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COMISIÓN DE
INVESTIGACIÓN
DE ACCIDENTES
E INCIDENTES DE
AVIACIÓN CIVIL

Report
EXT Punta Cana 2009

Accident involving an Airbus 330-343 aircraft, registration EC-JHP, in Punta Cana International Airport (República Dominicana), operated by Iberworld (Orbest), on 18 January 2009

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Foreword

This report is a technical document that reflects the point of view of the Civil Aviation Accident and Incident Investigation Commission (CIAIAC) regarding the circumstances of the accident object of the investigation, and its probable causes and consequences.

In accordance with the provisions in Article 5.4.1 of Annex 13 of the International Civil Aviation Convention; and with articles 5.5 of Regulation (UE) n° 996/2010, of the European Parliament and the Council, of 20 October 2010; Article 15 of Law 21/2003 on Air Safety and articles 1, 4 and 21.2 of Regulation 389/1998, this investigation is exclusively of a technical nature, and its objective is the prevention of future civil aviation accidents and incidents by issuing, if necessary, safety recommendations to prevent from their reoccurrence. The investigation is not pointed to establish blame or liability whatsoever, and it's not prejudging the possible decision taken by the judicial authorities. Therefore, and according to above norms and regulations, the investigation was carried out using procedures not necessarily subject to the guarantees and rights usually used for the evidences in a judicial process.

Consequently, any use of this report for purposes other than that of preventing future accidents may lead to erroneous conclusions or interpretations.

This report was originally issued in Spanish. This English translation is provided for information purposes only.

Table of contents

Abbreviations

00°	Sexagesimal degrees
A/THR	Auto-Throttle
ADC	Air Data Computer
AFM	Aircraft Flight Manual
AIP	Aeronautical Information Publication
AOG	Aircraft On Ground
AP1	Autopilot 1
ATC	Air Traffic Control
ATPL(A)	Airline Transport Pilot Licence
CAS	Calibrated Air Speed
cm	Centimeter(s)
CRM	Crew Resource Management
CSN	Cycles Since New
CVR	Cockpic Voice Recorder
DFDR	Digital Flight Data Recorder
DGAC	Dirección General de Aviación Civil (Spanish Civil Aviation General Directorate)
DME	Distance Measuring Equipment
FCOM	Flight Crew Operation Manual
FD	Flight Director
ft	Feet
ft/min	Feet per minute
ft/s	Feet per second
GPWS	Ground Proximity Warning System
g's	g-force
h	Hour(s)
HDG	Heading Mode
ICAO	International Civil Aviation Organization
IDAC	Instituto Dominicano de Aviación Civil
IF	Intermediate approach Fix
IMC	Instrument Meteorological Conditions
kg	Kilogram(s)
km	Kilometer(s)
kt	Knot(s)
LT	Local Time
m	Meter(s)
MAC	Mean Aerodynamic Chord
MAPt	Missed approach point
Mb	Milibar(s)
METAR	Meteorological Terminal Aerodrome Routine weather report
min	Minute(s)
MLG LH	Main Landing Gear Left
MLG RH	Main Landing Gear Righ
MLW	Maximum Landing Weight
NLG	Nose Landing Gear
NM	Nautical Mile(s)
NOTAM	Notice to Airmen
P/N	Part Number
PAPI	Precision Approach Path Indicator
PUJ	IATA code for Punta Cana airport
RA	Radio Altimeter
RNAV	Area navigation
s	Second(s)
S/N	Serial Number
SPD	Speed Mode

Abbreviations

STKPF	Sidestick
TSN	Time Since New
UTC	Coordinated Universal Time
V/S	Longitudinal Mode
VHF	Very High Frequency
VLS	Variable Low Speed in approach
VMC	Visual Meteorological Conditions
VOR	VHF Omnidirectional Radio Range

Synopsis

Owner and operator:	Iberworld[1]
Aircraft:	Airbus 330-343
Date and time of accident:	18 January 2009; 02:48[2] UTC
Site of accident:	International Airport (República Dominicana)
Persons onboard and injuries:	12 crew + 380 pax
Type of flight:	Commercial Air Transport – Scheduled revenue ops – International – Passenger
Date of approval:	19th September 2012

Summary of accident

On 17 January 2009, an Airbus A330-343 aircraft, registration EC-JHP, took off from the Charles de Gaulle Airport (France) at 16:24 en route to the Punta Cana Airport (Dominican Republic), where it landed at 02:48 the next day. The XL Airways France flight, XLF020, was operated by Iberworld and there were 2 flight crew, 10 cabin crew and 380 passengers onboard.

The adverse weather conditions and traffic upon the flight's arrival at the Santo Domingo control area delayed the landing for approximately 40 minutes.

The investigation has determined that the probable cause of the hard landing and subsequent runway departure was the crew's execution of actions intended to correct the aircraft's flight path so as to align it with the runway while at a very low altitude, along with the insufficient decrease in the descent rate during the flare maneuver due to the crew's desire to perform a firm landing.

As a result of the investigation, two (2) Safety Recommendations have been issued to the operator, and one (1) to the Instituto Dominicano de Aviación Civil (IDAC).

[1] Now Orbest.
[2] All times in this report are in UTC unless specified otherwise.

1. FACTUAL INFORMATION

1.1. History of the flight

On 17 January 2009, an Airbus A330-343 aircraft, registration EC-JHP, took off from the Charles de Gaulle Airport (France) at 16:24 en route to the Punta Cana Airport (Dominican Republic), where it landed at 02:48 the next day. The XL Airways France flight, XLF020, was operated by Iberworld and there were 2 flight crew, 10 cabin crew and 380 passengers onboard.

The adverse weather conditions and traffic upon the flight's arrival at the Santo Domingo control area delayed the landing for approximately 40 min.

According to the flight plan, the alternate airports were La Romana and Santo Domingo, located 33 NM and 81 NM away from the Punta Cana Airport, respectively.

Once cleared to land on runway 09 at the airport and immediately after touching down, the aircraft veered toward the left edge of the runway until it eventually entered to the strip. It was able to return to the runway after 650 m out of it and continue to the terminal.

No one was injured and the damage to the aircraft was limited to the area of the landing gear and the underside of the fuselage.

1.1.1. *Cruise and approach*

After a normal flight, the aircraft reached the Santo Domingo airspace and entered the Punta Cana Airport control zone at around 02:00 on 18 January (22:00 LT[3] on 17 January). There was adverse weather in the vicinity of the airport with storm cells, turbulence and heavy rain. The cloud ceiling was at about 1,000 ft and the visibility was between 4 and 6 km as a result of the rain and darkness.

As it neared Punta Cana, the aircraft was routed by Air Traffic Control (ATC) to intermediate approach fix (IF) POKEM, to the west of the field on the 272° radial at a DME[4] distance of 12 NM from the PNA VOR[5], where it entered a holding pattern above POKEM at an altitude of 4,000 ft.

Flight XLF020 was number two in the landing sequence behind a Boeing 737 that minutes earlier had done a go-around at the same airport. In addition, two more aircraft were also joining the holding pattern at different altitudes.

The weather improved some 35 min later and the Boeing 737 was cleared to land, which it did normally. Flight XLF020 was then cleared to descend from its flight level in

[3] LT: Local time.
[4] DME: Distance Measuring Equipment.
[5] VOR: Very high frequency omnidirectional range.

the holding pattern to initiate a direct non-precision VOR-DME approach to runway 09 at Punta Cana.

During the approach there were several active and fast moving storm cells in the vicinity of the airfield. The crew established visual contact with the field shortly before reaching the missed approach point (MAPt). The captain, who was the pilot flying, decided to continue the landing using visual references.

At the start of the approach ATC reported that the wind was from 050° at 5 kt. The aircraft's approach speed was 135 kt and it was configured for landing with full flaps at four miles from the runway threshold. There were no windshear or GPWS (Ground Proximity Warning System) warnings, though they did experience turbulence and oscillations.

During the approach it continued to rain heavily. The wind was from the left and decreasing in intensity as the airplane descended in altitude. There was moderate turbulence.

The aircraft's estimated weight was 168,000 kg, versus the maximum landing weight (MLW) of 187,000 kg. Its center of gravity was at 25.6% MAC[6].

Initially the autothrust (A/THR) was engaged in speed (SPD) mode. Autopilot 1 (AP1) was engaged in longitudinal mode (V/S) and lateral mode (HDG). Both flight directors (FD) were engaged.

On descending through 625 ft RA[7], the autopilot was disengaged and the flight was continued in manual.

The pilot flying decided to execute a firm landing to avoid hydroplaning, since he considered that there was standing water on the runway, though this last factor was not checked with the control service[8].

1.1.2. *Final approach and landing*

When the crew acquired the runway visually, shortly before the airport minimums[9], the control tower reported the wind was from 040° at 8 kt.

The captain noted after the incident that in those environmental conditions, he felt like they were flying into a "black-hole" after passing the PAPI[10] lights.

The windshield wipers were running on high. The captain ruled out employing the rain repellent due to the cost and maintenance associated with its use, as he stated later.

