Taiwan TTSB
國家運輸安全調查委員會
Transportation Safety Board

30 December 2020
Elit'Avia Malta Limited Flight EAU52P
Bombardier BD-700-1A10, 9H-OJP
Abnormal Runway Contact during Landing at Taichung International Airport
Aviation Occurrence Investigation Final Report

January 2022

TTSB-AOR-22-01-001

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According to the Transportation Occurrences Investigation Act of the Republic of China and the International Civil Aviation Organization (ICAO) Annex 13, this report is only for the improvements of flight safety.

Transportation Occurrences Investigation Act of the Republic of China, Article 5:

The objective of the TTSB's investigation of transportation occurrence is to prevent recurrence of similar occurrences. It is not the purpose of such investigation to apportion blame or liability.

ICAO Annex 13, Chapter 3, Section 3.1:

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.

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Executive Summary

On 30 December 2020, a Bombardier BD-700-1A10 (Global 6000) aircraft, Republic of Malta registration 9H-OJP, Elit'Avia Malta Limited flight EAU52P, with two pilots and one cabin crew, was being operated on an instrument flight rules (IFR) positioning flight from Korea Incheon International Airport (RKSI), Republic of Korea, to Taichung International Airport (RCMQ), Taiwan, Republic of China. The weather conditions at RCMQ were reported good visibility and strong gusty wind with significant crosswind for the landing runway 36. Just before touchdown, the flight crew attempted to compensate the disturbances in the roll and pitch of the aircraft induced by the gusty wind conditions, using significant control inputs. Both wing tips of the aircraft contacted the runway surface during landing. The left wing slat and aileron, the right winglet, aileron, and flap canoes were damaged. No injuries to the persons on board.

According to the Transportation Occurrence Investigation Act of the Republic of China and the content of Annex 13 to the Convention on International Civil Aviation Organization, the Taiwan Transportation Safety Board (TTSB), an independent transportation occurrence investigation agency, was responsible for conducting the investigation. The investigation team also included members from the Maltese Bureau of Air Accident Investigation (BAAI), the Transportation Safety Board of Canada (TSB), Bombardier, and Elit'Avia Malta Limited.

The 'Final Draft Report' of the occurrence investigation was completed in July 2021. In accordance with the procedures, it was reviewed at TTSB's 31th Board Meeting on 1st October 2021 and then sent to relevant organizations and authorities for comments. After comments were collected and integrated, the English version of the investigation report was reviewed and approved by TTSB's 34th Board Meeting on 7th January 2022.

There are a total of 10 findings from the Final Report. There is no safety recommendation issued to the related organizations, the safety actions are presented in the report.

Findings as the result of this investigation

The TTSB presents the findings derived from the factual information gathered during the investigation and the analysis of the occurrence. The findings are presented in three categories: findings related to probable causes, findings related to risk, and other findings.

Findings Related to Probable Cause

1. Taichung International Airport was affected by a strong cold high-pressure weather system at the time of the occurrence. The meteorological conditions were reported to be good visibility and strong gusty wind with significant crosswind for runway 36.

2. Two seconds before the aircraft touched down on the runway, the flight crew reacted with a significant and rapid control wheel input to compensate for the disturbances in the roll and pitch of the aircraft caused by the gusty wind conditions. The right wing down control input resulted in a maximum of 6.76 degrees right wing down roll angle and a 9.31 degrees nose up pitch attitude at 0 feet radio altitude. The aircraft touched down hard on the right main landing gear in a right rolling motion. The right wing tip of the aircraft probably contacted the runway surface at this time.

3. After the right main gear touched the ground and bounced, followed by the left wing down control input by the pilot flying in an attempt to stop the right roll motion, the aircraft rolled to the left. The aircraft reached a maximum roll angle of 9.4 degrees left wing down. With the pitch attitude at 8.26 degrees, the left wing tip of the aircraft contacted the runway surface.

4. The combination of the strong and gusty wind conditions, insufficient time to gain complete control of the aircraft due to late disconnection of the autopilot , the rapid decrease of the airspeed due to a rapid headwind reduction that was not compensated for by increasing thrust and the increased pitch angle by the pitch up control demand of the pilot flying, and the significant and rapid control input of the flight crew during flare to compensate the disturbance of roll and pitch by the gusty wind, resulted in a wingtips abnormal runway contact landing occurrence.

Findings Related to Risk

1. The autopilot was disengaged at 219 feet radio altitude. The pilot flying (PF) had only 16 seconds to transit from automatic flight to manual flight before the aircraft reached 30 feet and the PF started the landing flare for touchdown, which gave the PF insufficient time to gain complete control of the aircraft before landing in the strong and gusty wind conditions.

2. The difference between the Vref speed adders recommended in different manuals may create confusion and adversely affect the standardization of flight operations during approach and landing in strong and gusty wind conditions.

Other Findings

1. The flight crew were properly certificated and qualified in accordance with the related regulations and requirements. No evidence indicated any pre-existing medical conditions, fatigue, medication, or presence of other drugs or alcohol that might have adversely affected the flight crew's performance during the occurrence flight.

2. The occurrence aircraft was properly certified, with no reported technical issues related to the flight controls system in accordance with the relevant

technical documents.

3. The aircraft's weight and balance were within the operational limits for the duration of the occurrence flight.

4. The flight data recorder (FDR) parameters indicated that the autopilot coupled instrument landing system (ILS) approach of the occurrence flight was a stable approach in accordance with the company's stabilized approach criteria.

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Abbreviation

ACAS	airborne collision avoidance system
AFM	airplane flight manual
ATC	air traffic control
ATIS	automatic terminal information service
AP	autopilot
ATPL	air transport pilot license
AWOS	automated weather observation system
CFME	continuous friction measuring equipment
CG	center of gravity
CPL	commercial pilot license
CRM	crew resource management
CVR	cockpit voice recorder
FCOM	flight crew operating manual
FDR	flight data recorder
FDMP	flight data monitoring program
FH	flight hour
FSTD	flight simulation training devices
GPS	global positioning system
ICAO	International Civil Aviation Organization
IFR	instrument flight rules
ILS	instrument landing system
LWD	left wing down
MAC	mean aerodynamic chord
METAR	aerodrome routine meteorological report
NOTAM	notice to airmen
PAPI	precision approach path indicator
PF	pilot flying
PFD	primary flight display
PM	pilot monitoring
RA	radio altitude
RWD	right wing down
RESA	runway end safety area
ROPAT	recommended operational procedures and techniques
SOP	standard operating procedure

TCAS	traffic alert and collision avoidance system
TLA	throttle lever angle

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Chapter 1 Factual Information

1.1 History of Flight

On 30 December 2020, a Bombardier BD-700-1A10 (Global 6000) aircraft, Republic of Malta registration 9H-OJP, Elit'Avia Malta Limited flight EAU52P, with two pilots and one cabin crew, was being operated on an instrument flight rules (IFR) positioning flight from Korea Incheon International Airport (RKSI), Republic of Korea, to Taichung International Airport (RCMQ), Taiwan, Republic of China. At 1038 Taipei Local Time[1], the left and right wings of the aircraft contacted the runway surface during landing at RCMQ. The left wing slat and aileron, the right winglet, aileron, and flap canoes of the aircraft were damaged. No injuries to the persons on board.

The captain occupied the left seat in the cockpit and was the pilot monitoring (PM) for the occurrence flight. The first officer occupied the right seat and was the pilot flying (PF). The occurrence flight departed from RKSI at 0809 hours for RCMQ to pick up passengers and continue to fly to Singapore. At the arrival time to RCMQ of the occurrence flight, a strong cold high pressure located at Mongolia drifting southward affected the weather condition in Taiwan. According to the aerodrome routine meteorological report (METAR) for RCMQ current at 1030 hours, the weather conditions were wind from 030 degrees at 27 knots gusting to 41 knots with visibility of more than 10 kilometers. The cloud coverage[2] was few at 500 feet, scattered at 1,500 feet, broken at 2,100 feet, temperature was 14 degrees Celsius, dew point 8 degrees Celsius, and altimeter

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[1] Unless otherwise noted, the 24-hour clock is used in this report to describe the local time of day, Taipei Local Time, as particular events occurred. Taipei Local Time is Universal Coordinated Time (UTC) +8 hours.

[2] Cloud amounts are reported in oktas. An okta is a unit of sky area equal to one-eighth of total sky visible to the celestial horizon. Few = 1 to 2 oktas, scattered = 3 to 4 oktas, broken = 5 to 7 oktas and overcast = 8 oktas. The METAR reports the height of the cloud base in hundreds of feet above aerodrome elevation.

setting (QNH) was 1020 hPa.

According to the flight data recorder (FDR), cockpit voice recorder (CVR), and the interview notes of the flight crew, the flight was normal for takeoff, climb, and cruise. The initial cruising altitude was FL380[3] and the final cruising altitude was FL400. Before descent, the PF conducted the approach briefing after obtaining the latest RCMQ automatic terminal information service (ATIS) information Lima. The briefing included the arrival routes and the weather conditions. During approach, the captain advised the PF to keep the airspeed a little bit higher and plan to disconnect the autothrottle if the winds were gusty. The approach reference speed (Vref) was 127 knots according to the weight of the aircraft and the final approach speed was set to 132 knots, Vref + 5 knots, by the flight crew.

The approach in use at RCMQ was the ILS[4] (instrument landing system) runway 36 for the occurrence flight in windy and gusty conditions. The FDR, CVR, and interview data indicated that, when the aircraft was below 1,000 feet radio altitude (RA), the approach was normal and stable. The autopilot was disengaged by the PF at 1037:56 hours, radio altitude 219 feet; the autothrottle remained engaged. At 1038:05.4 hours, the radio altitude of the aircraft was about 70 feet, the PM called out "you are below glides" to remind the PF that the aircraft was below the glideslope. The PF responded "correct(ing)" and raised the nose of the aircraft about one degree to get back onto the glide path.

At 1038:08 hours, the radio altitude of the aircraft was 50 feet, indicated airspeed was 137 knots, pitch angle was about 5.3 degrees and roll angle was

[3] Flight level 380, equal to 38,000 feet.

[4] An ILS is a standard ground aid to landing, comprising two directional radio transmitters: the localizer, which provides direction in the horizontal plane or lateral flightpath tracking guidance; and the glideslope for vertical plane direction or vertical flightpath tracking guidance usually at an inclination of 3°. Distance measuring equipment (DME) or marker beacons along the approach provide distance information.

about 0.5 degrees right wing down (RWD), the altitude auto callout announced "fifty" in the cockpit. One second later, the throttle levers moved to idle. At 1038:11 hours, the aircraft passed over the runway 36 threshold at radio altitude of 34 feet, airspeed was 123.75 knots, groundspeed was 89 knots, the aircraft pitch angle was 5.6 degrees and roll angle was 2.4 degrees RWD. At 1038:12 hours, the altitude auto callout announced "thirty" at the aircraft radio altitude of 24 feet, airspeed was 125.5 knots, and pitch angle was about 6 degrees. At 1038:14 hours, the altitude auto callout announced "ten" at the aircraft radio altitude of 5.6 feet, airspeed was 113 knots, and pitch angle increased to about 8.5 degrees. One second later, at 1038:15 hours, the aircraft touched down on runway 36 with the airspeed 113 knots, pitch angle 10.2 degrees, and roll angle 5.88 RWD with the control wheel position about 62 degrees RWD[5]. The vertical acceleration of the aircraft at touched down was 2.12 g.

Right after touch down, at 1038:16 hours, the PF introduced a large amount of left wing down (LWD) control wheel input. The control wheel position changed from 62 degrees RWD to 81 degrees LWD, the aircraft roll angle changed from the maximum RWD bank angle 6.76 degrees to 9.4 degrees LWD, and the right main gear air/ground switch changed from ground to air. At 1038:17 hours, the autothrottle was disengaged and the right main gear air/ground switch changed to ground again. The aircraft started to decelerate without further incident.

During post-landing walk-around, the flight crew discovered damage on both wingtip areas.

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[5] At 1038:14.75 hours, the maximum RWD bank angle of the aircraft immediately before touch down were 6.76 degrees with a pitch angle of 9.31 degrees.

1.2 Injuries to Persons

No injuries to the persons on board.

1.3 Damage to Aircraft

Abrasions of outboard corner of the left outboard leading edge slat, the outboard trailing edge of the left aileron, the bottom of the right winglet, the outboard trailing edge of the right aileron, the tip of the right outboard flap canoe, and the tip of the right center flap canoe, see 1.12 for details.

1.4 Other Damage

None.

1.5 Personnel Information

1.5.1 Flight Crew

1.5.1.1 Captain

The captain was a Republic of Slovenia national. He joined Elit'Avia Malta on 16 May 2018. The captain was a Bombardier Canadair Regional Jet (CRJ) pilot for about 10 years. In 2017, the captain started to fly Bombardier BD-700 aircraft. At the time of the occurrence flight, the captain had total flying time of about 6,143 hours with about 1,710 hours on the BD-700.

The captain held an air transport pilot license (ATPL) issued by the Civil Aviation Agency of the Republic of Slovenia with single-engine piston land, multi-engine, instrument, and type rating on CRJ CL-65 and BD-700, endorsed with privileges for operation of radiotelephone on board an aircraft and a current Slovenian level 6 and English Level 5 language proficiency.

The captain passed his most recent annual line check on 3 July 2020.

The captain completed a one-day annual recurrent ground school training on 20 September 2020. The subjects of the ground school training included aircraft systems, performance, and weight & balance. The recurrent simulator training was conducted on 23 and 24 September 2020. The simulator training comprised upset prevention and recovery training, including windshear, stalls, approach, landing, and airborne collision avoidance system (ACAS) and traffic alert and collision avoidance system (TCAS) events, and normal/abnormal procedures including go around, hydraulic system, landing gear and brake system, smoke control and removal. The captain's performance of the training was assessed as "well done". The captain passed the proficiency check on 25 September 2020.

The captain received his most recent crew resource management (CRM) training on 6 May 2020 and fatigue management training on 2 September 2020.

The captain's Class 1 medical certificate was issued by the Civil Aviation Agency Republic of Slovenia on 15 May 2020 with no limitations.

The result of the captain's alcohol test performed by the RCMQ operation officer after the occurrence indicated the alcohol value was zero

1.5.1.2 First Officer

The first officer was a Netherlands national. He had his initial flight training in 2005 and was a single-engine piston aircraft flight instructor for 7 years. At the time of the occurrence flight, he had 3 years BD-700 flight experience, having flown for a private owner for 2 years and then joining Elit'Avia Malta in 2020. His total flying time was about 3,841 hours with 484 hours on BD-700.

The first officer held a commercial pilot license (CPL) issued by Civil Aviation Authority Netherlands with single-engine piston land, multi-engine piston land, instrument, night, flight instructor, and type rating on BD-700, endorsed with privileges for operation of radiotelephone on board an aircraft and a current English Level 6 language proficiency.

The first officer passed his most recent annual line check on 3 July 2020.

The first officer completed a one-day annual recurrent ground school training on 18 June 2020. The subjects of the ground school training included aircraft systems, performance, and weight & balance. The recurrent simulator training was conducted on 24 and 25 June 2020. The simulator training comprised upset prevention and recovery training, including windshear, stalls, approach, landing, and ACAS and TCAS events, and normal/abnormal procedures including go around, hydraulic system, landing gear and brake system, smoke control and removal. The first officer's performance of the training was assessed as "very high standard". The first officer passed the proficiency check on 26 June 2020.

The first officer received his most recent CRM training on 14 December 2020 and fatigue management training on 7 September 2020.

The first officer's Class 1 medical certificate was issued by the Civil Aviation Authority Netherlands on 14 May 2020 with limitations of "CORRECTION FOR DEFECTIVE DISTANT VISION".

The result of the first officer's alcohol test performed by the RCMQ operation officer after the occurrence indicated the alcohol value was zero.

Basic information of the occurrence flight crew is in Table 1.5-1.

Table 1.5-1 Flight crew basic information

Item	Captain	First Officer
Gender	Male	Male
Age as of occurrence	35	35
Commenced employment with Elit'Avia Malta	16 May 2018	20 Jan 2020
License issued	ATPL – Aeroplanes	CPL – Aeroplanes
Type rating date of expiry	BD-700 30 November 2021	BD-700 31 July 2021
Medical certificate date of expiry	Class 1 15 May 2021	Class 1 11 June 2021
Total flying time	6,143 hrs and 20 mins	3,841 hrs and 30 mins
Total flying time on BD-700	1,710 hrs and 55 mins	484 hrs and 05 mins
Total flying time last 12 months	432 hrs and 44 mins	306 hrs and 30 mins
Total flying time last 90 days	61 hrs and 26 mins	91 hrs and 30 mins
Total flying time last 30 days	10 hrs and 28 mins	31 hrs and 30 mins
Total flying time last 7 days	2 hrs and 50 mins	2 hrs and 50 mins
Total flying time last 24 hours	2 hrs and 50 mins	2 hrs and 50 mins
Rest period before occurrence	16 hrs 25 mins	16 hrs 25mins

1.5.2 Flight Crew Activities within 72 hours Before the Occurrence

1.5.2.1 Captain

The captain stayed at home without flight duty for more than 10 days.

28 December 2020 Slovenia time (UTC+1)

0700L woke up

1300L departed from home

1445L positioning flight from Slovenia to Frankfurt as a passenger

1805L positioning flight from Frankfurt to Seoul as a passenger

29 December 2020 Seoul time (UTC+9)

1200L landed at Seoul

1315L checked in to Seoul Incheon airport transit hotel

2100L went to bed

30 December 2020 Seoul time (UTC+9)

0315L woke up

0700L checked out from hotel

0853L departed RKSI on the occurrence flight as the captain

1.5.2.2 First Officer

The first officer stayed at home without flight duty for more than 10 days.

28 December 2020 Netherlands time (UTC+1)

1000L woke up

1800L departed from home to airport

2100L positioning flight from Amsterdam to RKSI as a passenger

29 December 2020 Seoul time (UTC+9)

1600L landed at Seoul

2230L went to bed at the transit hotel

30 December 2020 Seoul time (UTC+9)

0100L awakened, stayed in bed slept/snoozed on and off until 0600L[6]

0700L checked out from hotel

0853L departed RKSI on the occurrence flight as the first officer

1.6 Aircraft Information

1.6.1 Aircraft and Engine Basic Information

Basic information of the occurrence aircraft is shown in Table 1.6-1.

