Bundesstelle für
Flugunfalluntersuchung

German Federal Bureau of
Aircraft Accident Investigation

Investigation Report

Identification

Type of Occurrence:	Serious Incident
Date:	30 September 2017
Location:	Sylt Airport
Aircraft:	Airplane
Manufacturer / Model:	Airbus Industry / A320-214
Injuries to Persons:	None
Damage:	None
Other Damage:	Runway edge lighting
State File Number:	BFU17-1339-5X

Abstract

An Airbus A320 landed at Sylt Airport on runway 32. It overshot the runway and came to a stop in the grass about 80 m after the end of the runway.

Factual Information

History of the Flight

The Airbus A320 had been on a flight from Dusseldorf Airport to Sylt Airport. The Pilot in Command (PIC) was Pilot Flying (PF) and the co-pilot Pilot Monitoring (PM).

The flight crew had the METAR of Sylt Airport of 0720 hrs[1] and of 0750 hrs available during cruise flight. The Cockpit Voice Recorder (CVR) recording showed that due to the low cloud base, the flight crew asked the controller for an instrument approach procedure[2] to runway 32.

At 0756:56 hrs, the flight crew conducted the approach briefing for runway 32. The following was discussed: approach and go-around procedures, tail wind component and the maximum wind speed permissible for the airplane. The auto brake setting “medium” was selected.

At 0811:50 hrs, the air traffic controller issued the ILS approach clearance to runway 32. At 0814:45 hrs, by the PF’s request, the PM put the flaps in position 1. About 20 s later he put the flaps in position 2. At 0815:58 hrs, at a distance of about 11 NM prior to the runway threshold the airplane was stabilised for the approach in regard to the glideslope and the localizer.

At 0816:27 hrs, the controller instructed the flight crew to change to Sylt Tower frequency. At about 0816:38 hrs, autopilot and autothrust were disengaged. At that time the airplane had an altitude of about 2,500 ft AMSL. At 0816:48 hrs, the tower controller issued the landing clearance: “[Call sign] *Sylt Tower, wind one four zero degrees one one knots, runway tree two cleared to land, runway is wet water patches*”.

The two pilots discussed whether to change the previously selected auto brake setting “medium” but decided against it. At 0817:12 hrs, the landing gear was extended and about 23 seconds later the flaps were put in position 3.

The PF instructed the co-pilot to add a speed of 5 kt to the V_{APP}[3] (V_{LS}[4] + 5 kt) in the approach menu of the Mode Control Unit (MCDU). Subsequently, the PIC requested

[1] All times local, unless otherwise stated.
[2] Instrument Landing System - ILS
[3] V_{APP} - Final approach speed
[4] V_{LS} - Lowest selectable speed

to put the flaps in position Full. Then the pilots completed the landing checklist. At the time, the airplane was about 4.6 NM from threshold 32.

At 0819:14 hrs, the 400 ft AGL point was crossed and the PF said "Land". The tower controller once again gave the flight crew the current wind data (140°/10 kt).

At 0819:24 hrs, the PF said to the PM he had runway 32 in sight. One second later the minimum approach altitude for the ILS approach of 230 ft AMSL was reached. He said: “Continue”. The threshold was crossed at about 50 ft Radio Height and with a ground speed of 163 kt. Another 6 s later, the PF said: “Na komm, geh runter (come on, go down).“ One second later the automatically generated computer voice of the Enhanced Ground Proximity Warning System (EGPWS) announced: “Five“, another two seconds later again: "Five", According to the Flight Data Recorder (FDR) data the airplane touched down at 0819:49 hrs about 930 m beyond threshold 32.

The auto brake function was deactivated about 5 s after touch-down by the PF applying the pedals in the cockpit. The FDR data showed that the maximum brake pressure was reached.

At 0820:12 hrs, the airplane crossed the end of runway 32 with a ground speed of approximately 44 kt and came to a stop after approximately 80 m. Via the intercom the PF instructed the cabin crew twice: “Attention crew on station“.

Once the fire brigade had reached the airplane they contacted the flight crew. Passengers and crew disembarked via mobile stairs. No one was injured.

The PIC later told the BFU that he had had the impression that he had flared too far and was aware that they had touched-down somewhat late. But he had not seen the necessity for a go-around procedure.

The co-pilot stated that he had had the impression that a go-around was imminent, but he had not intervened. During the police interview the co-pilot said that the approach lighting could be seen very well.

Personnel Information

Pilot in Command

The 61-year-old PIC held an ATPL(A)) issued on 2 March 2015 by the Luftfahrt-Bundesamt in accordance with Part-FCL. The licence listed the ratings for PIC on A320 in accordance with instrument flight rules (PIC IR). It was valid until 31 March 2018.

The BFU had been provided with his class 1 medical certificate, valid until 25 February 2018, with the restrictions TML[5] and VNL[6]. He had a total flying experience of 17,000 hours, of which 5,757 hours were flown on Airbus A320.

For him this was the first flight of the day. He also stated that he had not felt tired. Prior to this flight he had had two days off.

Co-pilot

The 35-year-old co-pilot held a Commercial Pilot's Licence (CPL(A)) issued on 31 July 2015 by the Luftfahrt-Bundesamt in accordance with Part-FCL. The licence listed the ratings as co-pilot for Airbus 320 in accordance with Instrument Rules (COP IR). It was valid until 31 July 2018. The licence also listed the ratings as COP IR for A330 and A350. It was valid until 31 January 2018.

The BFU was provided with his class 1 medical certificate, valid until 30 April 2018. He had a total flying experience of 6,148 hours, of which 4,038 hours were flown on Airbus A320.

For him this was the first flight of the day. He also stated that he had not felt tired. On the day before he had conducted a flight with four legs.

Aircraft Information

The Airbus A320-214 is a short and medium range transport aircraft equipped with 2 fan jet engines (Fig. 1).

Manufacturer	Airbus Industry
Year of manufacture	2009
Manufacturer's serial number	3908
Operating time	25,501 hours
Flight cycles	18,826
Engine type	CFM56-5b4/3
Maximum zero fuel mass	61,000 kg

[5] Limited period of validity of the medical certificate
[6] Valid only with correction for defective near vision

Maximum take-off mass	77,000 kg
Maximum landing mass	64,500 kg

The Aircraft had a German certificate of registration and was operated by a German operator.

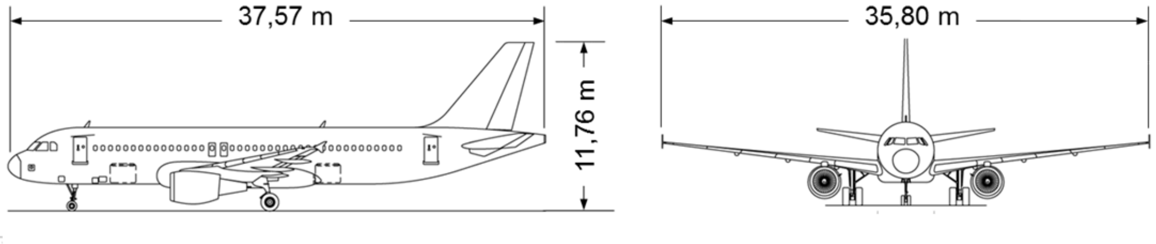

Fig. 1: Two-way view of the Airbus A320-214 Source: Manufacturer/Adaptation BFU

Aircraft Operating Limitations

In the Flight Crew Operating Manual (FCOM), 14.01.2016, chapter LIM-12 *Limitations - Environmental Envelope and Airport Operations* lists a permissible tail wind component of 15 kt during take-off and touch-down.