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[6] MAC: Mean Aerodynamic Chord.
[7] RA: Radio Altimeter.
[8] On the date of the event the airport had no available information about the water level conditions on the runway (point 2.9.4. of Annex 14 ICAO).
[9] For the non-precision approach maneuver, the radio altitude specified in the Dominican Republic's AIP for the Punta Cana Airport at the missed approach point (MAPt) is 680 ft (633 ft RA).
[10] PAPI: Precision approach path indicator.

A few seconds before the landing, the aircraft was offset to the right of the runway centerline, as calculated by integrating the acceleration and coordinate data recorded on the digital flight data recorder (DFDR). The direct data from the DFDR showed that control inputs were made to lower the left wing slightly, resulting in a trajectory some three degrees to the left of the runway heading until the aircraft was centered above the runway. The left bank input resulted in an 18° extension in the left-side spoilers just before touchdown, which occurred as a result of a loss of lift from that wing.

The aircraft flared up smoothly to a pitch angle of 4°, after which the angle was reduced to 2°. The copilot, according to his statement, was looking outside on short final and noticed that he saw three white lights out of the four on the PAPI system, and warned that they were high in the landing path. The descent rate, which had been 18 ft/s some ten seconds before the landing, was 14 ft/s when the airplane initially contacted the runway.

The initial contact within the runway took place at the aiming point, to the left and just after passing over the PAPI lights. The airplane first touched the ground abruptly with the left leg, reaching a vertical acceleration of 2.109 g's and a lateral acceleration of 1.113 g's.

The DFDR data confirmed the severity of the hard landing experienced during the incident, classified as being in the AOG Zone, in keeping with the criteria of the diagram in Figure 1, which is taken from the airplane's Maintenance Manual, with a delta value for vertical acceleration of 1.11 g's and a descent rate of 14.7 ft/s.

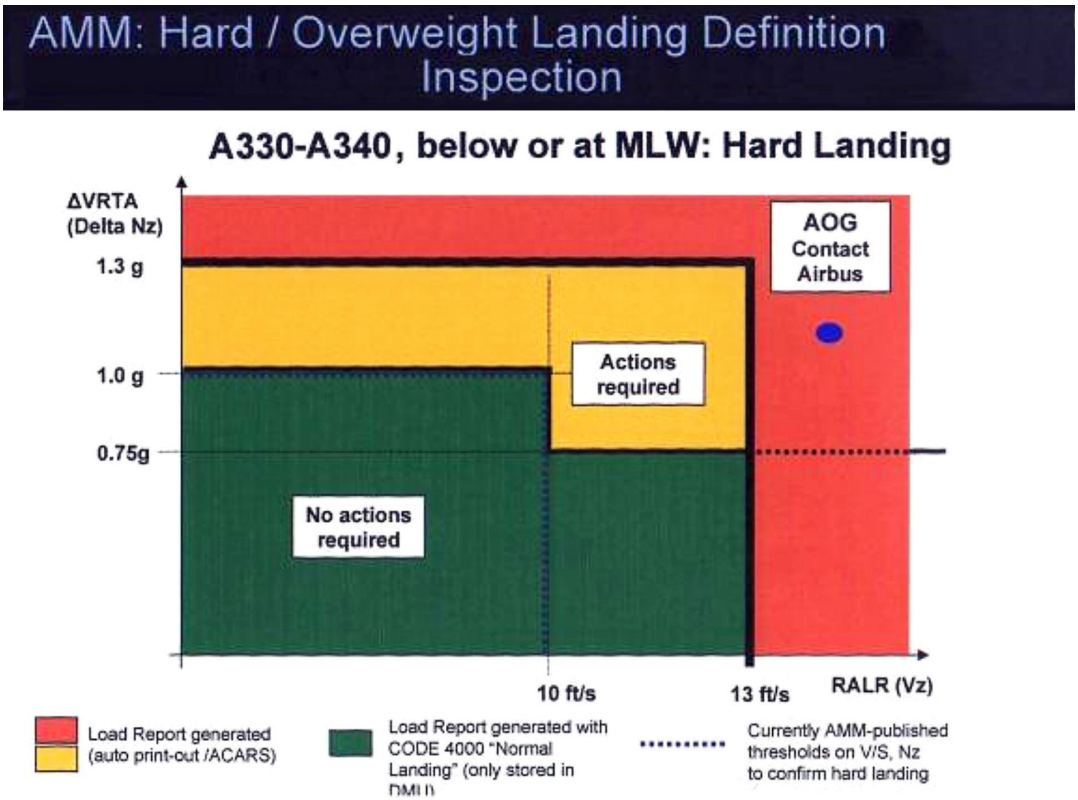

Figure 1. Landing zones

The aircraft's heading at the instant of the initial contact was two degrees right of the runway heading, and the airplane was banked 6° left. The aircraft continued moving left after the initial contact.

As it traveled over the ground, the aircraft skidded left and exited about 20 m beyond the paved surface as it continued to slide. Four seconds after touching down, the DFDR recorded lateral accelerations of 0.566 g's as the ground spoilers deflected fully. At that time a control input of 13° right was given to the rudder that returned the aircraft to the center of the runway.

The tracks left by the airplane on the landing run allowed investigators to accurately reproduce its path as it departed the runway to the left, see Figure 2. The ground was fairly compact and able to absorb the load from the tires without having them sink. The tracks reached a depth of 15 cm. The total length of the runway excursion was about 650 m (figure 2) (figure 3).

Figure 2. Tracks of left main landing gear

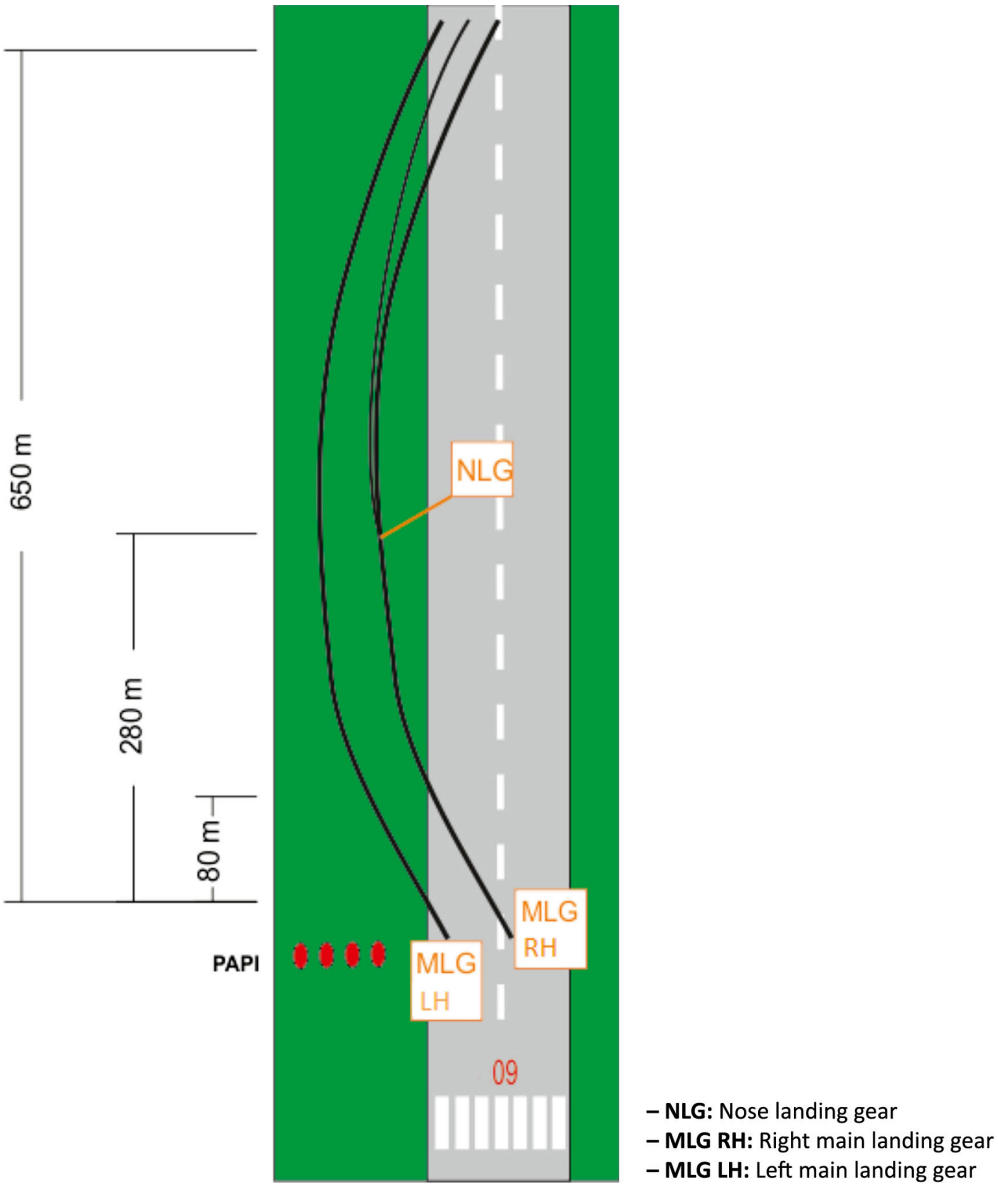

Figure 3. Runway excursion

1.1.3. *End of landing run and deplaning*

The maximum longitudinal deceleration values were reached between 14 and 19 seconds after the initial contact as the airplane returned to the runway after the initial excursion and the hydraulic pressure increased in response to an input to the brake pedals. The maximum longitudinal deceleration value was 0.211 g's. Reverse engine thrust was not used.

