

Final Report

AIRBUS A380 REGISTRATION A6-EVJ RUNWAY EXCURSION ON LANDING, CHANGI AIRPORT

2 MARCH 2023

TIB/AAI/CAS.216

Transport Safety Investigation Bureau
Ministry of Transport
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The Transport Safety Investigation Bureau of Singapore

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ABBREVIATIONS

A-SMGCS	Advanced Surface Movement Guidance and Control System
AGL	Above Ground Level
ATC	Air Traffic Control
BEA	Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile
CRM	Crew Resource Management
ECAM	Electronic Centralised Aircraft Monitor
FDR	Flight Data Recorder
FMC	Fault Management Centre
FO	First Officer
ft	Feet
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
nm	Nautical Miles
OM	Operations Manual
PF	Pilot Flying
PIC	Pilot-in-Command
PM	Pilot Monitoring
RH MLG	Right Hand Main Landing Gear
SOP	Standard operating procedure
VMC	Visual Meteorological Conditions

SYNOPSIS

At about 1427h on 2 March 2023, while making an approach into Singapore Changi Airport, an Airbus A380 drifted right of the Runway 02L centreline. The aircraft touched down to the right of the runway centreline and veered to the right after touching down. The right-hand (RH) main landing gear (MLG) departed the runway briefly and its wheels hit and broke three runway edge lights.

The Transport Safety Investigation Bureau classified this occurrence as a serious incident.

AIRCRAFT DETAILS

Aircraft type	:	Airbus A380-842
Operator	:	Emirates
Aircraft registration	:	A6-EVJ
Date and time of incident	:	2 March 2023, 1427h Local Time
Location of occurrence	:	Changi Airport Runway 02L
Type of flight	:	Scheduled
Persons on board	:	464

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 Airbus A380 aircraft was operating from Dubai, United Arab Emirates, to Singapore on 2 March 2023. The Pilot-in-command (PIC) was the Pilot Flying (PF) and the First Officer (FO) the Pilot Monitoring (PM).

1.1.2 Throughout the flight from Dubai to Singapore the flight crew did not experience any anomalies with the aircraft systems.

1.1.3 The weather information available to the flight crew indicated that, at the estimated landing time, the weather over Changi Airport would be good. When the flight crew first contacted Singapore Approach, the flight crew reported that they had received the latest aerodrome and weather information through the most up-to-date Automatic Terminal Information Service¹ (ATIS) at that time, which did not report rain over the aerodrome. Nonetheless, the flight crew discussed the landing performance for both dry runway and wet runway.

1.1.4 The flight was subsequently transferred from Singapore Approach to Changi Tower. During the instrument landing system (ILS) approach to Changi Airport Runway 02L (i.e. about 15nm from the south of the aerodrome), both the PIC and the FO observed some clouds over the north north-west of the aerodrome. The flight crew checked the weather radar and concluded that the weather build-up was not significant at that time. They also noted that the go-around path (between 5,000ft and 6,000ft) was clear of weather.

1.1.5 According to the Runway Controller, it was raining over the aerodrome when the aircraft was making its final approach. The ATIS information had been updated and was broadcasting rain over the aerodrome. The flight crew also