Approach Speed and Landing Distance

Using the Electronic Flight Bag (EFB) the flight crew calculated an approach speed (V_{APP}) of 131 kt and a landing distance required of 1,990 m for a tail wind component of about 12 kt.

Landing mass	about 55.7 t
Remaining fuel (included in the landing mass)	about 8 t
Flap configuration	Full
Runway Condition	Water on the runway
Auto brake position	Medium
Wind direction & wind speed	140° / 12 kt

Tab. 1: Input data for the calculation of the landing distance Source: Operator/BFU

Electronic Flight Bag

The EFB consisted of an Apple IPad on which software for the calculation of the landing distance was installed.

Documentation on Board

The on-board documentation included the Hold Item List (HIL) as part of the Techlog. It showed the following entries with which the airplane had taken off in Dusseldorf.

Item	CDL[7] / MEL[8] / Crew Info[9]	Due Date[10]
Steering Deviation During Taxi	Crew Info	10.10.2017
Engine No. 1 Fire Loop B INOP	CDL / MEL	27.09.2017
FWD LAV Flush Cover Broken		6.10.2017
Captain Table Unserviceable	CDL / MEL	24.02.2018

Tab. 2: Minimum Equipment / Configuration Deviation List Source: Operator/BFU

It was investigated whether the entry *Steering Deviation During Taxi* had any effect on the controllability of the airplane on the runway. The analysis of the data showed that there was no tendency to deviate laterally from the runway centre line.

Meteorological Information

At the time of the incident it was daylight. According to the METAR[11] of Sylt Airport of 0820 hrs, horizontal visibility was 1,200 m. The runway visibility range of runway 32 was more than 2,000 m. No changes were expected. Wind direction 140° with 11 kt. Cloud cover was 8/8 at 200 ft GND with mist and rain. Temperature was 15°C, dewpoint 14°C, and QNH 1,015 hPa.

The tower controller stated that at the time of landing it had been raining.

[7] CDL – Configuration Deviation List
[8] MEL – Minimum Equipment List
[9] Crew Info
[10] Due date
[11] METAR: short standardised report providing the weather information of an individual airport

Previous METAR

At 0750 hrs horizontal visibility was 1,800 m. Wind direction 140° with 11 kt. Cloud cover was 8/8 at 300 ft GND with mist. Temperature was 15°C, dewpoint 14°C, and QNH 1,015 hPa

Aids to Navigation

The approach to runway 32 of Sylt Airport was conducted as ILS approach. According to the Aeronautical Information Publication (AIP) chart of 10.Dec.2015, minimum descent altitude for the ILS CAT I (C) approach to runway 32 was 230 ft AMSL. Runway 14 was equipped with a Required Navigation Performance (RNP) approach. According to the AIP chart of 17.08.2017, Obstacle Clearance Altitude (OCA) was 410 ft for LNAV approaches of category C aircraft.

Radio Communications

Radio communications between the flight crew and the tower controller were held in English. According to the CVR, radio communications were clearly understandable. The BFU was provided with a transcript as well.

Aerodrome Information

Sylt Airport (EDXW) is located 3.3 km north-east of Westerland city on the north Frisian island Sylt. Aerodrome elevation is 51 ft AMSL. The airport had 2 runways in the directions 142°/322° (14/32), and 058°/238° (60/24). Runway 14/32 had a concrete surface. It was 2,120 m long and 45 m wide. The touchdown zone of runway 32 was 600 m long. Runway 32 was equipped with a Light Intensity High (LIH) lighting system.

Sylt Airport does not have an Airport Surface Friction Tester. According to the statement of the aerodrome operator no rubber removal procedures had been conducted for several months prior to the occurrence. The airport runway safety team checked the runways daily.

On the day of the occurrence it had been raining. According to the statement of the tower controller, the runway was wet and due to dips puddles of water had formed on the runway. He could not say, however, how wet the runway had been at the time of landing.

The aerodrome operator stated that generally surface water was collected and drained through a drainage system at the runway edge. He stated in writing that the drainage system was maintained by a technician. Documentation of the maintenance work conducted was not provided.

Flight Recorder

CVR and FDR Information

Manufacturer CVR	Honeywell
Model	SSCVR
Part number	980-6022-001
Serial number	18776
Manufacturer FDR	L-3COM
Model	FA 2100
Part Number	2100-4043-01
Serial number	403152

CVR and FDR were seized by the BFU. The BFU avionics laboratory was able to read-out the data.

The quality of the CVR recording was good. The recorded radio communications were clearly understandable. The results were 3 audio files of 30 minutes each and 2 sound files of 120 minutes each.

A total of 163:54 hours of flight data had been recorded by the FDR. In order to determine the position of the airplane, the coordinates the FDR had recorded were synchronised with the coordinates of the threshold (Source: AIP AD 2 EDXW of 29.05.2014). The times the FDR had recorded were synchronised with the times the CFR had recorded so that individual events could be correlated.

Approach

When passing the altitudes listed below the FDR recorded the following values:

1,000 ft radio height

- Indicated Airspeed (IAS) about 139 kt, Ground Speed (GS) about 158 kt
- Wind speed about 22 kt, wind direction about 183°
- Glideslope deviation +0.0 Dots, localizer deviation 0.9 Dots

500 ft radio height

- IAS about 139 kt, GS about 158 kt
- Wind speed about 22 kt, wind direction about 183°
- Glideslope deviation +0.0 Dots, localizer deviation 0.9 Dots.

50 ft radio height:

- IAS about 151 kt, GS about 163 kt
- Wind speed about 12 kt, wind direction about 144°
- Glideslope deviation +0.3 Dots, localizer deviation 0.1 Dots

Figure 2 shows the aerodrome chart of Sylt Airport with red markings for the crossing of the threshold, the touchdown point, for the runway excursion and the final position of the airplane.

The markings were determined with the FDR data and incorporated into the AIP chart (of 18.09.2014).