Table 1.6-1 Aircraft basic information

Aircraft basic information (statistics date: 30 December 2020)	
Nationality	9H (Malta)
Aircraft registration number	9H-OJP
Aircraft model	BD-700-1A-10
Manufacturer	Bombardier Inc.
Aircraft serial number	9764
Date of manufactured	2016
Date of received	30-Apr-2019 (date registered with Elit'Avia Malta)
Owner	Bombardier G6000-9764 Ltd.
Operator	Elit'Avia Malta Ltd.
Number of certificate of registration	653/1
Certificate of airworthiness number	653

6 The PF stated that he was feeling well rested and fit to fly.

Certificate of airworthiness, due date	07-May-2021
Total flight time (hours:minutes)	2873:05
Total flight cycles	703
Last periodic check/ Perform date	250 FH Check/ 21-Dec-2020 (2844:53 FH / 696 CYC)

Basic information for the two Rolls-Royce engines is shown in Table 1.6-2.

Table 1.6-2 Engine basic information

Engine basic information		
Number/position	No. 1/ Left	No. 2/ Right
Manufacturer	Rolls-Royce Deutschland Ltd	Rolls-Royce Deutschland Ltd
Model	BD700-710A2-20	BD700-710A2-20
Serial number	22707	22706
Manufacture date	13-Oct-2016	12-Oct-2016
Time since last maintenance	258:43	258:43
Cycle since last maintenance	64	64
Time since new	2857:53	2857:53
Cycle since new	697	697

1.6.2 Aircraft Maintenance Information

A review of the last 3 months maintenance records, found no reported technical issues related to the flight control system in accordance with the technical logbooks, minimum equipment list, configuration deviation list and deferred defect log. A review of applicable airworthiness directives and service bulletins found no anomalies. No anomalies were noted during the most recent 250 flight hour (FH) check before the occurrence.

1.6.3 Weight and Balance Information

The actual takeoff weight of the occurrence aircraft was 86,207 lbs. The aircraft's center of gravity (CG) for takeoff was located at 31.0% mean aerodynamic chord (MAC). The CG for landing was located at 30.4% MAC. The center of gravity envelope of the BD-700 is depicted in Figure 1.6-1. Table 1.6-3 shows the occurrence aircraft's weight and balance data. The aircraft's weight and balance were within the operational limits for the duration of the occurrence flight.

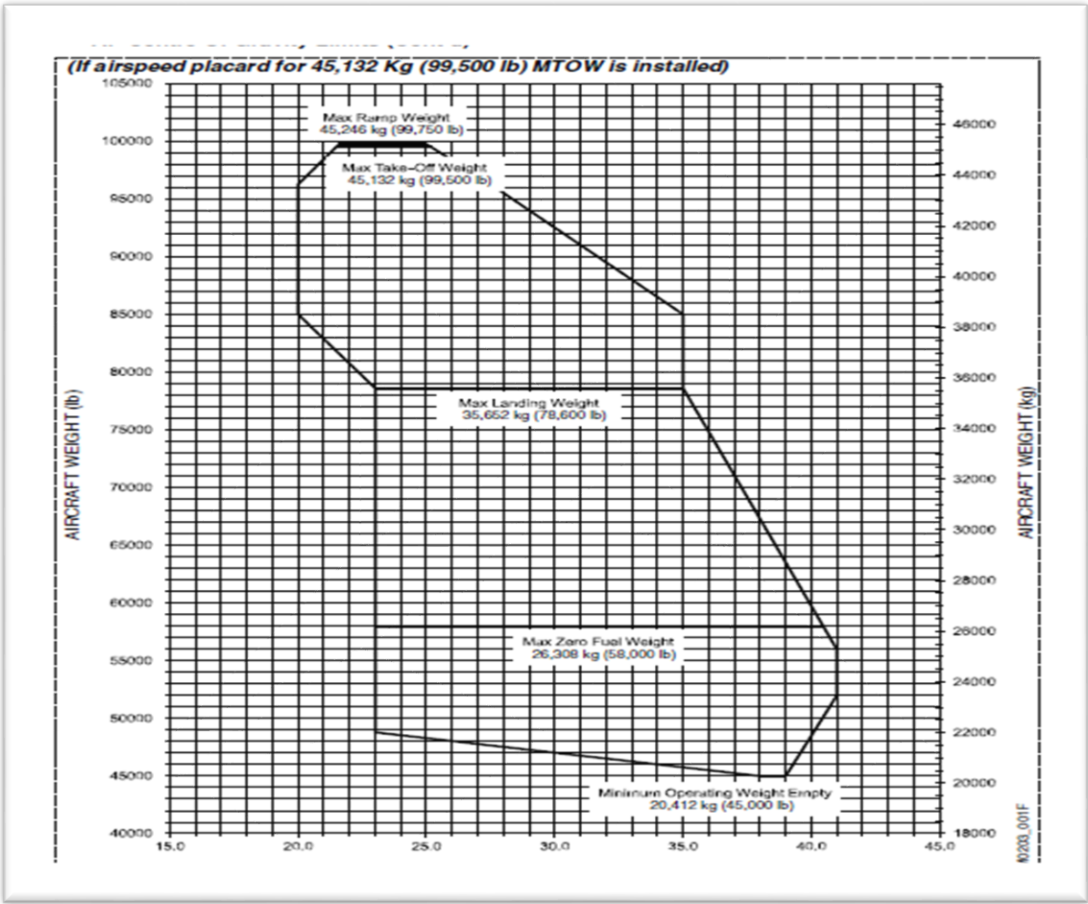

Figure 1.6-1 BD-700 CG envelope

Table 1.6-3 Weight and balance data

Max. zero fuel weight	58,000 lbs.
Actual zero fuel weight	52,607 lbs.
Max. takeoff weight	99,500 lbs.
Actual takeoff weight	86,207 lbs.
Takeoff fuel	33,600 lbs.
Estimated trip fuel	8,650 lbs.
Max. landing weight	78,600 lbs.
Estimated landing weight	77,557 lbs.
Takeoff/landing CG	+31.0/+30.4 MAC

1.7 Weather Information

The high-pressure of 1088 hPa was located and almost stationary in Mongolia. Taiwan was affected by the strong cold high-pressure system drifting southward. The northeasterly wind on the ground had increased significantly, with wind speeds ranging from 10 to 28 knots.

The aerodrome routine meteorological reports (METAR) for RCMQ around the time of the occurrence were:

METAR at 1000 hours, wind from 030 degrees at 28 knots gusting to 41 knots, visibility greater than 10 kilometers, few clouds at 500 feet, scattered clouds at 1,200 feet, broken at 2,100 feet, temperature 14°C; dew point temperature 8°C, altimeter setting 1020 hPa , trend forecast-no significant change, remarks: altimeter setting 30.14 in-Hg, runway 36 wind not available[7]. (ATIS L)

METAR at 1030 hours, wind from 030 degrees at 27 knots gusting to 41 knots, visibility greater than 10 kilometers, few clouds at 500 feet, scattered

[7] The runway 36 anemometer (one of automated weather observation system (AWOS) S sensors) operated normally but the data transformation was malfunction from 1420 on 29 December to 1520 on 30 December 2020. The wind information of ATIS was acquired from AWOS C at the time of the occurrence.

clouds at 1,200 feet, broken at 2,100 feet, temperature 14°C; dew point temperature 8°C, altimeter setting 1020 hPa , trend forecast-no significant change, remarks: altimeter setting 30.13 in-Hg, runway 36 wind not available. (ATIS M)

The sensors of the automated weather observation system (AWOS) were located at the approach ends and midpoint of the runway, as shown in Figure 1.7-1, providing real-time weather information to the displays of the weather center and the tower. The wind information from 1035 to 1041 hours was shown in Figure 1.7-2 and 1.7-3. From 1037:56 hours (the radio altitude of the aircraft was 220 feet) to 1040:10 hours (the aircraft taxied into taxiway), the wind variations were from 010 to 050 degrees and from 14 to 31 knots for AWOS S, the wind variations were from 020 to 050 degrees and from 23 to 45 knots for AWOS C.

Figure 1.7-1 AWOS sensor locations

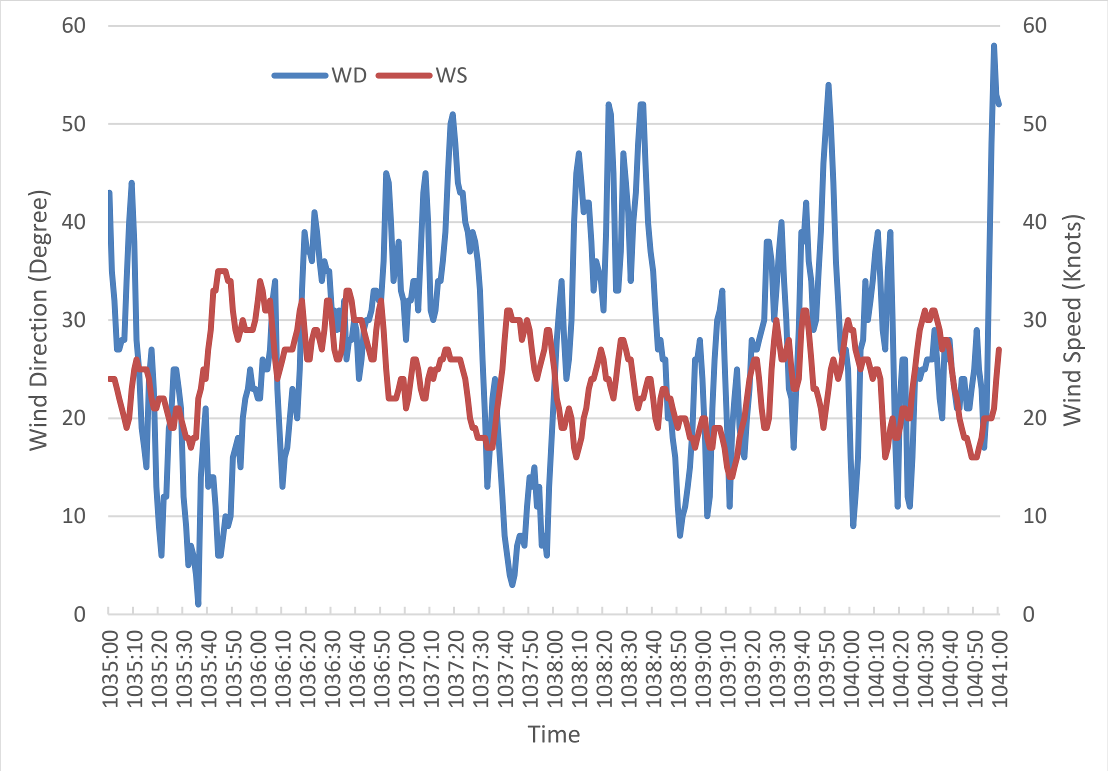

Figure 1.7-2 AWOS S wind speed/direction

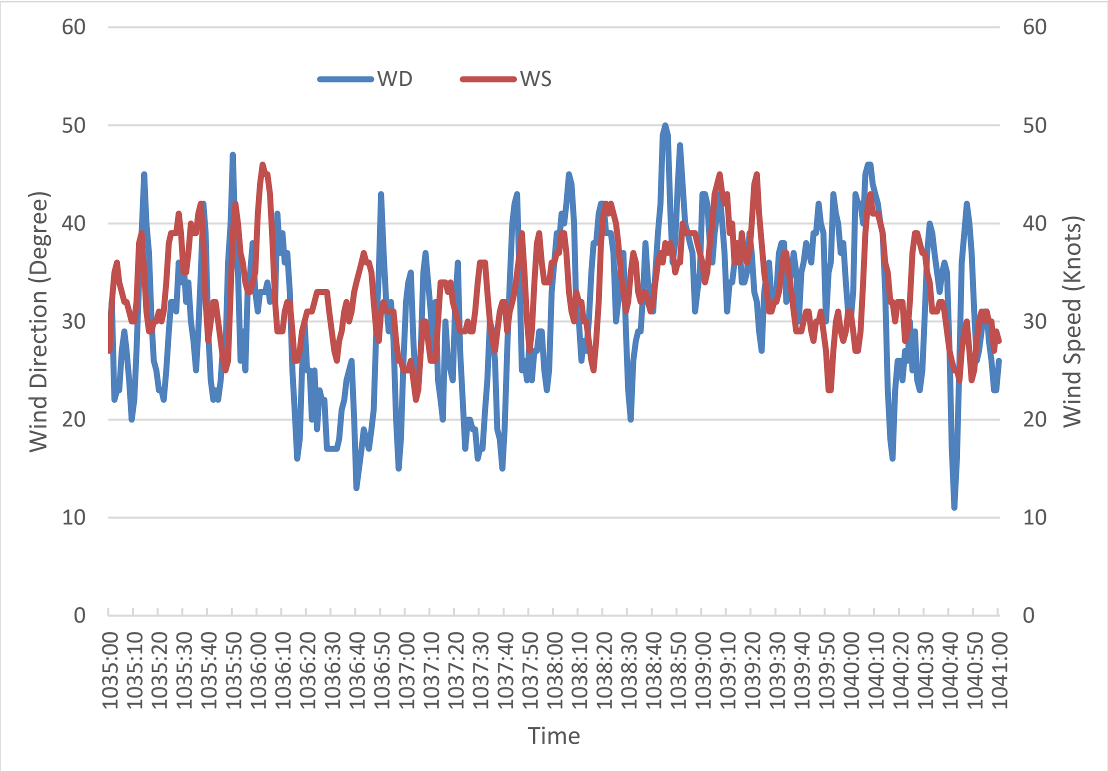

Figure 1.7-3 AWOS C wind speed/direction

1.8 Aids to Navigation

Not applicable.

1.9 Communication

Not applicable.

1.10 Aerodrome

1.10.1 Airside Basic Information

Taichung/Cingcyuangang (RCMQ) Airport is located 10 km northwest of Taichung City. There is only one runway, oriented north and south, and designated as runway 18/36 with declared dimensions of 3,659 meters long, 61 meters wide. Runway 18’s true bearing is 176.69°, and the threshold elevation is 653 feet. It has neither clearway nor stopway. Runway 36’s true bearing is 356.69°, and the threshold elevation is 663 feet. It also has neither clearway nor stopway, but a runway end safety area (RESA) with 90 meters square provided. (See Figure 1.10-1). The mean profile slope of runway 36 is about -0.09%, and the mean cross-section slope is about 0.53%.

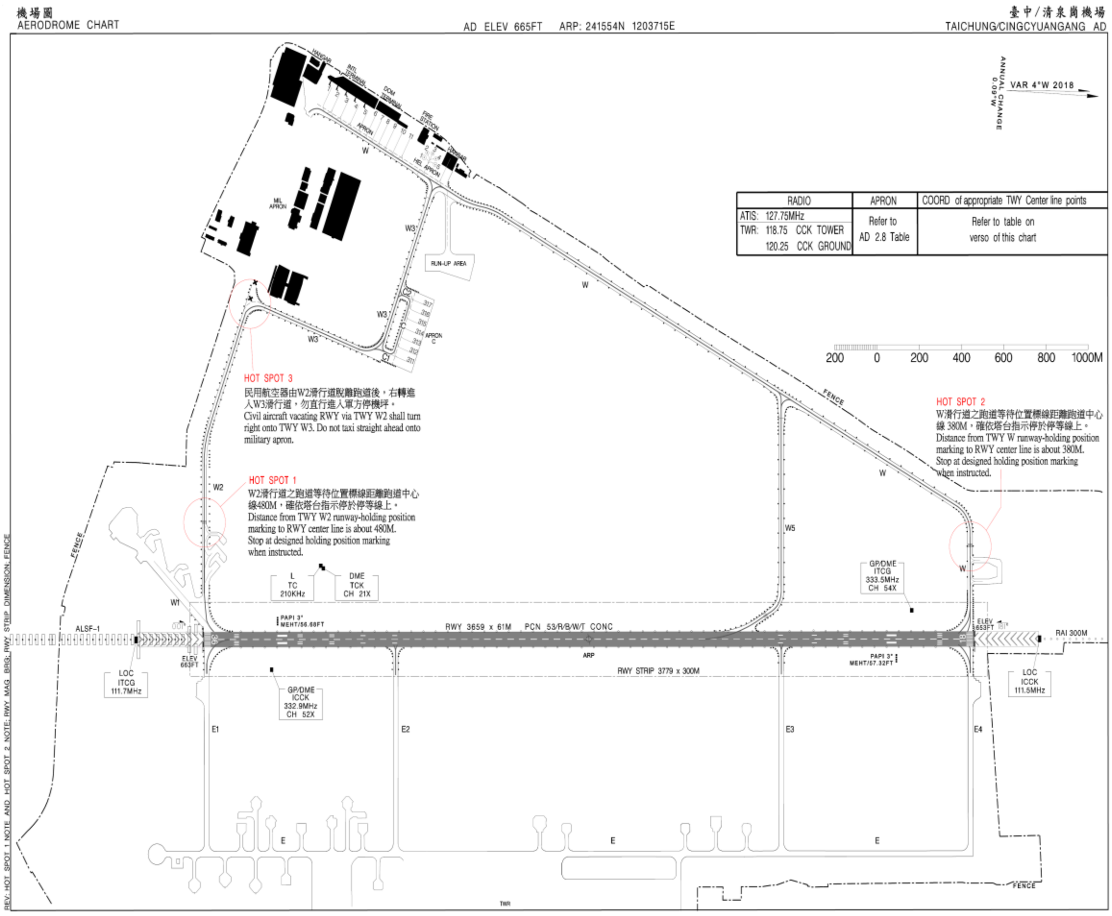

Figure 1.10-1 RCMQ Airport chart

Runway edge lights installed on both sides of runway 18/36 are high intensity and with 60 meters spacing. Both centerline lights and touchdown zone lights are not available. Runway 36 is a precision approach runway equipped with a category I approach lighting system consisting of 900-meter-long sequenced flashers (ALSF-1) and a high intensity precision approach path indicator (PAPI).

1.10.2 Runway Surface Friction

Surface friction measurements of runway 18/36 are carried out by a commissioned contractor using Grip-Tester, a continuous friction measuring equipment (CFME) conforming to ICAO[8] standards and recommended practices. With 1 mm depth of water sprayed on the dry runway surface, the measurement

[8] International Civil Aviation Organization.

conducts with 65km/h and 95km/h along a line approximately 3 meters on each side of the runway centerline. Whenever a one-third segment's friction value of the runway is lower than 0.53 at 65km/h, or 0.36 at 95km/h, the airport authority should plan to take corrective actions. Whenever a one-third segment's friction value of the runway is lower than 0.43 at 65km/h, or 0.24 at 95km/h, the airport authority should take corrective actions immediately and issue a notice to airmen (NOTAM) to warn that the runway might be slippery until the work has been completed.

<u>Measurement results before the occurrence</u>

The most recent measurement before the occurrence was conducted on 8 December 2020. Results are listed in tables 1.10-1 and 1.10-2.

