

Republic of the Philippines DEPARTMENT OF TRANSPORTATION CIVIL AVIATION AUTHORITY OF THE PHILIPPINES MIA Road, Pasay City 1300

AIRCRAFT ACCIDENT INVESTIGATION AND INQUIRY BOARD

FINAL REPORT

<u>RP-C5911</u> BOMBARDIER, DHC 8-402 (Q400)

OPERATOR: AIR PHILIPPINES CORPORATION (PAL EXPRESS)

TYPE OF OPERATION: SCHEDULED COMMERCIAL

DATE OF OCCURRENCE: DECEMBER 10, 2021

PLACE OF OCCURRENCE: MACTAN-CEBU INTERNATIONAL AIRPORT (RPVM), PHILIPPINES

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FOREWORD

This report was produced by the Aircraft Accident Investigation and Inquiry Board (AAIIB), Civil Aviation Authority of the Philippines, MIA Road, Pasay City, Philippines.

The report is based upon the investigation carried out by the AAIIB in accordance with Annex 13 to the Convention on International Civil Aviation, Republic Act 9497 Section 42, and Philippine Civil Aviation Regulation Part 13.

Readers are advised that the AAIIB investigates for the sole purpose of enhancing aviation safety. Consequently, AAIIB reports are confined to matters of safety significance and may be misleading if used for any other purpose. It should be noted that the information in AAIIB reports and recommendations is provided to promote aviation safety, and in no case is it intended to imply blame or liability.

Furthermore, no part of the AAIIB report or reports relating to any accident or investigation shall be admitted as evidence or used in any suit or action for damages arising out of any matter mentioned in such report or reports.



Republic of the Philippines DEPARTMENT OF TRANSPORTATION CIVIL AVIATION AUTHORITY OF THE PHILIPPINES MIA Road, Pasay City 1300

www.caap.gov.ph

FINAL REPORT

TITLE: A serious incident involving a Bombardier, DHC 8-402 (Q400) type of aircraft with Registry Number RP-C5911 owned and operated by Air Philippines Corporation (PAL Express), that had a gear-up landing resulting to runway excursion at Mactan-Cebu International Airport (RPVM), Philippines on December 10, 2021, 1140H(Local).

Notification of Occurrence to National Authority

The notification of serious incident to AAIIB CAAP was relayed by the Operator of the aircraft at 1400H (local) on December 10, 2021.

Identification of the Investigation Authority

The Aircraft Accident Investigation and Inquiry Board (AAIIB), the mandated accident investigation organization within the Civil Aviation Authority of the Philippines (CAAP) as the state of Occurrence/Registry/Operator conducted the investigation.

Organization of the Investigation

In accordance with provisions of Philippine Civil Aviation Regulation (PCAR) Part 13, an Investigator-In-Charge and Deputy Investigator-In Charge were appointed.

Authority Releasing the Report

The Final investigation report was released by Aircraft Accident Investigation and Inquiry Board (AAIIB) and published on the CAAP website on <u>31 May 2024</u>.

Synopsis:

On December 10, 2021 at about 1140H(Local), a Bombardier, DHC 8-402 (Q400) type of aircraft with Registry Number RP-C5911 operated by Air Philippines Corporation (PAL Express), had a runway excursion at Mactan-Cebu International Airport (RPVM), Philippines. The four (4) crew member and twenty-nine (29) passengers onboard did not sustain any injuries; however, the aircraft sustained no damage as a result of the occurrence. Instrument Meteorological Condition (IMC) prevailed at the time of the serious incident. The cause of the occurrence was attributed to a nose wheel steering fault that led to runway excursion.

LIST OF ACRONYMS AND ABBREVIATIONS

AAIIB	:	Aircraft Accident Investigation and Inquiry Board
AMO	:	Approved Maintenance Organization
ASPH	:	Asphalt
ATZ	:	Aerodrome Traffic Zone
CAAP	:	Civil Aviation Authority of the Philippines
CAP	:	Caution Advisory Panel
COA	:	Certificate of Airworthiness
COR	:	Certificate of Registration
CPL	:	Commercial Pilot License
CRM	:	Crew Resource Management
CVR	:	Cockpit Voice Recorder
CWP	:	Centralized Warning Panel
ECAM	:	Electronic Centralized Aircraft Monitor
EICAS	:	Engine Indicating and Crew Alerting System
FDR	:	Flight Data Recorder
FO	:	First Officer
IATA	:	International Air Transport Association
ICAO	:	International Civil Aviation Organization
IFR	:	Instrument Flight Rules
IMC	:	Instrument Meteorological Conditions
JTSB	:	Japan Transport Safety Bureau
MCIAA	:	Mactan-Cebu International Airport Authority
MHZ	:	Megahertz
OFSAM	:	Office of Flight Surgeon and Aviation
PCAR	:	Philippine Civil Aviation Regulation
PCN	:	Pavement Classification Number
PHC	:	Pilot Handle Control
PIC	:	Pilot-In-Command
PSEU	:	Proximity Sensor Electronic Unit
RTS	:	Return To Service
RWY	:	Runway
SCU	:	Steering Control Unit
SIC	:	Second-In-Command
TMA	:	Terminal Maneuvering Area
UTC	:	Universal Time Coordinated
VFR	:	Visual Flight Rules
VHF	:	Very High Frequency
WOW	:	Weight On Wheels





