CIAIAC

COMISIÓN DE
INVESTIGACIÓN
DE ACCIDENTES
E INCIDENTES DE
AVIACIÓN CIVIL

Report IN-035/2015

Incident involving
a Boeing 737-800 aircraft,
registration number EI-DLR,
operated by Ryanair,
at Barcelona airport,
on 12 December 2015

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DE ESPAÑA

MINISTERIO
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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°00'00"	Sexagesimal degree(s), minute(s) and second(s)
00 °C	Degree(s) centigrade
AENA	Aeropuertos españoles y navegación aérea («Spanish Airports and Air Navigation Authority»)
AP	Autopilot
ATPL(A)	Airline transport pilot licence (aircraft)
CPL(A)	Commercial pilot licence (aircraft)
CVR	Cockpit voice recorder
DFDR	Digital flight data recorder
E	East
h	Hour(s)
HKAC	Hong Kong Aviation Capital
IAA	Irish Aviation Authority
kg	Kilogram(s)
m	Metre(s)
Min	Minute(s)
N	North
PLC	Programmable Logic Controller
s	Second(s)
S	South
UTC	Coordinated Universal Time
UTE	Temporary union of companies
W	West

Synopsis

Owner:	Hong Kong Aviation Capital (HKAC), currently Avolon
Operator:	Ryanair
Aircraft:	Boeing 737-800
Date and time of incident:	12 December 2015; at 20:30 UTC
Site of incident:	Barcelona airport
Persons on board:	76; 2 passengers with minor injuries
Type of flight:	Commercial aviation – Air transport – Regular – National
Flight phase:	Parked – Disembarking the passengers
Date of approval:	2 November 2016

Summary of incident

The aircraft arriving from Sevilla, with flight number FR-6399, was parked at position 101 and disembarking the passengers through the finger.

During the disembarking, a flight attendant noticed the unusual behaviour of the aircraft nose and notified the flight crew that were completing the check list. The crew confirmed that the aircraft was lifted by the air bridge connected to door L1 and instructed the passengers that were still on board to sit down and fasten their seat belts.

A few seconds later, the door L1 collapsed and the nose of the aircraft collapsed from an estimated height of 2 m and hit its nose gear.

The rest of the passengers, who were still inside the aircraft, were disembarked through the rear door. A passenger reported knee injury and another showed anxiety.

Medical assistance was requested from the airport and the ambulance arrived to the aircraft in two minutes. On ground and at the steps of the plane it offered medical assistance to two passengers with discomfort or injuries.

It is considered that the uncontrolled lifting of the finger was caused by the combination of the failure of the electrovalve of the hydraulic elevation circuit and the modification of the interval for the activation of the pump of this circuit of the self-leveling system, that had been operated during the renovation of the finger a few months before.

Two safety recommendations are issued to Barcelona Airport and to the UTE that renovated the fingers at Barcelona Airport.

1. FACTUAL INFORMATION

1.1. History of the flight

The aircraft arriving from Sevilla, with flight number FR-6399, was parked at position 101 of terminal 2 of Barcelona Airport and disembarking the passengers through the finger (air bridge).

During the disembarkation, around 20:30 UTC (21:30 local time), a flight attendant noticed the unusual behaviour of the aircraft nose and notified the flight crew that were completing the check list. The crew confirmed that the aircraft was lifted by the finger connected to door L1 and instructed the passengers that were still on board to sit down and fasten their seat belts.

A few seconds later, the door L1 collapsed and the nose of the aircraft collapsed from an estimated height of 2 m and hit its nose gear.

The rest of the passengers, who were still inside the aircraft, were disembarked through the rear door.

A passenger reported knee injury and another showed anxiety. Medical assistance was requested from the airport and the ambulance arrived to the aircraft in two minutes. On ground and at the steps of the plane it offered medical assistance to two passengers with discomfort or injuries.

