

# Investigation Report

## Identification

Type of Occurrence:	Serious incident
Date:	20 January 2016
Location:	Munich
Aircraft:	Airplane
Manufacturer / Model:	Airbus / A320-216
Injuries to Persons:	None
Damage:	Minor damage to aircraft
Other Damage:	None
Information Source:	Investigation by BFU
State File Number:	BFU16-0055-EX

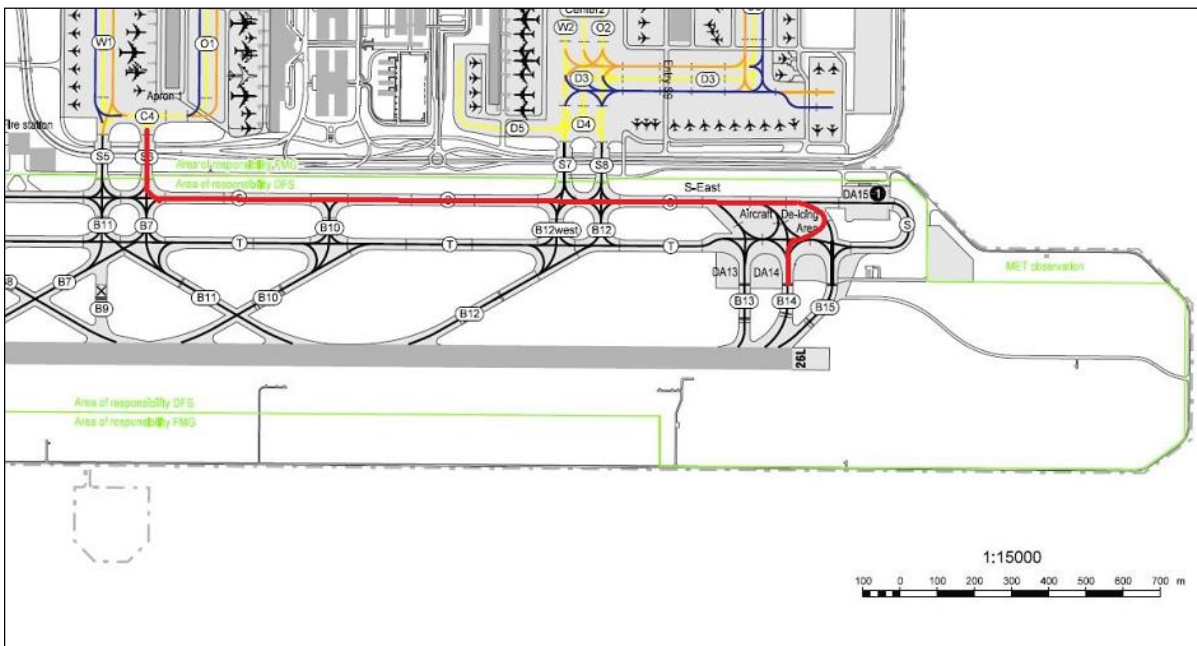
## Factual Information

The aircraft collided with two de-icing vehicles as it began taxiing from the De-icing Area (DA) 14 in front of runway 26L of Munich Airport. Persons were not injured. The aircraft was slightly damaged. Material damage on the two de-icing vehicles occurred.

## History of the Flight

The airplane was ready for a flight from Munich to Madrid and had 110 passengers and six crew members on board. After receiving instruction from apron control, the airplane taxied from the parking position to the holding position S6. Then the flight crew contacted Air Traffic Control (ATC) Munich Ground at 0741 hrs<sup>1</sup> and received the instruction to taxi via taxiway S to the de-icing area DA14.

According to the Flight Data Recorder (FDR) data the aircraft taxied on to taxiway S with a speed of about 20 kt. The Cockpit Voice Recorder (CVR) recordings showed that the co-pilot listened to ATIS during taxiing and then informed the Pilot in Command (PIC) about the content while the aircraft at 0745:32 hrs taxied straight past the turn-off to taxiway B14 with approximately 20 kt. About 60 m east of the turn-off the speed of the airplane began to decrease and at 0745:50 hrs had reached approximately 6 kt.