1. FACTUAL INFORMATION

Aircraft Registration No.	:	RP- C5911
Aircraft Type/Model	:	Bombardier/DHC 8-402 (Q400)
Operator	:	Air Philippines Corporation (PAL Express)
Address of Operator	:	APC PAL R1 Hangar, Gate 1, Andrew Avenue, Pasay City, Philippines
Place of Occurrence	:	Mactan-Cebu International Airport (RPVM), Philippines
Date/Time of Occurrence	:	December 10, 2021/ 1140H(Local)/0340UTC
Type of Operation	:	Scheduled Commercial
Phase of Flight	:	Landing Roll
Type of Occurrence	:	Runway side excursion

1.1 History of Flight

On or about 1140H local time, December 10, 2021, a Bombardier, DHC 8-402 (Q400) type of aircraft with Registry Number RP-C5911 experienced a runway excursion while on landing roll at Runway 04, Mactan-Cebu International Airport, Lapu-Lapu City, Mactan, Philippines. The flight took off from Godofredo Ramos Principal Airport (RPVE) in Caticlan, Kalibo, and Aklan at 1050H local time. The aircraft is being operated by PAL Express under PCAR Part 9. The four crew members and 29 passengers on board did not sustain any injuries. Instrument meteorological conditions prevailed at the time of the occurrence.

The aircraft came to a complete stop at the grassy left side portion of the runway, about 1,500 meters from the threshold of Runway 04, at coordinates 10.309431N, 123.980965E, and with a final heading of 22 degrees. Inspection of the aircraft shows it sustained no damages. No post-fire ensued. Mactan-Crash Fire Rescue Unit (CFRU) immediately responded to help secure the aircraft. The passengers deplaned normally out of the aircraft using the L1 door and were ferried to the airport terminal by bus services. At 1141H, Mactan Tower declared the activation of Emergency Plan: Aircraft Accident On-Airport (Emplan 1) and informed all responding units. At 1438H, the runway was opened and back to normal operation.



Figure 1. The aircrafts final resting point.

1.2 Injuries to Person (s)

Injuries	Crew	Passengers	Others	TOTAL
Missing/Fatal	0	0	0	0
Serious	0	0	0	0
Minor	0	0	0	0
None	4	29	0	33

1.3 Damage to Aircraft

The aircraft did not sustain any damage.

1.4 Other Damages

There were no reported other damages during the site investigation.

1.5 Personnel Information

1.5.1 Pilot-In-Command (PIC)

Gender	:	Female
Date of Birth	:	August 12, 1979
Final Report RP-C5911, Bombardier, DHC 8-402	(Q400)	

	Nationality	:	Philippines
	License	:	103325 – Airline Transport Pilot License (ATPL)
	Valid up to	:	August 31, 2023
	Type rating	:	Airplane: Multi Engine Land-Dash 8 Q400.
	Medical Certificate Valid until	:	Valid until August 26, 2022
	Total Flying Time	:	5,000 Hours
	Total Flying Time On type	:	1,500 Hours
1.5.2	First Officer (FO)		
	Gender	:	Female
	Date of Birth	:	June 22, 1994
	Nationality	:	Philippines
	License	:	133839 -Commercial Pilot License (CPL)
	Valid up to	:	July 31, 2023
	Type rating	:	Airplane: Multi Engine Land-Dash 8
			Q400. SIC only on Dash 8 Q400.
	Medical Certificate Valid until	:	Valid until September 19, 2022
	Total Flying Time	:	1,000 Hours
	Total Flying Time On type	:	800 Hours

1.6 Aircraft Information

In 2016, the PAL Express started operating the Bombardier Dash (DHC) 8-Q400 aircraft. The Dash 8, is a series of turboprop-powered regional airliners, introduced by De Havilland Canada in 1984. Its cabin was configured in a two-class 86-seat configuration.

1.6.1 Aircraft Data

Registration Mark	:	RP-C5911
Manufacturer	:	Bombardier
Country of Manufacturer	:	Canada
Type/Model	:	DHC-8-402 (Q400)
Operator	:	PAL Express
Serial No.	:	4587
Date of Manufacture	:	October 2018
Certificate of Airworthiness	:	October 24, 2022
Certificate of Registration	:	October 24, 2024
Category	:	Transport
Number of Flight Crew	:	2
Number of Passenger	:	86
Airframe total time	:	1929+40 Hours since last C of A

Note : Following the occurrence, PAL Express initiated the following corrective actions on the aircraft for return to service (RTS) (Appendix A-C).

1.6.2 Engine Data

The Pratt & Whitney PW150 engine was first entered into service in 1995. It has a higherpower version of the PW100 series, with the low-pressure compressor changed from a singlestage centrifugal compressor to a three-stage axial compressor, and the turbine modified to have improved cooling. All PAL Express Bombardier Dash 8-Q400 aircraft is fitted with this type of engine.

