the stick shaker⁴ was activated) and then decreased to +0.36G in 1.25 seconds, before stabilising at +1G after another 4 seconds.
- 1.1.13 According to the PIC, he switched on the fasten-seat-belt signs as soon as the turbulence was felt. In response to the stick shaker activation, the flight crew assessed the information displayed on the cockpit instruments. Aircraft parameters appeared normal to them. The autopilot remained engaged throughout the turbulence encounter and the PIC did not deem it necessary to disengage it. DFDR data showed that the aircraft pitch angle reached a peak of +1.02° (nose up) around the time the stick shaker was activated, before pitching downward to -1.03° (nose down) 1.26 seconds later. The indicated wind speed was relatively stable during the turbulence encounter.
- 1.1.14 The aircraft continued the descent to waypoint TAMOT and levelled off at 14,800 feet. Shortly after, the aircraft was transferred to Guangzhou ATC. The PIC made a pilot report (PIREP) to Guangzhou ATC regarding the turbulence encounter. The aircraft did not encounter turbulence for the rest of the flight.
- 1.1.15 The CIC made a PA announcement immediately after the turbulence, instructing the cabin crew and passengers to be seated and to have their seat belts fastened. Shortly after, a cabin crew member notified the CIC that two passengers⁵ and two cabin crew members⁶ were found injured. When the aircraft had stabilised, the CIC went to check on the passengers and cabin crew.
- 1.1.16 The CIC reported the injuries to the PIC. This was about 15 minutes before landing. After assessing the injuries, the CIC advised the PIC that urgent

⁴ Stick shaker is a mechanical device that shakes the control column to warn a flight crew of the onset of stall (source: Skybrary).

⁵ One passenger sustained a lower back injury (fractured lumbar spinal bone) and underwent surgery at a hospital in Guangzhou. The other passenger reported a suspected sprained ankle during the flight but was assessed by medical personnel upon arrival as not sustaining any injury.

⁶ One cabin crew member sustained serious injury (right foot fractures) and subsequently underwent surgery at a hospital in Singapore. The other cabin crew member sustained minor injury and was able to continue with cabin duties. After arriving in Guangzhou, eight other cabin crew members were also diagnosed as having sustained minor injuries.

medical attention via Med Link⁷ was not needed but suggested to the PIC to request for three wheelchairs and medical assistance to be made available upon arrival in Guangzhou. The flight crew informed the operator's ground handling agent to arrange for the wheelchairs and medical assistance. The flight crew assessed that the situation was manageable and that it was not necessary to declare a medical emergency.

1.1.17 One of the cabin crew members who were injured was unable to continue with cabin duties and was replaced by another cabin crew member to man Door 3R. A senior cabin crew member briefed the replacement cabin crew member on the safety equipment and emergency procedures pertaining to Door 3R.

1.1.18 The aircraft continued to Guangzhou and landed at 0110hrs without further incident.

1.2 Injuries to persons

Injuries	Flight Crew	Cabin Crew	Passengers	Total
Fatal	0	0	0	0
Serious	0	1	1	2
Minor	0	9	0	9
Uninjured	2	1	338	341
Total	2	11	339	352

1.3 Damage to aircraft

1.3.1 There was no damage to the aircraft.

1.4 Personnel information

1.4.1 PIC

Age	49
Licence type	Airline Transport Pilot Licence
Issuing authority	Civil Aviation Authority of Singapore
Licence validity date	Valid till 28 February 2025
Medical certificate	Class 1

⁷ Med Link is a tele-medical support service.

Medical certificate validity	Valid till 28 February 2025
Medical operational proviso	Holder shall wear corrective lenses that correct for distant vision and shall have available a second pair of spectacles while exercising the privileges of the license.
Last Base Check date	6 June 2024
Last Line Check date	10 March 2024
Total flying hours	11,520 hours
Aircraft types flown	Boeing B777, B787
Total hours on type	4,504 hours
Flying in last 90 days	238 hours
Flying in last 7 days	24 hours 30 minutes
Flying in last 24 hours	0 hour
Duty time in last 48 hours	8 hours 10 minutes
Rest period in last 48 hours	39 hours 50 minutes

1.4.2 FO

Age	37
Licence type	Commercial Pilot Licence
Issuing authority	Civil Aviation Authority of Singapore
Licence validity date	Valid till 31 March 2025
Medical certificate	Class 1
Medical certificate validity	Valid till 31 March 2025
Medical operational proviso	Corrective lenses for distant vision
Last Base Check date	2 August 2024
Last Line Check date	10 February 2024
Total flying hours	1,838 hours
Aircraft types flown	C172, PA28, PA44, Boeing B787
Total hours on type	1,578 hours
Flying in last 90 days	213 hours 27 minutes
Flying in last 7 days	12 hours 50 minutes
Flying in last 24 hours	0 hour
Duty time in last 48 hours	0 hour
Rest period in last 48 hours	48 hours

