CIAIAC

COMISIÓN DE INVESTIGACIÓN DE ACCIDENTES E INCIDENTES DE AVIACIÓN CIVIL

Report IN-044/2013

Incident on 11 December 2013, involving an ATR 72-212 aircraft, registration EC-LFA, while landing at the Tenerife-North Airport (Santa Cruz de Tenerife, Spain)

GOBIERNO DE ESPAÑA

MINISTERIO DE FOMENTO

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Edita: Centro de Publicaciones
Secretaría General Técnica
Ministerio de Fomento ©

NIPO: 161-16-212-7

Diseño y maquetación: Phoenix comunicación gráfica, S. L.

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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.º 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.

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Abbreviations

00°	Geometric degrees/Magnetic heading
00 °C	Degrees centigrade
AGL	Above ground level
ATC	Air Traffic Control
ATIS	Automatic Terminal Information Service
ATPL(A	Air Transport Pilot License (Airplane)
CAS	Calibrated Air Speed
CCAS	Central Crew Alerting System
cm	Centimeter(s)
CVR	Cockpit Voice Recorder
EASA	European Aviation Safety Agency
EGPWS	Enhanced Ground Proximity Warning System
FA	Flight attendant
FDR	Flight Data Recorder
FL	Flight Level
ft	Feet
ft/min	Feet per minute
g	Vertical acceleration
h	Hour(s)
hPa	Hectopascals
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
kg	Kilogram(s)
kias	Knots Indicated Air Speed
km	Kilometer(s)
kt	Knot(s)
LOC	Localizer
m	Meter(s)
METAR	Aviation routine weather report
P/N	Part Number
QNH	Altimeter sub-scale setting to obtain elevation when on the ground
RPM	Revolutions per minute
S/N	Serial Number
SIB	Service Information Bulletin
TWR	Tower
UTC	Universal Time Coordinated
Vapp	Final approach speed
VGA	Go-around speed
VHF	Very High Frequency
VMC	Visual Meteorological Conditions
VMCL	Minimum control speed during landing
VmHB	Minimum high bank speed
VOR	VHF Omni-directional Range

Synopsis

Owner and operator:	Naysa
Aircraft:	ATR 72-212A, registration EC-LFA
Date and time of incident:	Wednesday, 11 December 2013; at 18:44 local time[1]
Site of incident:	Tenerife-North Airport (Santa Cruz de Tenerife, Spain)
Persons onboard:	55; 51 passengers, none injured; 4 crew, none injured
Type of flight:	Commercial air transport – Scheduled – Domestic – Passenger
Fase de vuelo:	Landing – Landing run
Date of approval:	24 June 2015

Summary of incident

An ATR 72-212A aircraft, registration EC-LFA, operated by Naysa, departed runway 12 via the left side while landing at the Tenerife North Airport.

The aircraft bounce landed on the runway with the nose wheel, before bouncing an additional three times with the main gear before finally landing.

The aircraft's nose wheel and the main left gear wheel and strut were damaged.

The crew and passengers were uninjured.

[1] All times in this report are local, which is the same as UTC.

1. FACTUAL INFORMATION

1.1. History of the flight

On 11 December 2013, an ATR 72-212A aircraft, registration EC-LFA and operated by Naysa, took off from the Gran Canaria Airport on a commercial passenger flight to the Tenerife North Airport on the island of Tenerife. After taking off, it made a left turn to avoid clouds and continued the flight normally.

Once on approach and on the tower frequency, the crew were cleared to continue the approach after being informed of the traffic situation, in reply to their question as to whether the traffic ahead of them had landed on the runway or not.

Later, after the preceding aircraft had exited the runway, they were cleared to land on runway 12 after being told the prevailing wind conditions. Just as the crew finished their acknowledgment, the preceding traffic notified of the presence of heavy rain before the landing, with highly reduced visibility.

As the crew were close to touching down at the point on the runway near the E1 taxiway, their vertical speed was excessive, causing the aircraft to bounce several times and to divert to the left by the time they reached the E2 taxiway. Eventually the nose wheel departed the runway and rolled onto the grassy area to the left of runway 12 (see figure).

The captain then reported "runway excursion" to the tower and informed they would require assistance to move and that they were evacuating.