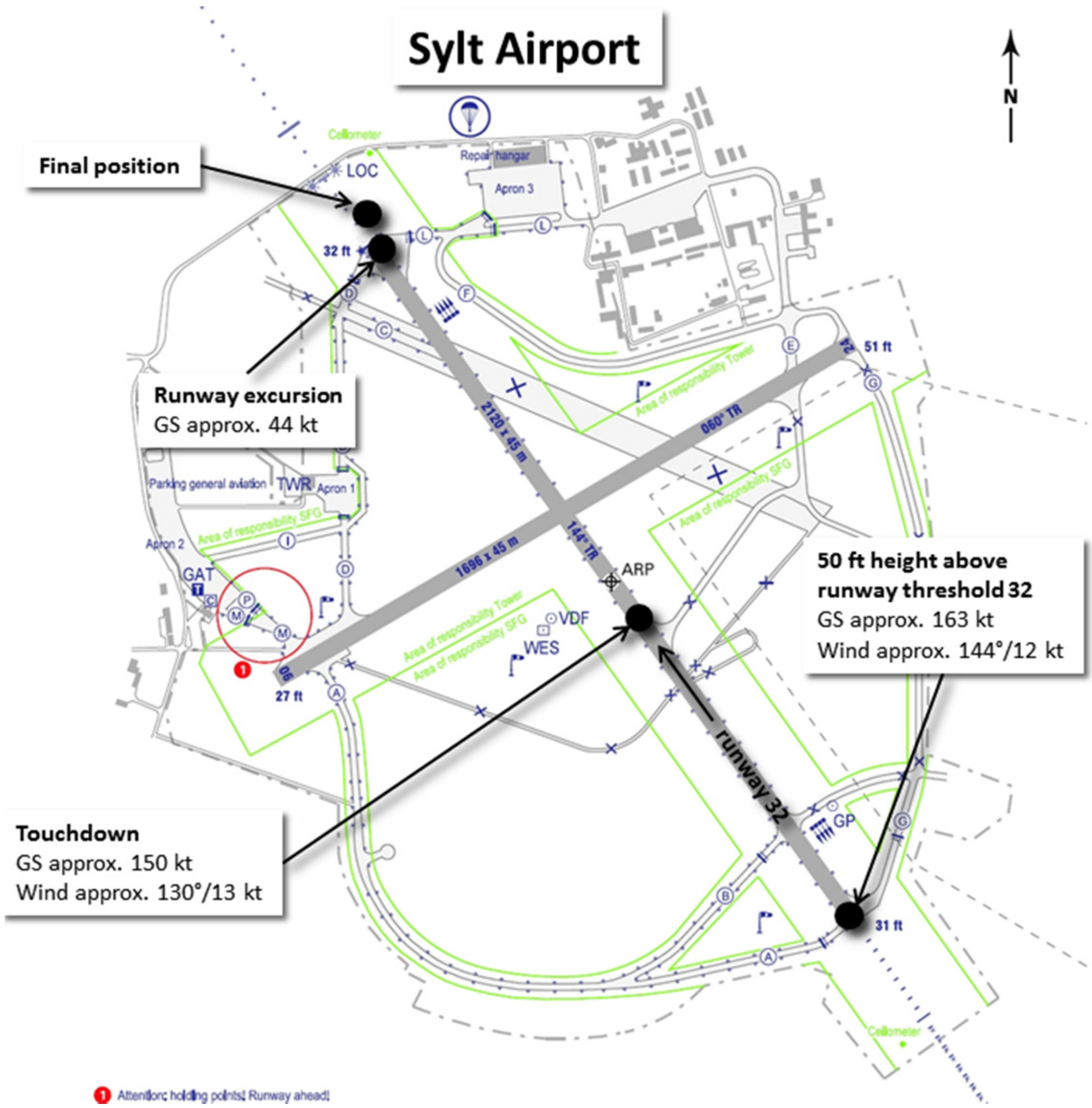

Fig 2: Aerodrome chart of Sylt Airport with FDR data

Source: AIP / Adaptation BFU

Figure 3 shows the vertical view from about 200 ft AGL (radio height) and the rolling distance until the final position. The FDR data was converted in relation to the middle of the threshold from the AIP and the distance given in meters (x-distance and y-distance from threshold). The crosses are the converted FDR values which were connected with plane lines.

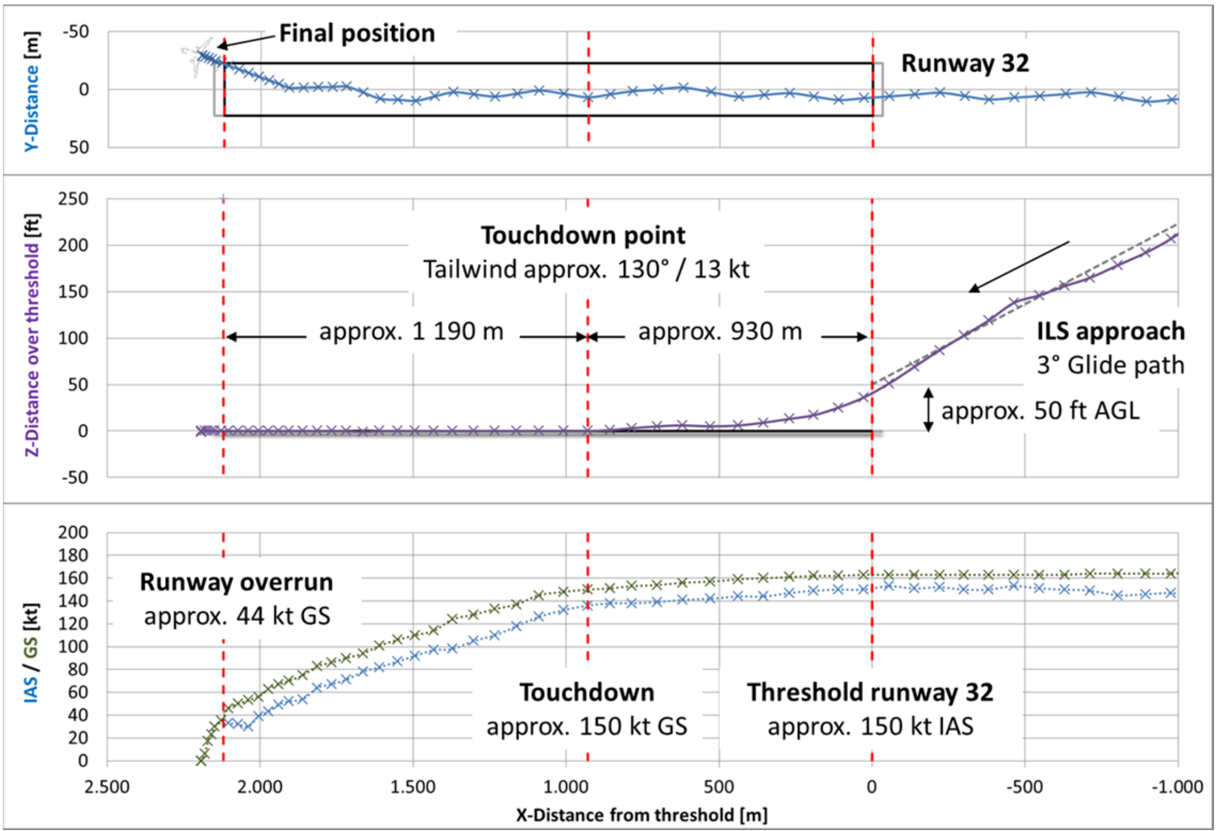

Fig. 3: Vertical view from 50 ft AGL (radio altitude) Source: BFU

The value of the radio altimeter indicates the height of the landing gear in feet above threshold 32 until touch-down and is depicted with a purple line in Figure 3 (Z-distance over threshold).

