Final Report

B777-200, REGISTRATION 9V-SQN

TURBULENCE ENCOUNTER

1 AUGUST 2017

AIB/AAI/CAS.150

Transport Safety Investigation Bureau
Ministry of Transport
Singapore

18 April 2018

The Transport Safety Investigation Bureau of Singapore

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Table of Contents

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GLOSSARY OF ABBREVIATIONS

ACARS	Aircraft Communication and Reporting System
ATC	Air Traffic Control
CB	Cumulonimbus
CIC	Crew-in-Charge
CVR	Cockpit Voice Recorder
FDR	Flight Data Recorder
FO	First Officer
LT	Local Time
Mhz	Mega Hertz
NM	Nautical miles
PA	Passenger Announcement
PF	Pilot Flying
PIREP	Pilot Report
PM	Pilot Monitoring
QAR	Quick Access Recorder
SATCC	Singapore Air Traffic Control Centre
SATCOM	Satellite Communication
SO	Second Officer
UTC	Coordinated Universal Time

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SYNOPSIS

On 1 August 2017, a B777-200 aircraft encountered turbulence while enroute from Singapore for Bangkok, Thailand. The aircraft continued to Bangkok without further incident.

A passenger sustained serious injury in the form of a fractured right foot. Two cabin crew members sustained serious injuries in the form of hairline fractures in their heels. Three other cabin crew members sustained minor injury

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

AIRCRAFT DETAILS

Aircraft type	:	Boeing B777-200
Operator	:	Singapore Airlines
Aircraft registration	:	9V-SQN
Numbers and type of engines	:	2 x Rolls Royce Trent 800
Date and time of incident	:	1 August 2017, 1317 hours Singapore time
Location of occurrence	:	Enroute from Singapore to Bangkok
Type of flight	:	Scheduled passenger flight
Persons on board	:	219

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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 The Boeing 777-200 aircraft departed Singapore Changi Airport at about 1305 hours for Bangkok, Thailand on 1 August 2017. The flight crew consisted of a Captain, a First Officer (FO) and a Second Officer (SO).

1.1.2 The SO was undergoing training and was occupying the right seat. He was the pilot flying (PF). The Captain, who was the instructor pilot, was occupying the left seat and was the pilot monitoring (PM). The FO functioned as Safety Officer for the flight and occupied the observer seat.

1.1.3 The fasten seatbelt sign selector was selected to the AUTO position for the take-off. On passing 10,300 feet, the fasten seatbelt sign automatically turned off. The PM selected the Passenger Address (PA) system and noted from the announcement made by the cabin crew that the fasten seatbelt sign had indeed been turned off.

1.1.4 As the PM looked outside the cockpit windows, he noted that the visibility was good outside. He observed that there were thick clouds building up ahead on the left side of the flight path. There were isolated clouds on the right side of the flight path with clear spots that the aircraft could fly through. According to the PF, the weather radar was indicating extensive Cumulonimbus (CB) clouds on the left side of their planned flight path and some scattered CBs to the right.

1.1.5 The PM discussed with the PF on the latter's plan to avoid the weather seen ahead in their flight path (the aircraft's heading was then about 350 degrees). PF's initial plan was to make a deviation to the left to go around the weather and to return to the planned flight path after clearing the weather.

1.1.6 The PM suggested to the PF that he look outside to have a better assessment of the weather as the visibility was good. The PF noted that the weather built up on the left was quite extensive while the weather on the right had only scattered spots of clouds with clear areas for the aircraft to pass through. So he decided to deviate to the right instead. He estimated that, at the rate the aircraft was climbing, it would be able to fly above the scattered CBs.

1.1.7 With clearance from Air Traffic Control (ATC), the aircraft climbed to 20,000

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feet. The PM then requested a heading of 010 degrees for the next 25 nautical miles (NM), in order to bring the aircraft on a parallel track to the right of the planned flight path. However, ATC cleared the aircraft only to a heading of 360 degrees[1]. The PM accepted this change to 360 degrees.

