Report

Accident on **21 March 2008**
at **Limoges-Bellegarde aerodrome (87)**
to the **Boeing 737-800**
registered **EI-DAF**
operated by **Ryanair**

BEA

Bureau d'Enquêtes et d'Analyses
pour la sécurité de l'aviation civile

Ministère de l'écologie, de l'énergie, du développement durable et de la mer, en charge des technologies vertes et des négociations sur le climat

Foreword

In accordance with Annex 13 to the Convention on International Civil Aviation, with EC directive 94/56 and with the French Civil Aviation Code (Book VII), the analysis of the accident and the conclusions and safety recommendations contained in this report are intended neither to apportion blame, nor to assess individual or collective responsibility. The sole objective is to draw lessons from this occurrence which may help to prevent future accidents or incidents.

Consequently, the use of this report for any purpose other than for the prevention of future accidents could lead to erroneous interpretations.

SPECIAL FOREWORD TO ENGLISH EDITION

This report has been translated and published by the BEA to make its reading easier for English-speaking people. As accurate as the translation may be, the original text in French is considered as the work of reference.

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Synopsis

Event:	Runway overrun during landing
Consequences and Damage:	Airplane bogged down, engines damaged
Aircraft:	Boeing 737-800
Date and Time:	Friday 21 March 2008 at 14 h 58[1]
Operator:	Ryanair
Place:	Limoges-Bellegarde aerodrome (87)
Type of Flight:	Public transport of passengers
Persons on Board:	6 Crew members, 175 passengers

[1] All times in this report are UTC, except where otherwise specified. One hour should be added to express official time in metropolitan France on the day of the accident.

1 - HISTORY OF FLIGHT

The airplane, coming from Belgium, was supposed to stop for 25 minutes at Limoges-Bellegarde aerodrome (87), without refuelling, then return to Belgium with more passengers. The copilot was PF on the leg.

The ATIS information at 14 h 01, heard by the crew, stated that runway 21 was in service, that the wind was from 280° at 13 kt with gusts to 25 kt, and mentioned light rain and mist. On the onboard weather radar, the crew identified a zone with high water content near the aerodrome. During the descent, below 6,000 feet altitude, they could see this precipitation. Thinking that these showers would probably reach the aerodrome at the time of landing, the crew asked the controller for an option, in case of missed approach, to climb on the extended centreline up to 4,000 feet[2]. The controller accepted the request.

[2] The published procedure requires a turn to the right at 1,900 ft, which would have placed the airplane in the centre of the precipitation.

On long final at 3,000 feet, the airplane was offset to the left of the extended centreline with a right crosswind of around fifty knots. The rain intensified, so the crew switched on the windscreen wipers and selected auto-braking on position "3".