Touch-down occurred about 930 m after crossing threshold 32. After about 1,190 m from the touchdown point the airplane veered right off the runway. After the runway excursion the ground speed shows the strong deceleration on the grass until the stop after about 80 m.

Figure 4 shows the touch-down point on the runway and the subsequent runway excursion.

The FDR parameter Acceleration Vertical (g) was chosen as indicator for the runway excursion. The FDR parameters Spoiler, T/R Unlocked and Deployed (Thrust Reverser), Brake Auto, Brake Pedal Position, Brake Press and Eng. N1 were selected for the depiction of the deceleration on the runway.

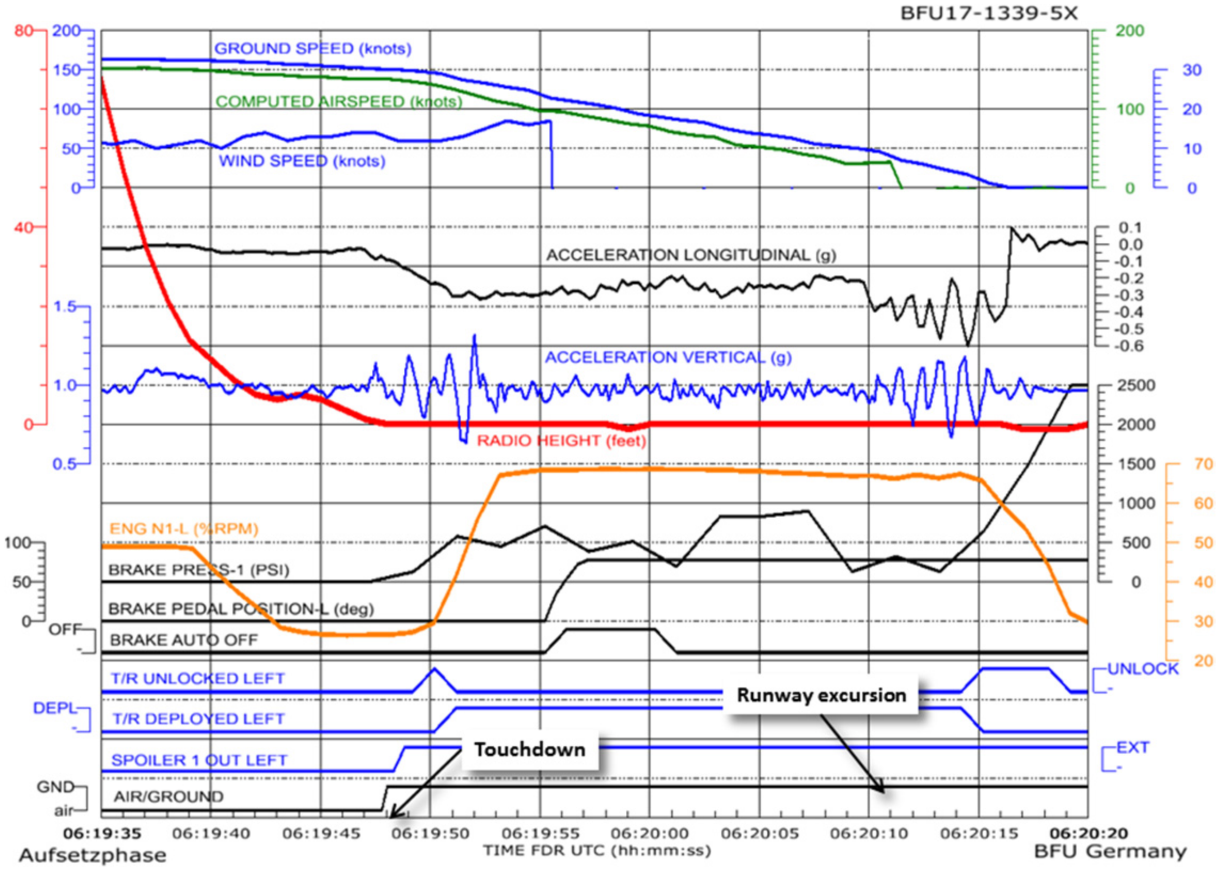

Fig. 4: FDR data, which was recorded during touch-down and the runway excursion

Source: BFU

The following FDR parameters were selected for the examination of the touch-down phase from the 50 ft AGL point, which is the crossing of the threshold, to the touch-down point: Radio Altitude, Pitch Angle, Ground Speed and Vertical Speed (Fig. 5).