Manufacturer	:	Pratt & Whitney
Type/Model	:	PW150A
Engine Serial Number (1)	:	PCE-FA1324
Engine Serial Number (2)	:	PCE-FA1325
Time Between Overhaul (1)	:	Modular Overhaul
Time Between Overhaul (2)	:	Modular Overhaul
Time Since Overhaul (1)	:	New
Time Since Overhaul (2)	:	New
Time Since New (1)	:	1,929+40 Hours
Time Since New (2)	:	1,929+40 Hours

1.6.3 Propeller Data

The aircraft is equipped with is an all composite blade propeller built by Dowty Propellers a GE Aviation company. The Bombardier Q400 Propeller is designated as the Dowty R408 propeller. The Bombardier Q400 Propeller has 6 blades with an advanced swept blade design. The design has optimized aerofoil sections, excellent climb and cruise performance in which has very low noise levels.

Manufacturer	:	Dowty Propellers
Type/Model	:	Composite/R408/6-123-F/17
Propeller Serial Number (1)	:	DAP1307
Propeller Serial Number (2)	:	DAP1306
Time Since Overhaul (1)	:	New
Time Since Overhaul (2)	:	New
Time Since New (1)	:	1,929 Hours
Time Since New (2)	:	1,929 Hours

1.7 Meteorological Information

Instrument Meteorological Conditions (IMC) prevailed at the time of the occurrence.

1.8 Aids to Navigation

The flight is being conducted through Instrument Flight Rules (IFR). Instrument Flight Rules (IFR) allows aircraft to be flown under Instrument Meteorological Conditions (IMC) by reference to aircraft flight instruments and advanced navigation systems.

1.9 Communications

The aircraft is equipped with operational Very High Frequency (VHF) transceiver used for communicating with aerodrome personnel and other aircrafts in the area.

1.10 Aerodrome Information

Mactan-Cebu International Airport (IATA: CEB, ICAO: RPVM), is located in Lapu-Lapu City ,Mactan. The airport is managed by the Mactan–Cebu International Airport Authority. The airport features two terminals. Terminal 1, built in 1990 serves as the Airport's Domestic Terminal. Terminal 2, constructed in 2018, serves as the Airport's International Terminal.

1.10.1 General Information

Aerodrome Name	:	Mactan-Cebu International Airport - RPVM
ARP coordinates and site at AD	:	101827N; 1235845.9830E
Aerodrome Operator address, telephone, telefax,	:	Mactan-Cebu International Airport Authority Mactan-Cebu, International Airport, Lapu-Lapu City 6016 +63 032 340-0226 Fax: +63 032 340-0228 SITA: NOPAPX
Types of traffic permitted	:	IFR-VFR CAT IX. Has Trauma Van, Ambulance, 3 Fire
AD category for fire fighting Rescue Equipment	:	Trucks, Individual Aluminized Protective Clothing, Fire Extinguishers, Self-Contained Breathing Apparatus, Power Saw, Stretchers, Fire Axe, Crow Bar, Bolt Cutter, 119 trained personnel.
Helicopter Landing Area Coordinates	:	Nil
ATS Communication Facilities	:	H24 TOWER 118.10Mhz GROUND CONTROL 121.80Mhz APPROACH CONTROL 1: 124.70Mhz APPROACH CONTROL 2: 121.20Mhz
Operational Frequencies	:	DOMESTIC RAMP: 123.25Mhz SUB-ACC CONTROL: 132.20Mhz ATIS: 126.60Mhz CLEARANCE DELIVERY: 125.10Mhz FSS RADIO: 5205Khz FOBS: 118.5Mhz
Airspace classification	:	A; ATZ-B; CTR-D; TMA and Sub TMA-D
Runway Direction	:	04/22
Runway Length	:	04/22 3310 Meters
Runway Width	:	04/22 45Meters
Surface	:	04/22 PCN 70 F/B/W/T CONC+ASPH

1.11 Flight Recorders

1.11.1 General

The recorders are placed under the custody of the Aircraft Accident Investigation and Inquiry Board (AAIIB), Civil Aviation Authority of the Philippines (CAAP), and were sent to the Japan Transport Safety Bureau (JTSB) laboratory in Tokyo, Japan, on December 22–28, 2021, for read-out and analysis. The AAIIB-CAAP requested assistance from the JTSB to download the aircraft's cockpit voice recorder (CVR) and flight data recorder (FDR) to assist in the investigation. Both recorders were successfully downloaded at the JTSB data recovery facility. This activity was performed by JTSB recorder specialists in conjunction with AAIIB investigators located in the Philippines. All data recovered from the recorders was provided to the AAIIB to assist with their Annex 13 investigation.

Note: A report detailing the results of the download of the recorders was provided to the AAIIB for reference.