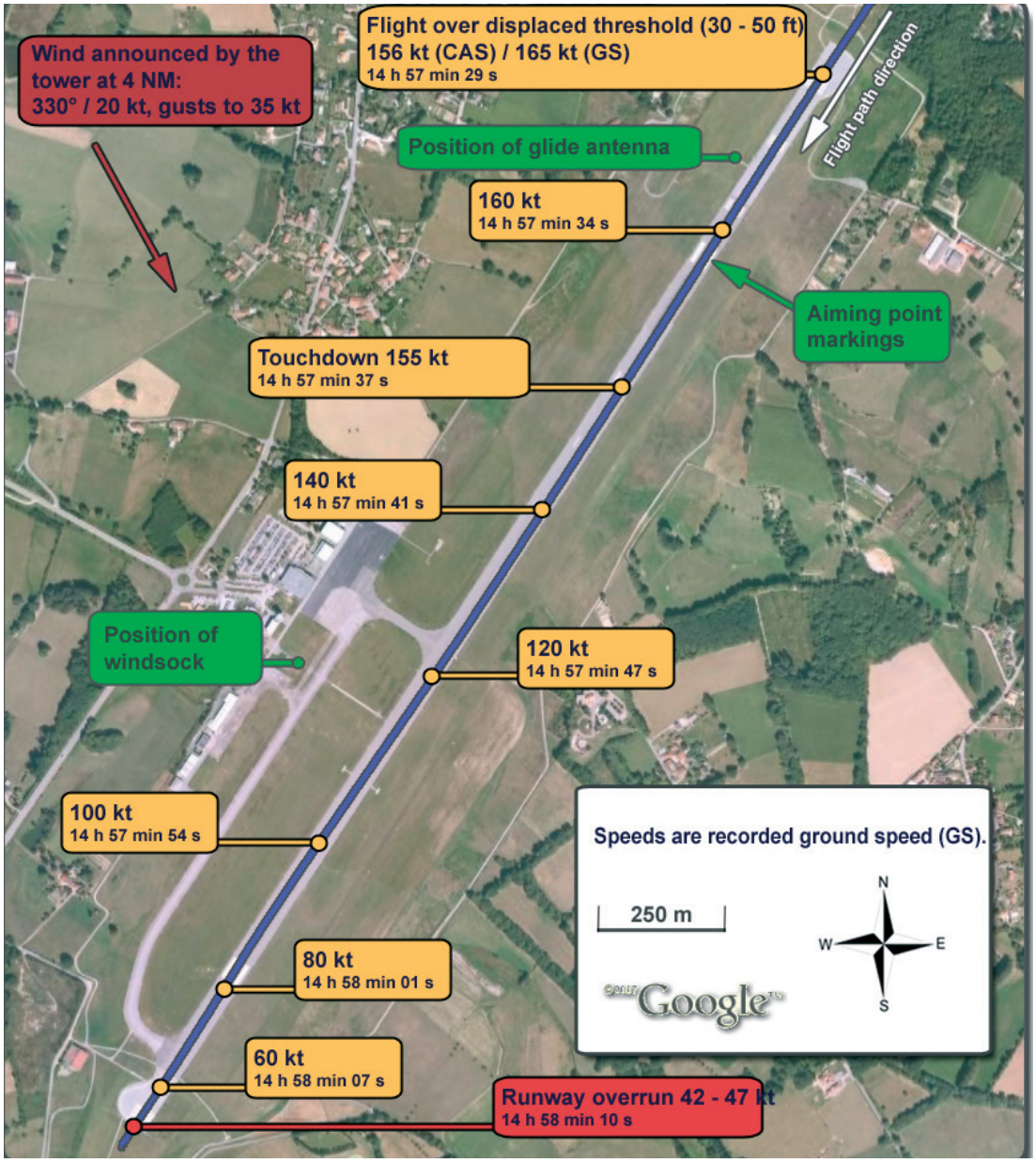
When the airplane was 4 NM out on final, established on the ILS axis, the controller cleared it for landing on runway 21, announced a wind from 330° at 20 kt with gusts to 35 kt, and indicated that the runway was wet. The crew acknowledged without reading back and continued the approach. At a height of 300 ft, the PF disconnected the autopilot and auto-thrust.

During the flare, while the rain was intensifying on the runway, the Captain took control of the airplane. The airplane touched down on the runway to the left of the centreline. The spoilers deployed immediately and reverse thrust applied without delay.

Experiencing some difficulty in getting back onto the runway centreline, the Captain placed the thrust levers in "REVERSE IDLE" to facilitate this, then switched to manual braking and again selected the thrust reversers to 80% of N1.

The airplane overran the runway at a speed of about 45 kt, then came to a stop around fifty metres past the runway end. The Captain called for an emergency evacuation.

The engines were damaged by the ingestion of earth and stones and the airplane was bogged down. Extensive excavation work was required in order to be able to tow the airplane back to the runway.



2 - ADDITIONAL INFORMATION

2.1 Meteorological Conditions

A disturbance was active in the Limoges region, with moderate rain over Limoges. The associated cold front reached Limoges at the time of the landing.

The following information was supplied by the meteorological station located on the aerodrome:

- The wind observed over the two minutes preceding the touchdown was from 330° on average with an average strength of 19 kt with maximum gusts[3] of 34 kt. Over these two minutes, its direction varied between 280° and 010°. The tail wind component may thus have occasionally exceeded 30 kt during the passage of the squall.
- The rainfall measurements, taken every six minutes, show that the airplane touched down at the time of a very heavy rain shower. Around 0.8 mm of water fell during the six minutes before the landing. 1.6 mm fell during the six minutes that included the landing.

[3] A gust has the effect of modifying the wind direction, generally in a clockwise direction in the northern hemisphere.

The crew stated that they did not pay attention to the wind information provided by the controller when the airplane was on final. They kept in mind a crosswind coming from the right with a headwind composite, in accordance with the ATIS. They added that they would have aborted the approach if they had been aware of the tail wind.