1.1.8 Subsequently ATC cleared the aircraft to climb further to 28,000 feet. The PM again requested for a heading change to 010 degrees. ATC asked the PM to stand by.

1.1.9 According to the flight crew, the following sequence of events occurred:

(a) At the moment the flight crew were told by ATC to stand by, the cabin crew-in-charge (CIC) called on the interphone from Door 2 Left to ask if they needed any drinks and to find out the departure and take-off time for his report.

(b) The PF switched the fasten seatbelt sign to the ON position[2].

(c) The FO answered CIC's call. He declined the drinks offer and provided the departure and take-off time information. As requested by the PM, the FO wanted to advise the CIC that they were expecting turbulence ahead but there was no response from the CIC.

(d) The FO tried twice to call the CIC but the calls were not answered. (However, the CIC said he did not hear any chime indicating that there was a call from the flight deck.)

(e) ATC called to clear them to a heading of 010 degrees.

(f) The PF made the heading change.

[1] ATC was unable to accede to the request for a heading of 010 degrees owing to the relatively busy air traffic situation at that time.

[2] The PF estimated that, as the clearance for a deviation to the right was not forthcoming, the aircraft would not be able to clear the scattered CBs as he had hoped for. The aircraft was then flying closer and closer to the scattered CBs. So he decided that it would be safer to have the fasten seatbelt sign switched on.

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(g) The PM picked up the PA handset and made an announcement to warn the cabin crew of a possibility of turbulence encounter but the aircraft encountered the turbulence before he could complete his announcement. The PM described the turbulence as moderate to severe and lasting for about three to five seconds.

1.1.10 According to the CIC, he was communicating with the flight deck through cabin interphone when the turbulence occurred.

1.1.11 Data from the Flight Data Recorder (FDR) and Quick Access Recorder (QAR) indicated that the turbulence was encountered at 1317 hours. The QAR data showed that the fasten seatbelt sign was switched on 28 seconds before the onset of the turbulence[3].

1.1.12 After the turbulence ceased, the PF switched off the fasten seatbelt sign. This was also captured in the QAR. After having reached the top of climb, the FO moved to occupy the right seat and took over as the PF from the SO and the SO moved to the observer seat, while the Captain went into the cabin to check on the injury situation.

1.1.13 In the meantime, the CIC went around the cabin to check on any injuries and found that four cabin crew members were injured[4] and were unfit for duty. This meant that the primary operating cabin crew would be short of one crew member to man one of the doors for landing. Fortunately, there was an off-duty cabin crew member travelling on board who volunteered to man the door. This was accepted by the Captain.

1.1.14 The CIC was informed by a cabin crew member that a male passenger had fallen during the turbulence. The CIC approached the passenger to ascertain his condition. The passenger told the CIC that he was not sure and would let him know later. At this moment, the Captain was not yet aware of this. Subsequently, the passenger updated the CIC that he was injured and needed medical attention.

1.1.15 The Captain sent an ACARS message back to the airline's base in Singapore to inform of the injuries due to the turbulence. The CIC also sent an ACARS

[3] All five injured cabin crew members recalled that the fasten seatbelt was not switched on at the time of the turbulence encounter and that the sign came on only after the turbulence encounter. The rest of the cabin crew members (the CIC and five other five cabin crew members) also recalled that the fasten seatbelt sign was not switched on before the turbulence encounter.

[4] At this moment, the CIC was not yet aware of a fifth crew member who had sustained minor injury.

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message to Singapore to provide additional information about the injuries. Singapore in turn informed the Bangkok station to stand by medical assistance on aircraft arrival.

1.1.16 After arrival in Bangkok, the CIC updated the Captain about the injury sustained by the passenger. He also informed the Captain that there was a fifth cabin crew member who had suffered an injury. All the injured received medical attention.

1.1.17 There was no damage to the aircraft.

1.2 Injuries to persons

1.2.1 A total of six persons on board sustained injuries:

(a) One male passenger sustained serious injury in the form of a fractured right foot.

