

FINAL REPORT

BOMBARDIER BD-700, REGISTRATION M-YSAI RUNWAY EXCURSION

16 JUNE 2013

AIB/AAI/CAS.094

**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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GLOSSARY OF ABBREVIATION

ACARS	Aircraft Communications Addressing and Reporting System
ATC	Air Traffic Control
CVR	Cockpit Voice Recorder
FDR	Flight Data Recorder
fpm	Feet per minute
ft	Feet
GS	Ground Speed
KIAS	Indicated Airspeed in knots
kts	knots
MSL	Mean sea level
ND	Navigation Display
NM	Nautical miles
PF	Pilot Flying
PFD	Primary Flight Display
PIC	Pilot-in-command
PIREP	Pilot Report
PM	Pilot Monitoring
QAR	Quick Access Recorder
QNH	Altitude above mean sea level based on local station pressure
RA	Radio Altitude
SIGMET	Significant Meteorological Information
UTC	Coordinated Universal Time
VFR	Visual Flight Rule

SYNOPSIS

On 16 June 2013, a Bombardier BD-700 private jet while landing at Runway 21 of Seletar Airport, experienced a strong gust of cross wind causing it to drift off and touch down on the left side of the runway. Both nose and left main gears touched down on the grass patch while the right main gear touched down on the edge of the paved runway. After touching down, the Pilot Flying manoeuvred the aircraft back onto the runway and subsequently taxied the aircraft to its parking bay. As a result of the runway excursion, two signboards on the left of the runway were damaged due to contact by the aircraft.

The aircraft sustained damages to its left flaps, left flap track fairings, left landing gear door and left thrust reverser lower clamshell door. There was no injury to any person.

The Air Accident investigation Bureau of Singapore classified this occurrence as an accident and instituted an investigation.

AIRCRAFT DETAILS

Aircraft type	: Bombardier BD-700-1A11
Operator	: Capital Investment Worldwide Inc.
Aircraft registration	: M-YSAI
Manufacturer's Serial number	: 9166
Numbers and type of engines	: 2 x Rolls Royce BR 700-710A2-20 Turbofan
Type of flight	: Private flight
Persons on board	: 5

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 The Bombardier BD 700 flew from Delhi, India to Seletar Airport in Singapore on 16 June 2013. The pilot-in-command, seated on the left seat, was the Pilot Flying (PF) while his co-pilot, seated on the right seat, was the Pilot Monitoring (PM).
- 1.1.2 Seletar Airport was a Visual Flight Rule (VFR) airfield and had a single runway (Runway 3/21). The aircraft was to land on Runway 21.
- 1.1.3 At 22:05:35, the aircraft was 6 NM from the runway. After confirming with the PF¹, the PM informed the tower controller that they had the runway in sight. The tower controller then cleared the aircraft to continue the approach. According to the PM, the weather was clear without rain or visual obstruction and the conditions were good for visual approach landing at that instance. The aircraft's weather radar display showed that the weather was clear in the approach path but there was heavy precipitation about 5-7 NM to the right of the runway. According to the tower controller and watch manager, the visibility at that point was good as they were able to see the landing lights of the aircraft.
- 1.1.4 At 22:05:42, the tower controller asked if the flight crew was able to sight the obstacle (a steel structure) located 2 NM from the runway. The PM replied in the affirmative, adding that they were familiar with the airport. The controller then cleared the flight to continue the approach to Runway 21.
- 1.1.5 At 22:06:01, the tower controller provided wind information of 260° at 4 knots. The PM acknowledged the information.
- 1.1.6 At 22:06:19, the tower controller gave the clearance to land. The PM acknowledged the clearance to land.
- 1.1.7 At 22:08:16, the tower controller informed the crew of severe low level windshear² that was observed in the vicinity of Seletar Airport³. The tower controller also informed that there was rain over the airfield and that the runway was wet. The PM acknowledged the information⁴ and informed the controller that they were at that moment flying over the water (Straits of Johor). Then the crew encountered rain, which intensified as they flew over the Singapore shoreline but the runway was still in sight. Both pilots assessed the weather condition to be adequate

¹ According to the PF, he was unable to sight the runway initially. The PM pointed out the runway to him.

² This was detected by the airport's Low Level Windshear Alert System (LLWAS).

³ Prior to this transmission, there was no report of any adverse weather condition.

⁴ The PF said after the occurrence that he could not recall hearing the controller providing the windshear warning.

and they continued with the approach.

1.1.8 In the subsequent one and half minutes, the tower controller provided the following wind information:

- At 22:08:41, 250° at 11 knots
- At 22:09:00, 260° with gusting wind of 15 knots
- At 22:09:46, 290° at 25 knots

1.1.9 At 22:10:09, when the aircraft was 220 ft above ground, the aircraft's Enhanced Ground Proximity Warning Computer (EGPWC)⁵ generated a windshear caution.