1.11.2 Cockpit Voice Recorder (CVR)

The aircraft was equipped with a CVR-120A cockpit voice recording with part number 1606-00-01 with serial number 1648 and manufactured in 2018. It was manufactured by the Universal Navigation Company. The recording medium has a recording duration of approximately 2 hours and 02.45 minutes. The quality of the recording is considerably good. A transcript was prepared starting from the time the ATC gave Airphil 2369 clearance to land at runway 04 up to the time the recording ends, excerpts of which are as follows:

01.10.55.716	ATC:	2369 wind 030 16 knots 0 4 you got the runway in sight clear to land.
01.11.01.855	PIC:	runway in sight clear to land Airphil 2369.
01.11.05.976	FO:	clear to land; wiper sound heard on background.
01.12.16.783	FO:	it weathers all the way captain
01.12.20.885		one thousand Radio Altimeter (RA).
01.12.22.452	FO:	continuing.
01.13.17.846	FO:	five hundred stabilized.
01.13.63.136	PIC:	keep it straight and level.
01.14.08.879	PIC:	speed is good; 50 RA.
01.14.10.627		40 RA.
01.14.12.535		30 RA.
01.14.14.753		20 RA.
01.14.17.663		10 RA.
01.14.24.793		rattle sound Touch down.
01.14.24.850		sound of engine with throttle on reverse mode for about 3 seconds.
01.14.27.229	PIC	all right simple.
01.14.28.843	FO:	ok.
01.14.30.210	PIC:	I have control; FO: your controls now captain.
01.14.37.496	ATC:	369 vacate via Charlie: engine sounds lower.
01.14.37.496	PIC:	vacate via Charlie; FO: Charlie check.
01.14.55.735	PIC:	Uy.
01.14.56.700		Hi tone.
04.14.59.820		sound of engine hi rev for about 5 seconds.
01.15.02.808	PIC:	hay wag po; sound of captain heavy breath.
01.15.13.778	FO:	nose steering captain.
01.15.19.791	PIC:	deb nako; at this point the aircraft have exited the runway.
01.15.27.933	ATC:	2369.

01.15.31.271	FO:	stan-by sir we have a technical problem and um requesting for support Standby for the support.
01 16 38 962	ATC	roger standby
01 15 42 676	ATC.	Cebu 206 expect to execute a missed approach. Traffic aircraft ab
01.15.42.070	me.	disabled on the runway.
01.15.45.324		sound of engine reverse for 3 seconds.
01.15.46.917		tone.
01.15.57.617		no more wipers sound.
01.16.22.748		sound of switch click.
01.22.45.047		sound of switch click.
01.16.31.552	sound of	engine on beta mode.
01.16.62.461	FO:	request for towing sir Airphil 2369: ATC: standby for assistance.
01.16.06.906	FO:	a problem with the nose wheel steering captain. Would you like me to read the QRH.
01.16.37.609		sound of tone on background and the crew is reading
		the ORH but due to ATC radio the crew could not be heard.
01.16.49.005	PIC: c	cabin crew remain seated we have currently veered off the runway were
011101191000		iust awaiting waiting towing instructions thank you for bearing with us
01 16 59 438		crew still at ORH and still the recording is unintelligible due to ATC
01.10.39.130		radio instructions to other traffic
01 17 29 000		sound of loud aircraft engine reverse power for about 10 seconds
01 17 40 300		sound of loud aircraft engine reverse power for about 12 seconds
01 17 41 146	FO	it did not move cantain
01 17 58 809	10,	sound of engine power lowers
01 18 21 807	CABIN	Mam your PA is still active please turn it off: PA Chime
01 20 12 984	ATC	confirm ah slipperv runway mam
01 20 17 421	FO [.]	a firm sir Airnhil 2369
01 20 33 010	10.	sound of engine thrust reverse for about 15 seconds
01 21 18 078		engine sound lowers, switch click sound
01.21.37.842	PIC:	breaks: FO: check
01 21 40 974	1101	tone PA
01 22 11 457		PIC talking to management telling what happened on the occurrence
01.23.46.058	ATC:	be advised an VFR operation is suspended poor visibility and rain
0112011010000		shower over the field
01.24.45.882	PIC:	start APU shutdown checklist; flight crew doing engine shutdown checklist
		engine sound power fading
01.25.32.089		PIC talking to other management personnel about what happened
01.31.08.097	PIC:	everyone Mylene speaking from the flight deck we expect to deplane here
		and were just waiting shuttle busses please remain seated thank you
		for bearing with us
01.33.10.002	GC:	are you ok mam (Ground Crew)
01.54.43.102	CABIN:	ladies and gentlemen the shuttle bus has arrived please remain seated
		and wait for further instructions for deplaning thank you
01.59.31.458	PIC:	queen ready to disembark we have CAAP clearance to disembark
01.58.32.972	ATC:	2369 is now ready to disembarked passengers
01.58.55.812	PIC:	affirm and copy sir were cleared to disembarked per CAAP personnel
01.59.03.144	PIC	ground cockpit were advised by tower cleared to disembark
		according to CAAP
01.59.59.333	GC:	captain I will now open the door
02.00.51.805	CABIN:	ladies and gentlemen passenger deplaning is only done strictly
		one passenger at a time.
02.01.39.160		flight crew trying to find flight recorders CB and pull as instructed by management

1.11.3 Flight Data Recorder (FDR)

The FDR was an FDR-25 solid-state flash memory type data recorder with part number 1607-00-00 and serial number 1744, manufactured in 2018, with a recording duration of approximately 25 hours of flight data. A number of parameters recorded of key interest were available. Such parameters include brake pressure, aircraft heading, rudder positions, thrust lever angles, movements, and autopilot (1) and (2) switch positions.