1.5 Aircraft information

1.5.1 Weather radar (WXR) system

1.5.1.1 The aircraft and WXR manufacturers reviewed the fault logs from the WXR system. No WXR faults were recorded during the occurrence flight. The flight

crew reported that the WXR provided consistent weather returns throughout the occurrence flight and was used for several minor deviations. There is no evidence that the WXR was not working normally

1.6 Meteorological information

1.6.1 Pre-flight briefing package

1.6.1.1 The pre-flight briefing package given to the flight crew indicated a vertical windshear (VWS)⁸ value of “1” at waypoint TAMOT. The weather prognostic chart forecasted that there was a possibility of occasional embedded cumulonimbus clouds with the top of the clouds extending up to 50,000 feet in the area above the South China Sea.

1.6.2 Location of Yagi at the time of turbulence encounter

1.6.2.1 The investigation team noted that the location of Yagi⁹ as indicated in the Tropical Cyclone Warning Bulletin issued by the Hong Kong Observatory (HKO) at 0045hrs on 6 September 2024 (one minute after the incident aircraft’s turbulence encounter) was about 195nm southwest of the aircraft (see **Figure 2**).

⁸ Vertical Windshear (VWS) value indicates the likelihood of a CAT. Greater VWS value means a higher probability of encountering CAT.

⁹ Yagi was centred about 400km (215nm) south-southwest of Hong Kong and moving west or west-northwest at about 15km/h across the northern part of the South China Sea, in the general direction of Hainan Island and Leizhou Peninsula.



(Source: Google Earth) (Annotated by TSIB) [Note: Aircraft not drawn to scale]

Figure 2: Distance between the aircraft and Yagi around the time of occurrence

1.6.3 Avoidance of adverse meteorological conditions

1.6.3.1 The flight plan, as proposed by the flight dispatcher and reviewed by the lead dispatcher, had taken into consideration the following:

- (a) The weather forecast for Guangzhou station was above operating minima.
- (b) There were limited FIR entry waypoints for China published in China's Aeronautical Information Publication.
- (c) Taking the western route (See **Figure 3**) over Vietnam meant flying closer to Yagi.
- (d) Flying the eastern route¹⁰ (See **Figure 3**) meant flying further away from Yagi.
- (e) Both the western and eastern routes required the aircraft to fly to the same FIR entry waypoint (between DULOP and ISBAN) for China.

¹⁰ This is the actual flight route taken by the occurrence aircraft.