Reconstruction of the taxi distance based on FDR data

After the ground controller had noticed that the airplane had taxied past the cleared taxiway he instructed the flight crew at 0745:52 hrs: "Hold position [...]", and about 20 seconds later added: "[...] you missed de-icing area one four in bravo one four. Are you able to turn sharp right for bravo one four and de-icing area?" The flight crew

<sup>1</sup> All times local, unless otherwise stated.

answered that they could do that. The airplane turned around and taxied back toward DA14.

At 0747:39 hrs the ground controller requested the flight crew to change to the de-icing frequency. The flight crew acknowledged the change of frequencies.

According to the CVR the pilots established radio contact with the de-icing vehicles at 0748:08 hrs. The team leader of the de-icing vehicles answered: "[...] please stop on the de-icing hold and confirm parking brake set and aircraft ready for de-icing". The crew acknowledged the information with: "We will do so. We will confirm." The two de-icing vehicles were standing at their respective taxiway edge markings facing each other.

At 0748:30 hrs the pilots began to complete the Before De-icing Checklist. First the CAB PRESS Mode selector was selected to Auto, and then the ENG BLEED 1+2, and the APU BLEED were selected to Off. At 0748:49 hrs the PIC requested the co-pilot to select the DITCHING switch to On and added: "Confirma, ditching?". Three seconds later the pilots began a conversation about the fact that just now the fire extinguishing system for the cargo compartment had been activated instead of the DITCHING switch.

At 0749:09 hrs the team leader of the de-icing vehicles asked: "[...] are you ready for de-icing?" The flight crew answered: "Ah, hold on [...]." The team leader said: "Okay, de-icing commences and ah we, make a two-step and ah anti-icing with type one fluid a hundred percent, I call you back."

At 0749:43 hrs the flight crew radioed the team leader: "So control, [...], we need to go back to the parking." After the team leader had answered: "Please [...] please say it again" The flight crew added at 0749:53 hrs: "We need to go back to the stand please. We have one problem." At 0749:55 hrs the team leader said: "You have technical problems, we will wait."

At 0750:25 hrs the flight crew used the ATC ground frequency again to inform the ground controller: "Yeah we have a technical problem. We need to go back to the parking area." He acknowledged this and after coordination with the tower informed the flight crew about two minutes later: "So we have to take you later then via the runway. So initially hold position here and monitor tower one two zero five. He will call you."

The BFU has a photo, which an employee of the de-icing company took from the adjacent DA13. It documents the positions of the airplane and the de-icing vehicles and the weather conditions at 0752 hrs.



Photo of the DA14 at 0752 hrs; view toward east

Photo: Witness/BFU

At 0753:51 hrs, the tower controller established contact with the flight crew. He explained his plan that the aircraft should taxi on to the runway after two approaching airplanes had landed and then leave it right away again at taxiway B13. After the flight crew had agreed the controller said at 0754:16 hrs: "Ok, prepare for that and I will give you a call as I said behind the second landing traffic."

At 0756:54 hrs the controller said: "[...] as we talked about line up runway two six left, make a one eighty and vacate the runway via bravo one three." The crew acknowledged this.

The FDR recording showed that at 0756:57 hrs the parking brake was released and the thrust levers of both engines were pushed forward. The engine thrust N1 started to increase at 0757:00 hrs and the airplane began to move. The speed increased to approximately 3 kt. At 0757:10 hrs the FDR recorded a change in longitudinal acceleration from 0.2 g to -0.15 g. Two seconds later the wheel brakes were actuated and at 0757:16 hrs the parking brake was set again.

At 0757:51 hrs the de-icer shouted via the radio: "[...] what have you ... what do you doing?" The PIC answered: "Sorry, sorry, we were cleared to entering the runway and we leaving contact you. What has happened?" The de-icer answered: "What have you done. Now we are crashed. You ... please stop now." The PIC acknowledged this with the words "we have stopped".

At 0758:23 Hrs the PIC informed the controller that the airplane had collided with both de-icing vehicles.