1.12 Wreckage and Impact Information

During the landing roll, the aircraft swerved to the left side of the runway and came into contact with the unpaved ground. The nose landing gear steering was not responding to the pilot inputs. The aircraft came to a full stop at coordinates 10.309431 N and 123.980965 E, with a final heading of 22^{0} .



Figure 2: The aircraft was not damage from external factor.

1.13 Medical and Pathological Information

Both Pilots have undergone the post-accident medical examination at CAAP-OFSAM and there was no medical impediment that could hinder their fitness to fly.

1.14 Fire

There was no reported post-crash fire during on-site investigation.

1.15 Search and Survival Aspects

Since the occurrence happened at an aerodrome, aerodrome emergency responders were able to reach the site immediately. The occurrence was survivable.

1.16 Test and Research

1.16.1 Nose Wheel Steering

An aircraft nose wheel steering and steering control unit (SCU) test was conducted on December 11, 2021, and it was performed by the operator's AMO and witnessed by AAIIB investigators. The nose wheel steering and SCU inspection were conducted to determine any malfunction that might cause the occurrence.

1.17 Organizational and Management Information

1.17.1 Operator

PAL Express, legally known as Air Philippines Corporation and formerly branded as Air Philippines and AirPhil Express, is a wholly owned subsidiary airline of Philippine Airlines. It is PAL's regional brand, with services from its hubs in Manila, Clark, Cebu, and Davao. PAL Express currently is operating nine (9) Airbus A320-200, four (4) Airbus A321-200 and eleven (11) Bombardier DHC-8-400 Q400.

1.17.2 Maintenance

The maintenance function of RP-C5911 is being undertaken by Air Philippines Corporation Repair Station with AMO Organization Number: AMO-0005 with official address at PAL R1 Hangar, Andrews Avenue, Nichols, Pasay, Philippines.

2.0 ANALYSIS

2.1 General

On or about 1140H local time, December 10, 2021, a Bombardier DHC 8-402 (Q400) type of aircraft with Registry Number RP-C5911 experienced a runway excursion while on landing roll at RWY 04, Mactan-Cebu International Airport. The First Officer (FO) said that she was the pilot flying until touch-down, then the Pilot-in-Command (PIC) would take over the controls. While on landing roll, the aircraft annunciator panel, nose wheel steering indicator, illuminated, and the aircraft started to veer towards the left of the runway. The PIC tried to bring the aircraft back to the center of the runway. Unfortunately, the aircraft continued its path and went out to the grassy portion of the runway. The PIC lost directional control of the aircraft and settled at coordinates 10.309431 N and 123.980965 E with a final heading of 22^0 .

2.2 Flight Crew Preparation and Actions

During the approach, the flight was met by the passing rain until they had visual contact with the runway, and the duty controller cleared them to land. At 01.14.24.793 CVR time, the sound of the aircraft touchdown was heard, followed by the sound of the engine with the throttle in reverse mode for about 3 seconds at 14.24.850 CVR time. At 01.14.30.210 CVR time, the PIC said, "I have control," and a response from the FO was, "Your controls now, Captain.".

After the aircraft controls were turned over to the PIC in preparation to taxi out the aircraft from the active runway, the FO was heard saying "Nose Steering Captain" at 01.15.13.778 CVR time. In the course of the investigation by AAIIB investigators, the PIC said that she recycled the nose wheel steering switch in the hope that it might reset the system and work normally again as the aircraft started veering to the left. The PIC also said that the right pedal was used to return the aircraft to the runway center line. Based on the FDR data, the PIC applied the right rudder pedal and also stepped on the right-side brake pedal, but the aircraft still progressed on its path. FDR data also reflects the PIC's corrective control measures by means of differential wheel brake and right rudder inputs to create a differential force to turn the aircraft to the right.

The aircraft continue to veer to the grassy area of the runway between Taxiway Echo "E" and Taxiway Golf "G" (Figure 9). At 01.17.29.000, the sound of a loud aircraft engine reversing power for about 10 seconds was heard. Another sound of loud aircraft engines reversing power for about 12 seconds was again heard at 01.17.40.300 CVR time. The sound heard suggests that the PIC was trying to dislodge the aircraft after being stuck on the soft ground by applying reverse power a couple of times. At 01.17.41.146 CVR time, the FO said, "It did not move, Captain." At 01.17.58.809, the sound of engine power decreasing followed this. At 01.20.33.010 CVR time, the sound of engine thrust reverse for about 15 seconds was again heard. At 01.24.45.882 CVR time, the PIC said, "Start the APU shutdown checklist; the flight crew is doing the engine shutdown checklist.

Contributing to this is the fact that the relevant descriptions in the company's manuals were unclear and that appropriate training was not given by the company to the PIC, specifically on nose steering failure during landing roll. Witnesses stated that the aircraft went out to the left side of the runway, like it was a normal situation during landing.