2.2 Aerodrome

On runway 21, the landing distance available (LDA) is 2,440 metres. According to ICAO Annex 14, the LDA being longer than 2,400 metres with no PAPI, the aiming point markings are located 400 metres from the threshold instead of 300 metres.

ICAO Annex 14, 5.3.5.1 (standard) specifies that a visual approach slope indicator system shall be provided to serve the approach to a runway whether or not the runway is served by other visual approach aids or by non-visual aids, where the runway is used by turbojet.

The aerodrome has a single windsock, positioned near the tower, thus about 1,600 metres from the threshold of runway 21. It is difficult to see it on short final.

The runway, made of tarred concrete, is not ribbed and has an upward slope on its first half, but then descends. The maximum slope reaches about 0.5%. The slip readings, made on a wet runway, show that runway adherence is above the regulatory requirements.

Part § 5.5.1.7 of the procedures for organisations providing air traffic services to aircraft in general air traffic (RCA 3) states that before a landing, the aerodrome controller must provide the direction and speed of the wind to the crew as well as any significant variations. The RCA 3, in part § 5.5.2.2, also states that information relating to the runway condition must be transmitted to airplanes, in particular the presence of water on the runway (damp, wet, presence of puddles, flooded).

2.3 Configuration chosen for the landing

The flaps were extended to 30° and auto-braking set to "3". The reference speed was 143 kt, for an approach speed of 158 kt, taking into account the wind. These choices by the crew are in accordance with the instructions in the operator's FCOM, stating that the standard flap setting is 30°. This configuration improves the handling on landing with a cross wind and gusts, compared to flaps at 40°, which allows a shorter landing.

2.4 Landing Distances

On the date of the event, the landing limitations taken into account during flight preparation included the margins[4] defined by the OPS1. These calculations are based on the certified performance data, which come from test flights that in particular take into account the following conditions: a dry runway, passing over the threshold at 50 feet, touchdown at 350 metres and immediate maximum application of all means of braking except the thrust reversers. Under these conditions, the landing distance is of the order of 1,000 metres. Taking into account the regulatory margins and with the chosen configuration with flaps extended to 30°, the runway distances to consider during flight preparation are 1,670 metres on a dry runway and 1,920 metres on a wet runway.

In flight, crews have at their disposal the "performance in flight" part of the QRH to check the landing distances in relation to the true conditions, without taking into account the regulatory distances for flight preparation. The QRH normal configuration landing distance data is not certified. It is provided as advisory information to help crew determine the actual landing distance performance of the airplane for different runway surface conditions and brake configurations.

In the absence of information transmitted on braking action, the manufacturer established the following correspondence between the condition of the runway and braking action:

Runway condition	Braking action
Dry	"dry"
Wet	"good"
Compact snow	"medium"
Ice	"poor"

The distances below were determined from the QRH, by taking into account wind information transmitted to the crew by the controller, the use of thrust reversers, a flap setting of 30°, the actual approach speed of 158 kt (Vref + 15 kt) and braking action considered as "good"[5]. The tail wind calculation gives 12 kt, based on steady wind component added to the half of the gust component.

Selection of auto-braking	Distances in QRH
"2"	3,297 metres
"**3**"	**2,569 metres**
"MAX MANUAL"	1,966 metres

[4] The landing distances must be less than 60% of the runway length on dry runway. If the runway is wet, an additional runway distance must be taken into account, by applying a coefficient of 1.15 to the dry runway value.

[5] This choice corresponds to a wet runway in the QRH. The manufacturer's documentation states "The performance level used to calculate the "good" data is consistent with wet runway testing done on early Boeing jets".

These same distances were calculated taking into consideration the wind that the crew selected, which was mentioned in the ATIS information:

Selection of auto-braking	Distances in QRH
"2"	2,764 metres
"**3**"	**2,170 metres**
"MAX MANUAL"	1,649 metres

2.5 DFDR readout

Readout of data from the FDR showed that the airplane, after having been slightly above the ILS glide slope on short final, touched down on the runway about 690 metres from the displaced threshold, at an airspeed of 147 kt and a ground speed of 155 kt. The tail wind component was only 8 knots at that moment and the remaining runway distance available was of the order of 1,750 metres.