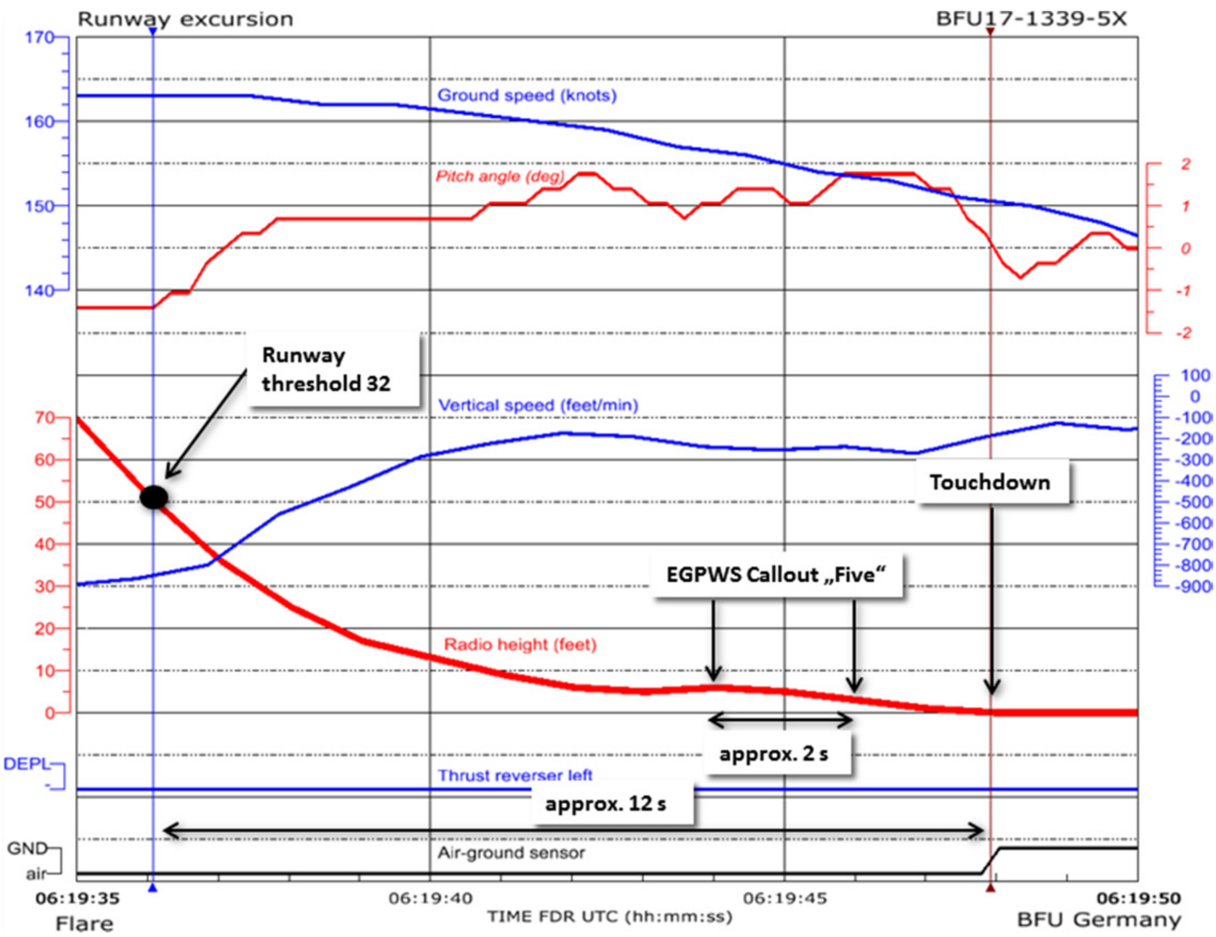

Fig. 5: FDR and CVR data of the flare phase until the touch-down point on runway 32 Source: FDR/BFU

During the occurrence flight the airplane needed approximately 12 s from the 50 ft radio height point to the touch-down point.

As comparison, the above-mentioned parameters of the last 20 flights, which were also recorded on the FDR, were examined as well. The airplane needed on average approximately 8 s for the same distance. During the occurrence flight the flare phase lasted about 4 s longer than on average.

The following FDR parameters were selected for the examination of the deceleration of the airplane on the runway, between the touchdown point until the runway excursion: Brake Pedal Position, Brake Pressure No. 1-4, Thrust Reverser Activation, Spoiler Activation (Fig. 6).

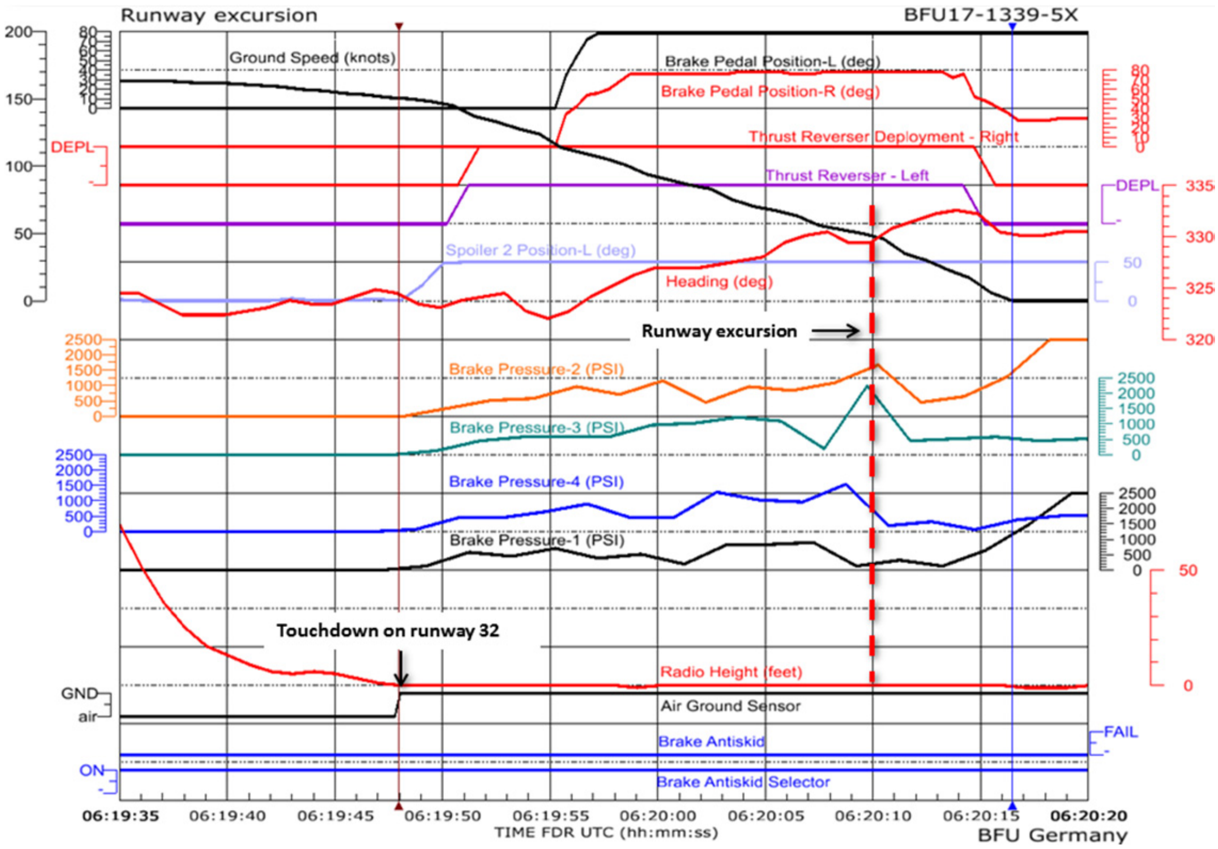

Fig. 6: FDR data illustrating the deceleration of the airplane on runway 32 Source: FDR/BFU

The analysis of the FDR data showed that the deceleration began after the air ground sensor was activated to ground. The mean rate of deceleration was approximately 0.3 g.

By pushing the pedals in the cockpit the auto brake system was deactivated. Afterwards the mean rate of deceleration fluctuated between 0.19 g and 0.32 g. According to the FDR, brake pedal position was about 80°. This was the maximum possible angle. The brake pressure, which was generated through the auto brake system, was between about 550 psi and about 2,200 psi.

Wreckage and Impact Information

The airplane had come to a stop in the grass about 80 m north of the end of the runway. One lamp of the runway threshold lighting of runway 14 had been damaged.

