Bundesstelle für
Flugunfalluntersuchung

German Federal Bureau of
Aircraft Accident Investigation

Investigation Report

Identification

Type of Occurrence:	Serious incident
Date:	8 January 2010
Location:	Nürnberg
Aircraft:	Transport aircraft
Manufacturer / Model:	Boeing / 737-800
Injuries to Persons:	None
Damage:	Minor damage to aircraft
Other Damage:	Minor crop damage
Information Source:	Investigation by BFU
State File Number:	BFU 5X002-10

Factual Information

History of the Flight

The Boeing 737-800 (B738) was scheduled for a flight from Nürnberg (EDDN) to Düsseldorf (EDDL); departure time 2030 hrs[1]. On board were six crew members and 125 passengers. Take-off run occurred with one hour delay at which the airplane veered to the right off the runway after about 150 m.

[1] All times local, unless otherwise stated.

From 2107 hrs to 2118 hrs the airplane was de-iced with 100% de-icing fluid type II (undiluted). While rolling to the runway the crew reported "... ready for departure". The controller answered "braking action on runway medium, contact tower ...".

After the initial contact with the tower the controller instructed "... hold short, I call you", which the crew acknowledged. When the controller asked "... ready for rolling" the answer was "affirm ...". Which was followed by the instruction "... line up one zero". At around 2128 hrs, about 13 seconds later, take-off clearance was given "... cleared take-off, company traffic is 6 miles". Rolling to and onto the runway occurred without stopping and with a ground speed of about 21 kt.

The airplane lined-up on runway 10 (runway direction 099°) with a right-hand turn. While lining-up on the runway the two main landing gears reached a position left of the runway centre line. The crew steered the airplane to the right and stated that afterwards it was no longer possible to steer it to the left.

According to the Flight Data Recorder (FDR) both thrust levers were moved from about 36° to about 46° while passing a heading (HDG) of about 20° with a ground speed of about 12 kt. Thrust of both engines increased from about 21% N1 to about 43% N1. The recordings of the left and right N1 show that the engines accelerated with a difference of initially about 2% and later about 4%; the left engine showed the higher thrust values throughout. After that, N1 of the left engine remained at about 43.2% and of the right at about 42.5%; for the next 9 seconds both values remained constant.

About 43% N1 of the left engine was reached at HDG 73°; at that time ground speed was about 12 kt. The airplane accelerated in 12 seconds from about 12 kt to 19 kt ground speed. The heading of about 112° was passed with a ground speed of about 19 kt. During the acceleration phase the airplane passed a heading of about 120° with a ground speed of about 17 kt. Once these values were reached the thrust levers were pulled back to about 5° and within 9 seconds engine thrust decreased to about 21% N1. Within 6 seconds ground speed decreased from 19 kt to 0 kt.

The aircraft veered off the right runway edge with about 17 kt ground speed. The nose wheel and the right main landing gear came to a stop after about 15 m (about 150 m after the threshold) and about 5 m alongside the runway in unpaved terrain; the left main landing gear remained on the runway. The fuselage was pointing into the direction of 107°.

Personnel Information

Pilot in Command (PIC)

The 50-year-old PIC held an Airline Transport Pilot's License (ATPL (A)) issued according to JAR-FCL, German. He held the type rating as PIC for B737 300 - 900. He was licensed for flights according to Instrument Flight Rules (IFR) and CAT III landings. His total flight time was about 5,291 hours; of which about 3,720 hours were on the type in question. The last simulator training was in August 2009.

The class 1 medical certificate was valid until 20 September 2010.

Co-pilot

The 39-year-old co-pilot held an Airline Transport Pilot's License (ATPL (A)) issued according to JAR-FCL, German. He held the type rating as co-pilot for B737 300 - 900 and was licensed for IFR flights and CAT III landings. He had a total flying experience of about 4,603 hours; of which about 1, 738 hours were on the type in question. The last simulator training was in July 2009.

The class 1 medical certificate was valid until 16 November 2010.

Aircraft Information

The Boeing 737-800 is a low-wing aircraft with two main and one nose landing gears. The aircraft is equipped with 186 seats. The two engines are installed underneath the wings and are equipped with thrust reversers.

The aircraft has a length of 39.50 m, a wing span of 34.40 m and a height of 12.50 m. Under ICAO Fire and Rescue guidelines it is a Class 7 aircraft.