At the end of the 2,500-m landing run, the airplane left runway 09 via the taxiway and proceeded to parking under its own power.

When the airplane stopped, the crew did a final check of the instruments. The engine parameters were normal and the only abnormal indication was a loss of pressure in one tire, which was associated with the landing and the bumps encountered during the excursion.

The deplaning was delayed by the rain and by the lack of available airside busses.

1.2. Damage to aircraft

There was no damage to the primary structure of the airplane.

The nose gear (NLG) and the right main landing gear (MLG RH) were intact, though tire #6 on the left main landing gear (MLG LH) blew out (figure 4).

The main struts had no apparent damage but were replaced as a precaution and inspected for overloading.

There was some minor damage, such as:

- Scratches to the main gear framework
- Damage to the hydraulic lines on brakes #2 and #4 (the latter of which was leaking)
- Hydraulic leak on a connection to the line on brake #1
- Scratches and punctures to some panels, fairings, gear doors and composite material coatings

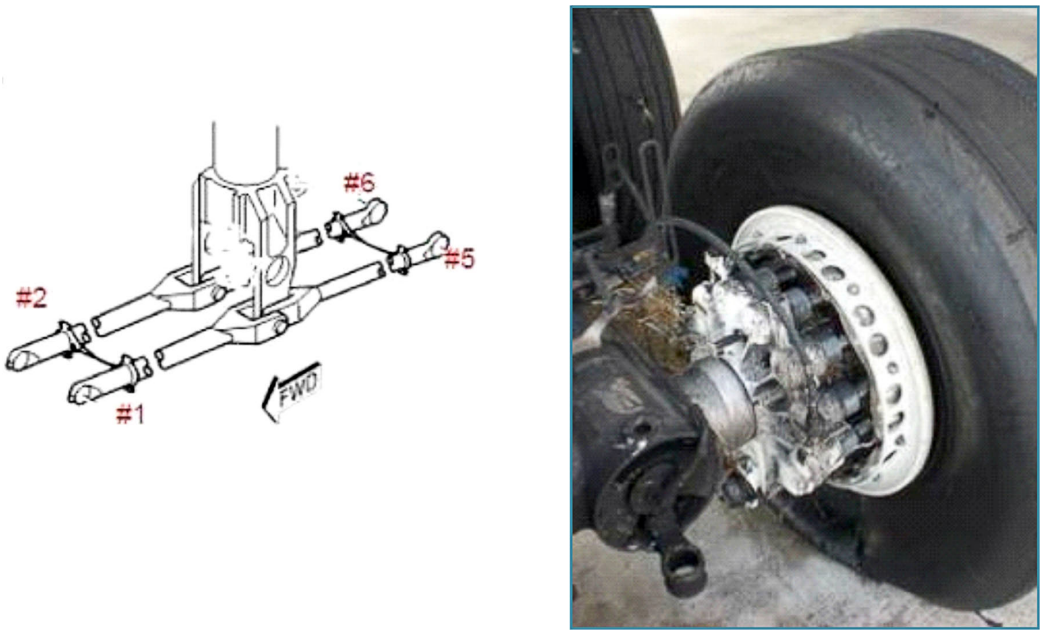

Figure 4. Close-up of MLG LH. Condition of tire

- Scratches and punctures on other metal coatings on the fuselage, spoiler panels and the skin of the left wing

All of the damage found resulted from scratches and impacts with material that was lifted from the ground or with debris from the blown tire and the runway lights and signs that were run over by the airplane.

1.3. Other damage

Found on the runway were pieces of two broken lights, metallic debris from a frangible sign struck by the airplane, bits of metal coating from airplane components and doors and gravel dragged by the tires during the runway excursion.

The flight crew did not report the event to the tower; instead, it was the next airplane that noticed the runway contamination and notified the tower. The airport was then shut down to check and clean the runway, a task that lasted approximately 2:15 h.

1.4. Personnel information

1.4.1. *Pilot in command (CM-1), seated in the LH seat*

Sex, age:	Male, 46
Nationality:	Spanish
Valid Airline Transport Pilot License (ATPL) and medical certificate.	
Type rating:	For the A330 and A320
Total flight hours:	17,569 h
Flight hours on the type:	1,630 h
Flight time[11] in the last 24 h:	10 h 28 min
Hours in the last 30 days:	65 h
Hours in the last 90 days:	191 h
Start of on-duty period[12]:	14:25 on 17/01/2009
Previous rest period:	28 h 24 min

[11] In accordance with Spain's DGAC Operating Circular 16B, of 16 July 1995, flight time is defined as the time elapsed from the time an aircraft starts to move from its parking stand for the purpose of taking off until it stops at the stand or stops its engines.

[12] Operating Circular 16B defines duty time as the time needed to prepare, conduct and complete a flight or series of flights. Duty time starts when the crewmember reports to the airport after a rest period and ends when the flight time is over.

Training:

- Crew resource management course during the periodic training of September 2008.
- Last competency check and low-visibility training in November 2008.

The pilot in command had 10 years of experience at the airline. He had been flying the A330 for three years and three months and alternated his flying time seasonally with the A320. He had flown into Punta Cana before.

1.4.2. *Copilot (CM-2), seated in the RH seat*

Sex, age:	Male, 32
Nationality:	Spanish
Valid Airline Transport Pilot License (ATPL) and medical certificate.	
Type rating:	For the A330 and A320
Total flight hours:	3,414 h
Flight hours on the type:	1,616 h
Flight time in the last 24 h:	10 h and 28 min
Hours in the last 30 days:	53 h
Hours in the last 90 days:	155 h
Start of on-duty period:	14:25 on 17/01/2009
Previous rest period:	28 h 24 min

Training:

- Crew resource management (CRM) conversion course due to change in airplane type in April 2008.
- Last competency check and low-visibility training in December 2008.

1.5. Aircraft information

The A330-343 is a twin-engine, medium-to-long range wide body passenger airplane. The dimensions of this model are shown in Figure 5:

The distance from the nose to the main landing gear is 28.85 m, and the two main legs are separated by a distance of 10.68 m.

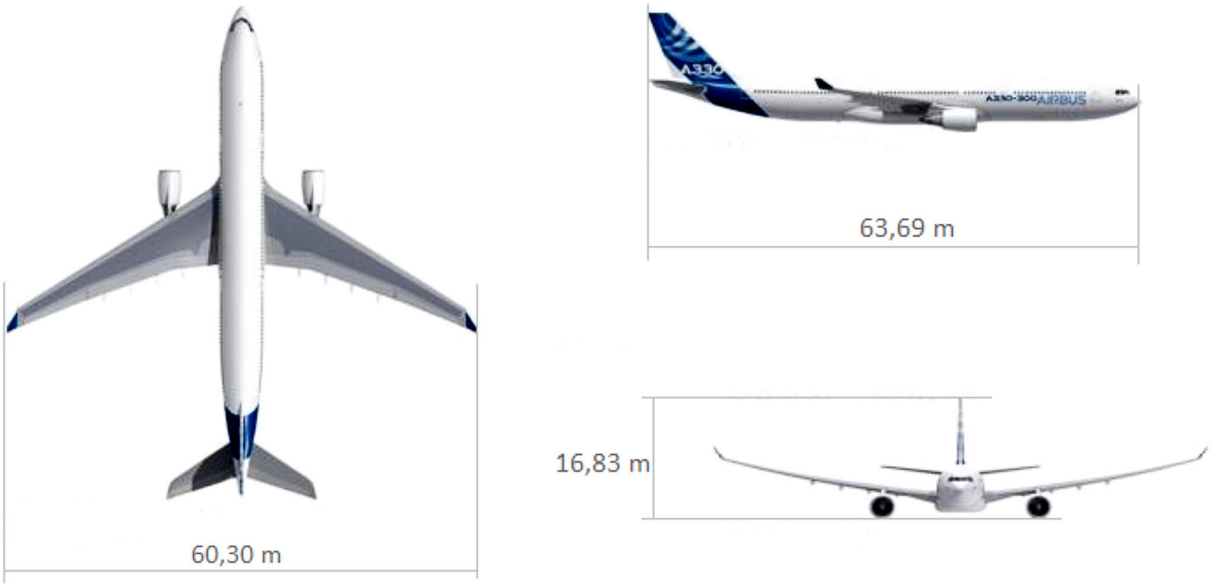

Figure 5. Views of the aircraft

Aircraft EC-JHP was manufactured in 2005 with serial number 670. At the time of the incident it had 18,265 flight hours and 2,242 cycles. It has two Rolls Royce RB211-Trent 772B-60/16 engines and is configured to carry 388 passengers. Its maximum landing weight is 187 tons.