Figure 1. Attitude of the aircraft lifted by the finger

1.2. Injuries to persons

Injuries	Crew	Passengers	Total in the aircraft	Others
Fatal				
Serious				
Minor		2	2 (165 flight total)	Not applicable
None	6	68	74	Not applicable
TOTAL	**6**	**70**	**76**	

1.3. Damage to aircraft

The left front door L1 broke and collapsed due to the weight of the frontal part of the aircraft loaded on it, as well as its hinges and opening and closure arms.

The subsequent inspection of the nose gear and tail cone showed absence of damages to these parts of the aircraft.

1.4. Other damage

As regards the air bridge, the cabin swivel chain was broken, the swivel floor had been bent and damages to the safety shoe could be noticed. No other injuries were caused.

1.5. Personnel information

The Captain, of Spanish nationality, was aged 30 and held an Airline Transport Pilot's License ATPL(A) issued by the Irish Aviation Authority (IAA) on 28 August 2010, with type rating B-737-800 and instrument and no other rating. His experience was 7,400 h, of which 6,200 were in the type. Both the type rating and the corresponding Class 1 medical certificate expired on 28 February 2016.

The Co-pilot, of Portuguese nationality, was aged 24 and held a Commercial Pilot's License CPL(A) issued by the Irish Aviation Authority (IAA) on 14 July 2015, with type rating B-737-800 and instrument. His experience was 350 h, of which 50 were in the type. The type rating expired on 14 July 2016 and the Class 1 medical certificate expired on 08 November 2016.

1.6. Aircraft information

- Make: Boeing
- Model: 737-800 AS
- Serial number: 737-33596
- Year of manufacture: 2006
- Engines, number/make and model: Two (2) CFM 56-7B S/N: 802252 and 892125
- Empty weight: 41,413 kg
- Maximum weight upon take-off: 79,010 kg
- Weight at the time of incident: 50,800 Kg
- Total cell hours: 30,492 h
- Total cycles: 18,931 cycles

1.7. Meteorological information

Not applicable.

1.8. Aids to navigation

Not applicable, the aircraft was already stopped in its parking position on the platform of terminal 2 of Barcelona Airport.

1.9. Communications

Radio communications had been normal and the control service received by the crew had already finished.

1.10. Aerodrome information

Barcelona Airport has two terminal buildings after it recent expansion. Terminal 2 corresponds to the old area situated north of runway 25R with its corresponding ramp n.º 2 that services the terminal fingers and remote parking positions close to this terminal.

The aircraft was parked on position n.º 101 connected to the finger and located in the second position of the boarding area in the extremity of the terminal T2 building.

The finger at position 101 had been installed in 1991 by Trabosa, and its hydraulic system was refurbished in 2001 and its screen and control panel were renovated in

2005 by ThyssenKrupp Airport Systems. Recently, in June 2015 its translation and control system were renovated by UTE Adelte&Ports Maritime, S.L.– Luis Pares, S.L.

1.11. Flight recorders

Flight recorders CVR and DFDR on board the aircraft were neither kept nor downloaded, because it was considered that the incident started after said equipment had stopped recording, which happens after the last plane engine stops after having completed a flight.

1.12. Wreckage and impact information

The finger was brought close to the aircraft once the latter got to its parking space, the operation being coordinated with the aircraft, door L1 was opened, the safety shoe was placed underneath the door (photo 2) and the disembarkation of the passengers was started.

Figure 2. Positioning of the safety shoe between the door and the finger floor

While the passengers were disembarking and approximately 90 passengers had got out, an audible alarm on the finger got activated, according to the flight coordinator who was in its cabin. At the same time the lifting of the finger started, due to the apparent failure of the self-leveling system, and this lifted the aircraft by the left front door.

When the flight attendants realised what was happening, they stopped the disembarkation of the passengers and asked the people still on board to move towards the front of the aircraft to sit down anywhere, as the door was expected to collapse and the aircraft nose to fall.

Briefly after this, the door L1 of the aircraft, by which the aircraft was being lifted by the finger, could not bear the load of the aircraft nose, collapsed and the aircraft fell, hitting the nose gear against the platform area.

Several elements of door L1 were severely damaged by deformation due to overload. The "hard landing" and "tail strike" inspection had a negative result with regard to the damages produced to these elements: nose gear and tail skid and cone.