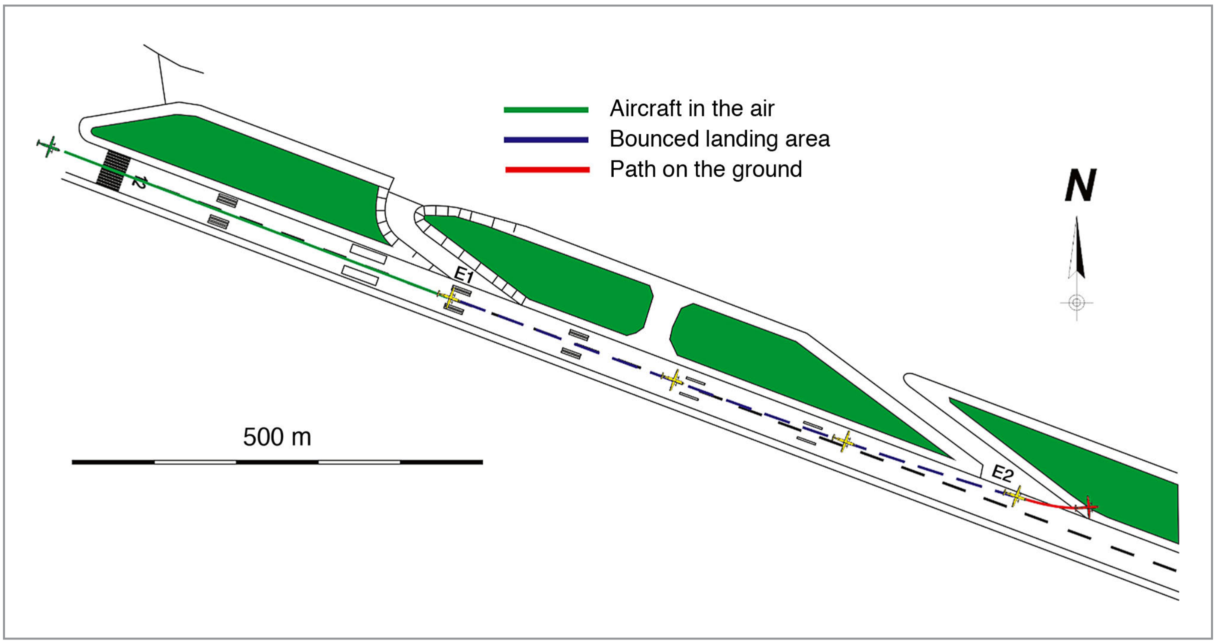


Figure 1. Diagram of the runway and aircraft's flight path (every element is to scale)

The airport's Emergency Plan was activated and the passengers were evacuated and the aircraft was towed.

The runway remained closed, forcing various aircraft to be diverted to their alternate airports.

Once the aircraft had been towed and the runway checked, the runway was declared "Clear and operational" at 20:33:45.

1.2. Injuries to persons

Injuries	Crew	Passengers	Total in the aircraft	Others
Fatal				
Serious				
Minor				Not applicable
None	4	51	55	Not applicable
TOTAL	**4**	**51**	**55**	

1.3. Damage to aircraft

The aircraft's nose wheel was destroyed and there was damage to the main landing gear, specifically to the leg and strut on the left side.

Figure 2. Close-up of the nose wheel

1.4. Other damage

There was no additional damage.

1.5. Personnel information

The pilot, a 34-year old Spanish national, had an Airline Transport Pilot License (ATPL(A)), issued by Spain's National Aviation Safety Agency, and an ATR 42/72 rating, valid until 31 March 2014. He also had the corresponding class-1 medical certificate, which was valid until 26 September 2014.

He had a total of 5,107:57 flight hours, of which 4,014:12 had been on the type and 312:15 as the pilot in command.

The first officer, a 42-year old Spanish national, had an Airline Transport Pilot License (ATPL(A)), issued by Spain's National Aviation Safety Agency, and an ATR 42/72 rating, valid until 28 February 2014. He also had a class-1 medical certificate, which was valid until 21 December 2014.

He had a total of 4,675:15 flight hours, of which 3,978:41 had been on the type.

Since their shift had started in the afternoon, the crew had not gotten up early and the captain had had 17 h of rest following his previous duty period, and the first officer 38 h.

1.6. Aircraft information

The aircraft was an ATR 72-212A, serial number 902, manufactured in 2010. It had a maximum takeoff weight of 22,800 kg and was equipped with two Pratt & Whitney PW-127M engines.

At the time of the event it had 6,446.96 aircraft hours and 11,668 landings.

The aircraft had an airworthiness review certificate issued by Spain's National Aviation Safety Agency that was valid until 8 March 2014.

According to documentation provided by the operator, the aircraft had undergone the inspections specified in its maintenance program, which had been approved by the National Aviation Safety Agency. The last of these had been a 300-hour inspection conducted on 1 December 2013, and which contains items involving checks of the cabin smoke system, the condition of the landing gear doors, lubrication of the landing gear doors and system, operational checks of the trim system, a check of the propeller feathering and a check of the fuel distribution system. The maintenance was carried out by Organización Mantenimiento e Ingeniería Aeronáutica del Atlántico Sur, S. L., which had National Aviation Safety Agency authorization no. ES.145.010.

1.7. Meteorological information

According to Spain's National Weather Agency, sunset in Santa Cruz de Tenerife on 11 December 2013 took place at 18:09.

According to the 17:30 METAR for the Tenerife North Airport for 11 December, the wind was from 180° at 7 kt, variable between 110 and 240°, prevailing visibility was 3,000 m, 800 m to the southeast, with rain and fog in the vicinity of the airport, few clouds on the surface and overcast at 600 ft, temperature 14 °C, dew point 14 °C, QNH 1,018 hPa with no significant changes.