2.3 Aircraft Steering System

Outline of the aircraft steering system according to the company's aircraft operations manual. The principal components of the steering system of the aircraft include a Steering Control Unit (SCU), a steering motor, steering actuators, a steering switch, a pilot hand control column (Figure 3), and rudder pedals. The movement of the Pilot Handle Control (PHC) or rudder pedals is converted into an electric signal, which is sent via SCU to the steering motor, then by moving the steering actuators proportionally. There is no mechanical linkage between the handle or rudder pedals and the steering actuators. The steering actuators operate on pressure from the No. 2 hydraulic system. With the steering switch "ON" and nose wheels on the ground, the nose wheels can be steered up to eight degrees left and right using rudder pedals. During high-speed taxiing, takeoff roll, or landing roll, it can be steered up to 70 degrees left and right using the steering handle. With the steering switch "OFF," the nose wheels are in caster mode, in which they can be steered up to 120 degrees left and right. "CASTER MODE" is one of the SCU's modes. When the SCU is in this

mode, the nose wheels can be steered neither by rudder pedals nor by the steering handle, but their direction changes freely up to 120 degrees left and right and according to the side force acting on the tires.



Figure 3: The aircraft pilot handle control.

In any of the following cases, where the nose wheels are in caster mode, the steering light and master caution light illuminate, and an audible warning (single chime) is activated.

- 1. With the steering switch in the "STEERING" position, when hydraulic pressure to steering motor drops.
- 2. With the steering switch in the "OFF" position, when hydraulic pressure is applied to steering motor.
- 3. When nose wheels are steered left or right beyond 70 degrees.
- 4. When SCU fails.
- 5. When SCU senses failure in any of the steering system components.
- 6. When PHC is turned in excess of 8 degrees left or right with the nose gear shock strut not sufficiently compressed (i.e. nose gear's weight-on-wheel sensors (WOW) detecting an "in-air" condition). "WOW sensors" are installed on the nose gear and on the left and right main gears. Each WOW sensor senses compression of the shock strut resulting from the aircraft's weight placed on the gear when the aircraft is on the ground. The sensors thus detect whether the aircraft is on the ground or in the air.
- 7. When handle is turned in excess of 8 degrees left or right within one second of compression of the nose gear shock strut (i.e. WOW sensors detecting an 'on-ground' condition). The SCU has a built-in test equipment (BITE), which registers a fault code when the steering system fails, to facilitate troubleshooting.
- **8.** A summary of the aircraft steering system section from the manufacturer's manual are as follows:

During takeoff, when the nose gear WOW sensor signal changes from "on-ground" to "inair", the SCU ignores all signals from the handle and rudder pedals and sends a neutral command to the servo valve to cause the nose wheels to be hydraulically centered. Five seconds later, the hydraulic pressure is cut and the nose wheels enter caster mode. During landing, when the nose gear WOW sensor signal changes from "in-air" to "on-ground", the hydraulic steering using rudder pedals or the PHC starts with a one-second delay.



Figure 4: The aircraft nose wheel steering schematic.

2.4 Aircraft Steering System Check Conducted after Occurrence

A BITE check was conducted after the event by the operator, AMO, and witnessed by the AAIIB investigators. During the Steering System Check on the nose steering light, it was set to be illuminating at the aircraft annunciator panel. The inspection was conducted to determine whether the aircraft's steering function was normal. In order to simulate the conditions during aircraft landing, the aircraft was connected to an external electric power supply, and the No. 2 hydraulic system was pressurized by the hydraulic source. The operation of the rudder pedals and PHC was conducted according to the aircraft maintenance manual, and no abnormality in the steering function was found.

Simulation was also conducted for the steering function using PHC in the aircraft. The Electro-Hydraulic Servo Valve Coil (EHVS) and Pilot Hand Control (PHC) appear on the SCU. This related abnormality or operation of the PHC with the aircraft "in-air" condition codes was found. The EHVS code is automatically registered every time the SCU power is turned "on" and does not always mean detection of a fault. As a result of the BITE check, the EHVS and PHC fault codes were recorded. The steering system function was confirmed to be normal.

2.4.1 No other abnormalities were detected by the SCU. The functional check forms part of the company "Work package C5911-131221 AOG WORKPACKAGE for RP-C5911, the 13Dec.2021 (00:01) in CEB"



Figure 5: The SCU BITE check.



Figure 6: Nose steering check.

2.5 Weather Conditions during Approach and Landing

According to the weather information provided by Mactan Tower during the time of occurrence, there was wind at 0600, visibility of 4 kilometers, cloud conditions scattered at 2,000 feet, AGL overcast at 9000 feet, a field temperature of 27 degrees Celsius, a dew point of 23 degrees Celsius, altimeter settings of 1008 millibars, and runway 04 is in use.

2.6 Aircraft Indication and Warning

The annunciator panel, also known as the Centralized Warning Panel (CWP) or Caution Advisory Panel (CAP), is a group of lights used as a central indicator of the status of equipment, systems, or sub-systems in an aircraft. The lights are usually accompanied by a test switch, which, when pressed, illuminates all the lights to confirm they are in working order. A test switch is also available to check for burned-out lamps. More advanced modern aircraft replace these with the

integrated electronic Engine Indicating and Crew Alerting System (EICAS) or Electronic Centralized Aircraft Monitor (ECAM) (Figure 7).