The PIC stated that during completion of the Before De-icing Checklist the Cargo Smoke FWD DISCH button on the cargo smoke panel for the fire extinguishing system of the forward cargo compartment had been actuated instead of the DITCHING button to close the outflow valve on the cabin pressure panel. Therefore the flight crew decided to return to the stand. After the controller had issued the taxi clearance the flight crew had looked right and left and seen no obstacles. Then the PIC began taxiing. He had had the impression that the parking brake had still been set. Therefore he actuated the wheel brakes.

The team leader stated that the airplane did not turn into taxiway B14 but instead taxied towards taxiway B15, which is farther east. Then the airplane had turned and taxied toward taxiway B14. He stated that the pilots had established radio contact, and he then issued the clearance to taxi to DA14. Once the airplane had reached the holding position, the team leader had contacted the pilots. The flight crew had replied: "parking brake set, aircraft ready for de-icing." The de-icing vehicles had been positioned left and right of the airplane in a distance of 4 - 5 m in front of the wings. Immediately before the de-icing would have started, the cockpit reported a technical problem. The team leader had responded: "... we will wait". No de-icing fluid had been applied at that time.

The team leader heard the aircraft engines ramping up and observed that the stop bar lighting on the taxiway in front of the airplane was switched off and the airplane began to move. After the collision he radioed the flight crew and they acknowledged that the airplane had been stopped.

## Personnel Information

### Pilot in Command

Since 1999, the 42-year-old PIC had been holding an Airline Transport Pilot's Licence (ATPL(A)) issued by the Spanish civil aviation authority (AESA). Ratings for the Airbus A320 and instrument flights (IR(A)) valid until 30 June 2016 were listed in the licence.

The pilot held a class 1 medical certificate valid until 19 October 2016.

He had a total flying experience of more than 15,000 hours; more than 1,000 hours of which were on type. Since 2014 he had been flying as PIC.

### Co-pilot

The 35-year-old co-pilot held a European Union Airline Transport Pilot's Licence (ATPL) issued by the Spanish civil aviation authority (AESA) on 9 September 2009. Ratings for the Airbus A320 and instrument flights (IR(A)) valid until 31 December 2016 were listed in the licence.

He held a class 1 medical certificate valid until 31 August 2016.

He had a total flying experience of about 7,680 hours; more than 3,000 hours of which were on type.

## Aircraft Information

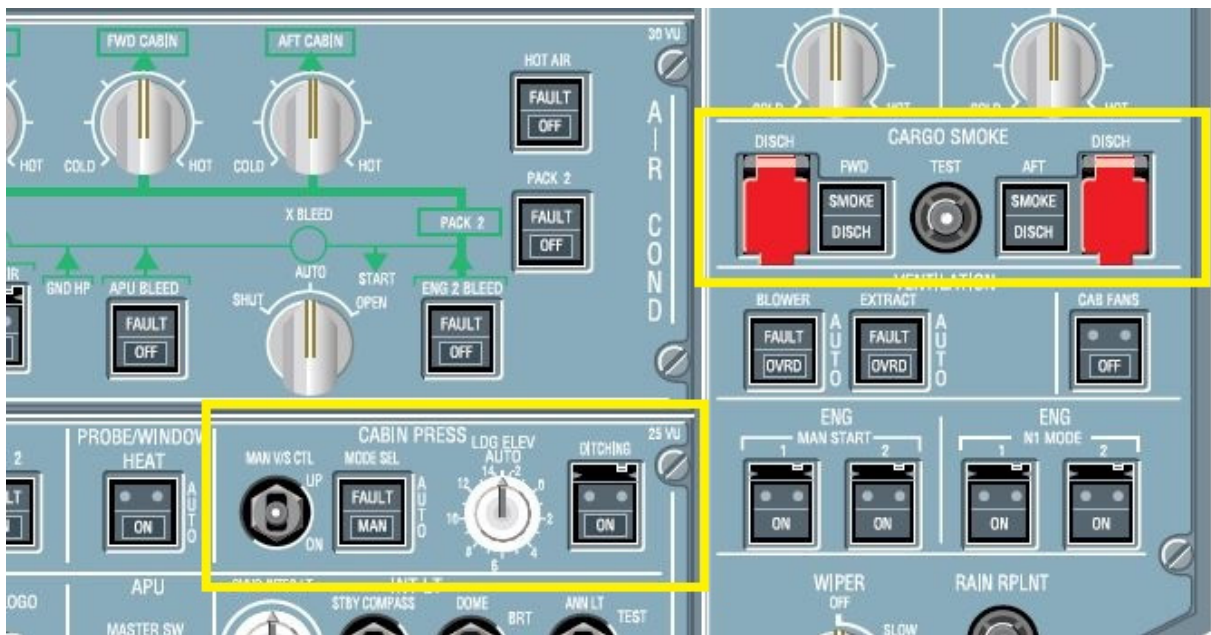
The Airbus A320 is a twin-engine aircraft in midwing configuration and mixed construction. The aircraft had a Spanish certificate of registration and was operated by a Spanish operator.