The information provided by the Tenerife North ATIS confirmed the METAR data, indicating wind from 140° at 6 kt, variable between 120 and 180°, visibility of 3,000 m, 800 to the southeast, overcast above 600 ft, temperature 14 °C, dew point 14 °C and QNH 1,017 hPa.

The eastern islands in the Canary archipelago were experiencing adverse weather conditions, prompting a red alert on the island of La Palma. The Canaries Forecast and Surveillance Group, part of the National Weather Agency, had published several bulletins warning of adverse phenomena ("orange" level) and forecasting a 40-70% chance of heavy rains for the island of Tenerife on 11 December. An orange storm alert indicates that very heavy rain and/or strong winds and/or hail larger than 2 cm are predicted for the affected area. Due to the nature of these phenomena, more severe storms are possible at times.

The 16:00 significant weather chart for 11 December also called for the presence of cumulonimbus clouds mixed with layers of other cloud types, turbulence and moderate icing from the surface to levels above FL 180.

1.8. Aids to navigation

Runway 12 at the Tenerife North Airport has a category I ILS.

1.9. Communications

During their arrival to the Tenerife North Airport, the crew were in contact with Tenerife Approach, changing over to the Tenerife Tower upon reaching the 10-mile point.

1.10. Airport information

The Tenerife North Airport is located in the city of San Cristobal de la Laguna and is 13 km west of the city of Santa Cruz de Tenerife. It has one 3,171 × 45 m asphalt runway in a 12/30 orientation. Runway 12 has a category I ILS. This runway and the ground immediately preceding it have a positive gradient. The aerodrome is at an elevation of 2,077 ft.

1.11. Flight recorders

The aircraft was equipped with a cockpit voice recorder (CVR) and a flight data recorder (FDR), both made by L3 Communications. The CVR was a FA2100 model, P/N 2100-1020-02, S/N 000623346. The FDR was a FA2100 model, P/N 2100-4043-00, S/N 000623411.

Information of relevance to the investigation

The information of most relevance to the investigation is summarized below. The flight data recorder and cockpit voice recorder were synchronized.

Based on CVR data:

UTC Time	Remarks
18:11:03	The aircraft is cleared by Las Palmas ATC to take off.
18:21:59	The crew talk about the bad weather conditions.
18:29:05	Approach briefing. The approach speeds selected are 113 kt and 118 kt.
18:34:08	Inquiry by another crew as to the airfield conditions at Tenerife North and if flights are landing. The reply indicates overcast conditions but with visibility before minimums. The last go-around had been three and a half hours earlier.
18:39:27	ATC clears ILS direct 12.
18:42:02	The captain asks ATC if the preceding traffic has landed, and is informed that it is on final.
18:42:46	Crew check landing gear down and then complete the “Before landing checklist”.
18:43:37	Preceding traffic reports “Exiting runway”.

UTC Time	Remarks
18:43:41	ATC reports wind 180/10 gusting to 20, cleared runway 12.
18:43:53	Preceding traffic reports heavy rain just before landing with very low visibility.
18:45:53	The EGPWS is heard calling out two hundred, one hundred, fifty, forty, thirty, twenty, ten, followed by the sound of the gear touching down.
18:46:08	Captain says "careful".
18:46:11	Sound of second landing, followed by bangs and first officer saying "go around, go around". Sound of captain saying "We're staying, we're holding on", constant whistling and a loud bang.
18:46:45	Captain is heard ordering an evacuation.
18:47:01	Report runway excursion to TWR.

Based on FDR data (see Appendix for FDR data and graphs):

UTC Time	Remarks
18:45:19	At a radio altitude of 852 ft, the pitch angle went from +3° to –4° in six seconds.
18:45:59	Pitch angle –5°. Radio altimeter 114 ft.
18:46:04	Sink rate 1,200 ft/min. Pitch angle –5°. Radio altimeter 23 ft.
18:46:06	Possible contact with nose wheel. Vertical acceleration 2.41 g. Pitch angle -2°. Radio altimeter –2 ft. Sink rate 450 ft/min. Calibrated airspeed 130 kt.
18:46:10	Initial contact with main gear.
18:46:12	Maximum vertical acceleration 2.60 g.
18:46:13	Second contact with main gear.
18:46:14	Maximum pitch angle 10°.
18:46:15	Third contact with main gear.
18:46:18	Final contact.

1.12. Wreckage and impact information

The aircraft sustained damage to its nose leg and to the left main landing gear only. During its landing run, the aircraft moved down the runway, with only the nose wheel exiting the runway and becoming stuck in a grassy area near taxiway E2.

Figure 3. Tracks left by the nose wheel on the ground

1.13. Medical and pathological information

N/A.

1.14. Fire

N/A.