Table 1.10-1 The most recent measurement results before the occurrence, 65km/h

Runway	**1st 1/3 Segment**	**2nd 1/3 Segment**	**3rd 1/3 Segment**	**Runway**
18	0.63	0.65	0.70	36
	0.67	0.63	0.69	

Table 1.10-2 The most recent measurement results before the occurrence, 95km/h

Runway	**1st 1/3 Segment**	**2nd 1/3 Segment**	**3rd 1/3 Segment**	**Runway**
18	0.66	0.64	0.65	36
	0.65	0.62	0.67	

<u>Measurement results right after the occurrence</u>

The first measurements after the occurrence were conducted on 5 January 2021. Results are listed in tables 1.10-3 and 1.10-4.

Table 1.10-3 The first measurement results after the occurrence, 65km/h

Runway	1st 1/3 Segment	2nd 1/3 Segment	3rd 1/3 Segment	Runway
18	0.68	0.69	0.74	36
	0.72	0.68	0.73	

Table 1.10-4 The first measurement results after the occurrence, 95km/h

Runway	1st 1/3 Segment	2nd 1/3 Segment	3rd 1/3 Segment	Runway
18	0.66	0.64	0.68	36
	0.68	0.63	0.66	

There was no rubber removal work carried out in the interval between the measurements before and after the occurrence.

1.11 Flight Recorders

1.11.1 Cockpit Voice Recorder

The aircraft was equipped with a solid-state cockpit voice recorder (CVR) made by L3Harris Avionics Systems, part number 2100-1225-24, serial number 001089488. The CVR is capable of 2 hours of 4-channel high-quality recording. It records the flight crew conversations, radio communications, cockpit area sound, and digital data (data link and GMT). An examination of the downloaded CVR data indicated that 124 minutes and 14.5 seconds of 4 channels were recorded, which included the descent phase from an altitude of FL200, approach and landing at RCMQ, taxing, parking, and engine shutdown. The CVR audio quality of each channel was either good or excellent. The investigation team made a transcript of 11 minutes of the CVR recording related to the occurrence.

Timings for the CVR recording were established by correlating the CVR events to common events on the flight data recorder (FDR) and then synchronizing those events with the air traffic control (ATC) timing system.

1.11.2 Flight Data Recorder

The aircraft was equipped with a solid-state FDR made by L3Harris Avionics Systems, part number 2100-2245-22, serial number 001094442. The FDR readout was performed based on the interpretation document[9] provided by the manufacturer of the aircraft. The FDR recording contained about 85 hours 12 minutes and 44 seconds of data with approximately 1,207 parameters.

After downloading, parsing and confirming the mandatory FDR parameters, the flight data related to the occurrence are summarized as follows:

1. At 1037:56 hours, autopilot (AP) was disengaged, with autothrottle remaining engaged, radio altimeter 219 feet, airspeed 132 knots, groundspeed 87 knots, pitch attitude 2.46 degrees nose-up, roll attitude 1.49 degrees RWD, magnetic heading 10.2 degrees, windspeed 49 knots, wind direction 23.2 degrees, throttle lever angle (TLA)[10] 5.4 degrees (left) and 5.8 degrees (right).
2. At 1038:11 hours, the aircraft flew over the threshold of runway 36, radio altimeter 34.3 feet, airspeed 123.75 knots, groundspeed 89 knots, pitch attitude 5.0 degrees nose-up, roll attitude 2.46 degrees RWD, magnetic heading 9.9 degrees, windspeed 41 knots, wind direction 29.5 degrees, angle of attack (AOA[11]) 10.2 degree (left) and 8.96 degree (right), TLA 1.5 degrees

---

[9] SSFDR DATA INTERPRETATION – FLIGHT DATA RECORDER CONFIGURATION STANDARD (FRCS) REPORT, RAE-C700-441, Revision: B.

[10] According to FDR readouts, the TLA was about 38 degrees maximum during takeoff phase, about 2 degrees during flight idle, about 0 degrees during ground idle and about -23 degrees minimum during thrust reverser in use.

[11] The angle of attack parameter recorded on the FDR is the angle of attack as measured by the vanes; it is not the aircraft (body or fuselage) angle of attack.

(left) and 1.5 degrees (right).

3. At 1038:14.75 hours, the aircraft radio altimeter was 0 feet, airspeed 111 knots, groundspeed 87 knots, pitch attitude 9.31 degrees nose-up, roll attitude reached the maximum RWD angle of 6.76 degrees.

4. At 1038:15 hours, the aircraft radio altimeter was -2.5 feet, airspeed 113 knots, groundspeed 87 knots, pitch attitude 9.8 degrees nose-up, roll attitude 5.88 degrees RWD, magnetic heading 8.8 degrees, windspeed 30 knots, wind direction 34.4 degrees, vertical acceleration with 1.44g value, AOA 23.81 degree (left) and 19.68 degree (right), TLA 1.14 degrees (left) and 1.58 degrees (right).

5. At 1038:15.25 hours, the 「air/ground」 parameter of right landing gear changed from air to ground, radio altimeter -2.5 feet, airspeed 112.5 knots, groundspeed 87 knots, pitch attitude 10.19 degrees nose-up, roll attitude 0.87 degrees LWD, vertical acceleration with 2.12g and lateral acceleration of 0.26 maximum value were recorded .

6. From 1038:15 to 1038:17 hours, the 「air/ground」 parameter of both main landing gear changed 4 times with roll attitude and magnetic heading changes as follows:

Time	**Left landing gear (air/ground)**	**Right landing gear (air/ground)**	**Roll attitude（degree）**	**Magnetic heading（degree）**
1038:14.75	air	air	6.76 RWD	-
1038:15.00	air	air	5.88 RWD	8.9
1038:15.25	air	air → ground	0.87 LWD	-
1038:15.50	air → ground	ground	5.53 LWD	-
1038:15.75	ground	ground	9.31 LWD	-
1038:16.00	ground	ground → air	9.4 LWD	5.6
1038:16.25	ground	air	6.15 LWD	-
1038:16.50	ground	air	2.19 LWD	-

1038:16.75	ground	air → ground	2.54 RWD	-
1038:17.00	ground	ground	2.1 RWD	2.5

7. At 1038:17 hours, autothrottle was disengaged, the airspeed was 114 knots, groundspeed 85 knots, magnetic heading 2.5 degrees, TLA 1.05 degrees (left) and 1.75 degrees (right).

8. At 1038:19 hours, the 「air/ground」 parameter of nose landing gear changed from air to ground, airspeed 102.75 knots, groundspeed 82 knots, pitch attitude 0.79 degrees nose-up, TLA -0.35 degrees (left) and -0.17 degrees (right).

9. At 1040:10 hours, the aircraft vacated runway 36.

10. The FDR stopped recording at 1253 hours.

Figure 1.11-1 and 1.11-2 shows the occurrence related FDR parameters during the landing phase of the aircraft, and Figure 1.11-3 shows the FDR flight path of the occurrence flight.

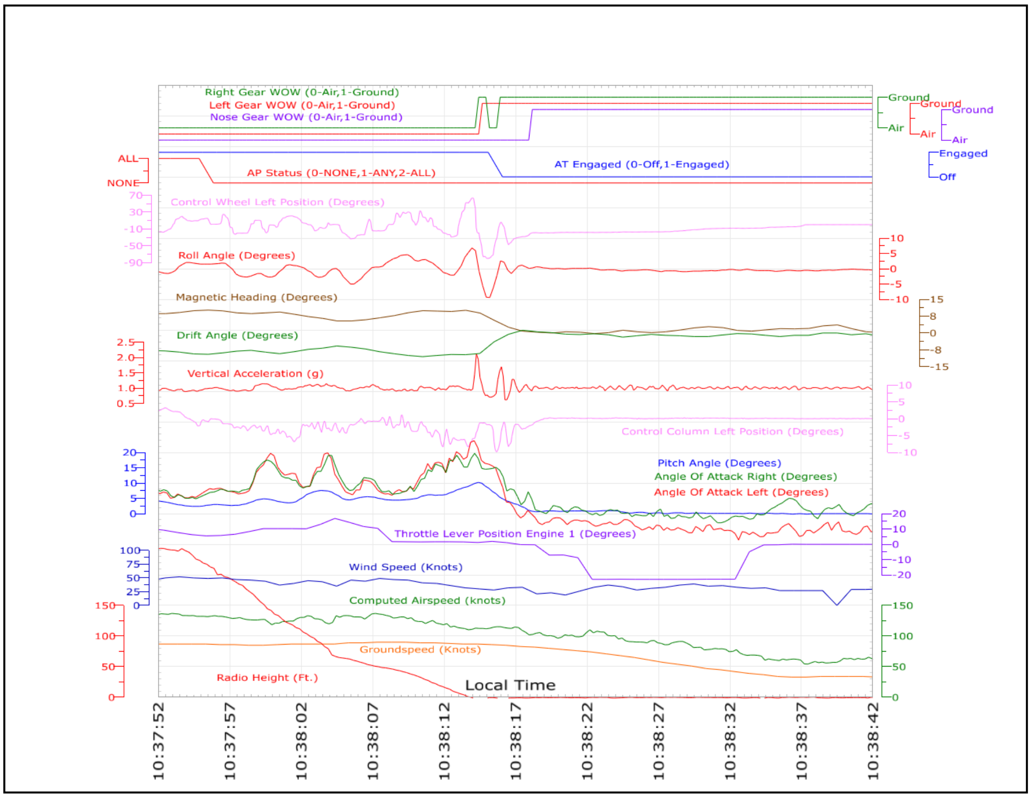

Figure 1.11-1 FDR readouts during landing phase (from AP disengaged)

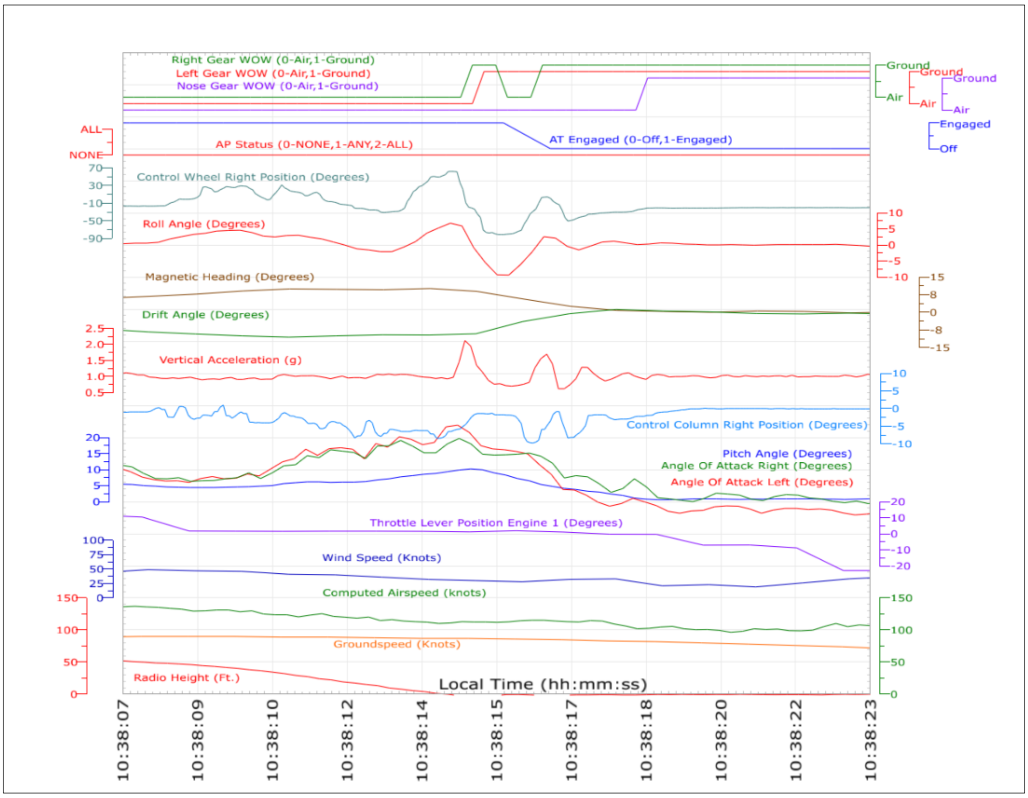

Figure 1.11-2 FDR readouts during landing phase (from RA 50ft)

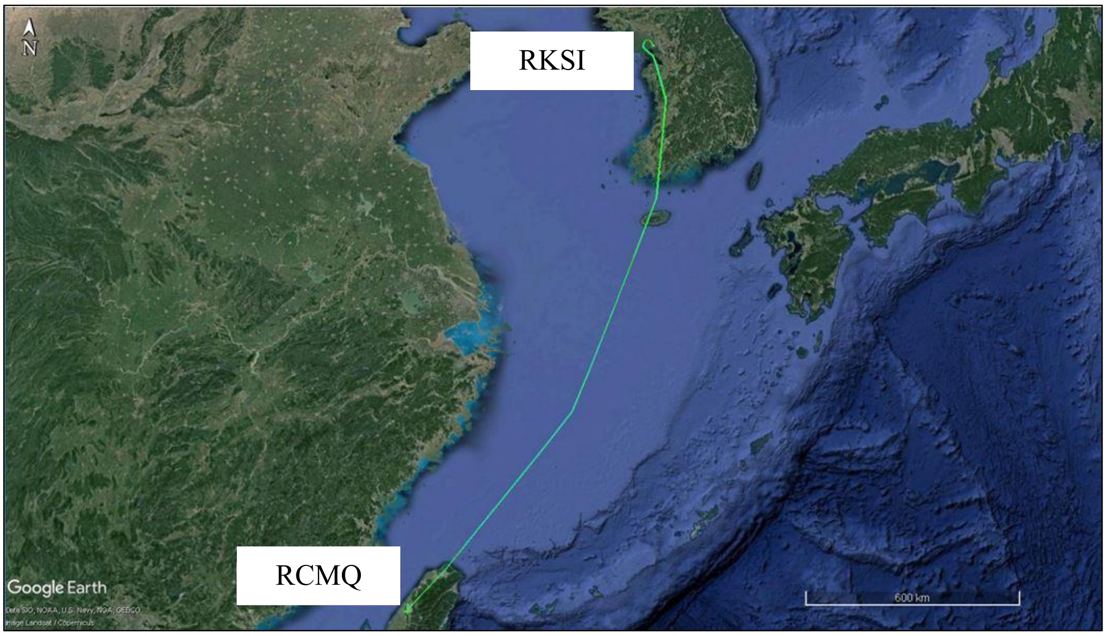

Figure 1.11-3 FDR recorded flight path of occurrence flight

1.12 Wreckage and Impact Information

1.12.1 Site Survey

The investigation team arrived at RCMQ around 1515 hours on the occurrence day, and then searched for significant wing contact marks on the runway 36 surface around 1537 hours. The team utilized global positioning system (GPS) equipment and a camera to conduct a ground survey of the occurrence site. The team found the first (right) wing mark (R1) at about 503 feet from the runway threshold, then the three parallel (left) wing marks (L1 to L3) were found about 636 feet from the runway threshold.

The first wing mark (R1) starts about 503 feet from the runway threshold and 19 feet to the right of the centerline, and stops about 515 feet from the runway threshold and 20 feet to the right of the centerline, with a total length of 12 feet. The mark points 5 degrees away from the runway centerline direction.

The second wing mark (L1) starts about 636 feet from the runway threshold and 53 feet to the left of the centerline, and stops about 652 feet from the runway threshold and 52 feet to the left of the centerline, with a total length of 15 feet. The mark points 3 degrees towards the runway centerline direction.

The third wing mark (L2) starts about 618 feet from the runway threshold and 53 feet to the left of the centerline, and stops about 658 feet from the runway threshold and 51 feet to the left of the centerline, with a total length of 42 feet. The mark points 3 degrees towards the runway centerline direction.

The fourth wing mark (L3) starts about 633 feet from the runway threshold and 43 feet to the left of the centerline, and stops about 650 feet from the runway threshold and 42 feet to the left of the centerline, with a total length of 17 feet. The mark points 3 degrees towards the runway centerline direction.

The survey item list is shown as table 1.12-1. Figure 1.12-1 shows the superimposed site survey items and FDR recorded flight path. Figure 1.12-2 is a close-up of the site survey items. Figure 1.12-3 shows the first wing mark. Figure 1.12-4 shows the second to fourth wing marks.

Table 1.12-1 Survey item list

No.	Survey item	Distance from runway 36 threshold (ft)	Length (ft)
1	First wing mark(R1)	503~515	12
2	Second wing mark(L1)	636~652	15
3	Third wing mark(L2)	618~658	42
4	Fourth wing mark(L3)	633~650	17

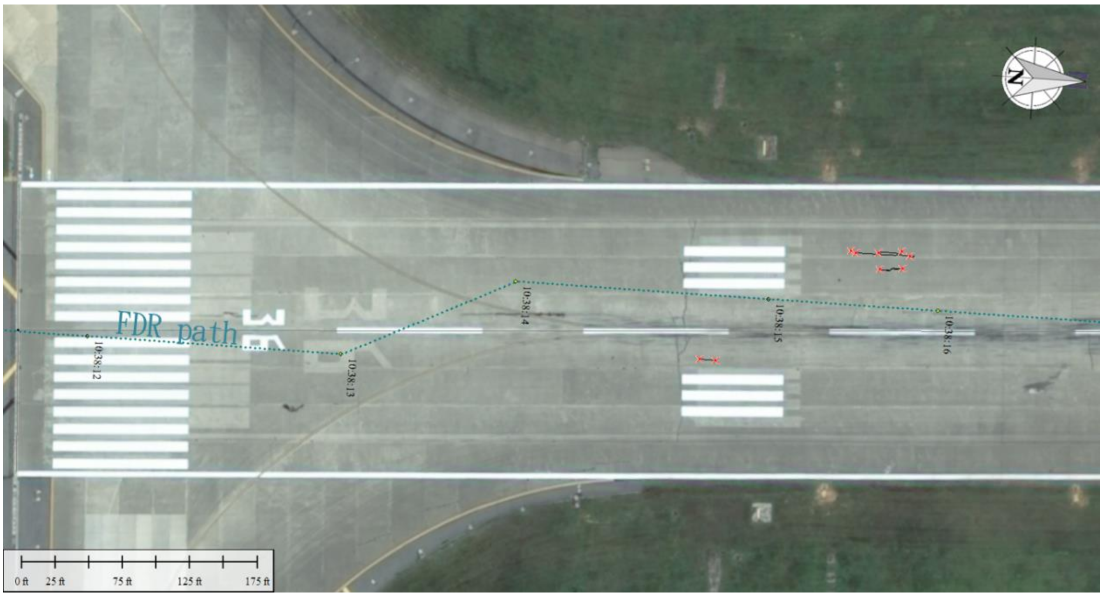

Figure 1.12-1 Superimposed site survey item and FDR flight path

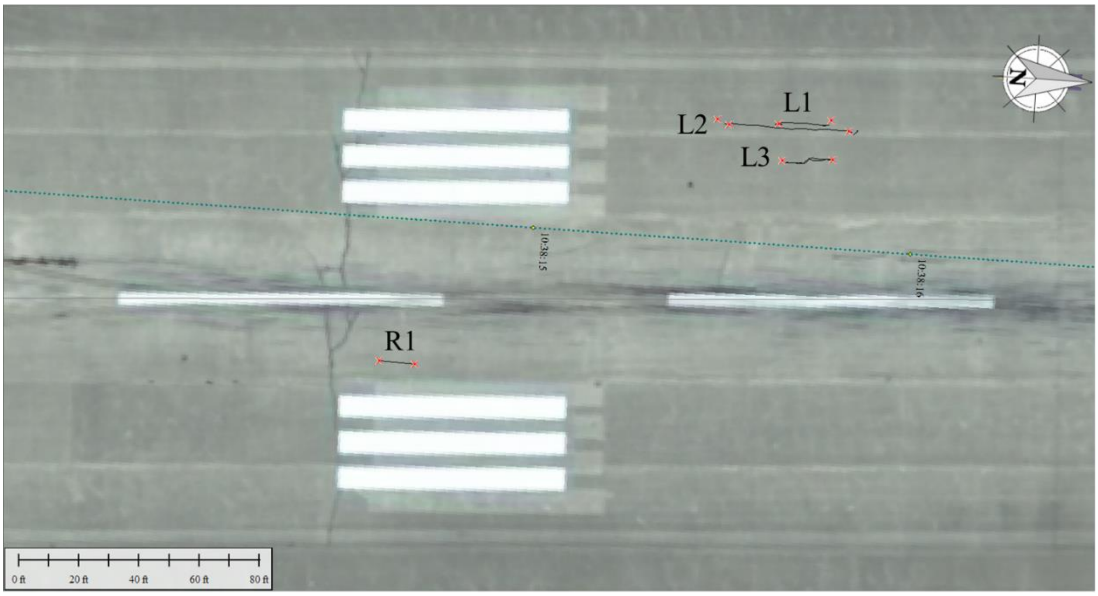

Figure 1.12-2 Close-up of site survey item

Figure 1.12-3 First wing mark (R1)