Manufacturer:	Airbus Industries
Type:	A320-216
Manufacturer's Serial Number (MSN):	5570
Year of manufacture:	2013
Engines:	CFM International, CFM56-5B6/3

Total operating time of the aircraft was approximately 6,835 hours at 4,682 cycles.

The documentation of the aircraft manufacturer showed that prior to de-icing the outflow valve had to be closed by activating the push-button marked DITCHING at the cabin press panel.

In case of smoke in the cargo compartments (front or aft) the respective fire extinguishing system had to be activated via a switch marked DISCH, protected by a red cover, located on the cargo smoke panel of the overhead panel.



Cabin press panel and cargo smoke panel

Source: Airbus

## Meteorological Information

The aviation routine weather report (METAR) of 0750 hrs (06:50 UTC) gave the following weather conditions:

Wind: 220° / 3kt  
 Clouds: 1/8 – 2/8 at 300 ft above ground  
 Ground visibility: General 2,500 m, south-east of the airport 550 m  
 Runway Visibility Range (RVR): Runway 26L 500 m to 2,000 m  
 Weather phenomena: individual wafts of mist  
 Temperature: -13°C  
 Dewpoint: -14°C

Barometric air pressure (QNH): 1,016 hPa

Sunrise was at 0755 hrs.

## Radio Communications

Radio transmissions between the crew and Munich Apron, Munich Ground, as well as with Munich Tower were recorded, and the recordings made available to the BFU for evaluation.

## Aerodrome Information

Munich Airport had two parallel runways, which were 4,000 m long, 60 m wide, and oriented 083°/263°. Airport elevation is 1,487 ft AMSL. At the time of the occurrence runway 26 was in use.

The taxiways had a width of 30 m.

## Flight Recorder

The airplane was equipped with a Flight Data Recorder (FDR) Honeywell SSFDR and a Cockpit Voice Recorder (CVR) Honeywell SSCVR. Both recorders were read out at the BFU flight data recorder laboratory.

The FDR had recorded 845 parameters over a recording duration of 26:34 hours. The CVR recorded a total of five channels; two of which with 120 minutes and three of 30 minutes duration.

## Wreckage and Impact Information

The Serious Incident occurred at DA14 approximately 160 m north of runway 26L.

The aircraft's nose landing gear stood on the centre line of the taxiway. The fuselage nose was immediately north of the CAT II/III hold bar, about 7.5 m behind the de-icing hold marking.



Positions of the airplane and the de-icing vehicles after the collision

Source: Police/BFU

The airplane's wings' transition zones with the sharklets had collided with the booms of the de-icing vehicles. Both sharklets of the airplane were slightly damaged.

The drivers' cabs of the de-icing vehicles stood abeam of the corresponding edge marking of the taxiway. The vehicles had tipped by about 20° and therefore stood on their left or right wheels, respectively.