1.15. Survival aspects

The crew decided to evacuate the passengers from the aircraft. No one was injured during this emergency evacuation.

After the incident the airport's Emergency Plan was activated. Runway 12 was closed to air traffic until 20:33, when the aircraft was towed from its position and the airport was restored to normal operations.

1.16. Tests and research

Since the crew stated that they had lost the displays from the EGPWS and that they had received a "GPWS fault" warning on the CCAS, the system was inspected on 20 December 2013.

According to information provided by the operator, this inspection did not reveal any problems with the system, and thus no follow-up actions were required.

1.16.1. *Statements from the flight crew*

The captain and first officer were interviewed separately, revealing the following:

Their first scheduled flight, from Tenerife to Fuerteventura, had been canceled due to the adverse weather conditions between Las Palmas and Fuerteventura.

They were then assigned the Tenerife-Las Palmas-Tenerife flight. Before departing, in addition to checking the dispatch information, they found out from colleagues about the conditions on the route and, seeing that the weather was acceptable, they decided to fly to Las Palmas, where they made an ILS approach to runway 21R. During this flight the captain was the pilot flying.

In Las Palmas they took on passengers from other flights that had been canceled, boarding a total of 51 passengers. They loaded 2,500 kg of fuel (a flight from Las Palmas to Tenerife North in the ATR normally requires 300 to 400 kg).

The first officer was the pilot flying on the return flight.

They climbed to FL 120 and had to request vectors to fly around cloud formations.

They stated that while in the cruise phase, they lost the EGPWS (Enhanced Ground Position Warning System) displays and received a "GPWS fault" warning on the CCAS (the Central Crew Alerting System on the ATR72).

They had icing along the way, which forced them to activate level 2 anti-ice protocols (heating) and then level 3 (deicing boots). They had to reduce their speed to 180 kt due to turbulence, though they later increased it to 190 kt after receiving the "Increase speed" warning.

The first officer did the approach briefing, selecting a VGA[2] of 113 kt and Vapp[3] of 118 kt. They reached the TFN VOR at FL120 due to clouds. They were number 2 in the sequence behind an Air Europa jet.

He stated that the tendency when flying an ATR on final is to add a speed factor on final to level the airplane's pitch angle, thus minimizing the risk of a tail strike.

[2] Go-around speed.
[3] Company policy had them increase the VmHB (minimum high-bank speed) by 10 kt which, for their landing weight of 20,200 kg, corresponded to 108 kt, as per the performance tables.

The Automatic Terminal Information Service (ATIS) was reporting overcast skies at 600 ft, and the Air Europa asked the controller if anyone had gone around, to which the latter replied that not since 14:30.

They flew the full approach procedure and 16 miles outbound, the controller gave them vectors to intercept the LOC.

They intercepted the glide slope at about 6,000 ft. The approach was stable, in IMC, with no turbulence or windshear. At 2,600 ft they had visual contact with the runway. They could see well, though it was still raining hard. They had the windshield wiper on at full speed.

The Air Europa crew, upon exiting the runway, reported reduced visibility due to rain. They kept this information in mind, but they could see the airfield well at that point. The first officer called out "airport in sight", and continued flying the ILS, but with suitable visual references. He disengaged the autopilot.

The captain stated that in light of the information received from the tower, that the wind was from 180° at 10 kt and gusting to 20 kt, he decided to increase their speed by a wind factor of 15 kt (the maximum allowed correction, resulting in a target Vapp of 123 kt). They also disengaged the yaw damper, since when the pedals are used to offset the effects of the crosswind, this system disengages suddenly, upsetting the pilot's control of the maneuver.

Both the captain and the first officer stated that the airport lights were very intense (verified by other pilots who were in and around the runway), and that they received no callouts from the airplane, and that if they did, they did not hear them (referring to the radio altimeter "50, 40, 30..." callouts, the speed of which pilots use to determine how quickly they are approaching the ground). The first officer wondered if the lights and rain could cause some sort of "magnifying glass" effect that made them think they were much higher when in fact they were already near the ground.

When recalling the landing sequences, both coincided in noting that they had a "pitch disconnect" warning during the second landing (decoupling of the control columns), and that even though the captain could not be certain that this effect took place, the first officer did notice that when he moved his column, the captain's did not.

Both also stated that they touched down with the nose leg the second time. The captain indicated that the first landing was hard, and that following the second touch down with the nose wheel and then bouncing, he took the controls and they made a flat third landing. The first officer, however, stated that the third landing was also made with the nose wheel.

They did not know if the nose gear was damaged. It all happened very fast. They seemed to have no directional control of the nose wheel and they slowly skidded left until they departed the runway.

After they departed the runway and set the parking brake, the captain called the tower to report the runway excursion and announced on the intercom with the passenger cabin "Crew take your positions". They read the "On ground emergency evacuation" checklist and when the propeller RPMs dropped to zero (propellers stopped), they ordered an evacuation on the captain's side. Later, FA no. 2 entered the cockpit to report that the evacuation was complete.

