

# **FINAL REPORT**

## **AIRBUS A380, REGISTRATION 9V-SKJ TURBULENCE EVENT**

**18 October 2014**

AIB/AAI/CAS.108

Air Accident Investigation Bureau of Singapore  
Ministry of Transport  
Singapore

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## **The Air Accident Investigation Bureau of Singapore**

*The Air Accident Investigation Bureau (AAIB) is the air accidents and incidents investigation authority in Singapore responsible to the Ministry of Transport. Its mission is to promote aviation safety through the conduct of independent and objective investigations into air accidents and incidents.*

*The AAIB conducts the investigations in accordance with the Singapore Air Navigation (Investigation of Accidents and Incidents) Order 2003 and Annex 13 to the Convention on International Civil Aviation, which governs how member States of the International Civil Aviation Organization (ICAO) conduct aircraft accident investigations internationally.*

*In carrying out the investigations, the AAIB will adhere to ICAO's stated objective, which is as follows:*

*"The sole objective of the investigation of an accident or incident shall be the prevention of accidents and incidents. It is not the purpose of this activity to apportion blame or liability."*

*Accordingly, it is inappropriate that AAIB reports should be used to assign fault or blame or determine liability, since neither the investigation nor the reporting process has been undertaken for that purpose.*

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## SYNOPSIS

The Airbus A380 aircraft encountered severe turbulence while on approach to Mumbai.

While descending from Flight Level (FL) 380 to FL150, the flight crew observed on the weather radar display a patch of isolated cumulonimbus (CB) clouds near their flight path. In anticipation of the adverse weather ahead, the flight crew turned on the “fasten seat belt” sign.

At about 86nm from Mumbai Airport, the flight crew requested for a heading of 300°, which would keep the aircraft at least 10nm clear of the adverse weather. The request was approved by ATC. The flight crew recalled that the flight was smooth and calm from the start of descent until the turbulence encounter.

When the aircraft had passed the observed weather, the flight crew, on two occasions with an interval of about two seconds, felt some light to moderate turbulence which lasted about one to two seconds each. The “fasten seat belt” sign had already been turned on but the cabin crew was still preparing the cabin for landing.

The Senior First Officer, who was the pilot flying the aircraft, made an announcement through the Public Address (PA) system just before the aircraft encountered the turbulence to instruct the cabin crew members to be seated. Some passengers and cabin crew members were thrown up towards the cabin ceiling and were injured. Four of them suffered serious injury.

The occurrence was most probably a case of encounter with clear air turbulence.

The aircraft eventually landed in Mumbai Airport and the injured persons received medical attention.

The Air Accident Investigation Bureau of India classified this occurrence as an accident and delegated its investigation to the Air Accident investigation Bureau of Singapore.

## AIRCRAFT DETAILS

Aircraft type	:	Airbus A380-841
Operator	:	Singapore Airlines
Aircraft registration	:	9V-SKJ
Numbers and type of engines	:	4 x Rolls Royce Trent 970-84
Date and time of incident	:	18 October 2014, 16:04 UTC
Location of occurrence	:	About 60nm southeast of Mumbai Airport
Type of flight	:	Scheduled passenger flight
Persons on board	:	433

## 1 FACTUAL INFORMATION

All times used in this report are Coordinated Universal Time (UTC). Mumbai time is 5.5 hours ahead of UTC.

### 1.1 History of the flight

1.1.1 The Airbus A380 aircraft was flying from Singapore Changi Airport to Mumbai Airport<sup>1</sup> in India. During their pre-flight briefing, the flight crew noted adverse weather was forecasted near Mumbai Airport.

1.1.2 Before departure, the Senior First Officer (SFO) conducted a routine brief to the In-Flight Supervisor (IFS) about the flight. The SFO highlighted that adverse weather was forecasted near Mumbai Airport and advised the IFS to prepare the cabin earlier for arrival.

1.1.3 The aircraft was in the vicinity of Mumbai at about 15:00. While the aircraft was descending from FL380 to FL150 on approach to Mumbai Airport and tracking towards waypoint MB372, the flight crew observed on their weather radar display a patch of isolated cumulonimbus<sup>2</sup> (CB) clouds on their flight path (see **Figure 1**). The CB patch was described by the flight crew as comprising a big patch of green cell that enclosed a smaller yellow cell, which in turn enclosed an even smaller red cell<sup>3</sup>. According to the flight crew, no magenta cell (which denotes a turbulence zone) was displayed on the weather radar display<sup>4</sup>.