The deceleration parameters showed that the airplane braking action was on average 0.11. The coefficients that correspond to 'medium' and 'good' are respectively 0.10 and 0.20.

During the landing rollout, the thrust levers were set on "REVERSE IDLE" then on "IDLE" for about ten seconds. Power up on the thrust reversers then took almost eight seconds.

2.6 Operator's procedures

The FCOM recommends, in a standard situation, use of auto-braking in position "2". It authorizes the Captain to use more efficient braking when necessary, stating that position "2" is a minimum when the runway is wet.

A chapter in the FCOM requires a check, before starting the approach, that the landing performances in relation to the conditions announced are compatible with the runway landing distance available.

Another chapter describes the dangers linked to the presence of a storm during the approach and landing phases: "An aircraft should avoid making an approach if a thunderstorm is active over the airfield or there are cells on the final approach centre line within 3 nautical miles of the field. Crews shall be particularly aware of windshear conditions, and shall review the windshear escape manoeuvre if such conditions exist."

Finally, a chapter states that the standard landing flap will be 30°. This configuration improves the crosswind and gust handling, compared to flaps 40° which allows for a shorter landing.[6]

[6]Standard landing flap setting will be flaps 30. This provides the most efficient and noise effective approach. Flaps 30 will also provide better crossing and gust handling .Flaps 40 will be used optionally to ensure adequate field length landing performance. Crews must be aware that flaps 40 will provide the best brake cooling performance. Flaps 40 will also be used for all autolands. Ideally the use of flaps 25 or flaps 30 as an intermediary setting when landing flaps 40 is recommended.

3 - ANALYSIS AND CONCLUSION

3.1 Flight preparation

The landing distance during flight preparation is of the order of 1,000 metres. The regulations make it mandatory to apply a first coefficient of 1.67 on a dry runway, then a second of 1.15 on wet runway. Thus, the resulting landing distance, of the order of 1,920 metres, appears to offer a high safety margin. This calculation is mainly used to take into account any possible limitations on airplane departure in relation to the conditions forecast for landing.

3.2 In-flight performance calculation

In flight, crews use performance data[7] on landing closer to reality to evaluate the possibility of landing in comparison to the transmitted conditions. Subsequently, many parameters have an influence during the course of the landing, which can increase the real stopping distance of the airplane. The accumulated effect of several unfavourable factors can lead to a significant reduction, or even the elimination of margins and finally to a runway overrun:

[7]Those of the QRH.

- The published landing performance values take into account passing over the threshold at 50 feet, and thus an aiming point 300 metres from the threshold. However, for all runways over 2,400 metres with no PAPI, the marks that represent the visual flight path aiming point are located at 400 metres. Yet, there are number of runways over 2,400 metres long, which has aiming point markings at 300 metres. For example, at Marseille for Rwy 32R, aiming point markings is at 300 metres from THR, same as PAPI and ILS GS antenna.
- The instructions for landing in case of a storm or a storm cell nearby determine the limits for undertaking the approach. This event shows that other meteorological phenomena can affect landing. The passage of a cold front causes rapid variations in wind direction and intensity, generally accompanied by heavy precipitation.
- If the wind moves round and becomes a tailwind, the touchdown point can be moved, and the speed and the landing distances increased.
- Crosswind can make lateral control difficult, and oblige the crew to defer using the thrust reversers.
- Precipitation can temporarily be greater than that transmitted and downgrade runway adherence.

3.3 Transmission of information

The crew were not fully aware neither of the intensity of the precipitation and condition of the runway, nor of the change in the wind direction. The controller had transmitted information on this subject, with the wet runway and the wind direction, though his message did not underline recent changes (wind rotation and strengthening precipitation). The relatively neutral form of this message did not warn the crew.

In conclusion, the regulatory margins, which appear to be adequate in normal conditions on a dry runway, can be considerably reduced or eliminated when a change in the meteorological conditions leads to an accumulation of unfavourable factors.

Information on these changes, which can affect flight safety, is essential to crew decision-making.

BEA

Bureau d'Enquêtes et d'Analyses
pour la sécurité de l'aviation civile

Zone Sud - Bâtiment 153
200 rue de Paris
Aéroport du Bourget
93352 Le Bourget Cedex - France
T : +33 1 49 92 72 00 - F : +33 1 49 92 72 03
www.bea.aero

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