The captain stated that on the CVR he will no doubt be heard asking for the "Leaving the Aircraft" checklist instead of the evacuation checklist, but the first officer properly corrected him.

According to the captain, only the EGPWS display was faulty, though if they received a GPWS fault on the CCAS, he thought that perhaps they did not have the GPWS.

When asked about the possibility of going around after the initial bounce, the captain said that it all happened so fast that by the time he wanted to take the controls to do it, the airplane's nose was already down and it was no longer possible. He eventually did take control before the third landing, but only to try to avoid another nose-wheel landing and to have the aircraft properly centered on the runway.

The captain also stated that the appearance of the "pitch disconnect" alarm light affirmed his decision not to do a go-around, since he was not sure which pilot had control.

1.17. Organizational and management information

1.17.1. *Stabilized approach criteria*

In its Operations Manual, Naysa stipulates the following criterion for considering an approach as stabilized:

- The aircraft is on the required visual or electronic glide slope with no deviations.
- There is no lateral deviation from the runway centerline or the electronic signal for the horizontal position.
- The sink rate is 1,000 ft/min or lower.
- The thrust is as required.
- Landing configuration.
- Wings level (maximum bank of 10°).
- Speed no higher than Vapp + 20 kt and no lower than Vapp.

- Checklists complete.
- In addition, when flying over the runway threshold:

  – The speed shall be between Vapp and Vapp + 10.
  – The airplane shall be in position to land in the thouchdown zone (3,000 ft or first third of the runway, whichever is less).

An approach must be stable by at least 1,000 ft AGL in IMC and by at least 500 ft AGL in VMC.

The final approach speed, Vapp, is calculated using:

Vapp = VmHB + WIND FACTOR or VMCL[4], whichever is greater.

The wind factor shall be the higher of:

- 1/3 the headwind component,
- or full gust speed.

The maximum correction shall be 15 kt, with an additional margin available for turbulence, windshear, etc.

1.17.2. *Bounce Landing*

In November 2013, the EASA issued a Safety Information Bulletin on "Bounced Landing Recognition and Recovery Training" (SIB 2013-20). This document was prompted by the investigation into an accident with similar characteristics and repeat occurrences of analogous events. Its purpose is to provide training recommendations to manufacturers, operators, training organizations and flight crews for these situations to aid them in recognizing a bounce landing and to provide guidelines for recovery.

The operator, in keeping with the indications in the SIB, describes a bounce landing in its Operations Manual as an abnormal situation, and provides guidance for recovery from unusual attitudes.

It states that a bounce landing can result from excessive speed, a steep approach angle or a combination of both factors during the final approach.

As a defense against bounce landings, it requires its crews to do a go-around if the aircraft's approach is not stabilized.

[4] VMCL: Minimum control speed during landing with all engines operating.

Thus, a crew experiencing a severe bounce landing:

- Must immediately execute a go-around if the flight performance allows complying with the published go-around maneuver. If not, the crew shall fly the single-engine departure maneuver flight path.
- Must not attempt to land.
- Must not apply forward pressure to the control column.

The syllabus for the third year of the company's training and periodic verifications program specifies training on bounce landing and contains the aspects mentioned in SIB 2013-20, which includes a partial list of some of the causal factors of bounce landings:

- Excessive sink rate.
- Excessive airspeed.
- Late flare initiation.
- Incorrect flare technique and power management.
- Gusty wind conditions.

The operator's Training Manager stated that they are having some problems providing this training since the simulator is not set up to generate this type of incident.

1.18. Additional information

1.18.1. *Illusions in flight*

Illusions in flight cause pilots to misjudge altitudes or misinterpret situations. Most illusions are caused by environmental and weather conditions, ground uniformity, the position and condition of the runway, and the aircraft's structure.

The most critical illusions are those that tend to occur during the landing phase.

The most common visual illusions and the pilot's typical response are:

> *Flying at night or in reduced visibility due to smoke, fog, snow, rain, haze, wet windshield, etc.*

The illusion produces the sensation of flying higher. The pilot will typically fly lower than in the theoretical standard approach. Especially at night, the feeling of flying higher than actual makes a low approach more likely. It is possible to crash into obstacles or strike wires, or even to land before reaching the runway.

Typical of nighttime landings when there are no external references except the runway lights is the *black hole illusion*. This situation can be made worse when there are lights, as from a city, at the end of the runway. Since the horizon is not visible, the runway's position seems higher, leading the pilot to lower the nose, thus increasing the probability of landing before reaching the runway. Similar situations can occur when there is fresh snow on or around the runway or during a blizzard.

Runway lighting

Bright lights make the runway seem closer, and faint lights more distant. A pilot will tend to fly lower or higher than the theoretical standard approach.

Runway with a positive gradient

The illusion creates a sensation of flying higher, meaning a pilot will tend to fly lower than the theoretical standard approach.