1.1.4 When the aircraft was at FL150 and about 86nm from Mumbai Airport, the flight crew informed Air Traffic Control (ATC) of their need to detour to avoid the adverse weather and requested ATC for approval to turn left heading 300°. The flight crew then turned on the “fasten seat belt” sign as a precautionary measure<sup>5</sup>. The flight crew’s aim was to stay at least 10nm

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<sup>1</sup> Chhatrapati Shivaji International Airport

<sup>2</sup> Cumulonimbus clouds are usually associated with thunderstorms and adverse weather.

<sup>3</sup> Weather radar can detect precipitation. Green/yellow/red cells correspond to areas of precipitation of low/medium/high intensity. Magenta cells denote areas of wet turbulence areas. Clear air turbulence (CAT) cannot be detected.

<sup>4</sup> According to data from the Flight Data Recorder (FDR), the weather radar had detected at least one magenta cell about six to seven minutes before the turbulence encounter. However, the FDR did not have data about the location of the magenta cells or about whether the cells could have been shown on the weather radar display.

<sup>5</sup> Turning on the “fasten seat belt” sign is an instruction for the passengers to be seated. The cabin crew members are still required to perform duties in preparing the aircraft for arrival. The pilots will make a PA announcement for the cabin crew to be seated before landing or if necessary for safety.

clear of the green edge of the weather radar returns displayed<sup>6</sup>. ATC granted the approval. The flight crew recalled that the flight was smooth and calm from the start of descent until they first encountered the turbulence.

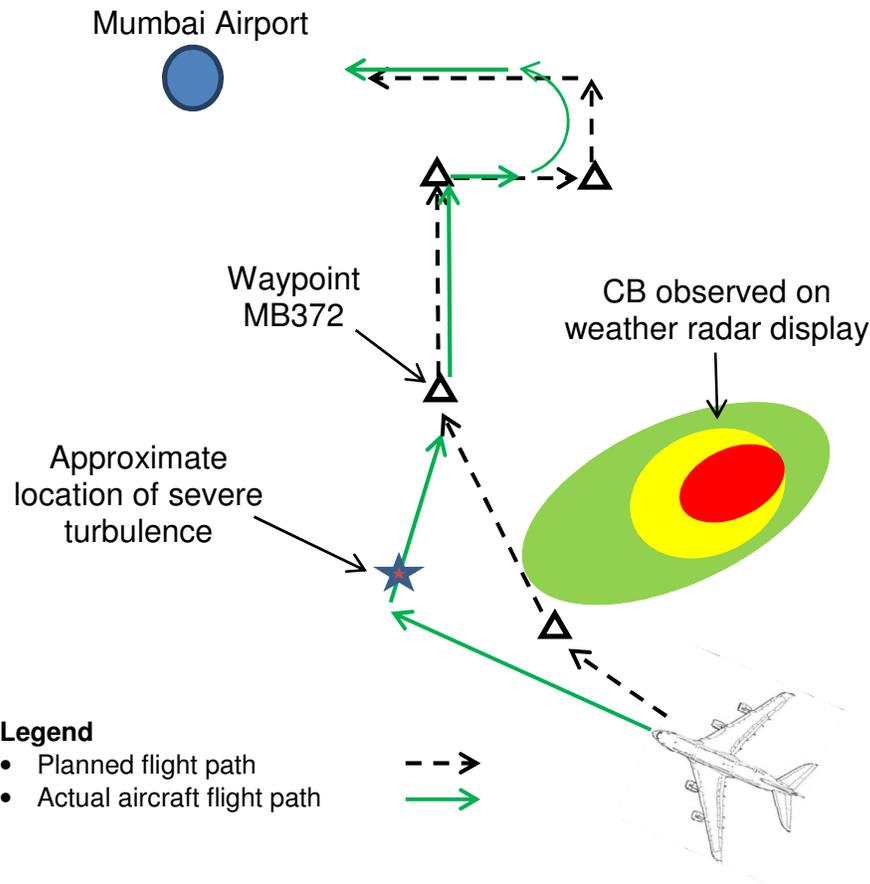


Figure 1: Aircraft flight path (not to scale)

- 1.1.5 According to the CVR data, the flight crew turned on the fasten seat belt sign and made the corresponding PA announcement at about 15:59:41.
- 1.1.6 Before the aircraft passed the observed weathers, ATC had asked the flight crew twice to fly direct to MB372 but the flight crew declined on both occasions as such a direct track would bring the aircraft into the CB clouds.