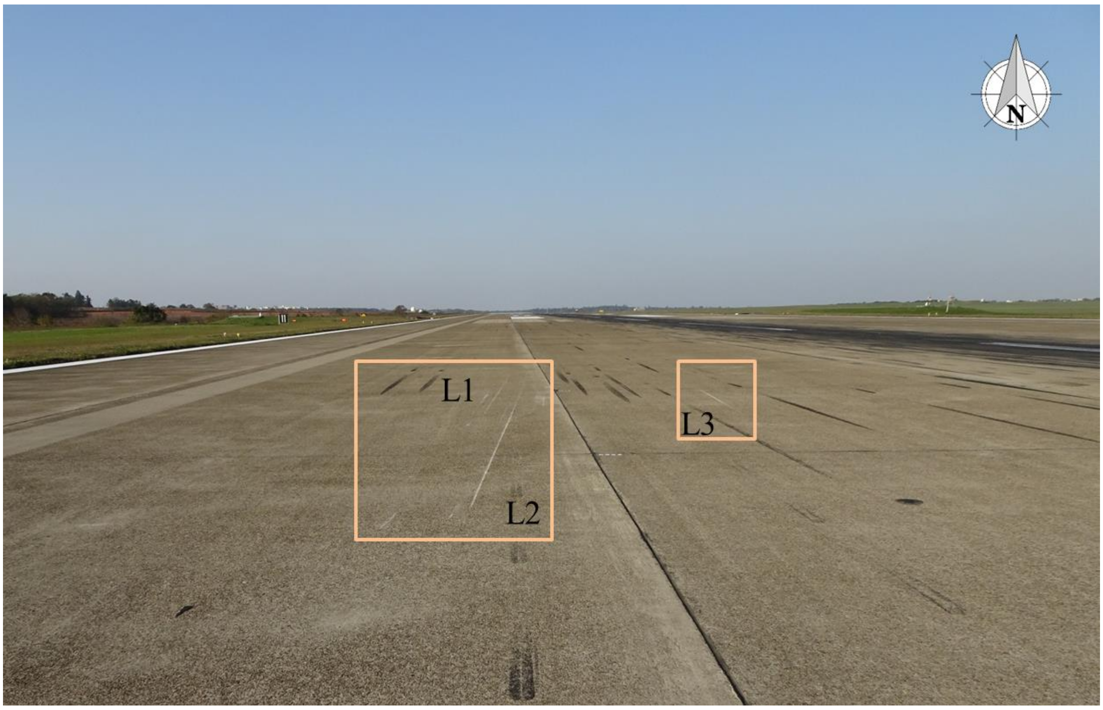

Figure 1.12-4 Second to fourth wing marks (L1~L3)

1.12.2 Damage

The aircraft sustained abrasive damage during the occurrence, most of the damage was located at the bottom and trailing edge of the outboard end on both wing areas, the details are shown as follows.

An abrasion was detected on the right end bottom of the most outboard slat on the right wing; the abrasion area was about 0.75 sq.cm.

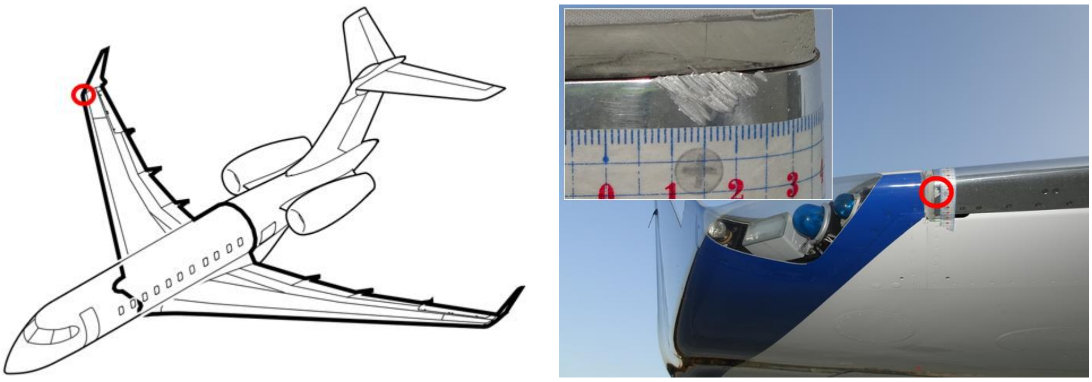

Figure 1.12-5 Right slat

An abrasion was detected on the middle bottom of the right winglet; the abrasion area was about 18 sq.cm.

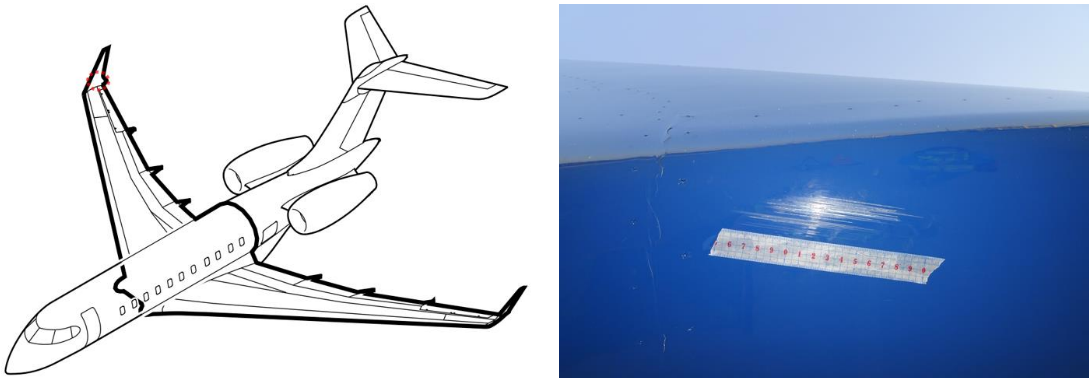

Figure 1.12-6 Middle bottom of the right winglet

An abrasion was detected on the very end of right wing and split into 2 delaminations at the trailing edge. The damage area abraded on the trailing edge connects with the winglet trailing edge, the length of separation at the trailing edge was about 40 cm long, and the abrasion area was about 100 sq.cm.

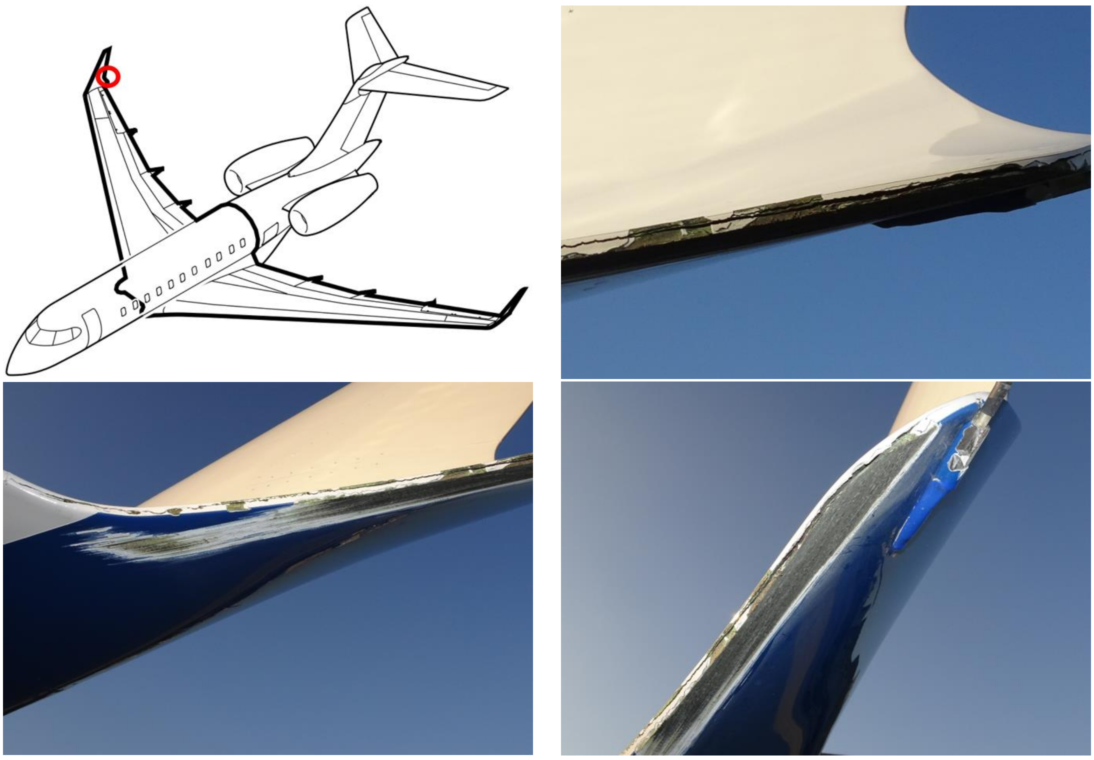

Figure 1.12-7 Trailing edge of the end of right wing

An abrasion was detected on the right end of the aileron and split into two delaminations at the trailing edge, the aileron had severe damage at the right end trailing edge corner. The abrasion damage extended into the honeycomb in the aileron trailing edge corner, the abrasion area was about 158 sq.cm. The length of separation at the right end of the aileron was about 48 cm long.

The outboard two static wicks on the aileron were lost, one of the detached static wicks was found at the right wing touchdown zone. The most outboard static wick location was worn down to the aileron surface by abrasive contact.

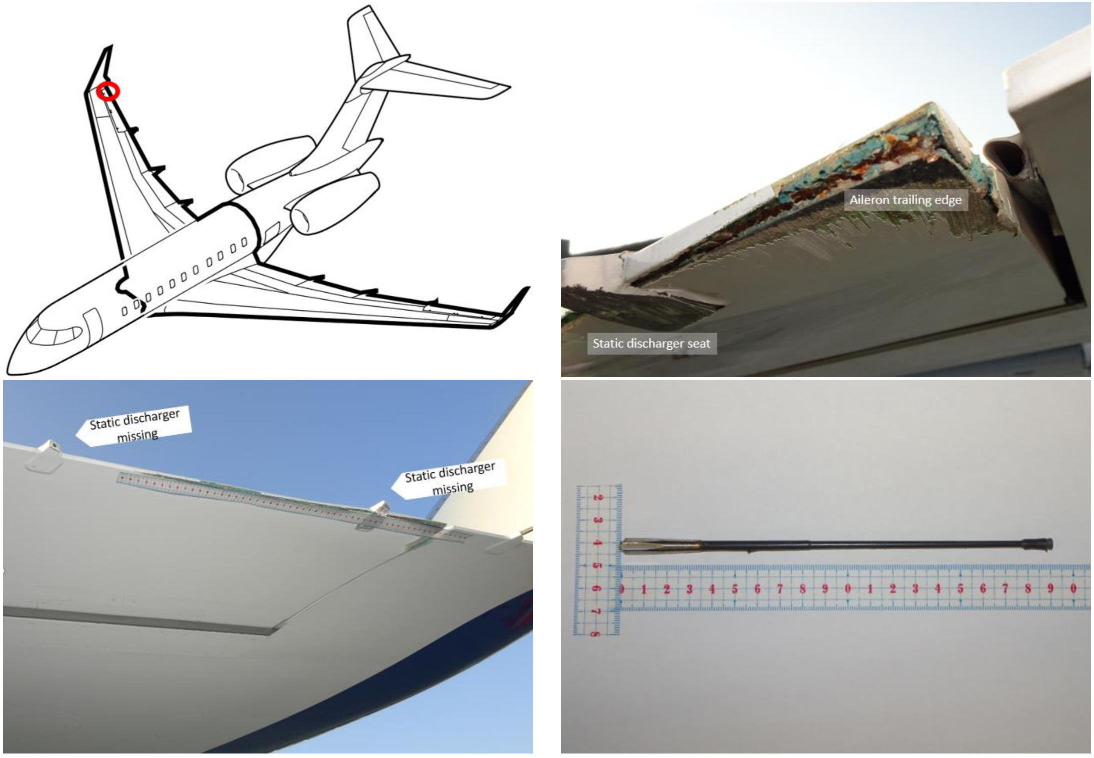

Figure 1.12-8 Right aileron

Severe abrasive wearing was detected on the aft end of the most outboard flap fairing on the right wing; the area of wear was about 13 cm long and 3 cm wide.

Figure 1.12-9 Right outboard flap fairing

An abrasion was detected on the right end bottom of the most outboard slat on the left wing; the abrasion area was about 13 sq.cm.

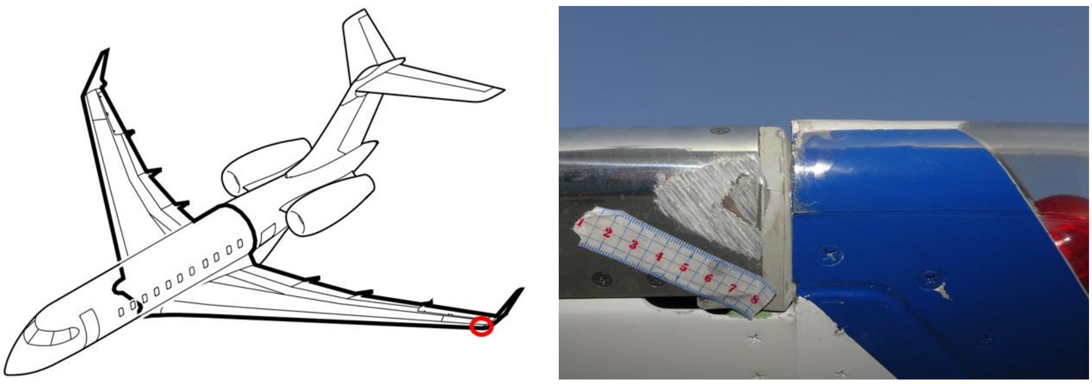

Figure 1.12-10 Left slat

An abrasion was detected on the very end of the left wing, abraded on the trailing edge at the connection with winglet trailing edge, the length of separation at the trailing edge was about 25 cm long, and the abrasion area was about 25 sq.cm.

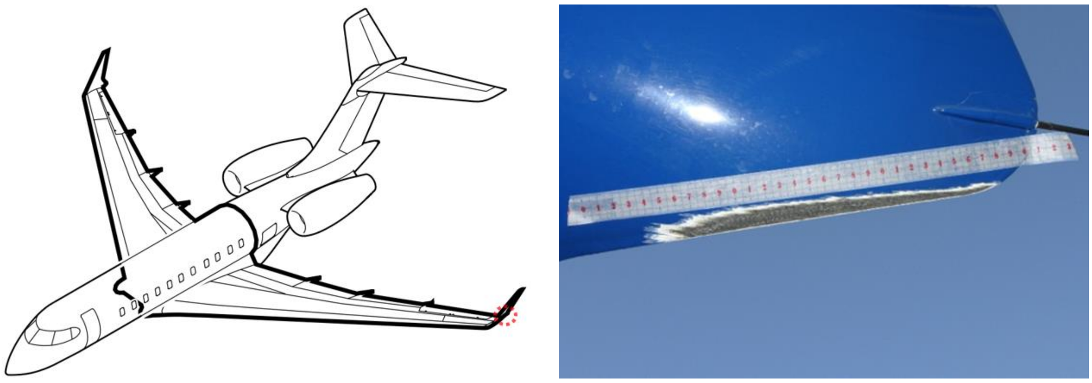

Figure 1.12-11 Trailing edge of the end of left wing

An abrasion was detected on the middle bottom of the left winglet; the abrasion area was about 78 sq.cm.

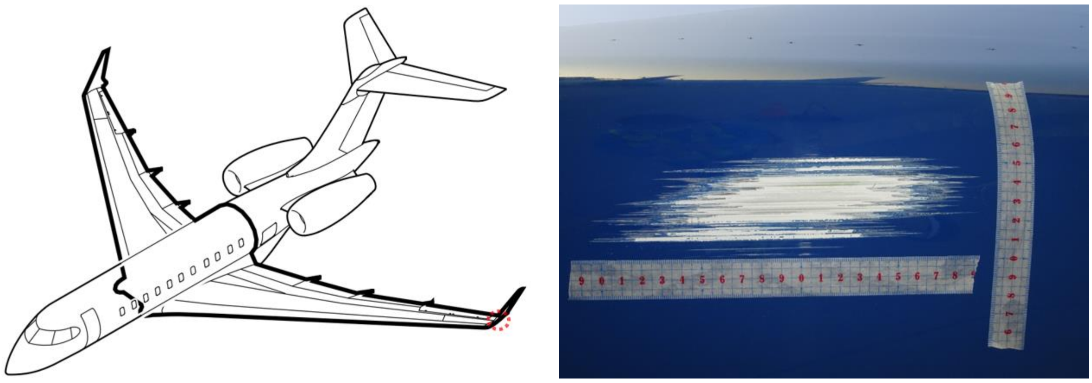

Figure 1.12-12 Middle bottom of the left winglet

An abrasion was detected on the right end of the aileron and split into two delaminations at the trailing edge, the aileron had severe damage at the left end trailing edge corner. The abrasion damage extended into the honeycomb in the aileron trailing edge corner, the abrasion area was about 245 sq.cm. The length of separation at the left end of the aileron was about 48 cm long.