Approach with fog

During approaches when the runway is in sight from far away, the sudden disappearance of visual references due to mist or fog can lead to the illusion of flying higher, thus causing a pilot to correct the situation by lowering the nose.

Changes in pitch

The illusion changes depending on the position of the nose, leading to a feeling of flying higher if the nose is raised and lower if the nose is lowered.

Effect of rain on the windshield

Heavy rain can affect depth perception by altering the runway lights, making them seem less bright. The resulting illusion can make the lights seem more distant from the observer. Similarly, a few rain drops on the windshield can amplify the runway lights, making them seem twice as large, leading the pilot to believe that he is closer to the runway threshold than he actually is and causing him to descend prematurely. The diffraction of rain drops on the windshield can cause various optical illusions; for example, even if an aircraft is perfectly aligned with the glide slope, the pilot may sense being above or below the correct glide slope, or being off center, to the left or right of the runway centerline, depending on the angle of the windshield and other factors. The apparent error can be on the order of 200 ft at a distance of one mile from the runway threshold.

1.19. Useful or effective investigation techniques

N/A.

2. ANALYSIS

The pilots were duly qualified to fly the aircraft, having valid licenses, ratings and medical certificates.

The aircraft had a valid certificate of airworthiness and had undergone all of the scheduled maintenance inspections. There were no malfunctions or defects pending resolution.

According to recorder data and to the accounts of the flight crew, the approach was completely normal until immediately prior to the landing.

Based on information provided by the National Weather Agency, on the conversations recorded on the CVR and on the pilots’ own accounts, it was raining hard at the time of landing and visibility was reduced. In addition, the windshield wiper was on its highest speed setting, which also contributed to diminishing the pilots’ view somewhat.

Both pilots stated they had misjudged the distance to the runway and that the runway lights were very bright. While bright runway lights can increase visibility and facilitate an approach in low visibility conditions, as an aircraft approaches the runway and prepares for landing, they could lead to erroneous perceptions.

The prevailing weather conditions at the time of landing were favorable to the appearance of optical illusions caused by flying in reduced visibility, be it due to fog or rain, and leading to a sensation of flying higher, with the pilot’s reaction tending to be to fly lower. Specifically, the black hole illusion, which occurs during nighttime landings when there are no outside references except for the runway lights, makes the runway appear higher, resulting in the pilot lowering the nose. Similarly, the sudden disappearance of visual references due to fog or mist when the pilot had the runway in sight from a long distance can lead the pilot to think that the nose is high, thus prompting the pilot to correct the situation by lowering the nose. The rain on the windshield can also cause effects that distort distance perception.

The geographic condition of the runway, namely its positive gradient, could induce the sensation of flying higher, prompting the pilot to fly lower.

Although the pilots stated that they did not hear the radio altimeter callouts, the sounds recorded by the CVR indicate that the EGPWS issued the relevant callouts. The findings of the inspection conducted afterwards also showed that there were no faults in the system.

According to the FDR data, the aircraft suddenly changed from a positive (+3) to a negative (–4) pitch angle in just 6 seconds at an altitude AGL of 800 ft. The pitch angle then remained negative (–5) until an altitude AGL of 23 ft. These values do not represent an ideal attitude for the aircraft in the moments immediately prior to landing. This situation could be explained by an improper depth perception and by the crew's inability to hear the GPWS callouts.

The FDR data confirm that the crew made a stabilized approach; however, in light of the wind conditions reported on final, the captain decided to increase their speed by the maximum wind factor allowed (15 kt). Their target Vapp speed was thus 123 kias. Although the speed recorded prior to landing was 130 kt, this does not violate the stabilization requirements contained in the Operations Manual to maintain speed between Vapp and Vapp+10 when flying over the runway threshold.

This increased speed, however, did favor lowering their pitch angle, which increased the risk that the initial contact with the runway would be made with the nose wheel in the event of a late flare.

The FDR data also indicate that the initial contact with the runway was with the nose wheel at a vertical acceleration of 2.41 g. This was followed by three further touchdowns with the main gear before the aircraft stopped, the first of these leading to the maximum recorded vertical acceleration value of 2.6 g.

These data are consistent with the breaking of the nose wheel leg and the subsequent loss of directional control, as well as with the damage to the left main gear. Once the aircraft's directional control was lost, its own inertia caused it to depart the runway.

The operator has included information in its manuals on how to avoid bounce landings and on how to proceed if one does occur. Likewise, in keeping with the EASA's recommendations, it stipulates training on bounce landings both on the ground and in the simulator, though it recognizes the limitations to said training due to the difficulty in accurately reproducing bounce landings in the flight simulator.

3. CONCLUSIONS

3.1. Findings

The flight crew were qualified for the flight operation in question and their level of activity was within the specified duty criteria.

The aircraft's airworthiness was suitable for the flight.

The approach was completely normal until just before the landing.