Figure 7: The aircraft annunciator panel.



Figure 8: The nose steering light.

The aircraft warning systems are intended to provide the flight crew with adequate warning and caution. In this occurrence, the aircraft swerved to the left, and the crew noticed "nose steering" at the indicated warning light (Figure 8).

2.7 Crew Resource Management (CRM) Training

CRM training is a mandatory requirement for air operators under the Philippine Civil Aviation Regulations (PCARs). Commercial operations often involve the use of a two-person flight crew. PAL Express operates the Bombardier DHC 8-402 (Q400) using a two-crew concept. Effective CRM is essential to ensuring a safe flight operation. Other than the CRM training the crew members received during their aircraft type training, neither pilot had taken any recent formal CRM courses.

The flight crew did discuss appropriate procedures for conducting the approach, such as runway in-use and atmospheric conditions, either prior to or during the approach. The flight crew discusses aircraft limitations, the exchange of controls after touch-down, call-outs, or the possible visual signs from the annunciators and audio indications. The flight crew has current CRM training given by the company. Overall, the flight crew did employ effective CRM during the approach but was unwary in the final moments of the flight.



Figure 9: Position were the aircraft stopped.

2.8 Loss of Steering Function by PIC's Handle Operation

There are cases of the manufacturer in which the nose wheel steering function becomes inoperative and the steering light illuminates. The nose wheel steering reverts to caster mode. As previously mentioned, there was a change of control from the FO to the PIC during the landing roll. At the time the malfunction was experienced, the PIC did not immediately apply wheel brakes. The PIC recycled the nose wheel steering switch from "on" to "off." The PIC also noticed that the steering column was not responsive. The PIC's application of right rudders and differential braking to not respond was recorded by the FDR. This event is somewhat like the occurrence of another Bombardier DHC-8-402, that happened at Kochi airport, Japan on November 21, 2004.

The PIC tried to dislodge the aircraft after being stuck on the soft ground by applying reverse power a couple of times, but to no avail. The nose wheel steering warning indication did extinguish, but the aircraft was already stuck in the ground, and so the PIC called her supervisors, and she elected to shut down the engines and deplane in their current position with the coordination of Mactan Tower and MCIAA.

3.0 CONCLUSIONS

3.1 Findings

3.1.1 Pilots

- **a.** The crew possess valid airmen licenses and medical certificates issued by Licensing and Certification Department and the Office of Flight Surgeon and Aviation Medicine (OFSAM), CAAP respectively.
- b. The crew are included on PAL Express list of pilots
- **c.** The aircraft is listed in the PAL Express operation specification.

3.1.2 Flight Operations

- **a.** The flight was carried out under PCAR Part 9, Air Operator Certification and Administration 2014 and the maintenance of which is under PCAR Part 6 Approved Maintenance Organization (AMO).
- **b.** The aircraft nose wheel steering indicator illuminated as stated by the flight crew on the day of the occurrence and was verified by the maintenance crew for a fault code was recorded on the SCU.

3.2 Probable Cause

3.2.1 Primary Cause Factor

The aircraft encountered a nose wheel steering fault that led to runway excursion.

3.2.2 Contributory Cause Factors:

- **a.** The runway condition was wet at the time of the occurrence.
- **b.** The flight crew became distracted in maintaining situational awareness when the nose wheel steering indicator illuminated at the annunciator panel.

4.0 SAFETY RECOMMENDATIONS

4.1 The safety deficiencies detailed in this report have been fully addressed as a result of the safety measures implemented by the Operator. Consequently, no further safety recommendations are being proposed.

5.0 SAFETY ACTIONS

5.1 After the occurrence, PAL Express have the PIC and FO undergone and completed the required corrective training and proficiency checks with the following scheduled respectively (Appendix D).

PIC

- a. Simulator type recurrent with corrective training at flight safety international (Seattle) Jan 28, 2022.
- b. Simulator proficiency check at flight safety international (Seattle) Jan 29, 2022.
- c. line proficiency check Feb 4, 2022 (MNL-ILO-MNL & MNL- CEB-MNL).

FO

- a. Simulator type recurrent with corrective training at flight safety international (Seattle) Mar 14, 2022.
- b. Simulator proficiency check at flight safety international (Seattle) Mar 15, 2022
- c. line proficiency check Feb 4, 2022 (MNL-KLO-MNL & MNL- LGP-MNL).