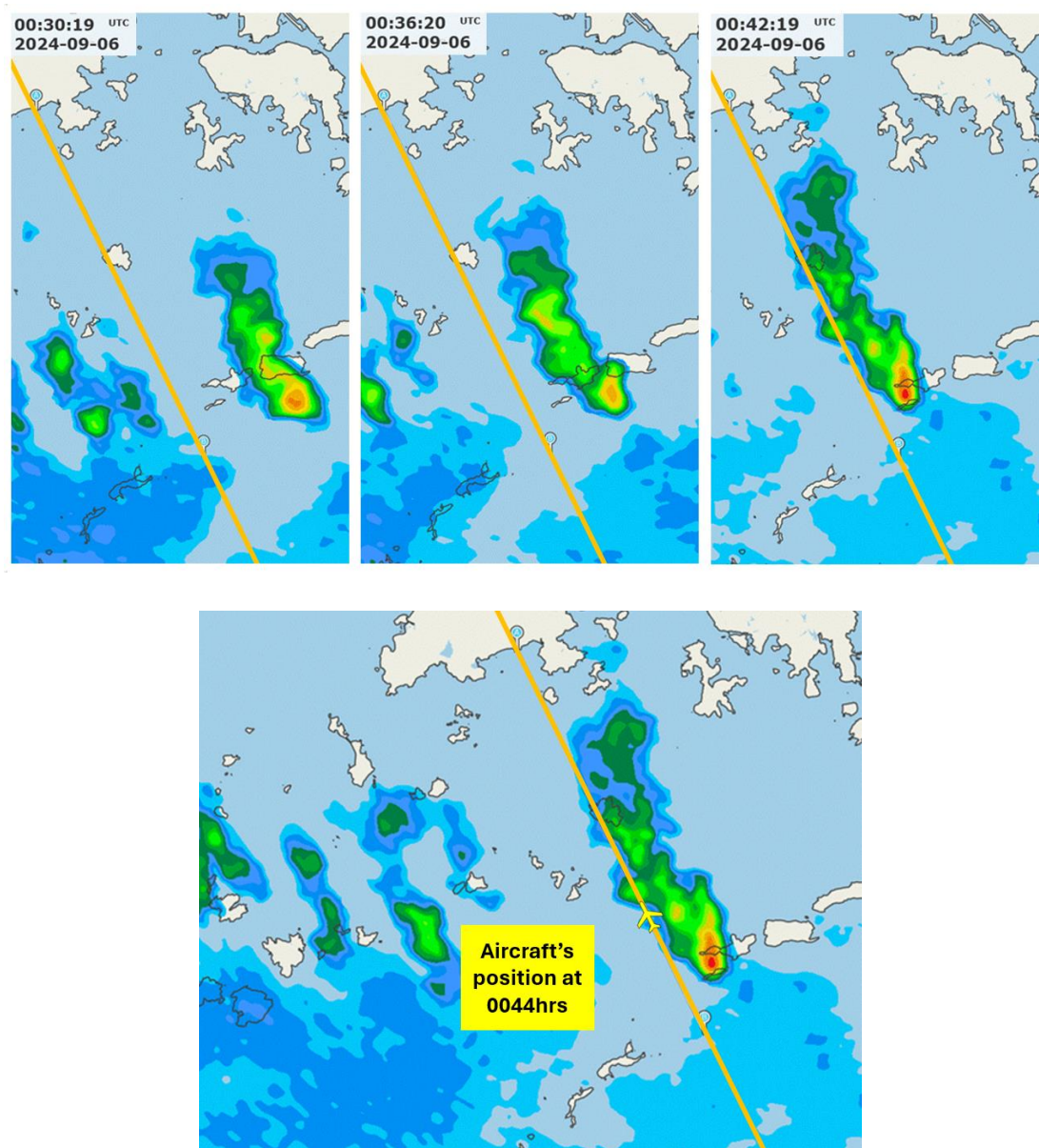
1.6.4.1 **Figure 4** is a series of ground weather radar images¹², shared by HKO and taken at 0030hrs, 0036hrs and 0042hrs¹³. The images show a weather cell at an altitude of about 10,000 feet and located to the right of the aircraft's flight path and that:

- (a) The cell consisted predominantly of low intensity radar returns (represented in green¹⁴), with some isolated areas of higher intensity returns (represented in yellow and red).
- (b) This cell was moving towards the aircraft's flight path.
- (c) A more intense convective cell (represented in red) had emerged by 0042hrs (i.e. two minutes prior to the turbulence occurrence) about 6.6nm to the south of the aircraft.

¹² A ground-based weather radar can detect adverse weather in a wider area covering up to 256km with the radar located at the centre of its coverage area, whereas aircraft's WXR is typically positioned at the nose of an aircraft for detection of weather ahead and is not able to detect weather cells rear of aircraft.

¹³ The ground weather radar images were taken six minutes apart.

¹⁴ For the colour legend used by the HKO ground weather radar images, refer to <https://www.hko.gov.hk/en/-wxinfo/radars/radar.htm>



(Source: HKO) (Annotated: TSIB) [Note: Aircraft not drawn to scale]

Figure 4: Series of ground weather radar images captured at 6-minute interval, illustrating the intensification of some areas within the weather cell (from yellow to red)

1.7 Flight recorders

1.7.1 The DFDR and Cockpit Voice Recorder (CVR) were removed from the aircraft after the occurrence. The CVR data around the time of the turbulence occurrence had been overwritten. Data from the DFDR around the time of the turbulence occurrence was available for TSIB's analysis.

1.8 Additional Information

1.8.1 Aircraft in the vicinity

1.8.1.1 The investigation team reviewed ATC radar recording from Hong Kong ATC and noted that, during the period one hour before and one hour after the time of the aircraft's turbulence encounter (0044hrs), no aircraft in the vicinity had requested Hong Kong ATC for deviation due to weather.

1.8.2 Activation of the fasten-seat-belt signs

1.8.2.1 According to the operator's Flight Crew Operating Manual (FCOM):

- (a) Under normal operating circumstances, flight crew should ensure the fasten-seat-belt signs are on when the aircraft is at 10,000 feet¹⁵ to landing; and
- (b) Flight crew should co-ordinate with cabin crew to commence arrival preparation earlier and should exercise their discretion to switch on the fasten-seat-belt signs earlier if weather conditions pose a threat during descent.

¹⁵ As mentioned in paragraph 1.1.13, the aircraft was at about 18,700 feet when it encountered turbulence.