The aircraft also had a valid airworthiness certificate and was maintained as per its approved program. The last inspections performed are shown in the table below:

Inspection	Date	Flight hours	Flight cycles	Periodicity
Weekly	13/01/2009	18,223	2,233	7 days
Type "A"	17/12/2008	17,824	2,169	600 flight hours (now 800)
Type "C"	30/04/2008	15,000	1,786	18 months
Type "2C"	30/04/2008	15,000	1,786	36 months
Structural	2005 airplane	N/A	N/A	6 years

1.5.1. *Data for left main landing gear (LH MLG)*

The main landing gear on the Airbus A-330-343 has two main legs with four wheels each, numbered 1-2/5-6 MLG LH and 3-4/7-8 MLG RH. Each wheel features a disc brake. The maximum speed with the installed tires is 204 kt.

The P/N of the full LH MLG is 20149001, and those of its components are:

- Main Strut Assy & Dressings P/N 201489001-150 Mod Strike 102

- Bogie Beam & Dressings P/N 201486003-025 S/N MDG0933
- TSN[13] 18,265 flight hours and CSN[14] 2242

1.6. Meteorological information

The aviation weather reports for the Punta Cana Airport for the time of the approach and landing were as follows:

	TAF 170400Z 01[15]	METAR 02:00 h	METAR 03:00 h
Wind	040° 8 kt 060° 10 kt	040° 8 kt	020° 8 kt
Visibility	10 km Temporatily 5,000 m Between 00:00 y 06:00	8,000 m	6,000 m Temporatily 4,000 m
Clouds	Few to clouds at 1,800 ft Chance of rain Temporatily 1,600 ft Between 00:00 y 06:00	Cloudy 1,600 ft RAIN	Cloudy 1,600 ft Intense rain Temporatily Overcast 1,200 ft
Temperature	16°	23°	23°
Dewpoint	4°	22°	22°
QNH pressure		1,014 mb	1,015 mb

The terminal aerodrome forecast (TAF) issued late on the 17th called for winds gusting to 28kt.

The Dominican Republic is located at 19° North latitude. Its subtropical climate is altered by trade winds from the northeast and by the country's topography.

Daytime heating is responsible for the movement of air masses. The convergence of air masses leads to high intensity vertical movements in the atmosphere that can lead to the formation of storms and heavy rains.

The islands and tropical coasts favor the formation of updrafts as ocean air blows in toward them. Irregularly scattered cumulus clouds and precipitation tend to be much more frequent over these areas than over open water.

[13] TSN: Time Since New.
[14] CSN: Cycles Since New.
[15] Weather forecast in the flight documentation prior to its dispatch in Paris.

1.7. Aids to navigation

The landing on runway 09 at the Punta Cana Airport followed a non-precision instrument approach that relied on the PNA VOR and on the PCA DME. Figure 6 shows the approach chart in effect at the time of the incident.

No problems were reported with the aids to navigation.

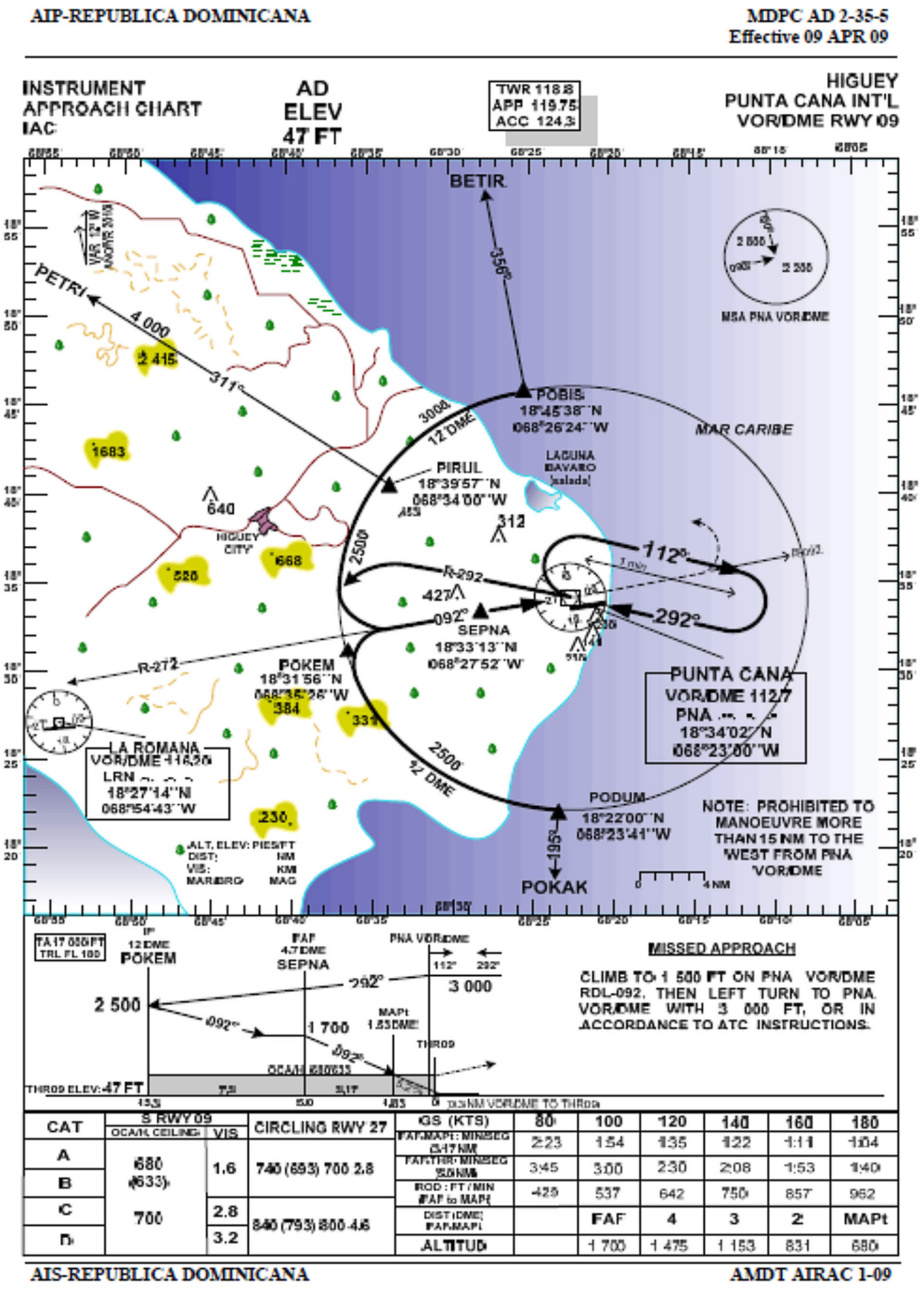

Figure 6. Approach chart for the runway 09 VOR/DME

1.8. Aerodrome information

The Punta Cana Airport (PUJ) is located on the east part of the Dominican Republic some 2.5 km away from the coast. The airport has one 3,100-m long and 45-m wide runway in a 09/27 orientation. The runway edge lights are located on a narrow paved shoulder. Its magnetic orientation is 96°/276° and the elevation of the 09 and 27 thresholds are 47 and 33 ft, respectively. Runway 09 is oriented toward the sea.

The inspections on the ground after the incident highlighted that the ground in the obstacle-free zone had a high load-bearing capacity. The height of the descending steps between the paved surfaces and the surface of the shoulder was always below 5 or 6 cm.

In the date of the event runway 09 had both runway edge and threshold lights, but it lacked lights along the centerline and at the end of the runway[16]. It also has a PAPI visual aid inclined at a 3° angle to indicate the approach glide path.

The information provided by the Dominican Republic's Navigation Division reported that the PAPI system was not in service on the date of the incident due to maintenance and to reposition the lights. It was placed in service after the incident once it was calibrated. The crew, however, stated that the PAPI was turned on. Specifically, between 100 and 150 ft RA, the crew saw three white lights and one red. There is no mention of the PAPI at the Punta Cana Airport in the list of NOTAMs[17] contained in the flight dispatch information or in the information provided by airport authorities.

1.9. Flight recorders

1.9.1. *Cockpit voice recorder*

The airplane was equipped with a Honeywell solid-state cockpit voice recorder, P/N 980-6022-001, S/N CR120-07347. This recorder taped the last thirty minutes of cockpit sounds on four channels, one each for microphone CM-1, microphone CM-2, microphone CM-3 and the area microphone.

The data from this recorder were downloaded normally. The most relevant information obtained from the resulting sound files is shown sequentially below:

- Acknowledgment that airplane is in FULL FLAPS configuration 4 NM from the runway.
- Crew surprised by the change in the holding circuit, published in the approach chart, to point POKEM.

[16] After the event the runway end lights have benn installed.
[17] NOTAM: Notice to Airmen.

- Possibility of go-around contemplated.
- Field reported in sight just above minimums.
- The last wind information, from 040° at 8 kt, is provided by the control tower just 38 s before touchdown, with the aircraft at a radio altitude of 391 ft and 6,600 m (3.56 NM) from the runway threshold.
- During the automatic call-out between 330 and 220 ft, the words "very high" are heard.
- No comments are made during the approach about the crosswind.
- No comments are made either about the airplane's offset from the runway.
- The crew realized they had departed the runway and that one tire had blown out.
- The captain informed the handling agent that there was 5,800 kg of fuel remaining.

1.9.2. *Flight data recorder*

The airplane was equipped with an L3 Communication solid-state flight data recorder, P/N 2100-4043-02, whose information was downloaded and proved useful to the investigation.