The presence of various simultaneous conditions (darkness due to nightfall and low cloud ceiling, positive gradient of the runway and the ground before the runway, constant rain, maximum speed setting on the windshield wipers, bright runway lights, visual fatigue) were conducive to the appearance of optical illusions that caused the crew to misjudge distances and elevations.

The aircraft made a landing at a high horizontal and vertical speed, followed by a runway excursion.

3.2. Causes/Contributing factors

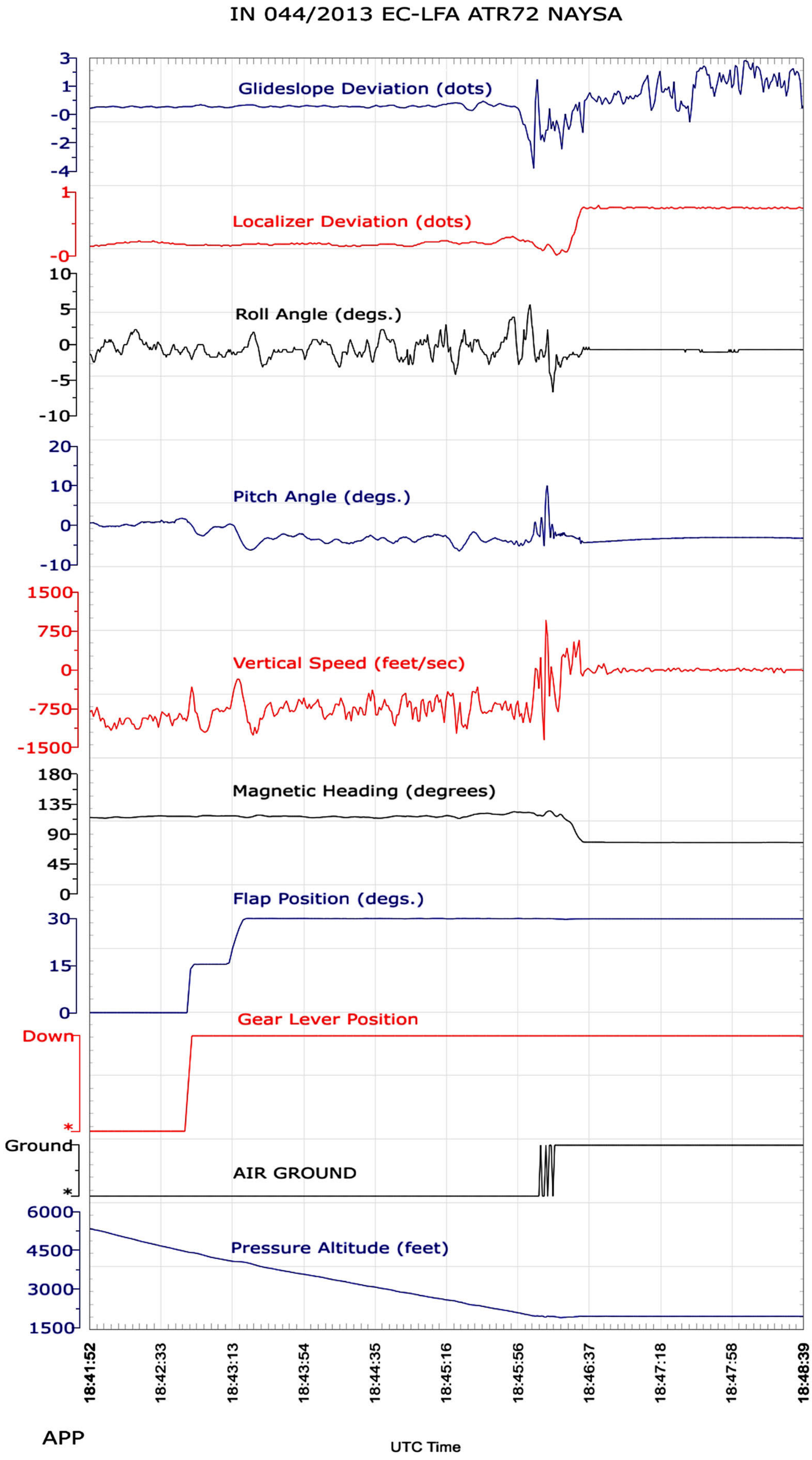
The incident was caused due to the aircraft making a hard landing at an incorrect attitude. Contributing to this was a faulty perception of distance due to the optical illusions generated by the adverse meteorological conditions that prevailed at the time of the landing.