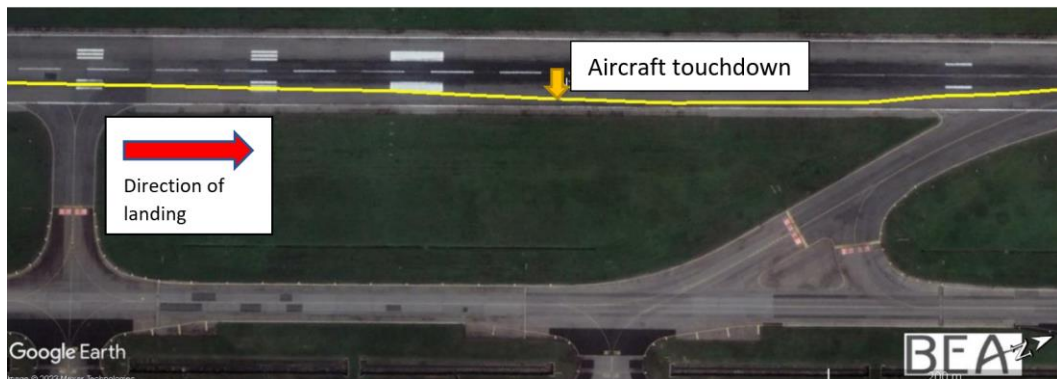
¹ ATIS is the automatic provision to arriving and departing aircraft of recorded current, routine aeronautical information (e.g. weather information, active runways, available approaches at an aerodrome, and any other information needed by pilots, such as important NOTAMs) by means of continuous and repetitive broadcasts. The recording is updated in fixed intervals or when there is a significant change in the information, such as a change in the active runway, significant meteorological phenomena, and information on recent weather of operational significance.

told the investigation team that the aircraft was flying through heavy rain during the final approach.

- 1.1.6 At 1424h, the Runway Controller at Changi Tower informed the flight crew that the preceding aircraft reported visual with the approach lights at 3nm.
- 1.1.7 As the aircraft flew through the rain, the flight crew saw the approach lights at about 3nm and saw the runway before descending past 200ft above ground level (AGL). According to the PF, the intensity of the rain suddenly increased around this time and he was surprised by this and his handling of the aircraft was somewhat affected but he did not elaborate further. He added that although the wipers were set to high speed, the view out of the cockpit was alternating between clear and blurry depending on the sweep of the wiper.
- 1.1.8 Data from the flight data recorder (FDR) indicated that when the aircraft was descending past 180ft, the PF disengaged the autopilot and flew the aircraft manually.
- 1.1.9 Shortly after the autopilot was disengaged, both the PF and the PM noticed that the aircraft was drifting towards the right of the extended runway centreline. The PM called out 'centreline²' to remind the PF to align the aircraft with the extended runway centreline. In response, the PF applied sidestick inputs (both pitch and roll) to try to arrest the drift. According to the PF, while he was aware that the aircraft was not aligned with the runway centreline, he perceived that the offset from the runway centreline was still acceptable for a safe landing.
- 1.1.10 When the aircraft was about 30ft AGL, the PM called out "go-around". The PF responded with "no it's OK". However, the PF told the investigation team that he actually did not understand what the PM had said but he did not ask the PM to repeat or clarify what he had said and he had responded to the PM with "no it's OK" just so that he could get on with focusing on landing the aircraft.
- 1.1.11 The PM called out "go-around" again when the aircraft was touching down on the runway. This time, there was no response from the PF and the PF continued with the landing roll. According to what the PF told the investigation team, he did not hear this second "go-around" callout by the PM.

² According to the operator's procedure, the appropriate callout should be 'Loc'. Although a different callout ('Centreline') was made by the PM, the PIC understood the PM's intent of informing him that the aircraft was drifting away from the centreline.

1.1.12 The FDR data indicated that when the aircraft was about 15ft AGL, the PF momentarily applied a sharp left rudder input (from 2° to 9°) and a left roll input, resulting in a bank angle less than half a degree to the left. These actions caused the heading of the aircraft to turn left towards the runway centreline but the aircraft continued to drift towards the right. Shortly thereafter, the rudder input was removed (i.e. the rudder was set to neutral) and a right roll input was applied, resulting in a bank angle to the right of up to 4 degrees. At about 1427h, the aircraft touched down to the right of the runway near the runway edge line and veered slightly further to the right (see **Figure 1**). The PF told the investigation team that while he was aware that the aircraft had touched down to the right of the runway, he believed he was still within the runway limits. The aircraft was steered back towards the runway centreline and, while still tracking towards the centreline, thrust reversers were applied.