The finger also suffered overload damages: damages to the safety shoe, cabin rotation chain and deformation of the cabin swivel floor.

1.13. Medical and pathological information

The airport medical services arrived at position 101 of terminal 2 at request of the crew of flight FR-6399 and its activation by the airport management centre.

In coordination with the crew, they are told that this is a preventive call and until that moment no medical emergency had been detected. The ambulance remained next to the aircraft until all passengers disembarked and waited for its services to be requested.

A passenger arrived at the ambulance, claiming that he had suffered a blow in the thigh and his leg was painful, but was not injured and his walking was not hindered. Later on, another female passenger arrived, who indicated that she also pain in her thigh.

Both passengers were offered the possibility to take an analgesic to reduce the pain, if needed. They were also told that they had to go to a hospital, where they could undergo a trauma exploration and, if necessary, a diagnosis X-ray, and were informed about the fact that it was impossible for the airport medical service to carry out such explorations at the airport. At the same time, they were offered the possibility to be taken to hospital in the ambulance, if desired. Both passengers refused both possibilities, they got on the airside transfer bus and did not show evidence of difficulties or limitations in walking.

1.14. Fire

There was no fire.

1.15. Survival aspects

Due to the nature of the incident and while the aircraft remained at the same height as the finger by which it was lifted, there was no risk for the passengers during disembarkation.

However, the threat of collapse of the aircraft front door due to the overload caused by the finger during its lifting increased the possibility of passenger injuries. Said risk would

have been higher if the cabin crew had not issued the alert and halted the exit of the passengers from the aircraft.

1.16. Tests and research

The finger n.º 101 of the Terminal 2 of the Barcelona Airport corresponds to a varied airport equipment, with a long service life that had been recently (in June 2015 this very finger) or were being renovated by the supplier that had been awarded the contract.

Post-event tests were performed, with the participation of the company that had carried out the renovation and the finger maintenance company in order to find out the origin of the malfunction.

During the functional testing of the finger, the failure mode occurred during the incident could not be reproduced or replicated. Its subsequent testing, however, showed that the electrovalve of the hydraulic lifting circuit would randomly get blocked or freeze in an open position, failing to perform its requested opening-closure function.

During the attempt to reproduce the failure mode, the rest of the fingers of terminal 2 and terminal 1 were tested with a hydraulic elevation system; and in more detail and specifically finger 107, which had the same typology-technology as the incident and had not been renovated yet. Here, it was found that the pressure group of the elevation system was not active beyond 1 second and therefore, although the control electrovalve would blocked, there would be no uncontrolled lifting/lowering movement due to said time limitation with pressure in the circuit.

The renovation of the finger already performed comprised the replacement of the translation on the platform for its positioning and implementation of a new control panel with new sensors, which also included changes to the programmable logic controller (PLC), which included the development of a new software for the control of the finger movements and a new layout of the control panel.

This new programmable logic controller had defined an activation interval for the pressure group (hydraulic pumps) in the elevation system of 600 s (10 min). Said condition introduced by the new software, along with the failure detected in the electrovalve of the hydraulic circuit explains the failure mode produced during the disembarkation of flight FR 6399, when the finger was lifted up to its physical limits without stopping.

1.17. Organizational and management information

According to the internal organisation of the Barcelona Airport, within the organisation of the Spanish Airports (AENA), the responsibility for the finger lies on the Flight Field

Department and on the Terminal Building Maintenance Department as regards certain operational and maintenance aspects.

Said fingers corresponding to terminal T2, due to the long service life since their assembly or commissioning in 1991, were undergoing a renovation and upgrading process initiated by the airport a few months before this incident. Said refurbishment included, among others, a modification and improvement of the finger handling control software. It did not include, however, an inspection of the condition of the control elements that were not modified during the renovation.