<sup>6</sup> Both the aircraft manufacturer and operator's procedures recommended flight crews to avoid all yellow, red and magenta cells by at least 20nm. In addition, the operator had issued a circular recommending flight crews to avoid adverse weather by at least 10nm when flying below FL230. According to the flight crew, they had assessed from the weather radar display that the edge of the green cell is at least 10nm from the edge of the yellow cell. Thus, staying clear of the green edge of the weather by at least 10nm would provide more than 20nm of separation from the nearest yellow edge, thereby adhering to both the procedures and circular.

When the aircraft had passed the observed weather, the flight crew obtained ATC's approval to track direct to MB372.

- 1.1.7 On the way to MB372, the flight crew, on two occasions with an interval of about two seconds, felt some light to moderate turbulence which lasted about one to two seconds each. At that time, the cabin crew was moving around in the cabin to check that passengers were seated and belted up, in response to the "fasten seat belt" sign that was turned on earlier in the descent (see paragraph 1.1.4). The cabin crew was also preparing the cabin for landing. About 4 minutes 30 seconds after the fasten seat belt sign was turned on, sensing that the ride was getting bumpier, the Senior First Officer, who was the pilot flying the aircraft, made an announcement through the Public Address (PA) system to request the cabin crew members to be seated.
- 1.1.8 The flight crew stated that the aircraft encountered severe turbulence, lasting about two seconds, immediately after the PA announcement was made (flight recorder data showed that there was a five-second interval between the announcement and the severe turbulence encounter). Some passengers and cabin crew members were thrown up towards the cabin ceiling. The cabin crew had not had enough time to ensure all the passengers were seated and belted up as well as to get themselves seated.
- 1.1.9 According to the flight crew, at the time of the severe turbulence, they did not see clouds outside the aircraft nor observe any weather cells on the weather radar display.
- 1.1.10 A member of the cabin crew informed the flight crew of some of the injuries on board<sup>7</sup>. Although the operator's procedures required flight crews to inform ATC of any significant event or serious incident, the flight crew considered it was unnecessary to do so at that time since the aircraft was almost on the final approach into Mumbai Airport and that ATC was already giving them a direct route to join the final approach path to the airport. Without knowing the full extent of the injuries sustained by the passengers and cabin crew, the flight crew felt that declaring an emergency would result in further queries from ATC which may cause possible delay to their landing.
- 1.1.11 The flight crew contacted the operator's ground handling agent in Mumbai to request for medical assistance on arrival.
- 1.1.12 The aircraft landed and taxied to the parking bay without further event. The

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<sup>7</sup> As the aircraft was descending and was going to land, the cabin crew did not have sufficient time to fully assess the situation of the whole cabin and thus were not able to provide a comprehensive and complete injury report to the flight crew.

injured persons received medical attention.

## 1.2 Injuries to persons

1.2.1 Two passengers and two cabin crew members were seriously injured in this accident.

1.2.2 Of the two seriously injured passengers, one (allocated lower deck economy seat) was injured in the rib area and the other (allocated upper deck economy seat) suffered a dislocated right shoulder and a cut in the stomach area. The former was seated but did not fasten his seat belt. The latter was leaving a lavatory when the severe turbulence struck.

1.2.3 Of the two seriously injured cabin crew members, one suffered a fractured left wrist and the other a fractured rib cage. They were both on the aircraft's upper deck, the former in a galley of the Economy Class and the latter in the Business Class.

1.2.4 A number of passengers suffered minor injury. Most of them were in the lavatory, queuing up for the lavatory or around their seats when the severe turbulence struck.

## 1.3 Damage to aircraft

1.3.1 A smoke detector in one main deck lavatory and a ceiling panel in another main deck lavatory were damaged.

1.3.2 Some panels in the cabin (see **Figure 2**) were also damaged.



Figure 2: Damaged ceiling panels in cabin

## 1.4 Flight recorders

1.4.1 The aircraft's Cockpit Voice Recorder (CVR) and Flight Data Recorder (FDR)

data were downloaded successfully and analysed.