(Source: BEA) (Annotation: TSIB)

Figure 1: Ground path of aircraft

1.1.13 At about the same time, the Watch Manager at Changi Tower noticed that all the white runway edge light icons (i.e. along both sides of the runway) shown on the control screen of the Advanced Surface Movement Guidance and Control System (A-SMGCS) had turned blue³. The Watch Manager immediately informed all the controllers in the tower and reported this fault to the aerodrome operator's Fault Management Centre (FMC). At the FMC, a fault message had also appeared indicating that three adjacent runway edge lights

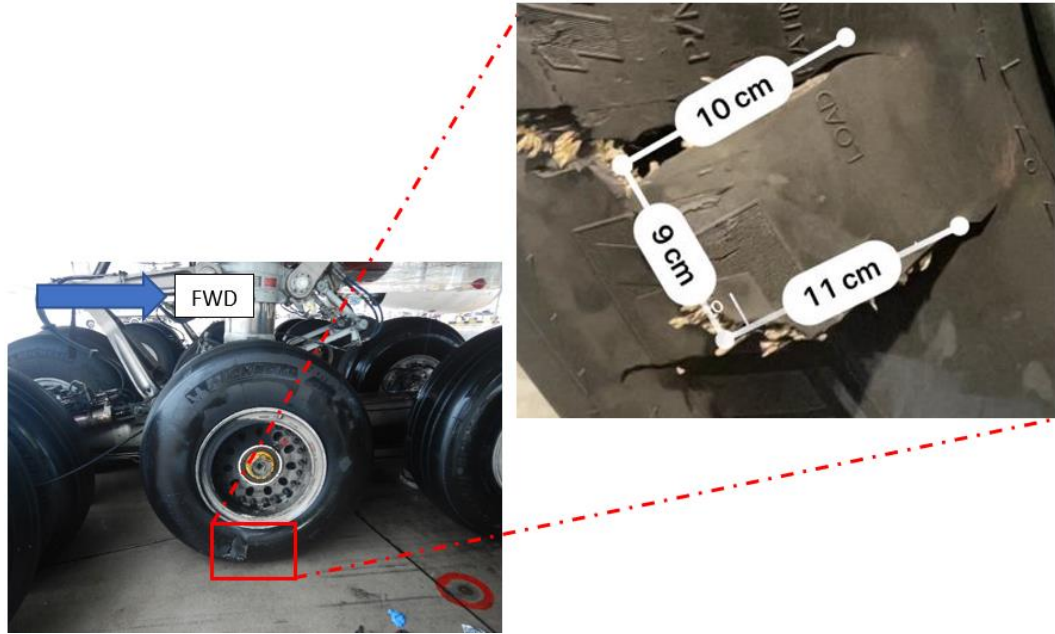
³ When the runway edge lights are switched ON by ATC, the icons representing these lights on the A-SMGCS control screens will be shown in white. When any of the following conditions are met, both rows of runway edge lights will be shown in blue:

- more than 15% of the runway edge lights are unserviceable;
- two adjacent lamps are unserviceable; or
- the Constant Current Regulator (regulating and supplying current to the runway edge lights) is faulty.

had become inoperative. The FMC informed the Watch Manager that three runway edge lights were inoperative, but the rest of the runway edge lights were operative and their intensity could still be controlled by Tower.