The section on the history of the flight makes repeated references to the values of the parameters recorded on the DFDR.

Further information on these and other data recorded during the incident is shown below:

- The aircraft was configured as follows:

  – The aircraft's weight was around 168,000 kg, for a maximum landing weight (MLW) of 187,000 kg.
  – The center of gravity was around 25.6% MAC.
  – The minimum approach speed (VLS) was 130 kt.
  – The approach speed was 134 kt.
  – The auto-throttle (A/THR) was engaged in managed speed mode.
  – Autopilot 1 was engaged in V/S (longitudinal) mode and HDG (lateral) mode.
  – Both flight directors were engaged.
  – The slats/flaps were fully extended.
  – The ground spoilers were armed.

- During the approach the following parameters varied between the values shown:

  – 131 kt < CAS ADC[18] < 142 kt
  – –0.7° < Pitch < +6°

[18] ADC: Air Data Computer.

- –7.7° left < Roll < +9.5° right
- +0.78 g's < vertical acceleration < +1.11 g's
- –0.03 g's < lateral acceleration < +0.04 g's

- The flight path recorded shows that the aircraft flew the holding pattern five times. Figure 7 utilizes a digital image of the area to show the flight path followed by the aircraft after it exited the holding pattern.
- The wind data recorded by the DFDR during the approach are consistent with the information reported by air traffic control. The crosswind from the left during this phase averaged 8 kt in intensity, dropping to 4 kt before touchdown. The values recorded with the aircraft on the ground are not considered since the yaw and slips that occur during the approach and landing make these values unreliable.
- The graphs in Figures 8 and 9 show the radio-altimeter and vertical speed for the descent phase that took place between the minimums and the touchdown.
  The descent rate graph shows that this rate reached a peak value of 21 ft/s (1,260 ft/min), decreasing to 14 ft/s (840 ft/min) during the flare.
- The aircraft's airspeed (CAS ADC) was 134 kt with slight variations. The pitch angle hovered around 5°, not exceeding 6°, dropping from those values on short final. Figure 10 shows the values for the aircraft's pitch angle and airspeed after 400 ft RA.
- Pitch inputs were made to the sidestick (STKPF >0) after the start of the flare. The pitch angle was between 4° and 2° (figure 11). The left spoilers deployed before touchdown. CAS was 135 kt and the vertical speed was 14 ft/s. The pitch angle on touchdown was 4.2°. A vertical acceleration of 2.109 g's was recorded at the instant of touchdown.

Figure 7. Aircraft flight path

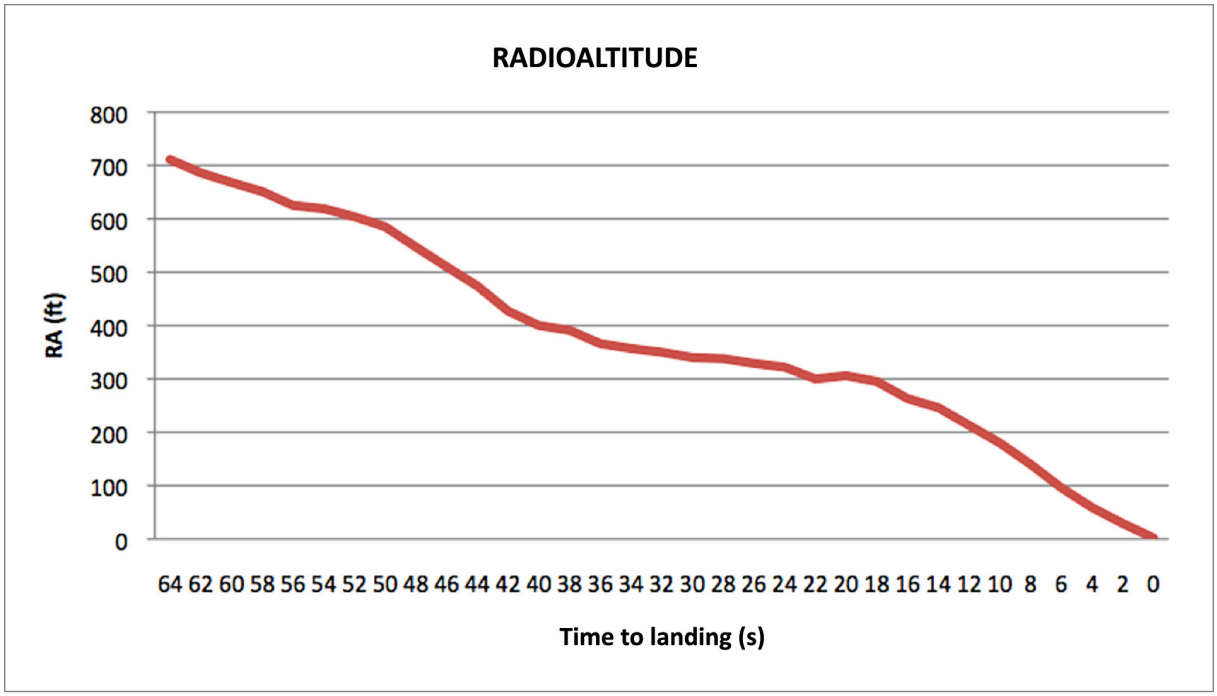

Figure 8. Descent profile

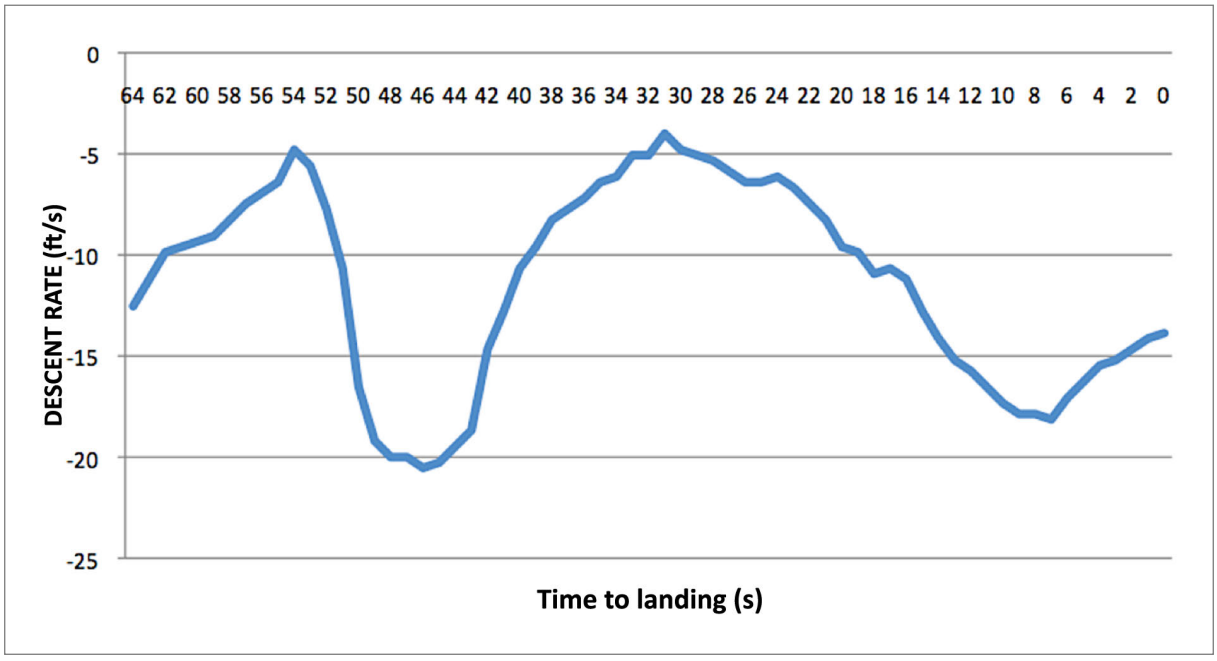

Figure 9. Descent rate profile

- The sidestick was used heavily to control the bank angle, as were the rudder pedals. The aircraft banked left before touchdown and a 6° left bank angle was recorded on touchdown. Just before touchdown, a right 24.4° rudder command (out of 30° max) was given.