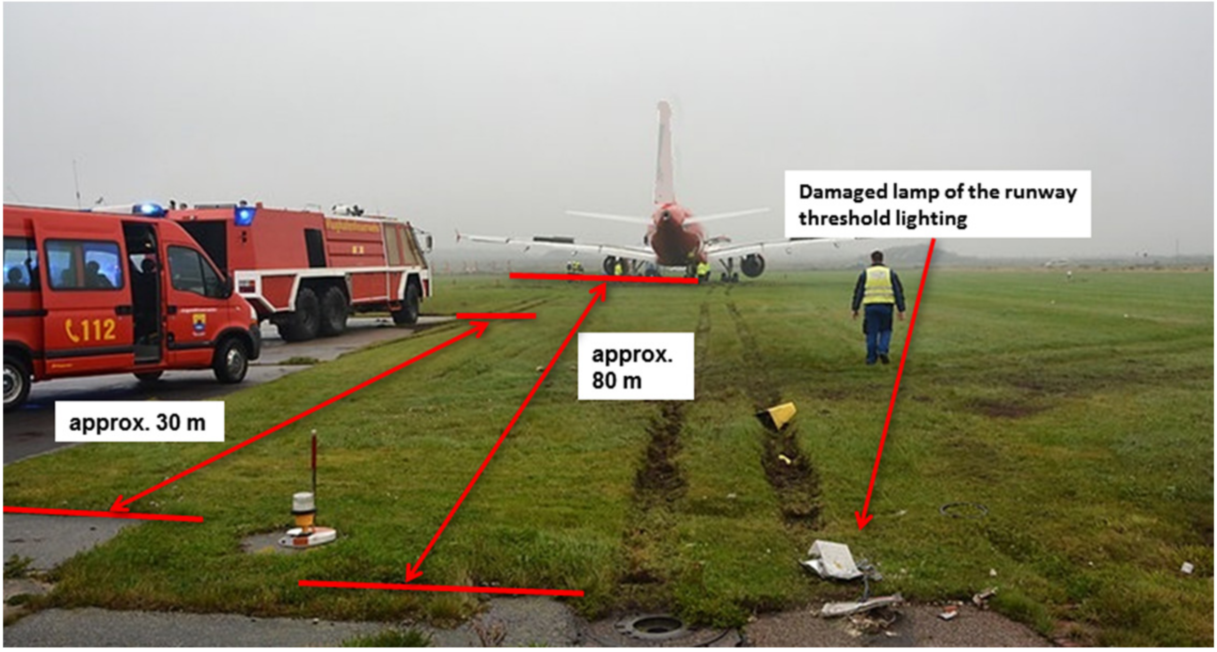

Fig. 7: Airplane position and damaged lighting Source BFU

BFU employees examined the airplane on site for damage. No damage was found. The BFU requested that the Brake Steering Control Unit (BSCU) be removed and seized. A Post Flight Report was compiled using the Centralized Fault Display System (CFDS) which the aircraft manufacturer later analysed.

Fire

There was no evidence of in-flight fire or fire during the landing.

Organisational and Management Information

Approach

The Operation Manual (OM-A), Chapter 8.3.18.2.10 Stabilized Approach Criteria, 07.03.2017, described a stabilized approach as follows:

> *[…] The approach is considered to be stabilized when the airplane is:*
>
> *• on the correct flight path/vertical profile for the flown approach*
>
> *• in the required landing configuration;*
>
> *• maintaining a rate of descent not greater than 1 000 fpm; if an approach requires a sink rate greater than 1 000 fpm, a special briefing must be conducted.*
>
> *• flying with the required speed (IAS of not more than target speed +10 knots and not less than Vref approach speed);*
>
> *• maintaining a thrust setting appropriate for configuration and not below the minimum thrust for approach as defined by the OM/ B / FCOM;*
>
> *• All briefings and checklists have been conducted. […]*

Standard Operating Call-Out

In the Standard Operating Procedures FCOM, Chapter PRO-NOR-SOP-90-D, 23.Dec.2014, the operator stipulated the call-out Go-Around Flaps for the go-around procedure.

Approach Speed

The Airbus Safety Magazine, Edition 24, Safety First, July 2017, describes V_{LS} and V_{APP} as follows:

> *[…]*
>
> *V_{LS} is the lowest selectable speed for the autopilot and the autothrust. Even if the selected target speed is below V_{LS}, the A/THR will maintain V_{LS} as a minimum.*
>
> *V_{APP} is the final approach speed when the Slats/Flaps are in landing configuration and the landing gears are extended.*

The V_{APP} can be computed by the AFS or inserted manually by the pilot through the FMS PERF Page. V_{APP} is based on the V_{LS} of the landing configuration. For Airbus aircraft, in normal operations, the V_{APP} is defined by:

V_{APP} = V_{LS} Landing CONF + APPR COR

[…]

Landing Procedures

The OM-A Vol.1, Rev 17.00, General Basic 8.3.18.2.13, 07.03.2017, defines the touch-down zone as follows:

The touchdown has to be accomplished within the touchdown zone or, if no touchdown zone markings available, 1 000 ft to 2 000 ft beyond the threshold.

Landing Distance Calculation

The FCOM definition *Factored In-Flight Landing Distance* listed a 15% safety addition for the in-flight calculation of the landing distance (FCOM „Performance Landing - General", Chapter PER-LDG-GEN P 2/4, 26.Aug.2015).

Brake Performance Classification

The table Runway Condition Assessment Matrix for Landing (FCOM, Chapter PER-LDG-DIS-MAT P 1/2, 14.Jan.2016) described the degree of the runway surface contamination with the respective brake performance classification. The CVR recording of the approach briefing shows that the two pilots had classified the runway surface contamination for the calculation of the landing distance as medium.

Figure 8 shows which data the pilots had entered into the EFB software to calculate the landing distance and the result. These are screen shots of the input mask on the EFB which were taken on site. The BFU has added more inscriptions.