(b) Two female cabin crew members sustained serious injuries in the form of hairline fractures in their heels.

(c) Three female cabin crew members sustained minor injuries.

1.2.2 The male passenger sustained the serious injury during the turbulence when he was walking back to his seat after using the lavatory[5].

1.2.3 At the time of the turbulence encounter, the five injured cabin crew members were serving meals or preparing their meal carts for cabin service.

1.3 Personnel information

1.3.1 Captain

Gender	Male
Age	46

[5] According to the passenger, the red "return to seat" sign came on when he was in the lavatory and there was a PA announcement. He could not recall the details of the announcement but, from his experience as a frequent flyer of this operator, inferred that the announcement had to do with asking passengers to return to their seats and fasten their seatbelts. He estimated that he left the lavatory about 10 to 20 seconds after the "return to seat" sign had come on. The turbulence occurred while he was walking towards his seat.

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Licence	Air Transport Pilot Licence issued by the Civil Aviation Authority of Singapore
Licence validity	Valid till 31 August 2018
Medical certificate	Class 1 Medical Certification. Nil Restriction
Last base check	5 July 2017
Total flying experience	13500 hours
Total hours on B777	6900 hours
Flying in last 24 hours	0
Flying in last 7 days	10 hours 24 minutes
Flying in last 90 days	191 hours 26 minutes

1.3.2 First Officer

Gender	Male
Age	30
Licence	Multi-Crew Pilot Licence issued by the Civil Aviation Authority of Singapore, rated on B777
Licence validity	Valid till 31 March 2018
Medical certificate	Class 1 Medical Certification. Nil Restriction Operational Proviso: To wear corrective lenses
Total flying experience	973 hours
Total hours on B777	868 hours
Flying in last 24 hours	0
Flying in last 7 days	10 hours 14 minutes
Flying in last 90 days	220 hours 50 minutes

1.3.3 Second Officer

Gender	Male
Age	25

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Licence	Commercial Pilot Licence issued by the Civil Aviation Authority of Singapore, rated on B777
Licence validity	Valid till 30 September 2017
Medical certificate	Class 1 Medical Certification Nil Restriction
Total flying experience	1275 hours
Total hours on B777	195 hours
Flying in last 24 hours	0
Flying in last 7 days	18 hours 24 minutes
Flying in last 90 days	161 hours 35 minutes

1.4 Aircraft information

1.4.1 After the occurrence, the fasten seatbelt sign operation on the aircraft was checked and was found operating normally.

1.4.2 The aircraft's maintenance record did not show any defect relating to the fasten seatbelt sign before and after the occurrence.

1.4.3 The fasten seatbelt sign and the lavatory's return to seat sign were controlled by the aircraft's Passenger Service System (PSS). Switching on the fasten seatbelt sign would also switch on the lavatory's return to seat sign. The PSS design was such that it was unlikely for the return to seat sign to be indicating ON when the fasten seat sign was not indicating ON. Post-occurrence tests on the ground also could not simulate a situation where the fasten seat sign was not indicating ON whereas the return to seat sign was indicating ON.

1.5 Flight recorders

1.5.1 The aircraft's Flight Data Recorder (FDR) was downloaded. The FDR data was of good quality and useful for the investigation. However, the ON/OFF status of the fasten seatbelt sign was not a parameter recorded by the FDR.

1.5.2 The Cockpit Voice Recorder (CVR) was overwritten. The communications between the flight crew and ATC and those among the pilots in the cockpit were not available for analysis.

1.5.3 The Quick Access Recorder (QAR) was downloaded. The QAR parameters

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included the ON/OFF status of the fasten seatbelt sign and the fasten seatbelt sign parameter was available in the QAR.

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2 ANALYSIS

The investigation looked into the following:

a. Fasten seatbelt sign

b. Deviation from weather

2.1 Fasten seatbelt sign

2.1.1 Data from the QAR indicated that the fasten seatbelt sign was switched on before the onset of the turbulence. This was corroborated by the account of the passenger who was seriously injured as well as the flight crew's account. Yet all the cabin crew members were quite certain that the fasten seatbelt sign was not turned on at the time of the turbulence encounter.