1.1.10 At 22:10:17, at 108 ft above ground, the EGPWC generated a windshear warning⁶.

1.1.11 The PF did not notice any windshear caution or windshear warning. The PM momentarily heard a windshear aural warning before touchdown. However, he did not initiate a go-around as required by the procedure in the Airplane Flight Manual.

1.1.12 At 50 ft, the PM noticed that the aircraft started to pitch up and he asked the PF to increase engine power, which the PF did. The aircraft then started to drift towards the left side of the runway. As the aircraft flared over the left side of the runway, the PM noticed that the right wing tip started to drop towards the runway⁷ but did not strike the runway.

1.1.13 The aircraft landed at 22:22:00, with the right main gear touching down first, on the runway pavement and close to the left edge of the runway. This was followed by the left main gear touching down on the grass patch left of the runway edge. The PF stated that the aircraft was "blown" off to the left side of the runway before touchdown. The PM noted that the aircraft started to drift to the left of the runway centreline just before touchdown. The PF applied slight right aileron⁸ and full right rudder pedal to try to bring the aircraft back to the runway, but he stated that the aircraft did not respond. The PM also instinctively applied right rudder but became aware that the PF had already applied maximum right rudder input.

1.1.14 Data from the FDR indicated that the aircraft continued to drift to the left after the PF's attempt to bring the aircraft back to the runway. However, the magnetic heading data indicated that the aircraft had turned towards the right in response to the PF's input.

1.1.15 After the nose gear had touched down, the PF was then able to steer the

⁵ Windshear caution alert is indicated by amber "WINDSHEAR" alert message on the cockpit's Primary Flight Display (PFD), which provides information that can assist the pilot in managing his flight in the vertical plane (e.g. airspeed, attitude, altitude).

⁶ The windshear warning consists of a red "WINDSHEAR" indication on the PFD, a boxed "WINDSHEAR" annunciation in large font on the Head-Up-Display (HUD) accompanied by a brief siren and a "WINDSHEAR-WINDSHEAR-WINDSHEAR" aural warning.

⁷ The right wing dipped because the PF applied right aileron to try to bring the aircraft back to the runway.

⁸ According to the PF, too much right aileron application may cause a wing tip strike.

aircraft back onto the runway. According to the PF, it took about 4-5 seconds before the aircraft responded to his directional input and started to steer back to the runway. He believed the aircraft responded after the crosswind had abated and the aircraft had slowed down following thrust reverser deployment.

- 1.1.16 After the aircraft stopped on the runway, it had to do a 180° turn on the runway to taxi to its parking stand. Both the PF and PM commented that during the 180° turn, the rain was so heavy that they could hardly see anything through the windshield except for the runway edge lights. They informed ATC that they had drifted off the runway and suggested that the runway be inspected for any possible debris.
- 1.1.17 According to the tower controller, he saw the rain move in from the shore towards the threshold of Runway 21 and described the rain as a very short and heavy downpour.
- 1.1.18 Due to the low light condition and rain, both the tower controller and the watch manager were unable to see if the aircraft had landed off the runway. They did not notice anything wrong with the landing until they were informed by the pilots.

1.2 Injuries to persons

- 1.2.1 There was no injury to any person.

1.3 Personnel information

1.3.1 Pilot and Co-pilot

	Pilot	Co-pilot
Gender	Male	Male
Age	58	59
Licence	Airline Transport Pilot Licence issued by the Federal Aviation Administration with BD-700 rating, validated by the State of Registry (expiry on 16 May 2014)	Air Transport Pilot Licence issued by the Federal Aviation Administration with BD-700 rating, validated by the State of Registry (expiry on 6 Sep 2014)
Total on BD-700	275 hr	1842 hr
Flying in last 24 hours	5 hr 30 min	Nil
Flying in last 7 days	13 hr	10 hr 14 min
Flying in last 90 days	104 hr 30 min	79 hr

- 1.3.2 Toxicology tests performed on both flight crew members did not show any anomaly.
- 1.3.3 While the PM was familiar with Seletar Airport, the PF had flown into Seletar Airport only a few times, and the occurrence flight was his first night landing as a PF.

1.4 **Flight recorders**

1.4.1 The aircraft's digital flight data recorder (FDR) and cockpit voice recorder (CVR) were removed by the operator's technical handling agent and handed over to the AAIB.

1.4.2 The CVR consists of four individual tracks, of which only the area microphone recording contained information relevant to the occurrence. The other three tracks (left hand seat, right hand seat and first observer seat) were recorded over as the CVR was not deactivated after aircraft arrived on the parking bay. The area microphone recordings were useful for the investigation as it captured the windshear aural warning. There was no verbal communication between the flight crew after the windshear aural warning sounded.

1.4.3 The FDR data were downloaded successfully and useful for the investigation.

1.5 **Additional Information**

1.5.1 Non-normal procedures in Airplane Flight Manual

1.5.1.1 The operator adopted the manufacturer's Airplane Flight Manual for its operation. The manual stated that go-around should be initiated when a windshear caution or warning is encountered.