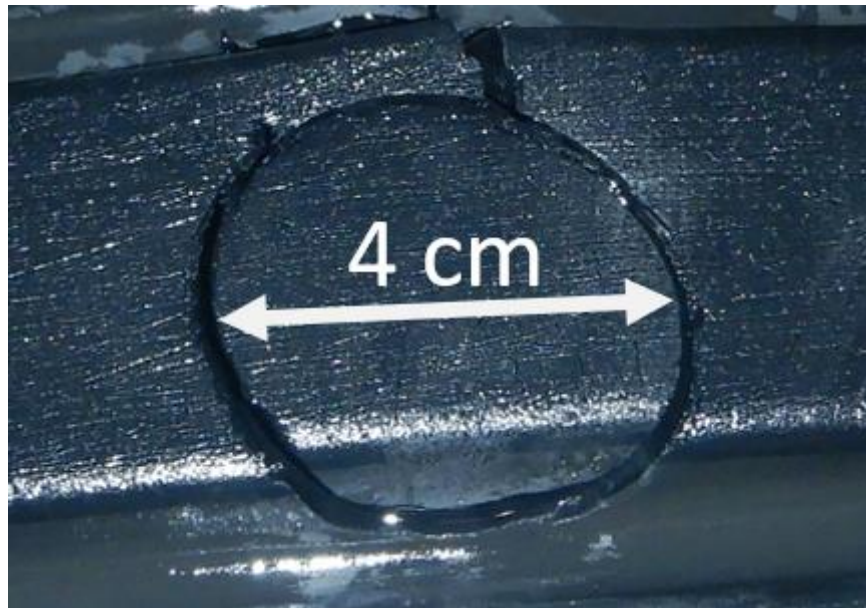
- 1.1.14 According to the flight crew, when the aircraft slowed down to about 80kts on the runway, an Electronic Centralised Aircraft Monitor (ECAM) message appeared that indicated low tyre pressure. The flight crew vacated the aircraft from the runway and taxied to its designated parking bay without assistance.
 - 1.1.15 After the aircraft had reached the parking stand, a ground staff informed the flight crew that one of the right-hand (RH) main landing gear (MLG) tyres had punctured. The flight crew left the aircraft to assess the damage. At 1509h, the flight crew informed ATC of the punctured tyre.
 - 1.1.16 At 1512h, ATC sent a runway inspection vehicle, Rover 39, to inspect the runway, the taxiways used by the aircraft⁴, as well as the aircraft's parking stand. Rover 39 subsequently informed ATC that no foreign object debris was found, and ATC informed the flight crew accordingly. ATC did not suspect that the runway edge light fault was related to the reported tyre puncture.
 - 1.1.17 At about 1616h, another runway inspection vehicle, Rover 35, when conducting a scheduled runway inspection, found three runway edge lights broken. Some light fitting debris pieces were found scattered on the runway shoulder pavement area and in the grass patch area. Some light fitting debris pieces were also found on Taxiway W7.
- 1.2 Injuries to persons
 - 1.2.1 There was no injury to any person.
 - 1.3 Damage to aircraft
 - 1.3.1 One of the RH MLG tyres was punctured (see **Figure 2**), and another RH MLG tyre was found with a circular incision (see **Figure 3**).

⁴ Rover 39 did not inspect the area around Taxiway W7 as the incident aircraft did not use Taxiway W7.



(Source: TSIB (left), SIA EC (right))

Figure 2: Punctured tyre

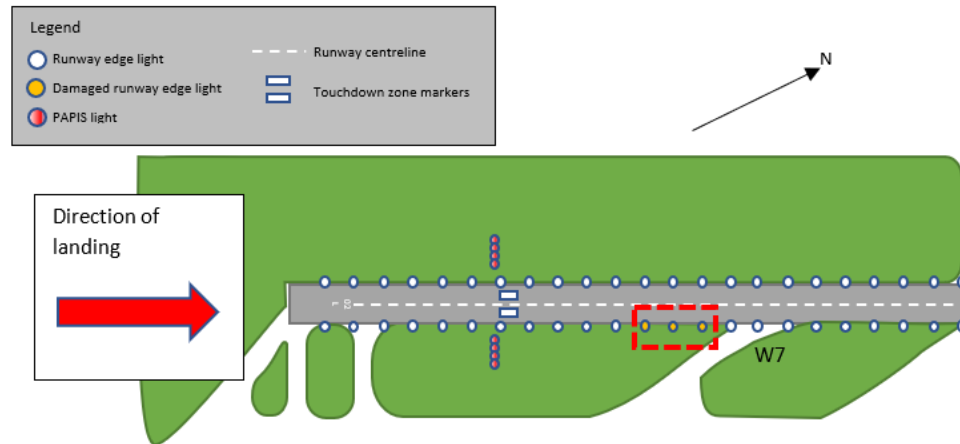


(Source: TSIB)

Figure 3: Tyre with a circular incision

1.4 Other damage

1.4.1 Three adjacent runway edge lights on the right side of Runway 02L were broken. The location of these broken runway edge lights and the recovered debris are shown in **Figure 4** and **Figure 5** below respectively.