Aircraft manufacturer	Boeing
Type:	B737-82R
Manufacturer’s serial number:	29329
Year of manufacture:	1999
Maximum take-off weight:	79,002 kg
Maximum landing mass:	65,317 kg
Total airframe time:	31,232 hours
Total flight cycles:	15,248
Type of engine:	CFM56-7B26

On 15 May 2007 the aircraft was registered in the Federal Republic of Germany and has since been operated by an air operator.

The Airworthiness Review Certificate was issued on 30 March 2009 by the German civil aviation authority (Luftfahrt-Bundesamt, LBA) and valid until 29 March 2010.

Meteorological Information

The routine weather report (METAR) of 2120 hrs showed wind velocity as 360°/10 kt; visibility as 7,000 m; light snow; scattered clouds in 2,200 ft and 5,000 ft; temperature as -5 °C; dew point as -7 °C; QNH as 1,007 hPa. Additional information concerning runway condition: Runway 10; wet snow; 51% - 100% of the runway covered; 2 mm high; braking action medium.

Aids to Navigation

Not applicable.

Communications

Radio communications were conducted in English. The radio communications recordings were available for the investigation.

Aerodrome Information

Nürnberg Airport has an aerodrome elevation of 1,046 ft AMSL. It has one runway for the directions 10/28. The concrete and asphalt runway is 2700 m long and 45 m wide.

Runway 10 was fully available for the take-off.

The fire and rescue service met the requirements for ICAO category 8.

The airport was closed for all air traffic from 2127 hrs to 0015 hrs.

At 2114 hrs braking action was measured on the runway. The following values were recorded for the individual sections: A: 41, B: 43, C: 47, total 44 which corresponded with the braking action "good". Following the measurement the runway was cleared of snow on a width of 38 m; a subsequent determination of the braking action did not

occur. According to witnesses braking action "medium" was reported to the aerodrome control service after the clearing of the runway.

Flight Recorders

Flight Data Recorder

The airplane was equipped with a Honeywell Solid State Flight Data Recorder (SSFDR), P/N 980-4700-042. For the investigation 969 parameters of the last eight flights were available.

Cockpit Voice Recorder

An Allied Signal Solid State Cockpit Voice Recorder (SSCVR), P/N 980-6022-001 was installed. The SSCVR had a recording capacity of two hours. The total two hours were available for the investigation.

Wreckage and Impact Information

The B738 came to a stop about 5 m to the right of the runway. The wheels of the nose and the main landing gears had sunk into the ground by about 15 cm. No other parts of the airplane had ground contact. The unpaved terrain clearly showed the tyre tracks of the landing gears until the stop. On the runway all three landing gears had left marks in the snow.

Main landing gear BFU

Nose landing gear BFU

Fire

There was no fire.

Organisations and their Procedures

The aircraft was operated by an air operator according to Regulation (EC) No 1008/2008. At the time of the occurrence the Air Operator Certificate (AOC) showed a total of 150 transport aircraft; 64 of them were Boeing 737-700/800.

Excerpts of the operator's OM/B

Chapter Normal Procedures:

2.2 Preflight and Ground Operations

[…]

2.2.16.1 Taxi

…Make all turns over 75° at a slow taxi speed (below 10 kts)

2.3.2 Take Off Roll

…Initiating Takeoff Roll

…Rolling takeoffs are accomplished in two ways:

- *If cleared for takeoff prior to or while entering the runway, maintain normal taxi speed. When the airplane is aligned with the runway centreline ensure the nose wheel steering wheel is released and the LHS applies takeoff thrust by advancing the thrust levers to just above idle (40% N1). Allow the engines to stabilize momentarily then promptly advance the thrust levers to takeoff thrust (autothrottle TO/GA). There is no need to stop the airplane prior to adding thrust.*
- *If holding in position on the runway, ensure the nose wheel steering wheel is released, release brakes and then apply takeoff thrust as described above.*

***Note:** Brakes are not normally held with thrust above idle unless a static run-up is required in icing conditions.*

In the Flight Crew Operation Manual (FCOM), Supplementary Procedures, issued for the operator the aircraft manufacturer describes the following procedure for take-off rolls in icing conditions:

“Takeoff Procedure:

Do the normal Takeoff Procedure with the following modification:

When engine anti-ice is required and the OAT is 3°C or below, the takeoff must be preceded by a static engine run-up. Use the following procedure: Run-up to a minimum of 70% N1 for approximately 30 seconds and confirm stable engine operation before the start of the takeoff roll."