2.1.2 While it was possible for the fasten seatbelt sign and cabin interphone systems to malfunction, the probability was considered very low, considering that there was no report of any defect relating to the fasten seatbelt sign or cabin interphone systems before and after the occurrence.

2.1.3 It is difficult to understand, in the absence of any evidence to suggest a malfunction of the fasten seatbelt sign system, how the cabin crew had perceived that the fasten seatbelt sign was not turned on. It cannot be proven but one possibility was that the cabin crew members were too engrossed in their service to have noticed the sign and the suddenness of the turbulence encounter and painful injuries could have affected their recollection.

2.1.4 When to switch on the fasten seatbelt sign is a judgment to be made by the flight crew. In this occurrence, the sign was switched on some 28 seconds before the turbulence struck. The PF made a sensible decision to switch on the fasten seatbelt sign when he judged that the ATC clearance for a deviation to the right (which would enable the aircraft to clear the scattered CBs) was not forthcoming (see paragraph 1.1.9(b)). However, judging by the flight crew's subsequent actions, viz. responding to the CIC regarding offer of drinks, trying to contact the CIC to warn the cabin crew of possible turbulence ahead, communicating with ATC regarding heading change, the flight crew probably did not expect that the turbulence could set in so soon. Had the flight crew judged that the turbulence encounter would be imminent, they could have made an urgent and direct broadcast to the cabin crew and passengers over the PA system.

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2.2 Deviation from weather

2.2.1 The operator in this occurrence had a guidance in its training for flight crew on weather avoidance and turbulence management that flight crews should maintain clearance from a CB by 20NM laterally and 5,000 feet vertically to minimise risk of encountering severe turbulence.

2.2.2 It may not be always possible or practical to deviate 20NM laterally or 5,000 feet vertically from weather clouds. Flight crew may have to make informed decisions using weather radar to determine on how best to route the flight path around weather in order to minimise turbulence encounter. In instance when deviation distance cannot be adequately achieved, it would be prudent for the fasten seatbelt sign to be switched on early for passengers to be seated and cabin crew to be alerted.

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3 CONCLUSION

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 aircraft was flying through the edges of some scattered clouds and encountered turbulence, resulting in serious injuries to one passenger and two cabin crews and minor injuries to three other cabin crew members.

3.2 The flight crew were aware of the weather build-up in their planned flight path and requested for deviation from the weather, but the Air Traffic Control (ATC) could only provide incremental heading change owing to the relative busy air traffic situation at that time.

3.3 The flight crew switched on the fasten seatbelt sign when ATC could not give them clearance for heading change when the flight crew requested a second time, but all the cabin crew did not recall seeing the fasten seatbelt sign illuminated or hear the chime when the fasten seatbelt sign came on.

3.4 The QAR data indicated that the fasten seatbelt sign was switched on about 28 seconds before turbulence encounter.

3.5 The investigation could not establish the reason why the cabin crew did not notice when the fasten seatbelt sign was switched on.

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4 SAFETY ACTIONS

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

4.1 The airline operator has taken the following safety actions:

(a) Shared the incident and the trend of turbulence injuries with its pilots at a safety forum.

(b) Issued an online circular to remind cabin crew members of the risk of turbulence and to re-emphasise the steps to take during turbulence, e.g. use of cabin/galley stronghold points.

(c) Reinforced the turbulence management pointers to cabin crew members through a video shown at an engagement session with cabin crew on 16 November 2017. This video was made available on the operator's intranet for all other cabin crew members to view.

(d) Included a presentation on turbulence management pointers to be shown after the safety video at each pre-flight session.

(e) Planned to use past turbulence cases in case studies for discussion on turbulence management during meetings of the Safety & Security and Work Accident Task Force.

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5 SAFETY RECOMMENDATION

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

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