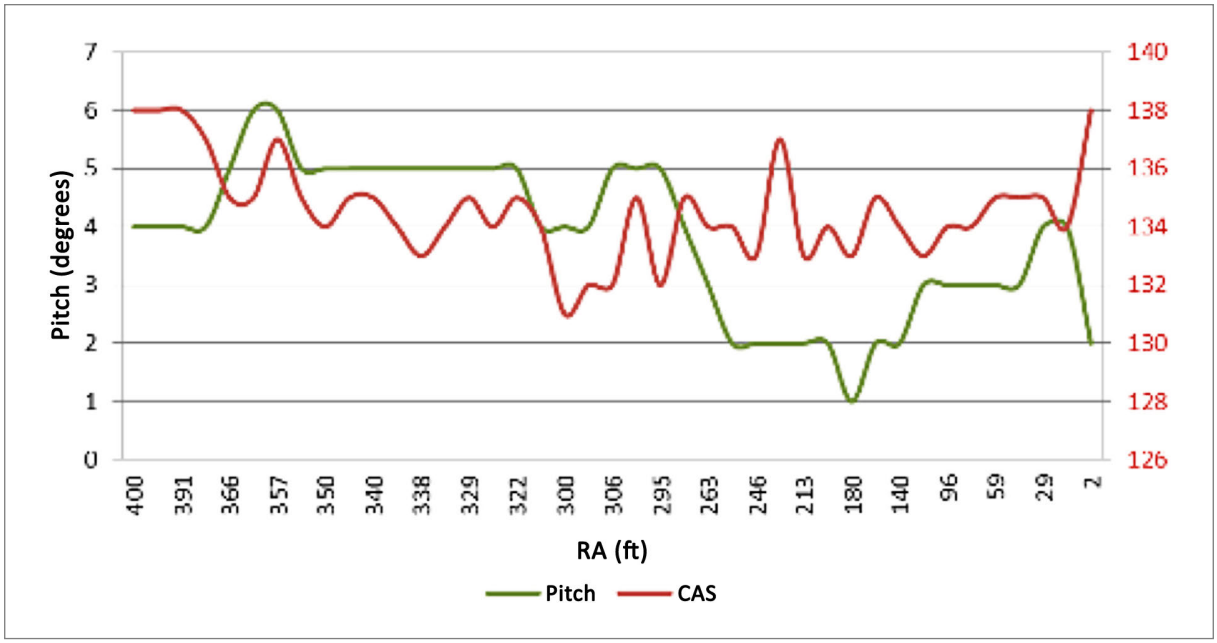

Figure 10. Pitch and CAS

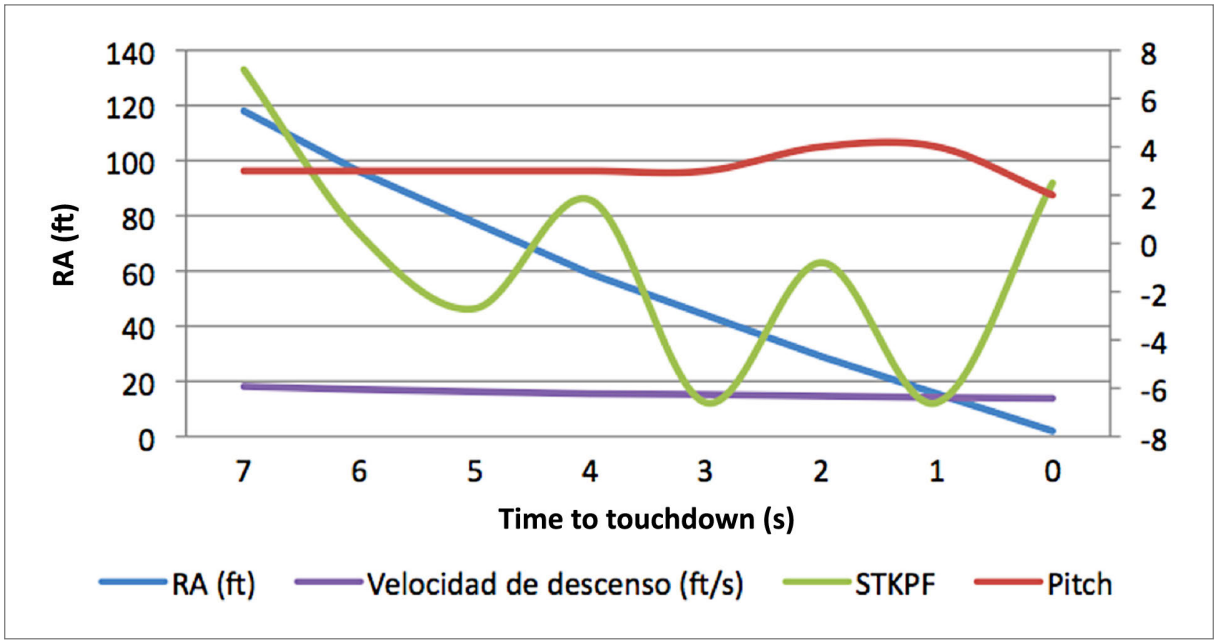

Figure 11. Pitch inputs to sidestick

Figure 12 shows the aircraft heading with respect to that of the runway (96°).

- Integrating the acceleration data yielded information on the lateral flight path and speeds. The lateral coordinates were accurate to +/- 5 m. On short final, 10 seconds before touchdown, it is estimated that the aircraft was 25 m right of the extension of the runway centerline.

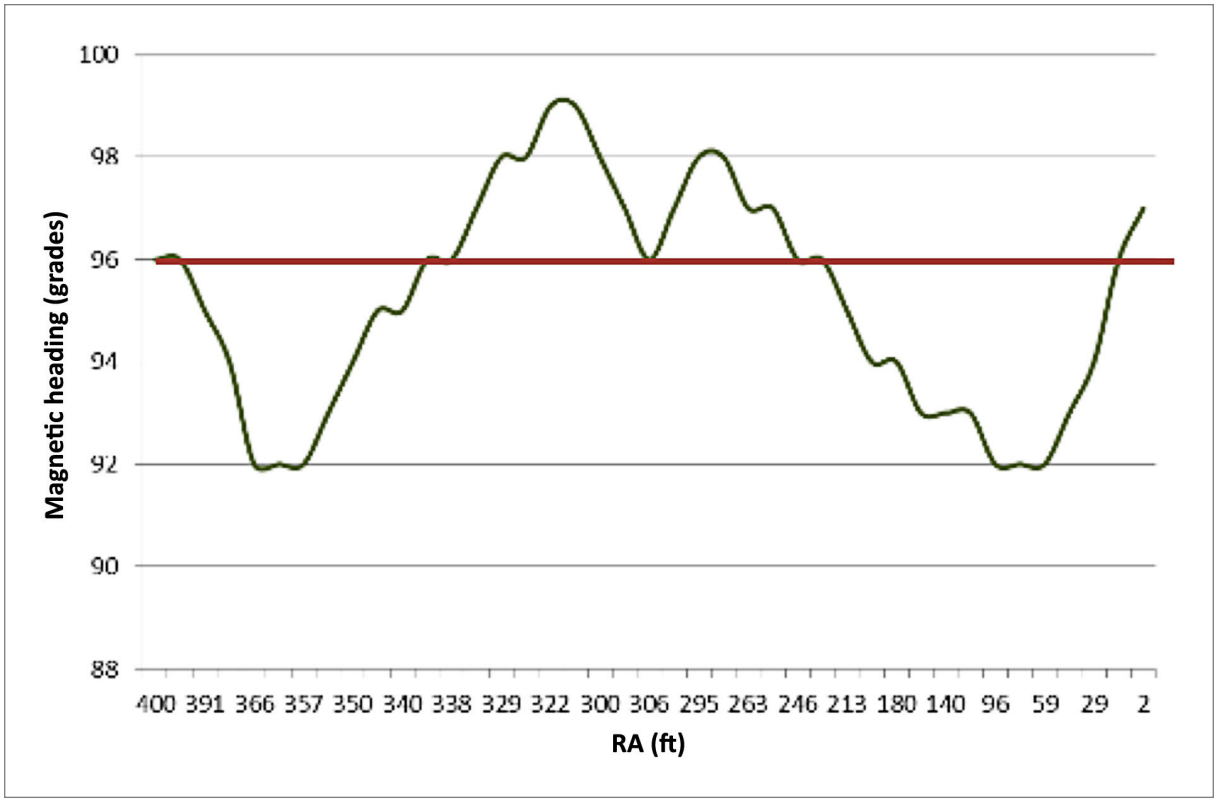

Figure 12. Variations in aircraft heading

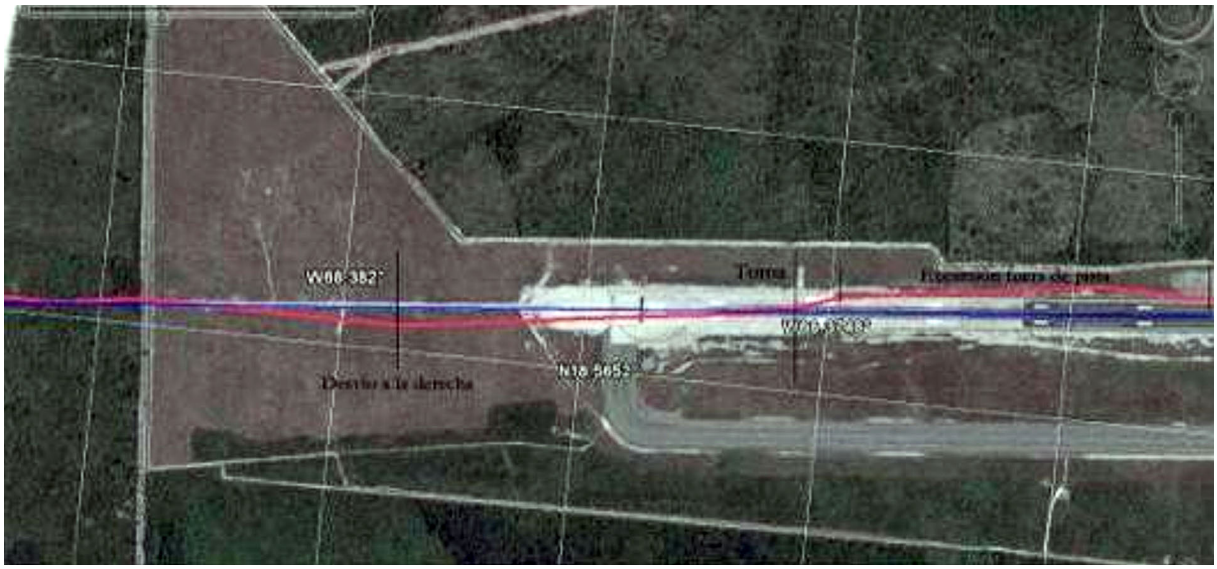

Figure 13. Representation of the approach path and landing based on DFDR coordinates

When it first made contact with the ground, the aircraft was oriented 3° right of the runway centerline and the flight path was 2° left with respect to the runway centerline, meaning that the aircraft's slip angle was 5°.