Analysis

On the day of the occurrence temperature was -5°C and it snowed continuously. These data show icing conditions prevailed which made the use of engine de-icing necessary for take-off. Furthermore, the runway was covered with snow. All METARs from 1750 hrs to 0020 hrs indicated braking action as "medium" and reported runway covered with snow. The 45 m wide runway was cleared on a width of 38 m. A 2 mm layer of snow was present and visible on the entire width due to the continuous snow fall.

At all times, ground speed of the airplane during line-up was at least 11 kt. The crew should have anticipated that with the recorded ground speed and the early increase in engine thrust on snow covered ground the airplane may possibly begin to skid and therefore could leave the cleared part of the runway.

Line-up did not occur according to OM/B requirements, i.e. engine thrust was increased too early (HDG 020°) since the airplane had to complete an 80° curve to reach the take-off direction 099°. Due to the large angle nose wheel steering had to be used as well.

The thrust increase, the large angle to the take-off direction, the snow-covered runway and the braking action "medium" resulted in the fact that the aircraft's two main landing gears crossed the runway centre line during line-up.

It was tried to correct this by turning the nose wheel even more. During the correction phase the aircraft was steered to a heading of about 118° in order to get back to the runway centre line. Due to the slippery ground, the increased engine thrust, the increasing ground speed and therefore the increasing acceleration (continuously increasing up to 0.12 g lateral) an unstable line-up was the result. Given the wintry conditions a safe and controlled take-off run was no longer possible.

According to the crew, once heading 118° was reached it was no longer possible to steer back to the take-off direction. The BFU is of the opinion that the reason for it was the ground speed of about 16 kt later increasing to 19 kt which was too high given the runway conditions. In combination with the slippery runway the aircraft could

no longer be stabilised for the take-off run. Due to the increased engine thrust a timely braking was no longer possible; as a result the runway was overrun to the right.

A rolling take-off according to OM/B requirements was not conducted. In fact, engine thrust was only increased to about 40% N1 but the airplane was neither aligned with take-off direction nor was the nose wheel steering in neutral. In addition, because of the slippery ground and the higher ground speed it was harder to steer and control the aircraft with the sensitive nose wheel steering.

A rolling take-off without an additional stop on the runway - as described in the OM/B - is not suited for the weather conditions prevailing at the time. Furthermore, due to the use of engine de-icing the procedure "static run-up" should have been applied which was not the case.

Therefore, both operating procedures - OM/B and FCOM - were not adhered to. The aircraft was never kept on the runway to increase engine thrust to 70% N1.

Moreover, the engines ran with differing engine thrust settings whereby the left engine always had the higher values. Even though the difference was marginal with a slippery ground this can already have an influence on distance and direction.

Conclusions

The cause for the serious incident was the increased ground speed during line-up on a snow-covered runway.

The investigation identified the following contributory factors:

The rolling take-off was not conducted according to OM/B requirements.

The procedure "static run-up" was not conducted even though, given the weather conditions, it would have been necessary.

The continuously falling snow resulted in snow-covered operating areas in spite of continued snow clearing services.

The published procedures for "adverse weather" and "initiating take-off roll" according to OM/B and FCOM were not conducted.

Safety Recommendations

Safety Recommendation No 24/2010

The operator should incorporate the procedure "static run-up" into the OM/B item 2.3 as take-off procedure (besides "rolling take-off" and "standing take-off") as described in the FCOM; so far it is only a Note.

Safety Recommendation No 25/2010

The operator should ensure that all crews are familiar with the corresponding Cold Weather Operations.

During the semi-annual simulator training and the respective check flights (OPC/LPC) Cold Weather Operations and their corresponding procedures should be trained and checked.
In addition, take off runs and abortions on short runways with the corresponding maximum take-off weight in wintry conditions and with contaminated runways should be trained during simulator training.
Furthermore, the training personnel should check these procedures in the scope of standardisation / quality assurance during regular flights.

The air operator has already implemented both safety recommendations.