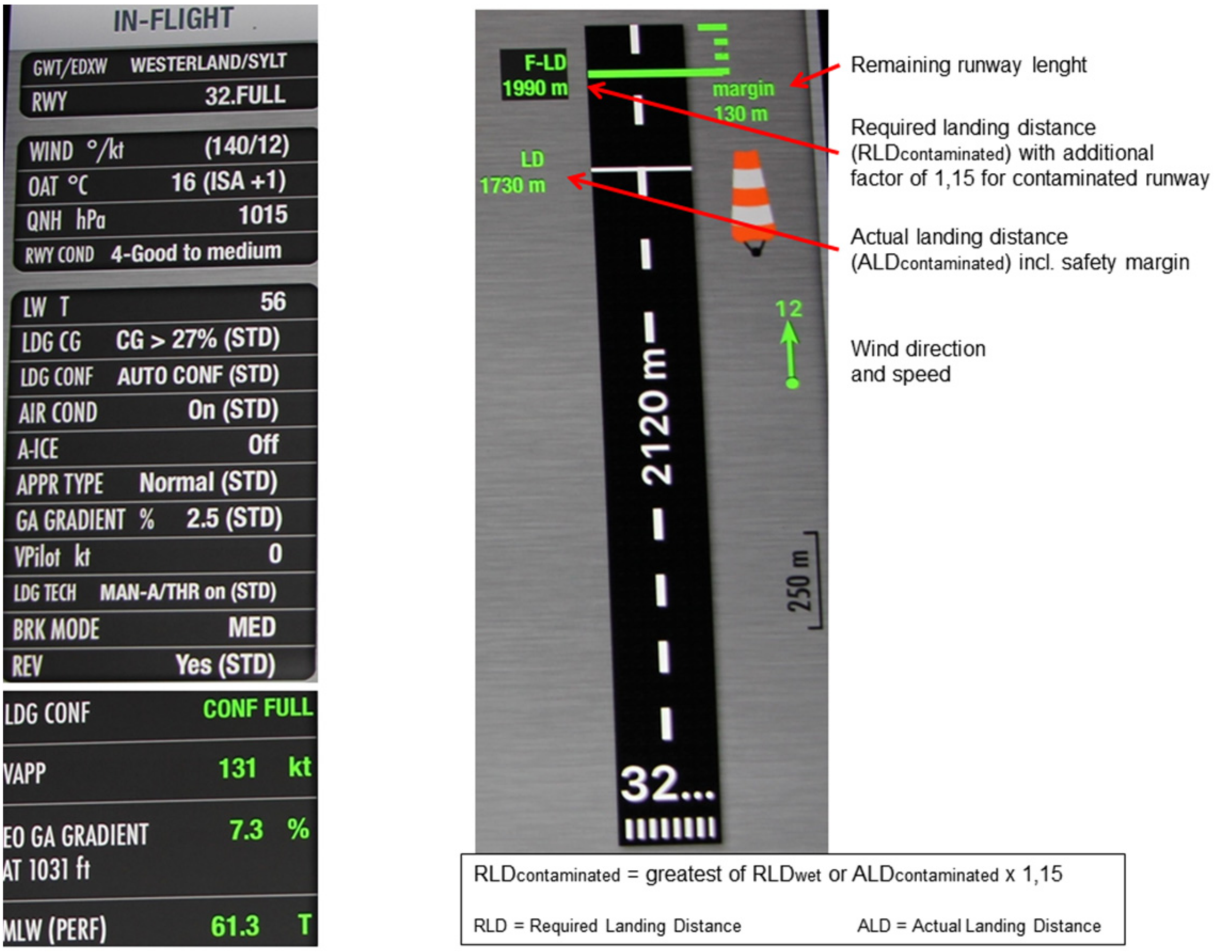

Fig. 8: Screen shots of the input mask for calculation of the landing distance

Source: Operator/BFU

Additional Information

Runway Condition Assessment Matrix for Landing

Based on the FDR data the aircraft manufacturer calculated the runway condition. Examined was the part of the runway where the airplane had a speed of 100 kt GS until the end of the runway. According to the Runway Condition Assessment Matrix for Landing, this runway area had a value of 4 (medium to good) to 3 (Medium). The following Fig. 9 illustrates this.

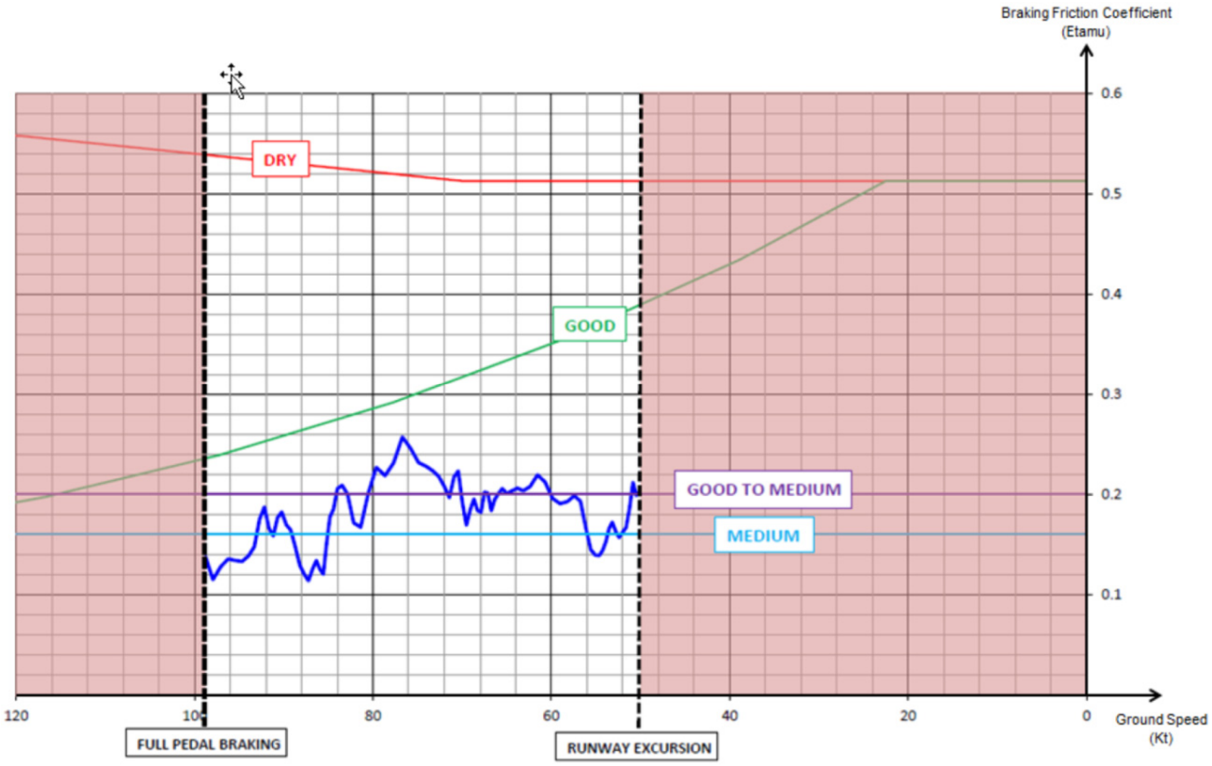

Fig. 9: Calculation of the friction coefficient for the classification of the code for the landing distance calculation

Source: Aircraft manufacturer

Easy Access Rules for Aerodromes

In the edition of January 2018, the European Aviation Safety Agency (EASA) published the Easy Access Rules for Aerodromes (Regulation EU No. 139/2014). In it EASA stipulates to keep the runways in good condition. Contamination of any kind, which would have a negative effect on braking action, should be avoided. The water drainage system should be checked and maintained regularly. In addition, friction measurement should be performed. This should be done in regular intervals to recognise a trend.

The following is an excerpt:

[…]

AMC1 ADR.OPS.C.010 Pavements, other ground surfaces, and drainage

(a) The aerodrome operator shall inspect the surfaces of all movement areas including pavements (runways, taxiways and aprons), adjacent areas and drainage

to regularly assess their condition as part of an aerodrome preventive and corrective maintenance programme.

(b) The aerodrome operator shall: […]

(3) take corrective maintenance action when the friction characteristics for either the entire runway or a portion thereof, when uncontaminated, are below a minimum friction level. The frequency of these measurements shall be sufficient to determine the trend of the surface friction characteristics of the runway. […]

Crew Resource Management

The following is an excerpt of the Journal of Aviation Technology and Engineering 3:2 published in 2014:

> *[…] Presently, the industry is experiencing the sixth generation of CRM, which focuses on the threats and errors that must be managed by crews to ensure safe flight. Current CRM embraces not only optimizing the person-machine interface and the acquisition of timely, appropriate information, but also interpersonal activities including leadership, effective team formation and maintenance, problem solving, decision making, and maintaining SA. Therefore, training in CRM requires communicating basic knowledge of human factors concepts that relate to aviation and providing the tools necessary to apply these concepts operationally. […] Current CRM training continues to offer key guidance on effective communication, task sharing, team building, and teamwork. […]*[12]

[12] Wagener, F., & Ison, D. C. (2014). Crew Resource Management Application in Commercial Aviation. Journal of Aviation Technology and Engineering, 3(2). https://doi.org/10.7771/2159-6670.1077

Analysis

Persons

Both pilots held the required and valid aeronautical licences and ratings. Corresponding with their ratings and flying experiences they were scheduled as pilot in command and co-pilot.