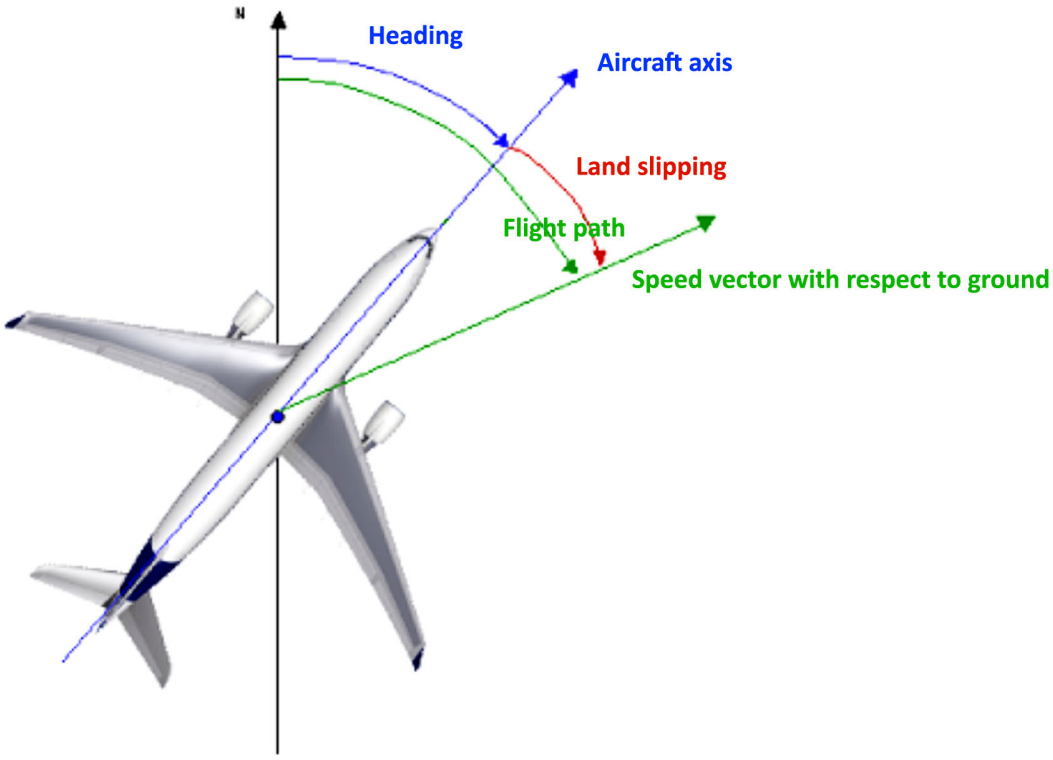

Figure 14. Heading, flight path and ground slip angles

- The lateral acceleration reached a value of 0.566 g's four seconds after the initial contact, indicative of a high acceleration to the right coinciding with the deployment of the ground spoilers.
- The heading and trajectory were the same ten seconds after touchdown.
- The aircraft's coordinates during its trajectory, as determined by the primary navigation system, were recorded by the DFDR. These are shown in Figure 15 overlaid on a digital photograph of the terrain.
  The diagram shows how the airplane deviated on short final, turned toward the runway centerline and then deviated again after touchdown.

Figure 15. Representation of the runway excursion made by the aircraft

1.10. Operating procedures

The operator has no special procedures in place for operations at the Punta Cana Airport.

The operator is currently validating the RNAV[19] approach for both runway 09 and for the new runway 08. In the operator's opinion, this method will allow airplanes to line up properly on the runway, avoiding the existing offset. It will also help airplanes transitioning from instrument meteorological conditions (IMC) to visual meteorological conditions (VMC) from being improperly lined up or at an excessive altitude above the runway at the missed approach point (MAPt).

The operator also has no special criteria other than those in the aircraft's FCOM[20] and AFM[21] regarding the use of rain repellent or crosswind and go-around limitations, which are common to the entire fleet.

1.11. Additional information

1.11.1. *Actions taken by the operator*

The actions taken by the operator's flight safety department in the wake of the incident were as follows:

- Continue the policy of reducing non-stabilized approaches and encouraging go-arounds.
- Proposal to include articles on optical illusions and reminders on tropical weather in the Flight Safety Bulletin.
- Encourage the use of rain repellent.

1.11.2. *Information in flight operations published by the manufacturer*

Airbus provides useful information to its operators on its website. The following operational recommendations made by the manufacturer are considered relevant to this case:

- Flight Operation Briefing Notes: "Approach Techniques: Flying Stabilized Approaches"

  Gives criteria on what is considered a stabilized approach and, relevant to this case, on pitch angles below 7°. In IMC conditions, Airbus recommends to be stabilized on

[19] RNAV: Area Navigation.
[20] FCOM: Flight Crew Operations Manual.
[21] AFM: Aircraft Flight Manual.

the final descent path at Vapp in the landing configuration, at 1,000 ft above airfield elevation. It warns about the difficulty of recognizing wind gradients during the descent, the difficulty of lining up in reduced visibility and about optical illusions.

- Flight Operation Briefing Notes: "Approach Techniques: Crosswind Landings"

  The maximum demonstrated wind components are applicable only under dry or damp runway conditions. In runways that are contaminated and have unreliable braking action, a maximum crosswind of 5 kt is recommended.
  The maximum crab and bank angles recommended are limited to 5°, or a combination of both in the event of strong crosswinds. There is a possibility of a tail, wing tip or engine nacelle strike at high angles. Safety margins are increased by raising the reference speeds by the appropriate amount to correct for the wind.
  It shows how on contaminated runways, an aircraft tends to maintain the crab angle by slipping on the runway in the direction of its speed vector.

- Flight Operation Briefing Notes: "Approach Techniques: Bounce Recovery – Rejected Landing"

  Gives criteria for deciding whether to conduct a full-stop landing or rejecting the landing and going around. Need to coordinate actions between both crewmembers for go-arounds, callouts, etc.
  In the event of a high bounce, a landing must not be attempted. Go around. If the reversers deploy, a go-around must not be initiated. The landing must be completed. If they have not deployed. a go-around is always possible, even from ground level.

- FCOM Bulletin Nº819/1 "Avoid hard landing"

  Avoid significant forward stick movement once the flare is initiated (releasing back pressure is acceptable).

2. ANALYSIS

2.1. Approach

Flight XLF 020, which took off from Paris, Charles de Gaulle on 17 January 2009, had an uneventful flight until it begun its descent into Punta Cana, at which time weather conditions forced it, and other aircraft, to hold above point POKEM, shown on the airport's instrument approach chart, for just over 35 minutes, repeating the hold pattern up to five times.

Neither the airplane nor any of its systems malfunctioned before or during the event. The analysis is thus focused on the weather and operational factors involved as the incident progressed.

The approach operation was conducted under the following conditions:

- The approach was taking place at night with shifting storm cells around the airfield, intense rain and moderate turbulence. The prevailing wind at the runway in use was from the left at an average speed of 8 kt. Moreover, given the runway's orientation toward the sea and the lack of lit population centers around the airport, there were no references on the ground.
- The aircraft had sufficient fuel (5,800 kg) to divert to the alternate airports if necessary. The airplane's range, therefore, did not place particular pressure on the pilots to hasten the landing maneuver, even if the weather situation at those airports had been similar to that at Punta Cana.
- The approach maneuver specified from point POKEM involved following a flight path that deviated 4° from the runway heading (difference between the 92° radial of the PNA VOR and the magnetic heading of runway 09 (96°) until the aircraft was at the MAPt minimum altitude.
- There are uncertainties regarding the availability of the glide slope visual indicator (PAPI). On the one hand, the crew stated that it saw the PAPI's four lights, three white and one red, which would indicate that the airplane was at a higher than normal altitude at the end of the approach. On the other hand, however, airport authorities reported that said visual aid was inoperative that day, though no NOTAMs were found informing of this situation. In light of this conflict, it is not known whether the PAPI was operational or if it was, if it was functioning properly.
- By the time the crew started the final approach to the Punta Cana Airport, it had accumulated 10 h 10 min of flight time and had been on duty for 12 h 10 min[22].