Position of the Aircraft after the collision

Photo: BFU

## Survival Aspects

At the time of the occurrence the drivers of the two de-icing vehicles had been in their respective cubicles at the end of the vehicles' booms. The cubicles had been approximately 6 m above ground. Initially the fire brigade secured the de-icing vehicles with steel cables. Then the two drivers were rescued.

## Organisations and their Procedures

The *Munich Airport Aircraft De-Icing Plan Winter Season 2015/2016* included operational procedures aiming at safe, proper, and efficient de-icing of aircraft. The de-icing plan was a supplement of the de-icing procedures for Munich Airport published in the Aeronautical Information Publication (AIP).

The airport management, air traffic service provider, and de-icing company had agreed on this plan.

Chapter 6 De-icing of jet aircraft stipulated among other things:

*When taxiing onto de-icing area assigned, pilot shall make sure, that the auxiliary power unit (APU) is switched off, flaps and slats are retracted and bleed air system is closed. The de-icing operation will commence after the pilot has confirmed, that parking brake is set and aircraft is ready for de-icing.  
[...]*

The phraseology which the de-icing personnel had to use had also been stipulated.

## Additional Information

### Association of European Airlines

The De-icing/Anti-icing Training Working Group of the Association of European Airlines (AEA) stated that they are working on developing safe, economic, and generally accepted standards and procedures for the de-icing of aircraft.

In August 2015, the AEA published their latest edition of the *Training Recommendations and Background Information for De-Icing/Anti-Icing of Aeroplane on the Ground (12th Edition)*.

Among other things, it contained recommendations regarding the communication between flight crews and de-icing personnel. Examples were listed and noted that the ICAO standard phraseology should be used.

On 31 December 2016, the AEA stopped all activities.

### Society of Automotive Engineers

The Society of Automotive Engineers (SAE International) develops aviation standards, which are accepted and applied by aircraft manufacturers, air operators, and authorities worldwide.

With respect to de-icing, in October 2016 the document ARP6257<sup>TM</sup> was published.

Chapter 3 Phraseology contained phraseology recommendations as standard phraseology for the communication between flight crews and de-icing personnel. The chapter differentiated between normal operations and abnormal operations. Section 3.2.2 Abnormal Operations listed examples for abnormal occurrences and described the standard phraseology for interrupted operations. There was no standard phraseology for cases where the flight crew has to abort the de-icing procedure.

## Analysis

### General

During the collision the aircraft was slightly and the de-icing vehicles were severely damaged. Due to the tilted position of the de-icing vehicles after the collision the danger of the vehicles toppling over and therefore the probability of severe injuries of the de-icing personnel was great.

The FDR data shows that six seconds after it had begun to move the airplane had collided with the de-icing vehicles. The data also shows that the aircraft had moved with low speed and that immediately after the collision the wheel brakes had been actuated and then the parking brake set.

Both pilots held the licences and ratings required for the conduct of the flight and each had more than 1,000 hours of flying experience on type and therefore were experienced.

### Individual Actions

The flight crew had been busy exchanging the ATIS information when the airplane passed the specified taxiway.

The CVR data shows that during preparation for the de-icing procedure the pilots had completed the Before De-Icing checklist step-by-step. Despite this step-by-step procedure and the additional question by the PIC "Confirma, ditching?" the co-pilot activated the fire extinguishing switch for the cargo compartments instead of the ditching switch.

The question of the team leader: "[...] are you ready for de-icing?" the PIC had answered with: "Ah, hold on [...]." Even though the PIC had not explicitly acknowledged with "ready for de-icing" but asked to wait, the team leader continued the communication routinely with: "Okay, de-icing commences and ah we, make a two-step and ah anti-icing with type one fluid a hundred percent, I call you back."

With the words: "So control, [...], we need to go back to the parking." And: "We need to go back to the stand please. We have one problem" the PIC wanted to inform the team leader that de-icing would no longer be needed since the airplane would not depart.

The team leader answered: "You have technical problems, we will wait". The BFU is of the opinion that this shows that he had understood the information regarding the

problem but not comprehended the decision of the PIC to taxi back to the parking position. It is highly likely that he assumed there would merely be a delay of the de-icing procedure. The PIC on the other hand did not realise that the team leader's words: "we will wait" indicated that his request to abort de-icing had not been understood completely and that the vehicles would remain in their positions.