The outboard two static wicks on the aileron were lost. The most outboard static wick location was worn down to the aileron surface level by abrasive contact, the upper structure of the static wick was detached.

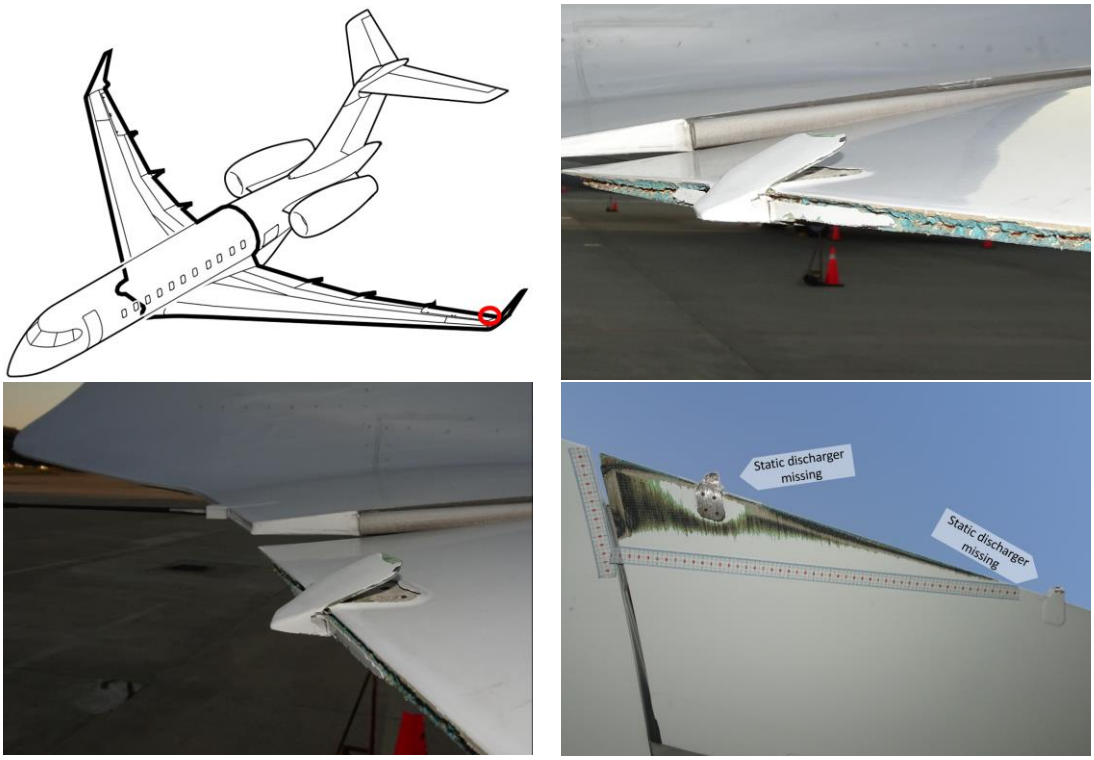

Figure 1.12-13 Left aileron

Severe abrasive wearing was detected on the most outboard flap fairing at the end tail on the left wing; the size of the abraded area was about 7 cm long and 1.5 cm wide.

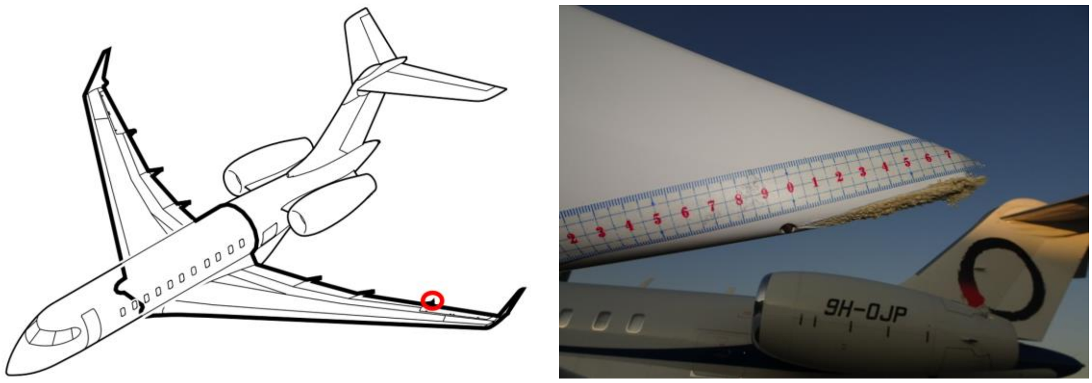

Figure 1.12-14 Left outboard flap fairing

1.13 Medical and Pathological Information

Not applicable.

1.14 Fire

Not applicable.

1.15 Survival Aspects

Not applicable.

1.16 Tests and Research

Not applicable.

1.17 Organizational and Management Information

Elit'Avia Malta is a private jet company, founded in 2006, with Air Operator Certificates (AOC) in Slovenia and Malta. Elit'Avia Malta provides aviation services to Europe, Middle East, Africa, Russia & CIS (Commonwealth of Independent States), and North America. At the time of the occurrence, Elit'Avia Malta operated a jet fleet consisting of one Challenger 604, two Challenger 650, one Gulfstream G450, one Falcon 7X, one Global 5000, and four Global 6000 for private aircraft charter service.

1.18 Additional Information

1.18.1 Aircraft Operating Information

1.18.1.1 Authority, Duties and Responsibilities of the Commander

According to Elit'Avia Malta Operations Manual Part A (OM-A, issued 08 REV 00-Dec 15/2020), Section 1.4, the commander has authority to decide on who will be PF and PNF[12] after taking into account of co-pilot's experience and operational conditions specified in OM-A 8.3.1.7 (e).

8.3.1.7. Assignment of PF duties

a) For most routine flight operations, commanders are encouraged to

[12] Pilot not flying. PNF is the same as PM.

share PF duties equally between the pilots whenever the circumstances allow.

b) In order to maintain and improve his skill in handling the airplane, the copilot shall carry out part of the flying and part of the total number of landings. As a commonly adopted rule, the copilot should be given the opportunity to fly at the controls around 50% of the total flight time and carry out such takeoffs, climb-outs, approaches and landings which fall within his flying time.

c) When a copilot is flying the airplane, the commander shall perform the PM duties and should not interfere with the PF dispositions and flying unless these are considered to be contrary to safety, regulations or SOPs.

d) For the more demanding circumstances or the less frequently encountered circumstances, the commander should take into account the copilot's experience level versus the circumstances before assigning PF duties to the copilot.

e) Conditions when the Left Pilot should act as PF include, but are not limited to, the following circumstances:

> *1) Ground operations up to initiation of the takeoff-roll and from after completion of the landing roll;*
>
> *2) When the copilot has less than 1 year experience on the airplane type and the crosswind component exceeds 15 kts or crosswind component is close to maximum authorised regardless of copilot's experience;*
>
> *3) Operations under adverse weather conditions, including operations on slippery or contaminated runways;*
>
> *4) Windshear is reported in the vicinity of the airport;*
>
> *5) Takeoff from or landing at an aerodrome categorized as C;*
>
> *6) Short field operations (SFOPS) are conducted;*

7) Approaches at night without glidepath guidance by means of visual or electronic glidepath guidance or glidepath indications on flight deck instruments;

8) System malfunctions affecting the airplane flight characteristics;

9) Rapid depressurization/emergency descent;

10) On ground emergency/passenger evacuation;

11) When otherwise prescribed, for example, for low visibility operations or per Aerodrome Information NOTAM; or

12) Any other condition in which the pilot in command determines it to be prudent to exercise the pilot in command's authority.

After the occurrence, Elit'Avia Malta issued a temporary revision of 8.3.1.7 (e)(2) in January 2021 as below:

2) When the total steady crosswind is 20 kts or more (15 kts for co-pilots under 1 year experience) and/or the gusting is 10 kts or more;

1.18.1.2 BD-700 Maximum Demonstrated Crosswind Component

According to the Global 6000 Airplane Model BD 700-1A10 Airplane Flight Manual (AFM), revision 36 Nov. 2020, the maximum demonstrated crosswind component for takeoff and landing [at 33 feet (10 meters) tower height] is 29 knots and is not considered limiting for takeoff and landing. Landings have been performed at an approach speed of Vref +1/2 of the gust.

The company maximum crosswind limitations are listed in Operations Manual Part B (OM-B, issued 04 REV 00-Oct 16/2020), section 1.32:

1.32. WIND LIMITATIONS

Tailwind and Maximum Crosswind Limitations

The maximum tailwind component approved for takeoff and landing is

10 Knots.

Satisfactory controllability during takeoff and landing has been demonstrate with 90-degree crosswind component during aircraft certification process. The AFM maximum demonstrated crosswind component was demonstrated on a dry runway by manufacturer's test pilots and is not considered to be limiting.

Elit'Avia Malta limits its 6000 crewmembers to the following crosswind (steady or gust) depending on reported runway condition.

Braking action	Friction coefficient	RWY Equivalent Condition	Max. Crosswind (KTS)
Good	≥0.4	1	25
Medium / Good	0.39 to 0.36	1	20
Medium	0.35 to 0.30	2,3	15
Medium / Poor	0.29 to 0.26	2,3	10
Poor	≤ 0.25	4	5
	FC below 0.20	5	Prohibited

When braking action or friction coefficient is reported or considered unreliable, use RWY Equivalent Condition for maximum crosswind determination:

1. *Dry, damp or wet runway (less than 3 mm water depth) or compacted dry snow*
2. *Runway covered with slush or wet snow*
3. *Runway covered with dry snow*
4. *Runway covered with standing water*
5. *Runway covered with ice*

Operation in strong gusty crosswinds is not recommended.

1.18.1.3 Automatic Flight Systems

According to Elit'Avia Malta OM-A, issued 08 REV 00-Dec 15/2020, the use of autopilot and autothrottle is described in section 8.3.1.12. :

8.3.1.12. Automatic Flight Systems (AFS)

a) General

1) Automatic flight systems may be used to their maximum extent within the limitations of the applicable OM-B.

2) When the autoflight system does not operate as anticipated, the first action shall be to disengage the autoflight system and control the flight path manually. Establishing the reason for the observed system behavior always takes second place.

3) Below 2500 feet AGL, the Pilot Flying (PF) shall be ready to immediately take manual control, if required. For this purpose he shall have one hand on the control wheel and, during approach only, the other hand on the throttles.

4) In selecting the level of automation to be used the PF should take account of the following considerations:

(i) PM workload,

(ii) Weather,

(iii) Crew alertness,

(iv) Traffic density,

(v) Airplane serviceability status.

As a general policy during normal line operations (scheduled line or base training flights are exempted) the highest available level of automation should be used.

5) .....

b) Autopilot

1) The autopilot should be engaged if one pilot is controlling the flight path unmonitored by another pilot, for example during non-normal operation or passenger address.

2) Pilots should remain current with manual flight. For this purpose it is recommended to regularly practice manual flight below approximately 10.000 feet AGL. Conditions taken into account when practising manual flight include, but are not limited to:

(i) Phase of flight;

(ii) Workload conditions;

(iii) Altitude/Flight Level (non-Reduced Vertical Separation Minima (RVSM));

(iv) Meteorological conditions;

(v) Traffic density;

(vi) Air Traffic Control (ATC) and Air Traffic Management (ATM) procedures;

(vii) Pilot and crew experience; and

(viii) Elit'Avia Malta operational experience with the aircraft type.

Pilots should use automated systems e.g. during high workload conditions, while operating in traffic congested airspaces, or when following airspace procedures that require the use of autopilot for precise operations.

3) Except for autoland operations, the autopilot(s) should be disengaged:

(i) For operations below (M)DA, and;

(ii) When the reported crosswind exceeds 15 knots, when descending through 500 ft RA.

c) Autothrottle/Autothrust

Except as provided for, and within the limitations of the respective OM-B, the autothrottle should be operated as follows:

1) During automatic flight the autothrottle should be engaged.

2) During manual flight the autothrottle should be disengaged.

d) ….

1.18.1.4 Stable Approach

Stable approach criteria is described in Elit'Avia Malta OM-A (issue 08 REV 00-Dec 15/2020), section 8.3.2.11.15.:

8.3.2.11.15. Stabilized approach (CAT.OP.MPA.115)

a) Each approach procedure shall be planned and executed in a manner to achieve stabilization criteria latest at the target height (stabilized approach window). Lowest target height is:

1) 1000 feet AGL for precision approaches;

2) Height corresponding FAF for non-precision approaches; and

3) 500 feet AGL for visual approach and 300 feet AGL for circle-to-land approach.

b) An approach is stabilized when all of the following criteria are met:

1) The airplane is on the correct flight path;

2) Bank angle is equal to or less than 15 degrees;

3) Only minor changes in heading and pitch are required to maintain the correct flight path, except in circle-to-land approach where heading stabilization shall be achieved latest at 300 ft AGL;

4) Indicated airspeed shall not be less than VREF and not greater than VREF + 20 kts;

5) The airplane is in the correct landing configuration;

6) Vertical speed is not greater than 1000 fpm (except for steep approach); and the ROD deviations should not exceed ± 300 fpm, except under exceptional circumstances which have been anticipated and briefed prior to commencing the approach; ,for *example, a strong tailwind;*

7) The thrust is stabilized above idle to maintain the target speed on the desired glide path;

8) Position allows a landing within the touch down zone of the runway, using normal maneuvers; and

9) All briefings and checklists have been completed.

1.18.1.5 Final Approach Speed

The final approach speed calculation is described in several sections in Global 6000 Model BD 700-1A10 Flight Crew Operating Manual (GL 6000 FCOM), and Elit'Avia Malta OM-A and OM-B:

According to the GL 6000 FCOM Volume 1, revision 36: Nov 11/2020, Chapter 10 NORMAL AND NON-NORMAL PROCEDURES, Section 10-01 H. Landing (2) SPEED ADDER FOR APPROACH AND LANDING IN GUSTY WIND CONDITIONS:

The VREF speed adder should be used for approach and landing when turbulence or gusty wind conditions are anticipated during the approach and landing.

When gusty conditions are reported, it is recommended to add half of the gust, to a maximum of 10 KIAS.[13] *(e.g. for winds of 15 kts gusting to 40 kts, half of the 25 kt gust is 12.5 kts, so in this case the correction applied to VREF is 10 KIAS.)*

Final approach speed calculation in OM-A, issued 08 REV 00-Dec 15/2020, section 8.3.2.12:

8.3.2.12. Touchdown

---

[13] The Bombardier has revised this guidance. The "maximum of 10 KIAS" was removed in the May 2021 revision of the FCOM.

To accomplish a safe landing the height of the airplane over the landing runway threshold should be approximately 50 feet. This height may vary according to information provided on the approach chart (TCH). Final approach shall be adjusted so as to achieve touchdown in the Touch Down Zone (TDZ) area, paying due regard to obstructions in the final approach area, runway length, runway conditions etc. ***If the touchdown cannot be accomplished within the TDZ a missed approach shall be initiated.*** *For the purposes of this section, the TDZ is defined as the area extending from 150 m to 1000 m from the landing threshold, or the first one third of the landing runway (whichever is less).*

Wind speeds including gust are to be compensated at the commander's discretion and according to the circumstances (expected or reported wind shear, available runway, specific wind phenomena at some aerodromes, possible malfunction, etc.).

Final Approach Speed = VREF + 1/2 steady wind + full gust (max. VREF + 20 KIAS)

Pilot shall start braking after touchdown of the nose gear but latest at 80 KTS. Aircraft shall reach safe taxi speed well before turning off the runway.

Brake for safety, not for comfort.

The final approach speed calculation is also mentioned in OM-B, issued 04 REV 00-Oct 16/2020, section 2.8.15:

2.8.15. Landing

For General information refer to OM-A 8.3.2.12.Touchdown.

Wind speeds including gust are to be compensated at the Commander's discretion and according to the circumstances (expected or reported wind shear, available runway, specific wind phenomena at some aerodromes, *possible malfunction, etc.). Below 500 feet above TDZE thrust shall be above idle and maximum 1000 fpm ROD must be maintained.*

Final Approach Speed = VREF + 1/2 gust (max. VREF + 10 KIAS)

Reduce thrust by 50 ft.

*The PM shall supervise the correct operation of the ground lift dumpers and call out "**SPOILERS OUT** and **THRUST REVERSERS OUT**" when extended.*

Avoid high flare. Lower the nose wheel without delay. Use rudder pedals for directional control (do not use nose wheel steering tiller).

Pilot shall start braking after touchdown of the nose gear but latest at 80 KTS. Aircraft shall reach safe taxi speed well before turning off the runway.

Brake for safety, not for comfort!

*LP shall call "**MY CONTROLS**" and take controls during landing roll when he deems necessary.*

1.18.1.6 Standard Callout

The callout for deviations is described in Elit'Avia Malta OM-A, issued 08 REV 00-Dec 15/2020, section 8.3.1.21. PNF monitoring duties and associated terminology:

8.3.1.21. PNF monitoring duties and associated terminology

In addition to other specific monitoring duties and calls described in this Operations Manual, PNF shall monitor the flight execution and inform PF immediately of observed deviations using the terminology described below. In addition and where applicable PNF shall verify that corrective action is taken.

a) Airspeed

When the airspeed deviates more than 5 kts from the desired or selected value or exceeds or tends to exceed a limit value, PNF shall call: "SPEED HIGH" or "SPEED LOW", as appropriate.

b) Vertical speed

When the vertical speed during descent deviates more than 500 ft/min from a predetermined value or exceeds or tends to exceed a limit value, PNF shall call: "SINK RATE".

c) Bank angle

When the bank angle exceeds or tends to exceed 30 degrees or any lower applicable bank angle limit, PNF shall call: "BANK ANGLE".

d) Altitude

When the aeroplane deviates more than 150 ft from the cleared altitude/flight level or exceeds or tends to exceed an altitude limit PNF shall call: "CHECK ALTITUDE".

e) Proximity to terrain

When undue proximity to terrain has been detected, such as during GPWS or windshear recovery, PNF shall call out each 100 ft Radio Altitude and the vertical trend at or below 500 ft, e.g. "TWO HUNDRED FEET CLIMBING, THREE HUNDRED FEET LEVEL, FIVE HUNDRED FEET DESCENDING".

f) Windshear

When windshear is detected or suspected on take-off or final approach and no windshear detection system is available, PNF shall call: "WINDSHEAR".

g) Attitude

When the attitude deviates significantly from the normal target *attitude for the phase of flight, the PNF shall call: “PITCH”.*

Also, OM-A section 8.3.2.11.15 Stabilized approach:

PM call-outs during final approach:

"SPEED" when speed becomes lower than VREF – 5 kt or higher than VREF + 10 kt;

"PITCH" when pitch att. becomes lower than 5° nose down or higher than 5° nose up;

"BANK" when bank angle becomes steeper than 7°;

"SINK RATE" when descent rate exceeds 1000 ft/min;

"LOCALIZER" when LOC deviation becomes ≥ ½ dot LOC;

"GLIDE SLOPE" when GS deviation becomes ≥ ± ½ dot GS;

"RWY/APP LIGHTS IN SIGHT" as soon as approach lights and/or runway (lights) are in sight.