1.17.1. *Internal investigation of the Barcelona Airport, Operational Safety Management Office*

Through its operational safety management office, the Barcelona Airport carried out an internal investigation and analysis of the incident that provided more details about the sequence of events and allowed the implementation of corrective measures.
Finger operational details:

- When its operator or ground controller completed the connection of the finger to the aircraft, he put the safety chock or shoe (figure n.º 2) with the self-leveling system (that regulates the height of the finger depending on the height of the aircraft through pressure sensors and activation/closure of thee lifting/lowering of the finger cabin) activated, and after checking that everything worked correctly, went to an adjacent parking position to remove or pick up another finger.
- When the finger no. 101 was lifted uncontrollably, the audible warning of its cabin started.
- The geometry of the aircraft B-737-800 allows the lifting of the nose gear to a height of only 1.60 metres until the tail makes contact with the ground. Consequently, its maximum lifting had to be less than 2 metres, because the tail was neither marked not damaged.
- The ground controller that arrived to finger 101 notified about its malfunction, noticed how it continued to go up, how the aircraft door collapsed, how it fell and hit the nose gear. He disconnected the finger and manually deactivated the self-leveling.
- There is no history of failures of the electrovalves or self-leveling system for this finger or the group of fingers of the terminal T2 of the Barcelona Airport.
- The final elevation of the finger reached the maximum operational limit or was very close to it and had a long and continuous rise.

Safety measures adopted:

- Additional inspection of the fingers, including the inspection of the modification of the self-leveling programming.

- Inspection of the protection measures in place at fingers in case of failure, considering this new failure mode and the extensive elevation of the finger.
- Make sure that all hydraulic finger elevation pumps have a maximum activation interval of 1 second.
- As a medium-term measure, inspect the condition of hydraulic circuits.

1.18. Additional information

After the occurrence of the incident subject to this investigation (on 12/12/2015), we received a safety report issued by Ryanair with regard to an incident that had occurred on 22 December 2015 at Barcelona Airport at parking position and finger n.º 104, with aircraft B-737-800 EI-DLJ arriving from Bruges (Belgium), where the flight and handling coordinator, during the external inspection of the aircraft noticed the shock absorber of the nose gear that had expanded more than usual, in his opinion. He notified the flight cabin to check the parking break and the ground controller was informed, who pressed the finger emergency stop. The disembarking of the passengers were halted and the airport authorities were notified. The rest of the passengers were disembarked through the rear door and stairs on ramp 2 of terminal 2.

Subsequently, the airport confirmed that after the notification of the incident, they sent finger operation and maintenance staff to position no. 104 and they established that the self-leveling system was working correctly and normally.

They also established the link with the previous incident subject to this investigation, where the flight coordinator was the same, was aware of the aircraft height variation, therefore he had erroneously appreciated the condition of the shock absorber of the nose gear, which was normal.

1.19. Useful or efficient investigation techniques

None.

2. ANALYSIS

2.1. Generalities

The Ryanair aircraft with flight number FR-6399 was parked at position 101 of terminal 2 of Barcelona Airport and disembarking the passengers through the finger (air bridge). During the disembarkation of the passengers, around 20:30 UTC (21:30 local time), a flight attendant noticed the unusual behaviour of the aircraft nose and notified the flight crew that were completing the check list. The crew got the confirmation that the aircraft was lifted by the finger connected to door L1 and the passengers that were still on board were given instructions to sit down and fasten their seat belts.

When a few seconds later the door L1 collapsed and got damaged, the nose of the aircraft collapsed from an estimated height of 2 m and hit its nose gear. The rest of the passengers, who were still inside the aircraft, were subsequently disembarked through the rear door.

A female passenger reported knee injury and another showed anxiety. Medical assistance was requested from the airport and the ambulance arrived to the aircraft in two minutes and offered medical assistance on ground and at the steps of the plane to two passengers that reported discomfort, although they eventually got on the airside transfer bus and refused transfer to a hospital for further diagnosis.

2.2. Finger failure

The functional tests carried out by the airport and the companies in charge of the maintenance and renovation of the fingers managed to isolate and reproduce the failures and elements that caused the uncontrolled lifting of the finger 101.