(Not to scale)

Figure 4: Location of damaged runway edge lights



(Source: TSIB)

Figure 5: Debris from the broken runway edge lights

1.5 Personnel information

1.5.1 PIC

Age	51
Licence type	Airline Transport Pilot Licence
Issuing authority	United Arabs Emirates General Civil Aviation Authority
Licence validity date	6 June 2030
Medical certificate	Class 1
Medical certificate validity	11 January 2024
Medical operational proviso	Not applicable
Last Base Check date	29 January 2022
Last Line Check date	14 January 2023
Total flying hours	13,098 hours
Aircraft types flown	A380, A320, B737
Total hours on type	5,778 hours
Flying in last 90 days	257 hours
Flying in last 7 days	21
Flying in last 24 hours	0
Duty time in last 48 hours	0
Rest period in last 48 hours	48 hours

1.5.2 FO

Age	40
Licence type	Airline Transport Pilot Licence
Issuing authority	United Arabs Emirates General Civil Aviation Authority
Licence validity date	29 August 2030
Medical certificate	Class 1
Medical certificate validity	2 June 2023
Medical operational proviso	Correction for defective distant vision and carry a spare set of spectacles
Last Base Check date	29 August 2022
Last Line Check date	29 October 2022

Total flying hours	9,571 hours
Aircraft types flown	A380, A330, A320, B747, B737
Total hours on type	1,512 hours
Flying in last 90 days	181 hours
Flying in last 7 days	0
Flying in last 24 hours	0
Duty time in last 48 hours	0
Rest period in last 48 hours	48 hours

1.6 Meteorological information

1.6.1 At the time of the incident, Changi Airport was experiencing Instrument Meteorological Conditions (IMC), i.e. weather conditions that entail pilots flying primarily by reference to instruments. The weather information obtained from the Singapore meteorological office indicated that:

- (a) there was a line of showers to the north of Changi Airport at 1300h moving southwards and affecting Changi Airport from 1410h onwards;
- (b) between 1415h and 1435h, the wind direction ranged from 344° to 020°, and the 2-minute average wind speed fluctuated between 11 knots and 16 knots; and
- (c) between 1415h and 1435h, the runway visual range⁵ fluctuated between 1500m and 2100m.

1.7 Aids to navigation

1.7.1 There was no reported fault to any navigation aids in the aerodrome prior to the occurrence.

1.7.2 According to the airfield lighting equipment log from 1419h until the time of the occurrence, the runway centreline lights and runway edge lights were switched ON and their intensity was set at 100%⁶.

⁵ Runway visual range is the range over which the pilot of an aircraft on the centreline of a runway can see the runway surface markings or the lights delineating the runway or identifying its centreline.

⁶ a) During day-time and under visual meteorological conditions (VMC), runway centreline lights and runway edge lights are switched OFF.

- 1.8 Flight recorders
 - 1.8.1 Data from both the cockpit voice recorder and the flight data recorder were available for download and analysis.
- 1.9 Medical and pathological information
 - 1.9.1 The flight crew and the controllers involved were not sent for medical toxicological tests.
- 1.10 Additional information
 - 1.10.1 Operator's go-around policy
 - 1.10.1.1 According to the operator's Operations Manual (OM), either the PF or the PM could initiate a go-around. It is stated in the OM that "once the (go-around) decision has been announced, it is irrevocable, and the missed approach shall be completed".
 - 1.10.1.2 The operator's OM also requires that, if, during the approach, it becomes apparent that the approach and landing cannot be completed as briefed, a go-around must be initiated.
 - 1.10.1.3 According to the PF and the PM, prior to the occurrence, they were both aware of and understood the operator's go-around policy in the OM.

b) During night-VMC conditions, runway centreline lights and runway edge lights are typically set at 3% intensity.
c) Under IMC, the runway centreline lights and runway edge lights may independently be set at either 10%, 30% or 100%.