1.18.1.7 Landing Procedures and Technique

BD-700 aircraft landing thrust and pitch control procedures are described in GL 6000 FCOM Volume 1, revision 36: Nov 11/2020, Chapter 4 NORMAL PROCEDURES, Section 04-08 APPROACH AND LANDING:

FULL STOP LANDING

The procedures outlined below are done simultaneously or in quick succession, as the situation requires.

Approach through 50 feet height point at VREF (Refer to the Airplane Flight Manual; Chapter 6; PERFORMANCE − LANDING PERFORMANCE) on stabilized glide slope of 3 degrees, with landing gear down, slats out and flaps at 30 degrees.

Thrust reversers may be used after touchdown to supplement the use of wheel brakes.

With the thrust reversers deployed, a nose-up pitching tendency will occur at high reverse thrust settings, particularly at aft c.g. light weights. This tendency is controllable with elevator and may be minimized by ensuring that nose wheel touchdown is achieved, and nose-down elevator applied, before selecting reverse thrust.

At or below 50 feet AGL:

1. Thrust levers ....IDLE

2. Airplane attitude......................... Maintain until close to the runway.

• Perform partial flare, and touchdown without holding off.

3. Ground lift dumping ....Check deployed

4. Brakes..Apply

• Apply brakes as appropriate for landing and runway conditions.

5. Thrust reversers.. Deploy

CAUTION

If maximum reverse thrust is required, MAX reverse may be deployed to a full stop. If Max reverse is not required, reverse thrust should be manually reduced to Reverse Idle by 50 KIAS to prevent re−ingestion of engine gases, ingestion of Foreign Object Debris (FOD) and prevent dust, sand, water or other contaminants from being blown onto airplane surfaces. If Max reverse is used below 50 KIAS a maintenance inspection will be required on the Compressor stage within the next 15 engine cycles.

6. Directional control .... Maintain

• Use aileron and rudder as required.

7. Engine instruments and Airspeed ....Monitor

• PM will advise PF of any engine limitations about to be reached or of any discrepancy.

8. Thrust reversers.....................................IDLE / STOW

• Confirm reversers are stowed.

NOTE:

Inadvertent positioning of the thrust levers between the IDLE and the REV detents will result in propulsion system anomalies, such as L (R) REVERSER FAIL indications.

9. Nose wheel steering .... As required

The landing technique of BD-700 airplane is described in the GL 6000 FCOM Volume 1, revision 36: Nov 11/2020, Chapter 10 NORMAL AND NON-NORMAL PROCEDURES, Section 10-01 H. Landing (5) LANDING TECHNIQUE:

(5) LANDING TECHNIQUE

At 50 ft AGL autothrottles retard to idle − based on Rad Alt. If autothrottles are not engaged, manually reduce thrust to idle at 50 ft AGL.

As soon as thrust is reduced to idle, the airplane will decelerate. Touchdown at approximately VREF −4 kts is reasonable. For a normal 3 degree glidepath, induce a flare at approximately 30 ft AGL, slightly earlier for steeper approach angles.

At touchdown, the GLD system extends all spoilers automatically. Maintain the pitch input initially and ease the nosewheel touchdown.

Continue to apply appropriate crosswind input, with increasing aileron deflection as speed decreases during the roll−out.

Autobrakes, if selected, activate at touchdown after GLD deployment; and, weight on wheels for 5 seconds or wheel spin−up to greater than 50 kts. Deceleration will occur at the preselected rate.

If autobraking is not selected for landing, smoothly apply wheel brakes and select thrust reversers as required. Apply brakes by steadily increasing pedal pressure, adjusting for runway condition and length available. Do not pump the brakes. Maintain deceleration rate until stopped or desired taxi speed is reached.

After main wheel touchdown, continue to "fly" the nosewheel down to the ground by adjusting aft yoke pressure as required. As speed decreases more aft yoke movement is usually required. This is more pronounced with greater forward CG balance. Do not hold the nose wheel off the surface or delay de−rotation excessively to avoid the nosewheel slamming onto the runway as speed and elevator effectiveness decay. Autobrake engagement prior to nosewheel touchdown will also accelerate de−rotation and will require timely aft yoke input to mitigate hard nosewheel touchdown. If thrust reversers are deployed prior to nosewheel touchdown, there may be a requirement to slightly reduce the control yoke aft pressure to avoid a pitch increase as reverse thrust is applied.

1.18.1.8 Crosswind Landing Technique

BD-700 airplane crosswind landing technique is described in GL 6000 FCOM Volume 1, revision 36: Nov 11/2020, Chapter 4 NORMAL PROCEDURES, Section 04-08 APPROACH AND LANDING:

11. CROSSWIND LANDING

The recommended technique for approach is the wings level crab technique where the aircraft is pointed into the wind to control direction.

If a crosswind is present, as the flare is commenced, application of rudder is used to align the fuselage parallel with the runway centerline.

As rudder is applied the aircraft will tend to roll in the direction of the rudder input. To counter this, simultaneous input of rudder and opposite aileron is required to keep the wings level. In this wings level condition there will be some sideways drift. A slight, into wind, wing down should control this sideways motion.

Excessive wing down can cause the wing tip to contact the runway. In order to minimize this possibility, the bank should be limited to less than 3 degrees and the touchdown should occur as soon as the aircraft is aligned with the runway. Prolonging the flare would increase the pitch attitude which brings the wing tip closer to the ground.

The aileron input is required throughout the landing roll and the input should be increased as the airspeed decreases.

Any lateral motion on final approach should be controlled using aileron inputs. The rudder should not be used to control lateral motion and should only be used in the flare to align the aircraft with the runway.

The use of autobrake is recommended for strong crosswinds.

In addition, crosswind landing technique is also described in Chapter 10 NORMAL AND NON-NORMAL PROCEDURES, Section 10-01 H. Landing (7) CROSSWIND LANDING TECHNIQUE:

<u>(7) CROSSWIND LANDING TECHNIQUE</u>

The recommended technique for approach in crosswinds is a *wings−level crab technique; the airplane is pointed into wind while tracking the extended runway centerline. Tracking correction should be made with aileron. Do not use rudder to control lateral tracking on final approach.*

If a crosswind is present, as the flare is commenced at approximately 30 ft, apply downwind rudder to align the fuselage parallel with the runway centerline.

As rudder is applied, the airplane will tend to roll in the direction of rudder input. To counter this, simultaneous input of rudder and opposite aileron is required to keep the wings level. Touchdown should occur as soon as the airplane is aligned with the runway. The action of removing into−wind crab and aligning with the runway may also be known as de−crab.

Do not prolong the flare or significantly delay touchdown. The airplane will start to drift, accelerating downwind as soon as de−crab occurs. Although a very slight into−wind wing−down may be tolerated after de−crab, the focus should remain on a wings level touchdown with minimum delay.

Delaying touchdown or extending flare usually requires increased pitch. With pitch increase, the tolerance for bank and wing tip ground clearance is reduced. Excessive wing−down can cause the wingtip to contact the runway. For gusty crosswinds, a deliberate positive touchdown is recommended. Otherwise, extending the flare in strong crosswinds may jeopardize a safe landing within the lateral confines of the runway.

If the final approach or landing phase becomes unstable, an immediate go−around is recommended.

After placing the nosewheel onto the ground, rudder input can be modulated to rely more on nosewheel friction to control airplane direction. The aerodynamic effect of rudder will rapidly diminish during the *after−landing deceleration. Nosewheel steering via rudder pedal input will become increasingly relied upon during the transition to taxi speed. Effectively the transition from predominant aerodynamic rudder control to nosewheel steering via rudder pedal input will be transparent to passengers.*

Into−wind aileron input is required throughout the landing roll, with input increasing as the speed decreases to taxi speed. This technique is especially important for wet/contaminated runways.

CAUTION

Nosewheel tiller steering should only be used at taxi speeds and below. Sensitivity of the tiller steering may contribute to over−controlling and pilot induced oscillations if used at higher speeds.

Division of flight control duties between the two pilots is not recommended. The PF should not use the tiller during the landing roll until the airplane has reached taxi speed.

The use of autobrake in crosswinds is recommended.

A VREF speed adder should be used for gusty conditions. The correct addition is "half the gust", to a maximum of 10 kts. Adding more speed on top of the appropriate gust adder may present additional challenges during the landing phase. Extra energy in the landing phase combined with ground effect may contribute to a tendency to float prior to touchdown. The stability of the landing will be significantly aggravated as crosswinds and drift tendency increase. Adding extra speed beyond the necessary adders is not recommended.

1.18.1.9 Wing Tip Ground Clearance

BD-700 wingtip ground clearance during landing is described in GL 6000 FCOM Volume 1, revision 36: Nov 11/2020, Chapter 10 NORMAL AND NON-

NORMAL PROCEDURES, Section 10-01 H. Landing (8) AIRPLANE GEOMETRY CONSIDERATIONS FOR LANDING:

<u>(8) AIRPLANE GEOMETRY CONSIDERATIONS FOR LANDING</u>

The wing sweep (34 degrees at the leading edge) and wing span contribute to reduced wing tip ground clearance as pitch increases during touchdown. This is exacerbated with increase in bank angles. It is therefore highly recommended to target wings level for landing.

Recommended pitch at touchdown is 7 to 8 degrees. The following table represents the worst case scenario for a touchdown with wings not creating lift.

PITCH ANGLE	BANK ANGLE AT WINGTIP GROUND CONTACT	
	ON GROUND - NO WING LIFT	IN FLIGHT - LIFT, INCREASED DIHEDRAL
0	10.6	13.5
3	9.6	12.3
6	8.5	11.2
9	7.4	11.2

- *It is highly unlikely that the airplane will ever encounter a tail strike.*

Pitch attitude required for tail strike is as follows:

− 15.3 degrees for fully compressed gear

Eye reference height at touchdown in the landing attitude is 4.75 m (15.60 ft).

1.18.1.10 Windshear

A guideline of windshear encounter operations are listed in Elit'Avia Malta OM-A, issued 08 REV 00-Dec 15/2020, section 8.3.11.5. Windshear:

8.3.11.5. Windshear

a) If windshear is suspected, maximum takeoff thrust should be used for *takeoff. The longest suitable runway should be used taking into consideration crosswind and tailwind limitations, and obstacles in the takeoff path.*

b) Pilots shall remain alert to the possibility of windshear, and be prepared to make relatively harsh control movements and thrust changes to offset its effects. Immediately after takeoff, the pilot's choices of action will be limited, since he will normally have full thrust applied, and be at the recommended climb speed for the configuration. If the presence of windshear is indicated by rapidly fluctuating airspeed or rate of climb/descent, or by a Windshear Alert and Guidance System (WAGS), ensure that full thrust is applied and aim to achieve maximum lift and maximum distance from the ground or follow WAGS guidance.

Similarly, if the windshear is encountered during the approach, positive application of the thrust and flight controls should be used to keep the speed and rate of descent within the normal limits. If there is any doubt, the approach should be abandoned and action taken as in the after takeoff case above. Whenever windshear is encountered, its existence should be notified to Air Traffic Control as soon as possible.

c) The following guidelines may be used to indicate uncontrolled changes from the normal steady state conditions. Changes in excess of:

1) 15 kts IAS;

2) 500 ft/min vertical speed;

3) 5 degrees pitch attitude;

4) 1 dot displacement from the glide path; and

5) Unusual throttle position for a significant period of time.

1.18.2 Interview Summaries

1.18.2.1 Captain

The occurrence flight departed from RKSI at 0009 UTC. Stop at RCMQ to pick up the passengers and then fly to Singapore.

The approach at RCMQ was ILS 36 with very windy and gusty condition. The captain was the PM of the occurrence flight.

The initial cruising altitude was FL380 and then climbed to FL400. There was jet stream en route for about wind speed of 180 knots. The descent was fine, the primary flight display (PFD) did not show any wind before the airplane turning base. During final approach, the head wind was about 50 knots.

The flight crew obtained RCMQ METAR and ATIS L before the approach. The approach briefing was conducted by the PF at 10 to 15 minutes before top of descend. The Vref speed for the approach was 129 knots[14]. Due to the wind conditions, approach speed was Vref + 5knots. The captain stated that he advised the PF to keep more energy for windy conditions for landing.

About 500 feet[15], the PF disconnected the autopilot. The approach was normal until about 100 feet, the airplane dropped and banked to the left. The PF pitched up further and the left landing gear touched the ground. The captain did not hear anything abnormal that indicated the wings of the airplane touched the ground.

When the airplane sank, the captain called out glide slope because the airplane was below the glide path. The captain put his hands on the control but did not give any input. When the airplane banked to the left, the captain helped to bank the airplane to wings level by right bank control input. The captain stated

[14] The Vref was 127 knots for the occurrence flight.
[15] Appears to be referencing pressure altitude.

that he considered to go around at the time but it was too late.

The captain remembered that the PF increased the thrust during sinking, but could not remember the pitch angle during flare. He did not look at the PFD because he was looking outside at the time.

The captain felt the left main gear touch the ground, did not remember feeling the right main gear touch the ground. It was a firm landing.

The captain thought the wingtips touched the runway surface because the airplane was pitched up too much and banked at the same time during the landing flare.

The maximum demonstrated crosswind for Global 6000 is 29 knots. The company limit is 25 knots. By calculation, the max crosswind encountered during approach was about 24 knots. It was within the limitation.

This was the first time the captain landed at RCMQ. The captain had flown with the first officer 2 times in the past, one in May, one in the summer to Taipei (RCTP). The captain stated that he always encouraged the first officer to fly the airplane to gain experience.

The approach was stable all the way, following the glideslope, everything was within limits, therefore the captain never thought about a go around. The PF was doing OK so there was no reason to consider taking over the controls. However, go around was still always an option for all flights.

The captain stated that if in the same weather conditions next time, he would be the PF.

In the manual, there is information about how much pitch angle versus bank angle are allowed during flare. The more pitch angle of the airplane, the less bank angle is allowed.

The captain felt normal physically and mentally for the flight. Did not take any medication before the flight.

The captain has never had an aviation incident before.

1.18.2.2 First Officer

Crew was reporting for duty at RKSI at 0700 local time and takeoff at 0900. First officer was the PF for the occurrence flight and everything was normal for climb and cruise. The flight crew received RCMQ ATIS L indicated wind was 030 degrees at 28knots, gusting to 41knots, visibility more than 10 kilometers, scatter or few cloud at 2,000 feet, altitude setting (QNH) was 1027. When switched to the approach frequency, controller provided the QNH was 1020. The PF conducted the approach briefing after obtaining the latest ATIS information. The briefing included the approach routes and the weather conditions. The captain advised the PF to keep speed a little bit higher, consider turning off the autothrottle and fly manually if wind is gusty. The Vref was 127 knots for the approach; the approach speed was Vref + 5 knots, 132 knots.

After crew inserted weather information into the flight management system (FMS), it gave cross wind component 14 knots and the number was within aircraft and first officer limit. The maximum demonstrated crosswind limit of Global 6000 is 29 knots; it was the same as the company limitations[16]. For the first officer with experience less than 1 year on Global, the crosswind limitation was 15 knots. The PF stated that the 1-year requirement for 15 knots crosswind limitation is not relative to time in the company, but for time on the Global type. Since he has 3 years experiences on Global, he is not restricted by the 15 knots crosswind limit. The PF stated that the wind gust was 40 knots and the crosswind component was

[16] The company limitation was 25 knots.

20 knots, it was within the limitation. The approach was quite stable, he did not consider the wind was challenging at that time.

At about 250 feet[17], the autopilot was disengaged and the PF was flying manually. Around 100 feet, wind became more gusty and the airplane sank below the glide slope. The PF raised the nose of the airplane to get back to the glide path.

About a little bit below 30 feet, the left wing dropped to the left and the PF gave full aileron input to the right. He expressed that it might be too late for the correcting action. The PF felt the wing drop like the wind had just gone, like a wind dip. The PF had full input on the control wheel but that just did not do anything.

Before touchdown, the left wing was still low. The PF recalled that the left main gear touched the ground first then the right main gear touched the runway. During the flare, the captain had his hands on the control wheel to help on the flight control. The PF cannot remember whether the PM made any call out during that time. He did not feel the wing touch the ground. The damage on both wing tips was discovered during post-landing walk around.

There was no windshear report from air traffic control (ATC). The wind condition was updated by ATC at 1,000 feet and the number was similar to what was in the ATIS. Auto call out for 100 feet and 50 feet were normal. The PF stated that normally at 50 feet, the autothrottle will reduce the thrust to idle and the airplane will pitch 1 degree up automatically. Around 30 feet, the pilot will pitch up 0.5 degree and at 10 feet pitch up 0.5 degree for normal landing.

For the occurrence flight, the PF stated that the drift angle was about 7 to 8 degrees for the approach. At about 100 feet, because the airplane was below the

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[17] Appears to be referencing radio altitude. According to the FDR, the actual height above ground when the autopilot was disengaged was 219 feet.

glide slope, PF pitched up about 1 degree. The PF stated that the pitch angle of the occurrence flight below 30 feet was about 1 to 2 degrees higher than normal flights.

Below 30 feet, when the left wing dropped, the PF put in the right aileron input and gave the left rudder input at the same time. His focus was on the roll control to level the wing. He thought that was the most important thing to do. The PF did not add any thrust after the aircraft descended below 50 feet. He had not considered a go around because the airplane was stable above 30 feet and everything was happening too fast below 30 feet. He was focused on keeping wings level, did not think about go around.

It was the first time that the PF had landed at RCMQ. The PF was a little bit tired due to jet lag but he felt it did not affect his performance for the occurrence flight. The PF had stayed home for 3 weeks before going on duty, he was happy to go do the flight. He felt good physically and mentally for this flight. He did not take any medication before the flight.

1.18.3 Sequence of Events

The sequence of events of the occurrence flight is listed in Table 1.18-1.