It was under these conditions that the aircraft started the approach after leaving the holding pattern. The aircraft descended on a 92° heading on the PNA VOR radial. They

[22] For public transport operations, Operating Circular 16B specifies that flight times for two-person flight crews shall not exceed 11 uninterrupted hours when the reporting time at the airport is between 06:00 and 14:59. The maximum duty time in this case shall not exceed 14 hours from the reporting time at the departure airport.

sighted the runway instants before crossing through the minimum altitude for continuing with the descent. The inputs made to the flight controls (STKPF parameter) confirm the presence of some turbulence and the difficulty the crew was having staying aligned with the runway.

As specified in the procedures, the crew was using the autothrust (A/THR), which allowed the pilot to focus on staying on the glide slope. The A/THR kept positive control of the CAS, which was maintained at around 133 kt.

No voices were heard on the CVR warning of an excessive descent rate on the glide slope. The values recorded on the DFDR are consistent with the values shown on the descent profile for the PNA VOR/DME instrument approach chart for runway 09. There were also no automatic GPWS or windshear warnings. This indicates that the approach was reasonably stabilized until the minimums.

Once the aircraft reached the MAPt, the crew deviated laterally from the glide slope.

By calculating and integrating the accelerations recorded on the DFDR, investigators were able to determine the approach flight path taken and the flight speed components. Based on these data, the resulting flight path indicates while on the final approach, the aircraft was offset 25 m to the right of the extension of the runway centerline, when it was 375 m from the threshold and 600 m from the touchdown zone. Likewise, in the final 10 seconds before landing, the course was corrected by dropping the left wing and commanding some right rudder in an effort to compensate for the offset by doing a sideslip approach.

As for the altitude, the radio-altimeter data and the reconstruction of the descent rate confirm that at the end of the approach and with the landing imminent, the descent rate was about 300 ft/min 30 s prior to touchdown, a value that rose to 1,088 ft/min seven seconds before touchdown before being reduced to 840 ft/min by means of a smooth flare that changed the pitch angle from 3° to 4°.

The difficulties in stabilizing the approach could have been due in large part to the prevailing conditions. The problem with seeing through the water on the windshield, the feeling of flying into a "black pit", as stated by the pilot, and the absence of runway centerline lights could have led the crew to instinctively reduce the aircraft's pitch so as improve their view and make a firm landing. The amount of water on the runway is believed to have been high, though it could not be estimated since the airport did not have that information[23] available.

Of significance to the incident is the fact that approach was not stabilized laterally on short final since the crew had little time to align with the runway and stabilize the descent once

[23] Presently there is a measurement and register procedure of the the water conditions on runway, which is available for the air control service.

the field was sighted, shortly after descending through the clouds to the MAPt altitude. This incident could have been caused by, among other reasons, the low minimums for the runway, considering the prevailing conditions and the aircraft type, and also by the fact that the MAPt was reached in IMC. The published minimums may assure a safe approach when the runway is in perfect conditions and the approach is not disrupted by the weather. But the operator should consider raising those limits when the runway may be contaminated or when its reduced length and width can pose other difficulties. In general it is regarded as positive to have an operator identify those situations that can arise at this or other airports where it flies by revising the airport classifications in its manuals. A safety recommendation is thus issued to the operator in this regard.

The crew's refusal to use rain repellent could have contributed to worsening the visibility conditions on the runway. The use of rain repellent was left to the crew's discretion in the operator's procedures in effect at the time of the event. The subsequent action taken by the operator to reinforce the use of rain repellent is regarded as a positive.

Likewise, and as mentioned earlier, the data indicate that the crosswind was compensated for by using a sideslip approach, in which the left wing is lowered into the wind and opposite rudder is applied, whereas the aircraft manufacturer recommends a crabbed approach.

2.2. Touchdown and landing run

The aircraft's motion when it contacted the runway was conditioned in large part by the lateral non-stabilized nature of the last segment of the approach, which resulted in the aircraft departing the paved area of the runway to the left after touchdown before returning to the center of the runway.

The aircraft touched down with the left wing tilted 6° down and the rudder turned 24.4° right. Even though those values still give the crew aerodynamic control over the airplane, its maneuverability was limited by the possibility of having the left wing tip strike the ground. This attitude also resulted in more drift to the left.

The flight path obtained by integrating the acceleration values recorded on the DFDR showed that the airplane's speed vector upon landing was 2° left of the runway heading while its heading was 3° right. This meant that the aircraft slipped 5° left. This situation persisted for three or four seconds until the ground spoilers extended fully, which allowed the crew to regain some lateral control.

Considering that the distance between the two main landing gear legs is 10.68 m and that the distance covered between the deploy of the MLG LH and the MLG RH was 80 m, it can be deduced that the airplane's path diverted by more than 7° at the time it departed the runway. The slip could have been exacerbated off the runway due to the

roughness of the terrain, resulting in the blow out of the tire on the MLG LH. This likely occurred when a high vertical acceleration was produced in concert with an increase in the lateral acceleration to 0.566 g's.

The energy built up by the excess descent rate that was not dissipated by the flare was absorbed by the struts and by the structure. Vertical acceleration values of 2.1 g's were reached that, though within design values, led to the struts being replaced as a contingency in the event of an overweight landing involving the left main landing gear.

The lateral control inputs made to the aircraft at the moment of landing influenced the vertical speed. The left bank command resulted in the spoilers on that side partially deploying 18°, reducing the lift and making the landing even harder.

As for the rest of the landing run, the aircraft slipped off the runway with very little friction, no more than 0.113 g's of lateral acceleration during the first contact with the runway, and possibly hydroplaning. Once off the runway, the lateral acceleration increased to 0.556 g's when the spoilers extended, increasing the friction between the tires and the ground and halting the airplane's slide.

It took the aircraft ten seconds to return to the runway. During the excursion, the highly compact terrain and the good drainage of the safety strip had a positive effect by limiting the amount of damage, even when the airplane was traveling over large amounts of standing water.

From an operational standpoint, the rest of the landing run, with the re-entry into the runway and braking without the use of reversers progressed normally. There were no aircraft performance-based problems during the landing; the airplane braked in a little over 2,000 m. It should be noted, however, that the debris dragged onto the runway contaminated the landing surface, posing additional hazards for the next airplane. The flight crew should have alerted ATC of the incident so that maintenance crews could have cleaned the affected runway as quickly as possible.

2.3. Condition of navigational aids at the Punta Cana Airport

As mentioned earlier, during the approach the crew noticed that it was high in the glide slope based on the PAPI lights. As noted in the Airport Information section, the Dominican Republic's Navigation Division reported that the PAPI system was out of order on the date of the incident for maintenance and to relocate the lights. The investigation could find no NOTAMs warning of this situation. These uncertainties regarding the availability of the glide slope visual aid (PAPI) prevented investigators from ascertaining the influence that this circumstance could have had on the approach maneuver. It is advisable, thus, that the civil aviation authority of the Dominican Republic, Instituto Dominicano de Aviación Civil (IDAC), reviews its procedures for issuing NOTAMs. A safety recommendation is issued in this regard.

3. CONCLUSION

3.1. Findings

1. The aircraft had a valid Airworthiness Certificate.
2. The flight crew had the proper licenses and ratings to carry out the flight.
3. The flight was uneventful until the start of the approach.
4. The aircraft was cleared to conduct a non-precision VOR/DME instrument approach to runway 09 at the Punta Cana Airport.
5. The approach to the airport was conditioned by meteorological and environmental factors: rain, storm cell activity, nighttime, lack of visual references.
6. The VOR radial at POKEM, start point for the approach, is offset by 4° with respect to the runway 09 heading.
7. The aircraft was configured for landing during the approach.
8. The crew did not verbalize the conditions under which the landing would be conducted.
9. The runway did not have centerline lights.
10. The runway was sighted by the crew instants before arriving at the MAPt.
11. The approach started in IMC and transitioned to VMC on final.
12. The crew did not use rain repellent.
13. On short final, the aircraft was 25 m to the right of the runway.
14. The flare was not sufficiently pronounced.
15. The aircraft contacted the runway at a 6° left bank angle and with 24° right rudder.
16. The left bank angle indicated above resulted in the left side spoilers extending 18°.
17. At the time of touchdown, the aircraft had a slide angle of at least 5° to the left.
18. A vertical acceleration value of 2.1 g's was recorded on touchdown, with lateral acceleration reaching 0.5 g's immediately afterward.
19. The aircraft's nose and main landing gear traveled over the left shoulder of the runway.
20. The crew was aware of the runway excursion.
21. The crew did not inform the tower of the runway excursion.

3.2. Causes

The probable cause of the hard landing and subsequent runway departure was the crew's execution of actions intended to correct the aircraft's flight path so as to align it with the runway while at a very low altitude, along with the insufficient decrease in the descent rate during the flare maneuver due to the crew's desire to perform a firm landing.

4. SAFETY RECOMMENDATIONS

REC 41/12. It is recommended that Orbest review its procedures in terms of the operating minimums for each aerodrome where it conducts or may conduct operations, and specifically for the Punta Cana Airport, that it review its approach and go-around procedures and any special limitations.

REC 42/12. It is recommended that Orbest establish a method or procedure for its flight crews to report to air traffic control any incidents during landing that could affect the condition of the runway.

REC 43/12. It is recommended that the Instituto Dominicano de Aviación Civil (IDAC) review the suitability of its procedures for issuing NOTAMs.