Due to their long-standing flying career, their high total flying experience, and experience on type, both pilots have to be considered as very experienced.

There were no medical limitations. The pilots stated that they had not been tired during the flight.

Aircraft

As part of the Air Operator Certificate (AOC), the aircraft was certified for commercial passenger transport. In accordance with aviation regulation the aircraft had a certificate of registration. There were no entries in the Hold Item List which would have allowed the conclusion of a defect of the navigation equipment and/or the receiver for the localizer and glideslope antennas.

The BFU examined the Hold Item List entry Steering Deviation During Taxi, and came to the conclusion that it was not a contributing factor to the occurrence.

The analysis of the CFDS Post Flight Reports by the aircraft manufacturer showed that the Brake Steering Control Unit had not malfunctioned. Therefore, brake system failure during landing could be ruled out.

The examination of the aircraft did not result in any findings which would have impaired a safe landing under the prevailing conditions.

Weather

Based on the weather data and the statement of the tower controller it had rained that day and the runway was wet. At the time of the occurrence runway visibility range was above the CAT 1 minimum of 230 ft AMSL.

The tower controller stated that water puddles had formed on the runway. There is no written proof concerning the intensity of the puddles. During the police interview both pilots said that the runway had been very wet. The aerodrome operator stated in writing that the runway had only been damp. Based on the METAR, the statement of both pilots and the landing clearance of the tower controller, the BFU is of the opinion that the runway was contaminated with standing water.

Due to non-existing documentation of the aerodrome operator, the BFU could not assess the water drainage system and its design to properly drain water off the runway. The aerodrome operator stated in writing that the water drainage system was maintained by their own technicians.

The BFU could not assess the amount of rubber contamination on the runway. Documentation as to when the last rubber removal procedure had been performed was not available. The airport runway safety team regularly checked the runway for contamination.

The contamination of the runway with water in not ascertainable quantity in combination with an unmeasured but existing amount of rubber deposit constituted a contributory factor in reduction of the braking action of the main landing gear wheels and lengthening of the braking distance.

Airport

The airport was properly certified and had the required inspection records s that the instrument approach - CAT I - could be conducted under the prevailing weather conditions. At the time of the occurrence no take-off or approach took place, which could have interrupted the localizer or glideslope signals.

Operator

The procedures described in the Operation Manual Parts A and B of the operator corresponded with aeronautical regulations.

Flight Crew Action

The CVR contained the approach briefing for runway 32 including a possible go-around procedure. The MCDU calculated the approach speed (V_{APP}) based on the actual aircraft mass.

After he had disengaged autopilot and auto-thrust during the approach the PIC instructed the co-pilot to add 5 kt to the approach speed (V_{APP}) in the approach menu of the MCDU. He did not explain this instruction. The airplane crossed the 50 ft radio altitude point at the threshold with about 151 kt IAS and a ground speed of about 163 kt. The software on the EFB had calculated a V_{APP} of 131 kt. It could not be determined which speed the MCDU had calculated.

Due to the added speed of 5 kt the landing distance required increased. The landing distance calculation was not updated. This resulted in an approach speed which was too high and inappropriate given the circumstances. The BFU does not understand the added speed because of the prevailing tailwind during the approach with no gusts speed increase was not required.

The added speed was an essential contributory factor which resulted in the runway excursion.

The high speed, the long flare phase and the prevailing tailwind resulted in a late touchdown. The touchdown point was about 930 m beyond the threshold and therefore about 330 m outside the stipulated touchdown zone. The remaining landing distance was approximately 1,130 m.

Given the prevailing limiting conditions an additional risk assessment would have made sense. It would have been advisable to conduct a detailed approach briefing including the individual actions during a go-around procedure.

Both pilots used the Runway Condition Assessment Matrix for Landing. Based on the degree of the runway surface contamination the respective brake performance classification was determined. The pilots classified the runway contamination as 4 - Good to Medium. The landing distance calculation based on this classification. Comparison of landing distance required and landing distance available showed a safety margin of 130 m.

The aircraft manufacturer calculated the landing distance for the area where the PIC had applied manual brake pressure. It showed that the pilots' calculation of the landing distance required was close to the actual values.

The airplane touched down about 330 m after the touchdown zone marking. At that time, both pilots were probably not aware that they were already in the second half of the runway.

After the ground spoilers had deployed the auto brake system activated about 2 s later with a mean deceleration of about 0.3 g. By activating the pedal in the cockpit the auto brake system was deactivated. Mean deceleration rate fluctuated between 0.19 g and 0.32 g. According to the FDR, brake pedal position was about 80°, which is the maximum possible angle. This shows that the PIC tried to achieve the highest possible deceleration.

The brake pressure, which was generated through the auto brake system with the switch position Medium, was between about 550 psi and about 2,200 psi. Due to the runway contaminated with standing water braking action was reduced. The fluctuating brake pressure can be explained by the opening and closing of the anti-skid valves[13]. It is hard to say if the airplane could have been stopped prior to the end of the runway if maximum manual brake pressure had been applied after touch-down.

Based on the calculation of the landing distance required (1,990 m) both pilots must have been aware that the safety margin was extremely small and about 130 m long. Especially with short runways, which in this case was also covered with water, a so-called positive touchdown, without long flare phase, would have been necessary. The PIC should have considered this in a risk assessment and included it into the approach briefing.

Crew Resource Management is one safety mechanism in aviation. The fundamental point is that the flight crew members monitor and observe each other and share which actions deviate from the standard procedure and give correction instructions. Teamwork in the cockpit also means that the other person is included in the decision making process. The co-pilot would have had the option to initiate a go-around procedure by using the callout Go-Around according to the Standard Callout Procedure of the operator.

Given the circumstances one of the pilots should have made the callout Go-Around and therefore initiated the go-around procedure. Had the go-around procedure been initiated in due time the runway excursion would have been prevented.

Conclusions

The actual approach speed of 151 kt (calculated V_{APP} of 131 kt) as the airplane crossed the threshold resulted in a longer flare phase and braking distance. The non-performance of the go-around procedure must be viewed as the cause for the runway excursion.

[13] Anti-Skid - prevents the grabbing of brakes.

Safety Recommendations

At the end of 2017 the operator declared bankruptcy. There is no legal successor. Therefore, the BFU will not issue any safety recommendations regarding organisation and procedures.

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Braunschweig 15 October 2020

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.

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