- 1.4.2 The FDR data show that the severe turbulence occurred within a period of 2 minutes and 20 seconds when the aircraft was at FL150 about 62nm southeast of Mumbai Airport. The maximum vertical acceleration recorded was +1.77G/-0.42G<sup>8</sup>.

## 2 DISCUSSION

### 2.1 Probable cause

- 2.1.1 The occurrence was most probably a case of encounter with clear air turbulence, given that there were no clouds in sight and no sign of adverse weather on the weather radar display when the severe turbulence was encountered. Based on the recorded parameters from the FDR, the aircraft manufacturer identified a period of higher vibrations/accelerations recorded on the FDR which lasted 2 minutes and 20 seconds. It was during this period that the severe turbulence occurred. It seems unlikely that the severe turbulence was a case of wake turbulence as the aircraft manufacturer has pointed out that wake turbulence typically lasts for a much shorter duration compared to the turbulent period of more than 2 minutes. Also, from ATC's radar plots, there appears to have been no aircraft nearby that could have caused wake turbulence.

### 2.1.2 However, the investigation team looked into the following safety issues:

- (a) Fixtures in aircraft cabin for grabbing hold of at the sudden onset of turbulence
- (b) Flight crew's notification to ATC

### 2.2 Fixtures in aircraft cabin for grabbing hold of at the sudden onset of turbulence

- 2.2.1 There are fixtures in the galleys (see **Figure 3**), located at a height which is easy to locate and hold on to, which a person may grab hold of at the sudden onset of turbulence. Although grabbing hold of such fixtures may not necessarily prevent injury, they are useful when one needs to steady oneself

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<sup>8</sup> 1G corresponds to a straight and level flight.

quickly.



Figure 3: Handles in galley

2.2.2 There were no similar fixtures in the passenger cabin compartments in the operator's A380 fleet of aircraft. Instead, the available methods to steady oneself in the cabin are as listed below:

- (a) In Economy Class - Holding on to the seat back (see **Figure 4**), or squatting down and grabbing the metal rail below the seats (see **Figure 5**).



Figure 4: Holding on to the seat back



Figure 5: Metal rail below seats

- (b) In Business Class - Grabbing the seat shell (frame) of a Business Class seat (see **Figure 6**) or squatting in between two Business Class seats (see **Figure 7**).



Figure 6: Holding on to the seat shell of Business Class seat



Figure 7: Squatting between Business Class seats

- (c) In Suite Class - Holding on to the hand grip at the window frame of the partition (see Figure 8).



Figure 8: Window frame of Suite Class seat partition

- 2.2.3 The European Aviation Safety Agency (EASA) is responsible for the design of this aircraft type. EASA required that, if the seat backs do not provide a firm handhold, there must be a handgrip or rail along each aisle to enable persons to steady themselves while using the aisles in moderately rough air. During the design approval process for this aircraft type, it was assessed that the seat backs would provide a firm hold in moderately rough air. Thus, no handgrip or rail was incorporated along the aisles of the cabin.
- 2.2.4 Being seated and belted up is a good safety practice against turbulence. For people who need to move in the cabin (e.g. to go to the lavatory), it seems useful to have means that allow such people to steady themselves against sudden onset of severe turbulence. However, EASA explained that the only safe means of securing oneself in a severe turbulence is to be seated and belted up, and that there is no practical means to help steady a person in an aisle that can effectively prevent serious injury during an unanticipated severe turbulence.
- 2.3 Flight crew's notification of injuries on board to ATC
- 2.3.1 After the flight crew felt the severe clear air turbulence, they did not inform ATC of the known injuries on board in view that the aircraft was almost on the final approach into Mumbai Airport and ATC was already giving them a direct route to join the final approach path to the airport. Also, the flight crew

was concerned that ATC might further query them on the details and extent of the injuries, which might lead to a possible delay to the landing.

- 2.3.2 Although the flight crew did contact the operator's ground handling agent in Mumbai to request for medical assistance to be ready and there was no delay to the aircraft's approach to and landing at Mumbai Airport, it would nonetheless have been desirable for the flight crew to inform ATC of the severe clear air turbulence encounter and the known injuries on board so that ATC could take this into consideration should they need to make any change to their air traffic control plans.

### 3 **SAFETY ACTION**

Arising from discussions with the investigation team, the operator concerned has taken the following safety action.

- 3.1 The operator has reminded its flight crew members on the importance of informing ATC of any emergency situations or injuries encountered in flight.

### 4 **SAFETY RECOMMENDATION**

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