2 ANALYSIS

The investigation looked into the following:

- (a) Handling of the aircraft
- (b) Rain intensity and information of rain over the aerodrome
- (c) Decision to continue landing after 'go-around' callouts

2.1 Handling of the aircraft

- 2.1.1 The autopilot was engaged during the approach and was maintaining the aircraft on the extended runway centreline. After the autopilot was disengaged by the PF when the aircraft was about 180ft AGL, the aircraft started to drift towards the right of the extended runway centreline. The left roll inputs applied by the PF was not sufficient to arrest the rightward drift of the aircraft.
- 2.1.2 As mentioned in paragraph 1.1.12, the PF had tried without success to prevent the aircraft from continuing to drift towards the right edge of the runway. According to the aircraft manufacturer's operational and safety documentation, the right technique to correct minor lateral deviation during approach is to apply small amount of roll input. In this case, the flight crew should have applied more left roll input instead of left rudder input. Applying rudder input is not an appropriate method to correct lateral deviations.
- 2.1.3 The aircraft ended up touching down near the right runway edge line, still drifting towards the right edge of the runway, and its momentum caused it to momentarily veer off the right edge of the runway.
- 2.1.4 According to the operator's standard operating procedure (SOP), if the pilots perceive, at any point during the approach, that the approach and landing cannot be completed as briefed, a go-around must be initiated. According to the aircraft manufacturer's operational and safety documentation, a go-around may be executed so long as reversers have not been selected. In this event, although the PF did perceive that the aircraft had drifted right of the centreline, he misjudged the magnitude of the drift and thought that the offset from the runway centreline was still acceptable for a safe landing.

- 2.1.5 The drifting of the aircraft to the right during the final approach constituted an unstable approach. It would have been prudent for a go-around to be conducted in such a situation.

- 2.2 Rain intensity and information of rain over the aerodrome
 - 2.2.1 The aircraft was flying through heavy rain during the final approach. According to the PF, at around 200ft AGL, the intensity of the rain suddenly increased and he was surprised by this and his handling of the aircraft was somewhat affected. To the extent that the PF did not provide details on his reaction to this sudden increase in rain intensity, the investigation team is unable to assess how the suddenness of the increase in rain intensity affected or could have affected the PF's handling of the aircraft.

 - 2.2.2 According to ATC's SOP, ATC should inform pilots of the prevailing weather if it has changed significantly from the last observed or broadcasted over ATIS weather, but there was no procedure requiring runway controllers to check that pilots had taken note of or were aware of the most up-to-date ATIS. When the flight crew first contacted Changi Tower, the then current ATIS was broadcasting that there was rain over the aerodrome. From the Runway Controller's point of view, there was no significant change in weather, so he did not inform the flight crew of the rain over the aerodrome. As can be seen from this occurrence, it is possible for pilots not to have been aware of the information on rain over an aerodrome. Hence, it is desirable that weather information over aerodromes be provided to pilots during landing.

 - 2.2.3 The investigation team opined that the lack of the updated weather information over the aerodrome did not contribute to the occurrence as the flight crew had already been aware of the rain situation and could have visually assessed the situation and reacted appropriately, including the need to go-around. Nevertheless, the investigation team opined that it would be desirable for such rain information to be provided by runway controllers to pilots during the approach for better flight planning by the latter.

- 2.3 Decision to continue landing after "go-around" callouts
 - 2.3.1 When the aircraft was about 30ft AGL and noting that the aircraft was still drifting, the PM called out "go-around". The PF told the investigation team that he did not understand what the PM had said but did not ask the PM to repeat

or clarify what the PM had said. Instead, he responded with “no it’s OK” just so that he could get on with focusing on landing the aircraft. It would have been more prudent for the PF to ask the PM to repeat or clarify his message.