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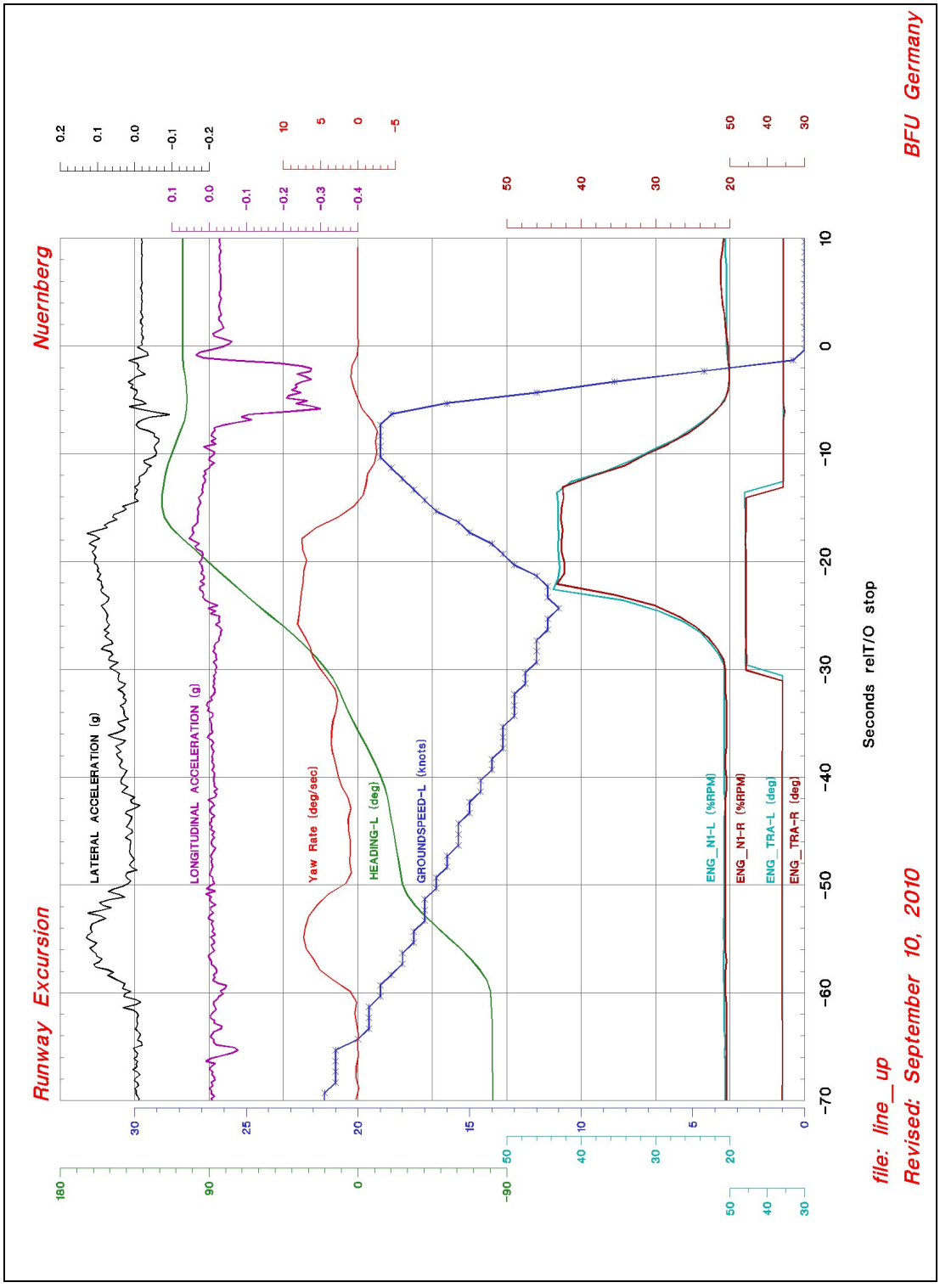
Braunschweig:	2 April 2012

Appendices

Excerpt Flight Data Recorder



This investigation was conducted in accordance with the regulation (EU) No. 996/2010 of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation and the Federal German Law relating to the investigation of accidents and incidents associated with the operation of civil aircraft (*Flugunfall-Untersuchungs-Gesetz - FlUUG*) of 26 August 1998.

The sole objective of the investigation is to prevent future accidents and incidents. The investigation does not seek to ascertain blame or apportion legal liability for any claims that may arise.

This document is a translation of the German Investigation Report. Although every effort was made for the translation to be accurate, in the event of any discrepancies the original German document is the authentic version.

Published by:

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