1.5.2 Service Bulletin 700-1A11-22-002

1.5.2.1 The aircraft manufacturer had issued Service Bulletin 700-1A11-22-002 on 12 December 2012 to offer a Windshear Escape Guidance (WEG) option as part of the automatic flight control system, which, when a windshear condition is detected, will provide windshear escape guidance consisting of lateral and vertical movement commands. If the auto-throttle is engaged, the WEG will also cause the throttle lever to be automatically advanced fully forward to provide maximum thrust.

1.5.2.2 At the time of the occurrence, the aircraft had not incorporated this Service Bulletin.

1.5.3 Operator's windshear training for pilots

1.5.3.1 Simulator training for the operator's pilots was contracted out to an external flight training school. The simulator training did not include windshear simulations.

2 **DISCUSSION**

2.1 **Awareness of windshear caution and warning**

- 2.1.1 The ATC had alerted the flight crew to the presence of severe low level windshear in the vicinity of Seletar Airport and this was acknowledged by the PM.
- 2.1.2 Despite being alerted by the ATC of a possible windshear encounter, both pilots did not notice the windshear caution while only the PM recalled hearing the “WINDSHEAR-WINDSHEAR-WINDSHEAR” aural warning when the windshear warning was activated. One would expect the flight crew to have heightened awareness of a possible windshear encounter after receiving the low level windshear warning issued by the ATC.
- 2.1.3 As it was the first time that the PF was performing a night landing at Seletar Airport, he might have been fixated on landing the aircraft safely in deteriorating weather conditions, resulting in him not noticing the windshear caution and warning.
- 2.1.4 The pilots’ simulator training did not include windshear simulations. Thus, the pilots might not have been familiar with the windshear related cautions and warnings and might have missed noticing the visual indications related to the windshear condition.
- 2.1.5 Relevant simulator training should benefit flight crews in becoming more familiar with the windshear related cautions and warnings.

2.2 **Response to windshear warning**

- 2.2.1 The PM did not call out the warning to alert the PF of the warning. The procedures in the Airplane Flight Manual did not require the PM to call out windshear cautions and warnings. Although not required by the procedures, acknowledgement of a windshear caution or warning by calling out is a useful crew resource management practice in ensuring that both pilots are aware of the situation.
- 2.2.2 The procedures in the Airplane Flight Manual required a go-around to be initiated when windshear warning is activated. The PM, after hearing the warning, observed that the vertical speed of the aircraft increased slightly but not to an extent of concern. In addition, he observed that the aircraft was responding to the PF’s input. As such, he did not see a need to initiate a go-around.
- 2.2.3 It would have been prudent for the PM to initiate a go-around when he heard the aural warning, as it is a requirement under the Aircraft Flight Manual.

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 air traffic controller had informed the flight crew of a low level windshear warning indicating the presence of windshear activity in the aerodrome. As the aircraft approached the runway, the weather conditions deteriorated and this was detected by the aircraft's windshear detection system.
- 3.2 The windshear caution was generated by the aircraft's windshear detection system but the visual indication was not noticed by both pilots. When the windshear warning was generated later, the PF did not notice the visual and aural indications related to this warning and the PM noticed only the aural indication.
- 3.3 Although the PM heard the aural warning, he did not initiate a go-around, which was required by the Airplane Flight Manual.

4 SAFETY ACTIONS

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

- 4.1 The operator has introduced a safety management system. As part of this system, the operator uses a risk assessment tool in the evaluation, for each planned flight, of the risks associated with equipment, operating environment, pilot qualifications and experience. If the operator deems the risk for a particular flight to exceed the tolerable limit, that flight will not be performed.
- 4.2 The operator has made diverting to an alternate aerodrome upon receipt of windshear warning from the air traffic control during approach a standard operating procedure.
- 4.3 The operator has incorporated the aircraft manufacturer's Service Bulletin 700-1A11-22-002 on installation of the Windshear Escape Guidance (WEG) as part of the automatic flight control system⁹.
- 4.4 The operator has required its pilots to conduct at least 10 landings into a visual flight rule (VFR) airport, of which five must be conducted at night, before being allowed to carry passenger into that VFR airport. In the meantime, the operator has suspended night landings into Seletar Airport.
- 4.5 The operator has incorporated windshear training as part of its recurrent simulator trainings.

⁹ Once a windshear warning condition is detected, the active WEG will be enabled. This will result in the flight director Windshear Escape Guidance mode (WSHR) being activated and in the flight director providing escape guidance, based on aircraft performance, consisting of lateral and vertical commands. The WSHR mode cannot be cancelled when a windshear warning is active. If the autothrottle is engaged, the WSHR mode will also cause the throttle lever to be automatically advanced fully forward to provide maximum thrust.

5 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:

- 5.1 The operator review its procedure to require flight crew to acknowledge any flight deck annunciations by calling out the cautions or warnings to enhance crew resource management. [AAIB Recommendation R-2014-004]
- 5.2 The operator review its operating procedures to ensure that, following an accident or a serious incident, flight recorders are de-activated immediately upon completion of the flight, so as to preserve the records of every flight recorder. [AAIB Recommendation R-2014-005]