- 2.3.2 The PM called out “go-around” again. By then, the aircraft was already touching down on the runway. According to the PF, he did not hear this second “go-around” callout and continued with the landing.
- 2.3.3 The operator’s SOP stated that whenever a “go-around’ callout is made by either pilot, it is mandatory that the pilots execute the go-around manoeuvre. The PM had called for a “go-around”. When he did not receive an appropriate response as per the operator’s SOP, he called for “go-around” again. However, by this time the aircraft had already landed. The PF’s decision to continue landing despite the “go-around” callouts by the PM was not in line with the SOP. Based on what the PF shared with the investigation team, he did not correctly perceive the first “go-around” callout and missed the second. As a result, the PF did not know that the PM had call for a go-around and thus, the PF did not execute the go-around manoeuvre as stated in the operator’s SOP.
- 2.3.4 The PF’s decision to continue landing without fully understanding what the PM said (i.e. the first “go-around callout) does not accord with good cockpit resource management (CRM) practices. The importance of effective communication cannot be over-emphasised. If unsure of what was said by the other pilot(s), a pilot should request the pilot(s) to repeat the message.

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 PF said that when the aircraft was around 200ft AGL, the intensity of the rain suddenly increased. He was surprised by the change in rain intensity and his handling of the aircraft was somewhat affected. The investigation team is unable to assess how his aircraft handling ability was affected.
- 3.2 After autopilot was disengaged during the approach, the aircraft drifted towards the right of the centreline. The PF did not manage to correct the rightward drift to bring the aircraft back to the runway centreline and did not consider conducting a go-around manoeuvre.
- 3.3 The PF's attempt to correct the aircraft's drift by applying rudder inputs was not an appropriate method to correct lateral deviations.
- 3.4 The PF misjudged the magnitude of the drift and thought that the offset from the extended runway centreline was still acceptable for a safe landing. The aircraft ended up touching down near the right runway edge line, still drifting towards the right edge of the runway, and its momentum caused it to momentarily veer off the right edge of the runway.
- 3.5 The PM called out "go around" twice before the PF landed the aircraft. The PF only heard the first callout but did not fully understanding the message. Despite so, the PF did not ask the PM to repeat or clarify the message but instead chose to continue to land.
- 3.6 There was a change in weather condition, i.e. rain, over the aerodrome after the flight crew had received an earlier ATIS that did not report rain over the aerodrome. The Runway Controller also did not inform the flight crew of rain over the aerodrome. However, the flight crew were aware of the rain situation as the aircraft was flying through weather during the final approach.
- 3.7 The lack of most up-to-date weather information from ATC did not contribute to the occurrence as the flight crew had already been aware of the rain situation and could have visually assessed the situation and reacted appropriately.

Nevertheless, it would be desirable for such rain information to be provided to pilots during the approach for better flight planning by the latter.

4 SAFETY ACTIONS

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

- 4.1 The operator has taken the following actions:
- (a) Shared a de-identified summary of the event with all pilots on 17 March 2023.
 - (b) Decided to include a case study of this event as part of its pilots' recurrent training from August 2023.
 - (c) Included, during the Annual CRM and Technical Training, a reminder to the pilots that once a go-around is announced by the PM or the PF, the go-around must be executed. The PM should be ready to take control and fly a missed approach, even if the aircraft touches the ground.
- 4.2 The air traffic service provider has conducted briefings between 4 and 7 September 2023 to remind its controllers to advise pilots under their control of prevailing weather conditions (e.g. rain over the airfield).

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.

5.1 It is recommended that the operator:

5.1.1 Remind its pilots the appropriate technique to correct lateral deviation during approach and landing. [TSIB Recommendation RA-2023-011]

5.1.2 Remind its pilots on the importance of crew resource management and of asking the originator of a message to repeat the message if they do not understand the message. [TSIB Recommendation RA-2023-012]