2 ANALYSIS

- 2.1 The aircraft encountered turbulence at about 0044hrs when it was descending through 18,700 feet towards 14,800 feet. Before that, the aircraft had been having a relatively smooth flight since entering Sanya FIR at around 0003hrs, with the flight crew observing no weather ahead on their flight path and on the WXR display and needing only minor deviations to the flight path to circumnavigate some small isolated patches of weather. During this period, the fasten-seat-belt signs remained off. This was an understandable decision on the part of the PIC in view of the absence of adverse weather prior to the commencement of descent. After all, the descent had not reached the 10,000 feet level where the flight crew would be required to turn on the fasten-seat-belt signs.
- 2.2 The aircraft encountered turbulence when it was descending through 18,700 feet. Given that, at the time of the turbulence event, Yagi was some 195nm from the incident aircraft (as known from HKO's Tropical Cyclone Warning Bulletin), the investigation team does not believe that Yagi was a factor in the turbulence encounter. The investigation team opines that the turbulence encounter was more likely associated with the convective cell that had emerged by 0042hrs about 6.6nm to the south of the aircraft, as shown in the series of ground weather radar images (see **Figure 4** in paragraph 1.6.4.1). However, it must be noted that, the flight crew did not have the benefit of these ground weather radar images. As mentioned in paragraph 2.1 above, the flight crew observed no significant weather on their flight path.
- 2.3 This occurrence serves as a reminder for the following:
- (a) An aircraft's WXR functions differently from a ground-based weather radar and may not be able to detect every pocket of turbulent air. While WXR green returns suggest areas with light precipitation which are generally considered safe for passage, the possibility, even though small, of an undetected adverse weather condition cannot be ruled out. Areas of convection may initially appear as light returns (green). However, they may have intensified before such changes become apparent on the WXR.
 - (b) An aircraft may have flown past a weather system but may not necessarily be out of range of the effect of the weather system.

- (c) Turbulence can occur unexpectedly, even when the WXR does not show any adverse weather. Airlines are already constantly reminding passengers that they should fasten their seat belts while seated and refrain from moving about in the cabin unnecessarily, even when the fasten-seat-belt signs are not turned on. Passengers will do well to heed this advice.

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 Between 0003hrs when the aircraft entered Sanya FIR and the turbulence encountered at 0044hrs, the flight crew observed no weather on their flight path and needed only to perform minor deviations to the flight path to circumnavigate some isolated small patches of weather. Hence, the PIC opted to leave the fasten-seat-belt signs off. The descent had not reached the 10,000 feet level where the flight crew would be required to turn on the fasten-seat-belt signs.
- 3.2 The aircraft encountered turbulence when it was descending through 18,700 feet. The investigation team opines that the turbulence encounter was more likely associated with the convective cell that had emerged by 0042hrs about 6.6nm to the south of the aircraft. However, this patch of convective activity was to the rear of the aircraft and was not displayed on the aircraft's WXR, and the pilot could not see the weather behind the aircraft.
- 3.3 The occurrence underscores the need for flight crews to be cautious when operating near convective activities and the importance for passengers to fasten their seat belt while seated, even when the flight appears smooth.

4 SAFETY ACTIONS

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

4.1 The operator has taken the following safety actions:

- (a) Revised the guidelines on 6 September 2024 for operating in areas affected by typhoons. The fasten-seat-belt signs shall remain ON from Take-off until Top of Climb and from Top of Descent until Landing. Cabin crew and passengers shall be seated during these phases of flight. For all other flights, flight crew shall exercise caution and implement turbulence management procedures accordingly when they operate in areas with shifting wind conditions.
- (b) To reduce risk of injury due to turbulence, published a Flight Staff Instruction and a Cabin Staff Instruction on 14 October 2024 to require the flight and cabin crew to make public announcements to emphasise the need for passengers to keep their seat belts fastened while seated and to avoid moving around when the fasten-seat-belt signs are turned on. The Flight Staff Instruction also reminds the flight crew to require passengers and cabin crew to be seated during critical phases of flight, or when operating in the vicinity of inclement weather conditions.
- (c) Made available on 1 November 2024 an International Air Transport Association Turbulence Aware app in flight crews' Electronic Flight Bag to provide more details on reported turbulence along their flight path.

SAFETY RECOMMENDATIONS

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

In view of the safety actions taken by the operator, no safety recommendation is proposed. Nevertheless, it bears repeating that passengers will do well to heed airlines' advice to fasten their seat belts while seated and to refrain from moving about in the cabin unnecessarily, even when the fasten-seat-belt signs are not turned on.