Table 1.18-1 Sequence of events

Taipei Time	Event	Source
0809	Takeoff from RKSI airport	FDR
1006:31	CVR recording started	CVR
1007 - 1021	The flight was during its descent toward waypoint ANPU, then FATAN with altitude around FL200. The crew received RCMQ ATIS information Lima.	CVR
1021	The captain advised the first officer to consider disconnect the autothrottle for final approach in gusty weather condition	CVR
1034:28	The captain advised the first officer "I will keep a little bit higher speed…"	CVR
1034:54	Contacted RCMQ tower control, established ILS runway 36 approach	CVR
1035	RCMQ tower control provided wind 030 degrees at 27 knots gusty 41 knots for runway 36, clear to land	CVR

1036:08	Before landing checklist completed	CVR
1036:59	PM called “one thousand passed and stabilized”	CVR
1037:24	PM called “five hundred”	CVR
1037:47	Auto callout “minimum minimum minimum”	CVR
1037:56	PF disconnected autopilot	CVR, FDR
1038:04	Auto altitude callout “one hundred”	CVR
1038:05	PM advised “you are below glides”, PF responded “correct(ing)”	CVR
1038:08	Auto altitude callout “fifty”	CVR
1038:12	Auto altitude callout “thirty”	CVR
1038:14	Auto altitude callout “ten”	CVR
1038:15	The occurrence aircraft touched down at the airspeed 113 knots, pitch attitude 10.2 degrees up, roll attitude 5.8 degrees right, vertical acceleration with 2.12g	CVR, FDR
1038:17	Autothrottle disengaged, auto callout “autothrust”	CVR, FDR
1040:10	The occurrence aircraft vacated runway 36	FDR

Chapter 2 Analysis

2.1 General

The captain and the first officer of Elit'Avia Malta flight EAU52P were properly certificated under Civil Aviation Agency of the Republic of Slovenia and Civil Aviation Authority Netherlands respectively. No evidence indicated any pre-existing medical conditions, fatigue, medication, or presence of other drugs or alcohol that might have adversely affected the flight crew's performance during the occurrence flight.

The occurrence aircraft was properly certified, no reported technical issues related to the flight controls system in accordance with the relevant technical documents. The aircraft's weight and balance were within the operational limits for the duration of the occurrence flight.

Taiwan was affected by a strong cold high-pressure system around the time of the occurrence flight. The weather conditions at RCMQ were reported good visibility and strong gusty wind with significant crosswind for runway 36. Windshear was not reported.

The analysis will focus primarily on the conduct of the flight in relation to the wind conditions during the approach and landing, followed by an analysis of the use of the autopilot and the autothrottle system by the flight crew.

2.2 Flight Operations

2.2.1 Approach and Landing

The CVR and interview records indicated that the flight crew completed the approach briefing before the top of descent. At around 1020 hours, when the aircraft altitude was FL200, the flight crew received ATIS information Lima, which indicated the wind at RCMQ was from 030 degrees at 28 knots, gusting to 41 knots. The captain advised the first officer to consider disconnecting the autothrottle for final approach in gusty weather conditions.

For the weight of the aircraft and a flap 30 landing, the Vref for the approach was 127 knots. The flight crew added a 5 knots adder to the Vref speed for the gusty wind conditions. The final approach speed was 132 knots.

2.2.1.1 The Final Approach

According to the CVR and FDR data, at 1036:08 hours, the aircraft descended through 1,370 feet radio altitude on the ILS approach to RCMQ runway 36 with flap 30 (slat 20), gear down and locked, airspeed was 135 knots, with autopilot and autothrottle engaged. At 1036:58 hours, the aircraft descended through 813 feet radio altitude, airspeed was 133 knots, the PM called "one thousand passed and stabilized". At 1037:40 hours, the PM called "approaching minimum", the PF responded "landing". At 1037:46 hours, the aircraft radio altitude was 302 feet, airspeed was 127 knots, the auto callout announced "minimum minimum minimum". The FDR parameters indicated that the autopilot coupled ILS approach of the occurrence flight was a stable approach in accordance with the company's stabilized approach criteria.

At 1037:56 hours, the autopilot was disengaged by the PF at 219 feet radio altitude, the autothrottle remained engaged. From this point on in the descent, there was a significant clockwise shift in wind vector. The aircraft was manually controlled by the PF, the airspeed varied between 127 knots and 133 knots, except for 1 to 2 seconds when the airspeed dropped to a minimum of 121.25 knots due to the gusty wind. The ground speed remained approximately constant between 85 knots to 89 knots. For further details, see table 2.2-1.

At 1038:08 hours, the aircraft was descending through 50 feet radio altitude, airspeed was 137 knots, the auto callout announced "fifty" in the cockpit. One second later, at 1038:09 hours, the autothrottle changed to "position throttle retard" mode, the fan speed of both engines was reduced from around 62% N1 to in-flight idle (around 34% N1) by the autothrottle system[18]. The indicated airspeed started to decrease from 132.5 knots at 47 feet radio altitude to 123.75 knots at 34 feet radio altitude, and further decreased to 113 knots at 5 feet and touchdown. During this time, the groundspeed went from approximately 90 knots to 87 knots; the difference between the delta airspeed (19.5 knots) and the delta groundspeed (3 knots) indicates a significant reduction in headwind. The vertical speed of the aircraft increased from -248 ft/min at 47 feet radio altitude to the maximum descent rate of -600 ft/min at 24 feet radio altitude; the aircraft touched down at a vertical speed of -341 ft/min.

[18] The engine N1 reduced from 62% at 50 feet to 42% at 24 feet, and to 34% at 5.6 feet, one second before touchdown.

Table 2.2-1 Flight crew actions and aircraft state during the final approach

Time	CVR Transcript	Radio Altitude (ft.)	Airspeed (kts)	Ground Speed (kts)	Vertical Speed[19] (ft/min)	Pitch Angle (deg)	Roll Angle (deg)	Wind Direction[20] (deg)	Wind Speed (kts)
1037:56[21]		219	132.25	87		2.46	1.49	8	27
1037:57		200	132.25	86		2.98	1.66	6	29
1037:57.4	PF : disconnect autopilot								
1037:58		192	128.75	86		2.63	-0.17	13	29
1037:59		177	127	85		3.16	-2.72	18	27
1038:00		156	127	85		4.65	-1.58	23	25
1038:01		136	121.25	86		4.30	-2.28	28	22
1038:02		121	124.5	87		3.51	1.31	31	21
1038:03		106	130.5	87		5.27	0.26	34	19
1038:03.8	Auto callout : one hundred								
1038:04		91	128	87		7.38	-2.8	28	19
1038:05		69	122.25	87		7.03	-0.08	24	20
1038:05.4	PM : you are below glides								
1038:06		63	133.5	89		4.57	-3.77	26	21

19 Derived from FDR radio height parameter.
20 AWOS S wind direction and speed.
21 Autopilot disengaged by the PF.

Time	CVR Transcript	Radio Altitude (ft.)	Airspeed (kts)	Ground Speed (kts)	Vertical Speed[19] (ft/min)	Pitch Angle (deg)	Roll Angle (deg)	Wind Direction[20] (deg)	Wind Speed (kts)
1038:07		57	131	89		5.27	-3.25	30	20
1038:07.0	PF : correct(ing)								
1038:08		51	137	90	-319	5.36	0.52	40	17
1038:08.2	Auto callout : fifty								
1038:09		47	132.5	90	-248	4.48	2.54	45	16
1038:10		42	131.25	90	-368	4.48	4.48	47	17
1038:11		34	123.75	89	-503	5.00	2.46	44	18
1038:12		24	125.5	89	-600	6.15	1.84	41	20
1038:12.0	Auto callout : thirty								
1038:13		15	120.25	88	-559	6.24	-1.58	42	21
1038:14		5.6	113	87	-525	8.08	0.96	42	23
1038:14.2	Auto callout : ten								
1038:15		-2.5	113	87	-341	9.84	5.88	38	24
1038:15.0	Sound similar to landing gear touchdown								
1038:16		-0.5	112.75	86	124	8.26	-9.40	33	24
1038:16.8	Auto callout : autothrust								
1038:17		-1.9	114	85	-26	4.47	2.10	36	25

2.2.1.2 The Landing

When the aircraft reached the flare altitude of 30 feet, the pitch up control column input by the PF resulted in an increase of the pitch angle of the aircraft from about 5 degrees nose up to 10 degrees nose up at touchdown. The flight crew recalled experiencing a wing dip to the left when the aircraft altitude was below 30 feet. The PF stated that he gave full aileron input to the right when the aircraft rolled to the left. The PM stated that he helped to bank the aircraft to wings level by right bank control input.

Just before touchdown, the flight crew attempted to compensate the disturbances in the roll and pitch of the aircraft induced by the gusty wind conditions, using significant control inputs. These conditions and the limited time available before landing after autopilot disengagement made it difficult to maintain the required wings level attitude of the aircraft. The numbers in table 2.2-2 indicate that two seconds before the aircraft touched down on the runway, the flight crew reacted with a significant and rapid control wheel input to counteract the left wing drop. The right wing down control input resulted in a maximum of 6.76 degrees RWD roll angle and a 9.31 degrees nose up pitch attitude at 0 feet radio altitude. The aircraft touched down hard on the right main landing gear in a right rolling motion. The right wing tip of the aircraft probably contacted the runway surface at this time. After the right main gear touched the ground and bounced, followed by the left wing down control input by the PF in an attempt to stop the right roll motion, the aircraft rolled to the left. The aircraft reached a maximum roll angle of 9.4 degrees LWD and the right main gear transitioned back to “air” mode. With the pitch attitude at 8.26 degrees, the left wing tip of the aircraft contacted the runway surface.

At touchdown, a peak normal acceleration of +2.12g and a peak lateral acceleration of +0.26g were recorded.

Table 2.2-2 Flight crew actions and aircraft state during the landing

Time	Radio Altitude (ft.)	PF Control Wheel FTU[22] (lbs)[23]	PM Control Wheel FTU (lbs)	Pitch Angle (deg)	Roll Angle (deg)[24]	Gear (L) on Ground	Gear (R) on Ground
1038:12	24	-29.25	-2	6.15	1.84	Air	Air
1038:12.25	22.37	-0.75	4.75	5.97	0.87	Air	Air
1038:12.50	19.25	19.75	2	6.06	-0.08	Air	Air
1038:12.75	17.5	27.25	-2.25	6.06	-1.23	Air	Air
1038:13	15.12	33	1.5	6.24	-1.58	Air	Air
1038:13.25	13.25	32.25	-6.25	6.76	-2.10	Air	Air
1038:13.50	9.62	20	-27.5	7.11	-2.10	Air	Air
1038:13.75	7.87	-17.75	-40.75	7.73	-0.70	Air	Air
1038:14	5.62	-9	-13	8.08	0.96	Air	Air
1038:14.25	4	-12.75	18	8.52	3.69	Air	Air
1038:14.50	1.25	-21	14.25	8.78	5.27	Air	Air
1038:14.75	0	-25	14.5	9.31	6.76	Air	Air
1038:15	-2.5	-66.25	-5.5	9.84	5.88	Air	Air
1038:15.25	-3.75	0.75	20.25	10.19	-0.87	Air	Air

[22] Force transducer unit.
[23] Negative value: left wing down control input. Positive value: right wing down control input.
[24] Negative value: left wing down. Positive value: right wing down.

Time	Radio Altitude (ft.)	PF Control Wheel FTU[22] (lbs)[23]	PM Control Wheel FTU (lbs)	Pitch Angle (deg)	Roll Angle (deg)[24]	Gear (L) on Ground	Gear (R) on Ground
1038:15.50	-3.25	12	-34.5	9.93	-5.53	Air	Ground
1038:15.75	-2.37	11.75	-65	8.96	-9.31	Ground	Ground
1038:16	-0.5	56	-75.75	8.26	-9.40	Ground	Ground
1038:16.25	-0.37	92	-35	7.20	-6.15	Ground	Air
1038:16.50	-1	71.75	9	6.50	-2.19	Ground	Air
1038:16.75	-1.75	6.75	-3.25	5.36	2.54	Ground	Air
1038:17	-1.87	2.75	16.75	4.74	2.10	Ground	Ground

2.2.1.3 Use of Autopilot and Autothrottle

The CVR and FDR data indicated that the autopilot was disengaged by the PF at 219 feet radio altitude. The autothrottle remained engaged for the approach and landing and was disengaged[25] 2 seconds after the aircraft touched down on runway 36.

According to the operator's OM-A, see 1.18.1.3, except for autoland operations, the autopilot should be disengaged for operations below MDA. In addition, when the reported crosswind exceeds 15 knots, the autopilot should be disengaged when the aircraft descends through 500 feet radio altitude. The reported crosswind components for RCMQ runway 36 for the occurrence flight was 14 knots steady wind gusting to 20.5 knots. Therefore, the autopilot should have been disengaged at either 500 feet radio altitude or no lower than the MDA for the occurrence flight.

There was no windshear reported for the approach of the occurrence flight. However, the existing wind conditions may have included small-scale up drafts and/or downdrafts, and local vortices close to the ground. Although use of the autoflight system has the advantage of an accurately flown flightpath at a selected speed and will reduce the workload of the pilots, it is essential to disconnect the autopilot at an altitude that allows the pilot to have ample time to adapt to the highly dynamic situations during landing. The autopilot was disengaged at 219 feet radio altitude. The PF had only 16 seconds to transition from automatic flight to manual flight before the aircraft reached 30 feet, where the PF started the landing flare for touchdown, which may have given the PF, especially in strong gusting wind conditions, insufficient time to gain complete control of the aircraft, and could have contributed to an over-controlled hard landing.

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[25] According to the FCOM, the autothrottle will disengage automatically on landing (weight on wheels).

In addition, according to the operator's OM-A, the autothrottle should be disengaged during manual flight. When the PF disengaged the autopilot, the autothrottle was not disengaged. The autothrottle of the aircraft remained in control of the thrust for the approach, flare, and landing. In accordance with the FCOM, the autothrottle retard mode activates when the aircraft is in a landing configuration and a radio altitude of 50 feet is reached. The retard mode commands both thrust levers to automatically retard to idle at a fixed rate during the landing flare. The FDR data indicated that the throttle lever positions for both engines were reduced from about 10 degrees to 1.5 degrees at the aircraft radio altitude reached 50 feet. A 20 knots decrease in airspeed occurred from 50 feet to touchdown, an excessive decrease as compared to a normal landing where a decrease of only 4 to 5 knots in the flare would be expected. Although the reduction in thrust and pitch up control input commanded by the PF contributed to this loss of airspeed, the majority of the decrease was most likely due to a rapid headwind reduction that was not compensated for by increasing thrust. Although the aircraft was still fully controllable, the aerodynamic effect of rudder and aileron was diminished during the rapid deceleration and made the flight control tasks more demanding.

The above analysis indicates that the combination of the strong and gusty wind conditions, insufficient time to gain complete control of the aircraft due to late disconnection of the autopilot, the rapid decrease of the airspeed due to a rapid headwind reduction that was not compensated for by increasing thrust and the increased pitch angle by the pitch up control demand of the PF, and the significant and rapid control input of the flight crew during flare to compensate for the disturbance of roll and pitch by the gusty wind, resulted in a wingtips abnormal runway contact landing occurrence.

2.2.2 Final Approach Speed

Interview records indicated that the Vref speed of the occurrence aircraft for the approach was 127 knots. The flight crew added a 5 knots adder to the Vref to compensate for the gusty wind conditions. The final approach speed was 132 knots.

According to the operator's FCOM and OM-B, see 1.18.1.5, the Vref speed adder should be used for approach and landing when turbulence or gusty wind conditions are anticipated during the approach and landing. It is recommended to add half of the gust, to a maximum of 10 knots to the Vref for the final approach speed.

Final Approach Speed = Vref + 1/2 gust (max. Vref + 10 knots)

However, the Vref speed adder recommended in the OM-A was to add half of the steady wind and full gust, to a maximum of 20 knots.

Final Approach Speed = Vref + 1/2 steady wind + full gust (max. Vref + 20 knots)

For the occurrence flight, the reported wind was 030 degrees at 28 knots, gusting to 41 knots. The final approach speed could be 133.5 knots in accordance with the recommended adder in FCOM or OM-B, or 147 knots in accordance with the OM-A. The difference between the Vref speed adders recommended in different manuals may create confusion and adversely affect the standardization of flight operations during approach and landing in strong and gusty wind conditions.

2.2.3 Pilot Flying Duty Assignment

According to the operator's OM-A, see 1.18.1.1, the commander of the flight decides who will be PF and PM after taking into account the first officer's experience and operational conditions. When the first officer has less than one year experience on the aircraft type and the crosswind component exceeds 15 knots or the crosswind component is close to the maximum authorized regardless of first officer's experience, the captain should act as PF.

The occurrence first officer had three years BD-700 flight experience. The reported crosswind component during approach for the occurrence flight was 14 knots steady wind gusting to 20.5 knots. Therefore, the first officer was qualified to be assigned as the PF for the flight. However, it is noteworthy that the PF did not take the captain's advice to disengage the autothrottle and keep the airspeed higher to compensate for the strong and gusty wind conditions. In addition, the PF reacted with too much control on the roll and pitch of the aircraft to recover from the wing drop during the flare. The operational conditions of the occurrence flight during final approach and landing appeared to be challenging considering the PF's flight experience.

After the occurrence, the operator issued a temporary revision of PF's requirement for wind conditions. When the total steady crosswind is 20 knots or more (15 knots for first officer under one year experience) and/or the gust component is 10 knots or more, the captain should act as PF.

Chapter 3 Conclusions

In this Chapter, the Taiwan Transportation Safety Board presents the findings derived from the information gathered during the investigation and the analysis of the occurrence. The findings are presented in three categories: **findings related to probable causes**, **findings related to risk**, and **other findings**.

The **findings related to probable causes** identify elements that have been shown to be directly causal to the occurrence, or almost certainly contributed to the occurrence. These findings are associated with unsafe acts, unsafe conditions, or safety deficiencies associated with safety significant events that played a major role in the circumstances leading to the occurrence.

The **findings related to risk** identify elements of risk that have the potential to degrade aviation safety. Some of the findings in this category identify unsafe acts, unsafe conditions, and safety deficiencies including organizational and systemic risks, that made this occurrence more likely; however, they cannot be clearly shown to have operated in the occurrence alone. Furthermore, some of the findings in this category identify risks that are unlikely to be related to the occurrence but, nonetheless, were safety deficiencies that may warrant future safety actions.

Other findings identify elements that have the potential to enhance aviation safety, resolve a controversial issue, or clarify an ambiguity point which remains to be resolved. Some of these findings are of general interests that are often included in the ICAO format accident reports for informational, safety awareness, education, and improvement purposes.