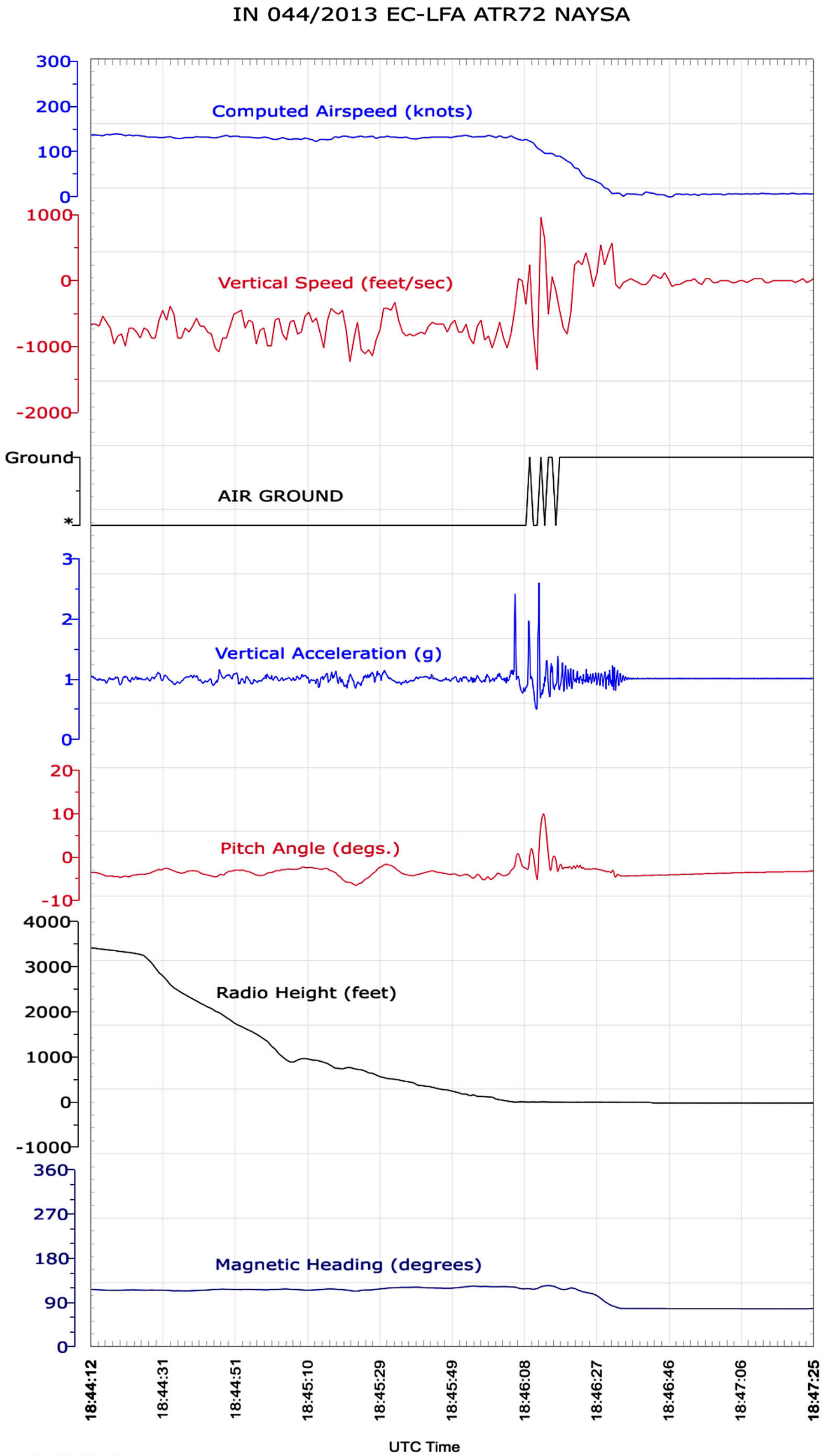
4. SAFETY RECOMMENDATIONS

None.

APPENDICES

APPENDIX 1
Flight data


IN 044/2013 EC-LFA ATR72 NAYSA
Glideslope Deviation (dots)
3
1
-0
-2
-4
Localizer Deviation (dots)
1
-0
Roll Angle (degs.)
10
5
0
-5
-10
Pitch Angle (degs.)
20
10
0
-10
Vertical Speed (feet/sec)
1500
750
0
-750
-1500
Magnetic Heading (degrees)
180
135
90
45
0
Flap Position (degs.)
30
15
0
Gear Lever Position
Down
*
AIR GROUND
Ground
*
Pressure Altitude (feet)
6000
4500
3000
1500
18:41:52
18:42:33
18:43:13
18:43:54
18:44:35
18:45:16
18:45:56
18:46:37
18:47:18
18:47:58
18:48:39
APP
UTC Time


IN 044/2013 EC-LFA ATR72 NAYSA
Computed Airspeed (knots)
300
200
100
0
Vertical Speed (feet/sec)
1000
0
-1000
-2000
AIR GROUND
Ground
*
Vertical Acceleration (g)
3
2
1
0
Pitch Angle (degs.)
20
10
0
-10
Radio Height (feet)
4000
3000
2000
1000
0
-1000
Magnetic Heading (degrees)
360
270
180
90
0
18:44:12
18:44:31
18:44:51
18:45:10
18:45:29
18:45:49
18:46:08
18:46:27
18:46:46
18:47:06
18:47:25
UTC Time

LANDING