-----END-----

Good morning sir, here are the action taken by PALEX's AMED in connection with our incident last 10 Dec 2021. Prior to RTS PAO 32-430 1. PERFORM FIM TASK 32.51-01-8,10.818. AIRCRAFT PULLING TO THE LEFT OR RIGHT DURING TAXI - FAULT ISOLATION - FUNCTIONAL TEST OF THE NWS SYSTEM (REFER TO AMM TASK 32-51 -00-720-801 - DO A CHECK OF THE RUODER PEDAL POTENTIOMETER RIGGING (REFER TO AMM TASK 32-51 - 1 1 -830-801 2.ON THE SCU, DO THE NWS BITE INDICATION RETRIEVAL (REFER TO AMM TASK 32-51-01-742-401). 3. PERFORI, I FII TASK 32-51 -00-810-801 - STEERING CONTROL UNIT (SCU) SHOWS EHVS - ALL FOUND SATISFACTORY After aircraft RTS PAO 32-431 1. Retrieval of Proximity Sensor Slectronic Unit (PSEU) per AMM task 32-61-00-742-801 for NLG and MLG -Proximity sensor faults related to weight on whlees and weigh off wheels - NO PRESENT FAULTS found - down, lock or downlock sensor faults - NO PRESENT FAULTS found - proximity sensor faults (near/far)- NO PRESENT FAULTS found 2. Measurement of the cylinder and WOW gap clearance - passed/within limits AED RECOMMENDATION: Monitoring of possible recurrence for the entire PALExpress Q400 fleet Have a great and safe day sir!

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Appendix A

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Appendix B

N	PAL	expres	s	Workpackage-Sum	mary	2		102727 08:29	14.Dec.202 Page 1 / 1
	0:01) in (IGE	C5911-131221 AOG WORKPACKA B 7. Manufacture-Date: 17. Oct.2018, Delivery-Date: 25. Oct.2018 PACKAGE	GE 1	for RP-	C5911, the <mark>1</mark> 3	3.Dec.	2021 IIII
No.	Type	WIO	ATA	Description	Est.MH	PickaRp	Ca	mments	
1	SHT		-00	Q400 36 ELAPSED HOURS CHECK (17) / Q400 38 ELAPSED HOURS CHECK		Not issued	1900 H - 1100H	gov	
2	381		42-01	[2400-32-900-892-A01 (00) / FC OF THE NOSE AND MAIN LANDING GEAR TIRE [PRESSURE		Not issued	1000H - 1000H	di	
3	Dec.	1614854	12	PEO GEN-12-003-1-01/W1014854 (DAILY - CABIN CLEANING PROGRAM		Not issued	L 1030 H - 1100H	the	
	WD	1616636	32	M-7082AP ISTEERING GAUTION LIGHT ILLUMINATED, UPON LANDING ROLL			· 0200# - 0230#	ch	
5	wo	1615805	06-50	PAD-MC-12-001-5911 REASON FOR ISSUANCE			102300 - 05450	cha	
6	wo	1615627	31	M-7084AP REMOVED COCKPIT VOICE RECORDER (CVR) AS REQUESTED OF CAAP INSPECTOR		Not issued	02344 - 0245H g	In .	
7	WC.	1515638	31	W-7083AP REMOVED FLIGHT DATA RECORDER (FDR) AS REQUESTED OF CAAP INSPECTOR		Not maked	1.02454 - 03004 CA	L	
9	wo	1617022	-92	PAD-32.430 REQUESTED ACTION:			- 0300H - 08404 g/m	/	
10	wo	1617728	05	PAG-05-005 THIS FAD IS ISSUED TO COVER THE NARROWED TASKS FOR HARD LANDING			1.0300H - 08VSH 4	h	

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Appendix C

R-1 Hangar, APC Gate 1		
Andrews Avenue, Nichols Pasay City 1300 Philippines Tel. : +63(2) 851-7601		
Reservations: +63(2) 855-9000		
Ref. No.: FOD-VP-RTA-2022	-099	
20 June 2022		
COL. ROMMEL RONDA Aircraft Accident Investig	ator	
Pasav City	it investigatio	on Board
	SUBJECT:	CORRECTIVE TRAINING COMPLETION
Dear Col. Ronda:		
This is to inform your offic December 10, 2021 have	ess: ce that the foll completed ar	lowing pilots involved in Mactan Runway Excursion incident last nd passed the required corrective training and proficiency checks.
Captain Maylene C. Tan	naray	
Simulator Type Recurren Venue: FlightSafety Inter	t with correctinational - Sea	ve training - Jan 28, 2022 Ittle
Simulator Proficiency Ch Venue: FlightSafety Inter	eck - Jan 29, 3 national - Sea	2022 attle
Line Proficiency Check -	Feb 4, 2022 (MNL-ILO-MNL & MNL-CEB-MNL)
First Officer Ma, Debora	ah Anne I. He	rnaez
Simulator Type Recurren Venue: FlightSafety Inter	t with corretive national - Sea	e training - Mar 14, 2022 ttle
Simulator Proficiency Ch Venue: FlightSafety Inter	eck - March 1 national - Sea	5, 2022 ttle
Line Proficiency Check -	Mar 21, 2022	(MNL-KLO-MNL & MNL-LGP-MNL)
Simulator Corrective Tr	aining Descr	ription
 Apply nose steering fa use of asymmetric brakin 	lure during ta g and power t	keoff or landing roll at low speed (below 60 knots). Emphasize the to maintain directional control.
Proper adjustment of p pedals while either side of	ilot seats and f the rudder is	i rudder pedals to ensure full application of both brakes on rudder s in full deflection.
		PAL express
Please be informed as	well that the	e above Simulator Corrective Training was already included in the

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Appendix D