The presence of a random and latent failure of the electrovalve of the finger elevation hydraulic circuit, along with the increase of the interval for activation of the pressure group in said hydraulic system (of 600 s instead of 1 s) introduced through the new programming, explain the failure mode occurred during the disembarkation of the flight FR 6399. After 1/3 and 1/2 of the passengers disembarked and probably also part of the luggage, the lifting of the finger was activated (due to the variation of the aircraft height with less weight detected through the safety shoe mounted between the door L1 and the floor of the swivel finger cabin) by the self-leveling system, and the input of hydraulic pressure was not halted due to an electrovalve failure and the increase of the time of the availability of the pressure in the circuit.

Although the airport performed a full analysis of the incident, causes and consequences and several corrective actions have been carried out, and we are sure that the test procedures has been improved after the renovation of stairways, a latent failure, such

as that of the electrovalve, might still be hidden in the operation of the fingers through the programmable logic controller, as it could have certainly occurred before the renovation of the finger.

The airport has a preventive and corrective maintenance of the air bridges that tries to guarantee its correct functioning throughout the life of the main system and the associated subsystems. But as experience in the maintenance of electromechanical elements proves, the reviews do not guarantee that these elements cannot fail in a period immediately after its verification.

In order to achieve a high degree of continuous safety and to avoid the lack of coordination and the appearance of new ways of failure in the renovation processes, a safety recommendation is issued to the Barcelona airport, in order to guarantee the preventive maintenance before and after the processes of renovation of the air bridges, to verify the good condition of the elements that will remain in them after the modification process.

The change of parameters in the logic programming originated as a consequence of the renovation also seems to have been done without taking into account factors of design and operation of the original air bridge as well as the absence of an evaluation of the possible failure modes of the old elements and systems and the new ones incorporated into the renovation proceee. For this reason, a safety recommendation is issued to the UTE (temporary joint venture) UTE Adelte & Ports Maritime, S.L.-Luis Pares, S.L. to evaluate all possible failure modes of the air bridges after their remodelling.

3. CONCLUSIONS

3.1. Findings

- All flight crew members had their permits and medical certificates valid and in force.
- The uncontrolled lifting up to its maximum operational height of the finger took place during the disembarking of the passengers, when one third to half of the passengers and load had already been disembarked.
- An audible alarm notifying its failure started and was heard by the flight coordinator.
- The flight attendant noticed the behaviour of the aircraft nose and halted the disembarkation of the passengers.
- The left front door collapsed and the front airframe of the aircraft fell over the nose gear from an approximate height of 2 m.
- The inspection and functional tests of the finger revealed the failure of an electrovalve of the elevation hydraulic circuit of the finger self-leveling system.
- The renovation of the finger, carried out a few months before, included an increase of the interval of activation of the hydraulic pump of the finger elevation circuit.
- The combination of the two aforementioned findings explained and reproduced the uncontrolled lifting of the finger.

3.2. Causes/contributing factors

It is considered that the uncontrolled lifting of the finger was caused by the combination of the failure of the electrovalve of the hydraulic elevation circuit and the modification of the interval for the activation of the pump of this circuit of the self-leveling system, that had been operated during the renovation of the finger a few months before.

4. SAFETY RECOMMENDATIONS

In order to achieve a high degree of continuous safety and to avoid the lack of coordination and the appearance of new ways of failure in the renovation processes, a safety recommendation is issued to the Barcelona airport.

REC 80/16. It is recommended to the Barcelona Airport that guarantee the preventive maintenance before and after the processes of renovation of the air bridges, to verify the good condition of the elements that will remain in them after the modification process.

The change of parameters in the logic programming originated as a consequence of the renovation also seems to have been done without taking into account factors of design and operation of the original air bridge as well as the absence of an evaluation of the possible failure modes of old elements and systems and the new ones incorporated into the renovation process. For this reason, a safety recommendation is issued to the UTE (temporary joint venture) UTE Adelte & Ports Maritime, S.L.–Luis Pares, S.L.

REC 81/16. It is recommended that UTE Adelte&Ports Maritime, S.L.–Luis Pares, S.L., who is renovating the finger, assess all its possible failure modes.