3.1 Findings Related to Probable Causes

1. Taichung International Airport was affected by a strong cold high-pressure weather system at the time of the occurrence. The meteorological conditions

were reported to be good visibility and strong gusty wind with significant crosswind for runway 36. (1.7, 2.1)

2. Two seconds before the aircraft touched down on the runway, the flight crew reacted with a significant and rapid control wheel input to compensate for the disturbances in the roll and pitch of the aircraft caused by the gusty wind conditions. The right wing down control input resulted in a maximum of 6.76 degrees right wing down roll angle and a 9.31 degrees nose up pitch attitude at 0 feet radio altitude. The aircraft touched down hard on the right main landing gear in a right rolling motion. The right wing tip of the aircraft probably contacted the runway surface at this time. (1.11.2, 2.2.1.2)

3. After the right main gear touched the ground and bounced, followed by the left wing down control input by the pilot flying in an attempt to stop the right roll motion, the aircraft rolled to the left. The aircraft reached a maximum roll angle of 9.4 degrees left wing down. With the pitch attitude at 8.26 degrees, the left wing tip of the aircraft contacted the runway surface. (1.11.2, 2.2.1.2)

4. The combination of the strong and gusty wind conditions, insufficient time to gain complete control of the aircraft due to late disconnection of the autopilot, the rapid decrease of the airspeed due to a rapid headwind reduction that was not compensated for by increasing thrust and the increased pitch angle by the pitch up control demand of the pilot flying, and the significant and rapid control input of the flight crew during flare to compensate the disturbance of roll and pitch by the gusty wind, resulted in a wingtips abnormal runway contact landing occurrence. (1.7, 1.11, 1.12, 2.2.1.1, 2.2.1.2)

3.2 Findings Related to Risk

1. The autopilot was disengaged at 219 feet radio altitude. The pilot flying (PF)

had only 16 seconds to transit from automatic flight to manual flight before the aircraft reached 30 feet and the PF started the landing flare for touchdown, which gave the PF insufficient time to gain complete control of the aircraft before landing in the strong and gusty wind conditions. (1.11.2, 2.2.1.1)

2. The difference between the Vref speed adders recommended in different manuals may create confusion and adversely affect the standardization of flight operations during approach and landing in strong and gusty wind conditions. (1.18.1.5, 2.2.2)

3.3 Other Findings

1. The flight crew were properly certificated and qualified in accordance with the related regulations and requirements. No evidence indicated any pre-existing medical conditions, fatigue, medication, or presence of other drugs or alcohol that might have adversely affected the flight crew's performance during the occurrence flight. (1.5, 2.1)

2. The occurrence aircraft was properly certified, with no reported technical issues related to the flight controls system in accordance with the relevant technical documents. (1.6.2, 2.1)

3. The aircraft's weight and balance were within the operational limits for the duration of the occurrence flight. (1.6.3, 2.1)

4. The flight data recorder (FDR) parameters indicated that the autopilot coupled instrument landing system (ILS) approach of the occurrence flight was a stable approach in accordance with the company's stabilized approach criteria. (1.11.2, 2.2.1.1)

Chapter 4 Safety Recommendations

4.1 Recommendations

There is no safety recommendation in this report. The safety actions of Elit'Avia Malta and Bombardier are presented in 4.2.

4.2 Safety Actions

Elit'Avia Malta and Bombardier provided the safety actions accomplished or being accomplished after the EAU52P occurrence. Those actions are presented as follows:

4.2.1 Elit'Avia Malta

4.2.1.1 Corrective Actions

Immediate - complete

1. Notice to crew (NTC) issued – crew to review Bombardier crosswind landing e-learning module;
2. Flight simulation training devices (FSTD) – satisfactorily completed for subject crew;
3. OM-A / B temporary revision (TR) and amendment with clarification of:
    - Nomination of the first officer as PF;
    - Advice with regards to use of Vref + 10 in strong / gusty winds.

Follow Up – in progress

1. Request with flight data monitoring program (FDMP) provider re event: Roll angle below 7 ft RA. Currently event roll angle below 20 ft RA;
2. FDM active monitoring of pitch and roll angles on landing;
3. Discussion with Bombardier company pilot – issue of Vref+10 limit as Vapp

raised[26];

4. Consider advice / training on:
   - use of auto thrust. Practice auto thrust override in the flare;
   - use of manual thrust – FSTD / aircraft practice.
5. Consider pilot monitoring function below 100ft:
   - Call outs / speed trend vector;
   - Bank / Pitch callouts;
   - Go-Around.

4.2.1.2 Preventative Action

Crew education and training

1. in landing in strong winds and strong crosswinds and effects of gust variation.
2. the role of the pilot monitoring in the last 100 ft of the approach should be examined.

Use of autopilot in strong and gusty wind conditions

The autopilot and autothrottle reduce pilot workload thereby increasing the monitoring capacity for the PF as well as the PM. However, the downside is that late disconnection of the autopilot and / or the autothrottle creates a ‘window of disconnect’ – it takes a finite time for a pilot to ‘get in sync’ with the aircraft in the transition from auto to manual control. In this incident autopilot disconnect to

[26] According to Bombardier, the "maximum of 10 KIAS" was removed in the May 2021 revision of the FCOM. The revised guidance (Global 6000 FCOM vol.1, rev. 38, page 10-01-113) now states the following: "*(2) SPEED ADDER FOR APPROACH AND LANDING IN GUSTY WIND CONDITIONS The VREF speed adder should be used for approach and landing when turbulence or gusty wind conditions are anticipated during the approach and landing. When gusty conditions are reported, it is recommended to add half of the gust, (e.g. for winds of 15 kts gusting to 40 kts, half of the 25 kt gust is 12.5 kts, so in this case the correction applied to VREF is 13 KIAS.)*"

landing was 16 seconds and disconnect occurred just before the most critical phase of flight.

It is therefore recommended that in conditions of strong and gusty wind conditions autopilot disconnection is effected no later than 500 ft RA to allow a period of familiarization and synchronization in manual aircraft control before reaching the flare.

Use of autothrottle system be considered

The autothrottle system is certified for use during the landing phase. In this incident the autothrottle system performed in accordance with its design philosophy. Thrust had increased from a nominal approach thrust setting of 55% NI to 62 % NI when the speed reduced to Vref and slightly below just above 50 ft RA.

However at 50 ft RA the autothrottle mode changes from speed to landing flare and thrust is progressively reduced to idle thrust for landing irrespective of airspeed and airspeed trend vector. This is not a criticism but a fact and is not challenged in this report.

Crew need to be aware of this design philosophy and need to be trained in options to intervene in the situation that the crew found themselves in during this incident.

The crew reported 'sink' below 100 ft RA which is confirmed by flight data. To counteract the sink, (increased rate of descent) given that the speed was correct required:

a. Pitch attitude nose up change to increase lift;

b. Thrust increase to counteract increased lift dependent drag and also contribute to total lift due vertical component of thrust. This action was achieved by the autothrottle between 100 ft and 50 ft RA prior to retard mode.

At 50 ft RA the autothrottle entered the retard mode and thrust was correctly commanded to idle by the autothrottle system. Speed was correct at 136 kts at this point. By 30ft RA speed had decreased to Vref -3 kts decreasing to Vref - 15 kts on landing and thrust was therefore required to stabilize speed and rate of descent. The PF had three options at this late stage:

c. Move thrust levers with autothrottle engaged, or

d. Disconnect the autothrottle system and control thrust manually, or

e. Go-Around.

Given that time is critical in this situation, and increase of thrust is the required operational solution, it is considered that movement / override of thrust levers to command more thrust is the preferred option. This option and skill requires briefing and training in the FSTD.

An alternative option is to manually control thrust and disconnect the auto thrust system in strong and gusty wind conditions. This requires training and regular practice.

Finally, a Go-Around in the flare is always an option and should also be practiced in the FSTD.

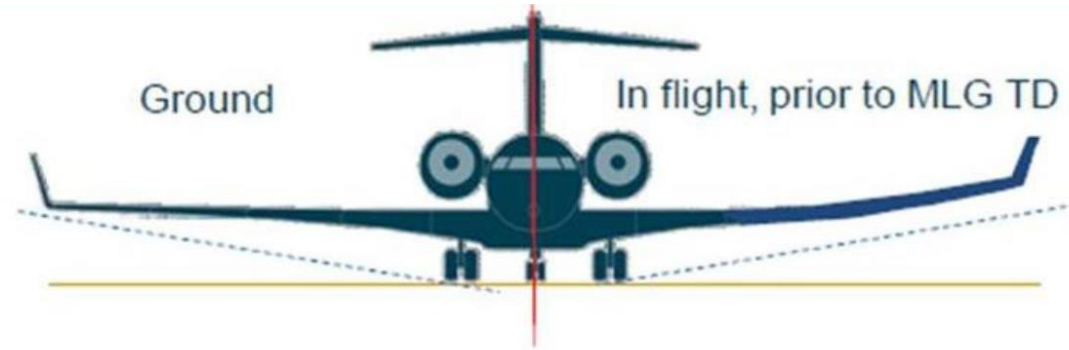
Options discussed introduce increased risk and should be risk assessed by Flight Operations and Crew Training managers.

Flight Data Monitoring

The Safety Manager of the occurrence operator believes that FDMP is second only to training standards, self discipline and professional standards in applied aircraft operational safety.

The Elit'Avia G6000 Fleet is enrolled into the FDMP.

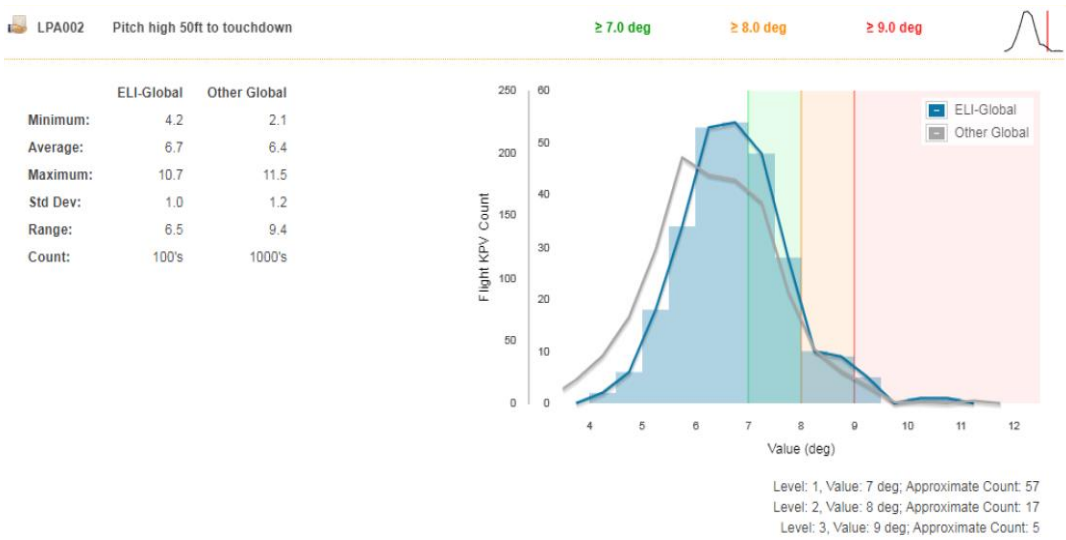
There is a direct correlation between pitch angle and roll angle with regards to risk of wing ground contact on landing. The following schematic is provided by Bombardier and is part of the e-learning module with regards to crosswind landings.



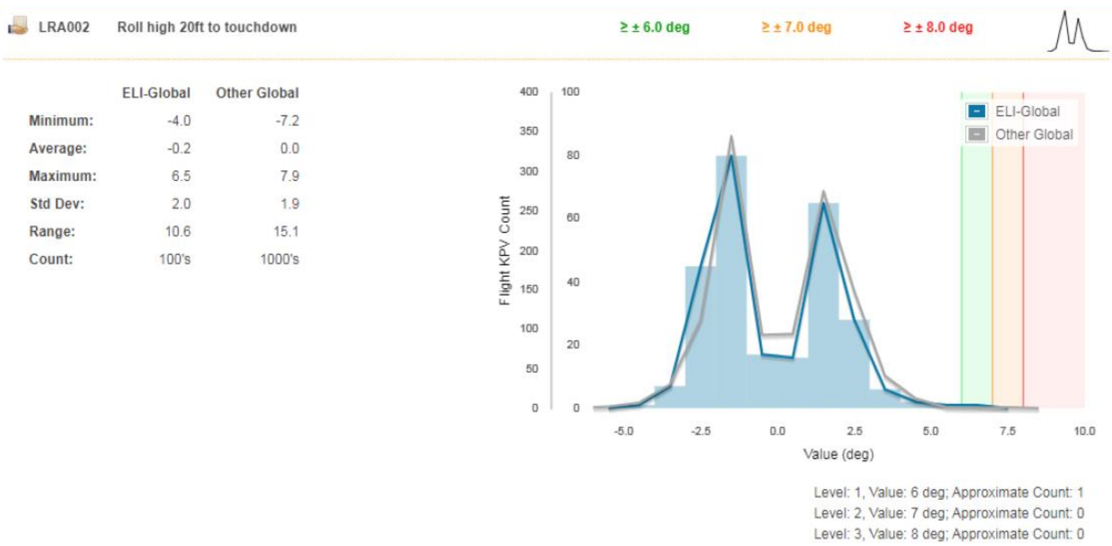
PITCH angle	Bank Angle for wing tip contact (ground, no lift)	In Flight (lift, increased dihedral)
0	10.6	13.5
3	9.6	12.3
6	8.5	11.2
9	7.4	10.1

The FDM relevant events available and monitored prior to the occurrence are:

e. Pitch angle 50 ft to touchdown: Event Code LPA002 with Level 1 set at 7 deg NU, Level 2 set at 8 deg NU and Level 3 at 9 deg NU.



f. Roll angle 20 ft to touchdown: Event Code LRA002 with Level 1 set at 6 deg roll, Level 2 at 7 deg roll and Level 3 at 8 deg roll.



The FDMP provider has been requested to introduce an additional event for roll below 10 ft RA to monitor roll angle close to the ground set at:

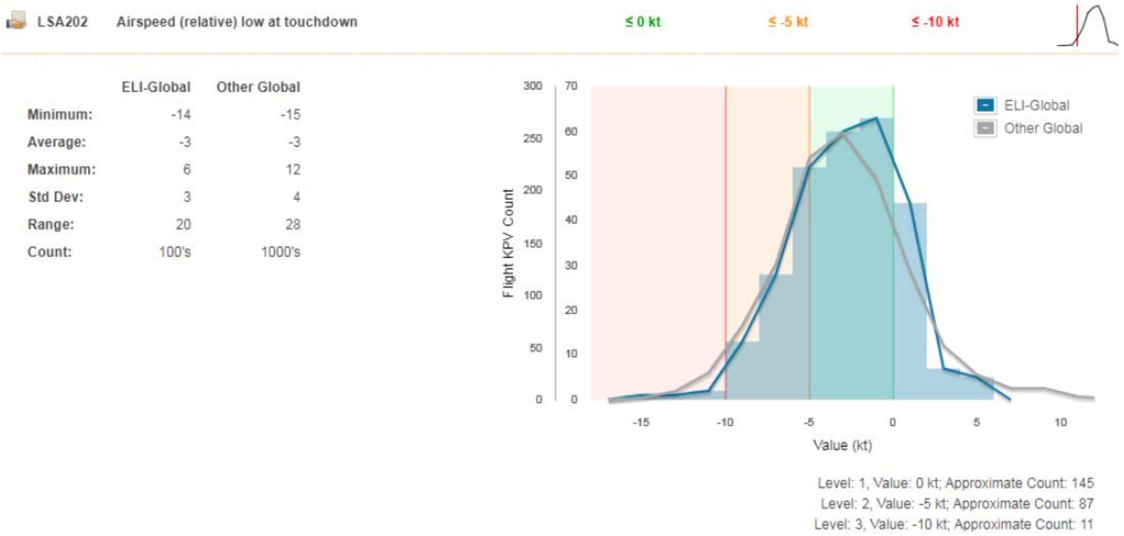
Level 1: Roll +/- of 3 deg or more

Level 2 Roll of +/- 4 deg or more

Level 3 Roll of +/- 5 deg or more

In the longer term an event that monitors Pitch / Roll combination at touchdown has been requested.

Finally, airspeed at touchdown is monitored by Event LSA 202. The trigger parameters and data spread is shown in schematic below:



It is proposed that the LSA202 parameters be changed to reflect that airspeed on landing is approximately 5% less than Vapp / Vref. The proposed Event Parameters:

Level 1 < Vref - 5 kts, Level 2 < Vref – 7 kts and Level 3 < Vref – 10 kts

4.2.2 Bombardier

Bombardier has implemented the following safety actions:

1. Introduction of a new chapter in the Global 6000 FCOM called ROPAT (recommended operational procedures and techniques). The purpose of the ROPAT is to provide recommendations and procedural guidance for operation of the Global 6000 airplane. The guidance presented is intended to facilitate safe and efficient operation of the Global 6000. The material in the ROPAT is not intended to be used as standard operation procedures (SOP), but may be used to facilitate the development of SOPs. With the introduction of the ROPAT, the FCOM can be used as a single reference manual for both training and operations. In particular, the ROPAT expands on the guidance available to the flight crew for wingtip strike avoidance. The ROPAT was

introduced in November 2020 and therefore would most likely not yet have been reviewed by the occurrence flight crew.

2. The free on-line crosswind operations training module, originally developed by Bombardier Training Services but now hosted by CAE, was repatriated to Bombardier's customer website in March 2021, in order to facilitate access for all Global customers. An Advisory Wire (AW700-00-0479 Rev 2) was issued on March 29th, 2021, instructing customers on how to access the repatriated training module. The AW states that the training module, " [...] discusses takeoff techniques, and approach and landing considerations. For landing, the geometry of the Global wing and the decreasing margin between wing and runway on flare and touchdown with the interrelationship of bank and pitch angle is presented in detail. The recommended technique can be summarized here as 'crab to flare, rudder to straighten and ailerons to keep wings level.' Other considerations are presented to provide an excellent opportunity for discussion by flight crews." and highly recommends that all Global series pilots review the material as well as their standard operations procedures.

3. The on-line training module was further improved and updated. The updated version was made available on Bombardier's customer website in June 2021.

   In addition to the above, Bombardier is working on the following:

4. Bombardier has requested that crosswind landing and wingtip strike avoidance be added as a training area of special emphasis in Transport Canada's Operational Evaluation Board (OEB) Report, the FAA's Flight Standardization Board (FSB) report, and EASA's Operational Suitability Data (OSD) for the aircraft type.

5. Bombardier is working on adding expanded guidance to the ROPAT with

regards to the following aspects of landings in crosswinds with strong gusty or turbulent conditions: the use of automation, thrust management in the final phase of the approach and landing, and the go-around decision.

6. Bombardier is working on expanding the on-line training module to include recommended guidance on division of Pilot Flying and Pilot Monitoring responsibilities.

7. Bombardier will recommend that training providers review and update crosswind landing training and, where necessary, include gusty or turbulent conditions within the maximum crosswind landing event, with additional emphasis on the following aspects: applying correct Vref adders, use of automation, Pilot Flying and Pilot Monitoring responsibilities during the approach and landing phase, speed and thrust management in the flare, and the go-around decision.