The PIC radioed the ground controller again and informed him that he intended to taxi back due to a technical problem. The ground controller and the aerodrome controller discussed further actions.

After the flight crew had switched to Munich Tower frequency, the tower controller issued the instruction: "[...] as we talked about line up runway two six left, make a one eighty and vacate the runway via bravo one three." The FDR data shows that the parking brake was released and one second later the thrust levers of both engines were pushed forward. While the flight crew was still acknowledging the controller's instruction the aircraft began to move. Within approximately four seconds the speed reached about 3 kt.

The change in longitudinal acceleration from 0.2 g to -0.15 g recorded at 0757:10 hrs indicates the time of the collision with the de-icing vehicles. The PIC stated that initially he had not attributed this with a collision but actuated the wheel brakes and set the parking brake. Later he recognised the situation due to the shouts of the de-icer.

## Defences

In the scope of this investigation, the term "defences" or "safety mechanism" means technical systems, actions, procedures and institutions which shall minimise the effects of technical and human errors to protect flight safety. These shall minimise the effects of technical and human errors to protect flight safety.

A procedure had been established for preparing the aircraft for the de-icing procedure, which the flight crew had to implement by completing the respective checklist. In addition, the DISCH switch had been protected against inadvertent activation by a red cover (red guarded button). The pilots worked together routinely. The BFU is of the opinion that the erroneous activation was caused by lack of concentration of both pilots; the co-pilot as executor and the PIC as pilot monitoring. It is possible that the similarity in lettering (DITCHING and DISCH) aided the mix-up.

Even though the de-icing plan valid for Munich Airport contained procedure descriptions and stipulations for the phraseology applicable for the communication

between de-icing personnel and pilots the team leader did not demand "ready for de-icing" confirmation from the flight crew. Neither the phraseology of the de-icing plan nor the AEA document contained precise stipulations for the communication if the de-icing procedure had to be aborted. This case shows that neither the pilot nor the team leader had used the wrong wording. Still both did not fully understand the other's information; instead they understood what fit their mental image of the situation (confirmation bias). De-icing companies and operators have recognised the importance of standardised communications and accepted their application, but there was no extensive ICAO standard phraseology in place for the de-icing process, which would apply for pilots and de-icing personnel. Therefore the possibility for miscommunication was increased.

The CVR recording shows that neither of the two pilots acknowledged the obstacle clearance in the area of the wings for e.g. with the words left and right side is clear. Contrary to the PIC's statement that they had checked left and right and not seen any obstacles, the BFU is convinced that neither pilot had directly looked toward the de-icing vehicles. It is very likely that the pilots had concentrated in this phase on the part of the runway into which they were about to taxi. It is highly likely that the pilots had already regarded the de-icing procedure as settled, because the airplane would no longer depart. In this case this resulted in the ineffectiveness of the visual control.

## Conclusions

This Serious Incident is due to:

- Misinterpretation in the communication regarding the abortion of the de-icing procedure occurred between the PIC and the team leader.
- Neither of the two pilots checked for obstacle clearance before taxiing.

The missing standardised phraseology for pilots and de-icing personnel contributed to the serious incident.

## Safety Recommendations

### Actions of the De-icing Company

The de-icing company stated that immediately after the occurrence it was stipulated that the de-icing vehicles have to be positioned parallel to the aircraft's longitudinal axis so that in case of collision the vehicles would not topple over.

### BFU Safety Recommendations

The BFU has issued the following safety recommendations:

BFU Safety Recommendation No.: 07/2017

The Society of Automotive Engineers (SAE International) should amend the document Aircraft Ground De/Anti-Icing Communication Phraseology for Flight and Ground Crews (ARP6257TM) to mitigate miscommunication.

Section 3.2.2 Abnormal Operations should include the recommendation to standard phraseology for pilots and de-icing personnel in regard to biunique communication in case the de-icing procedure has to be aborted.

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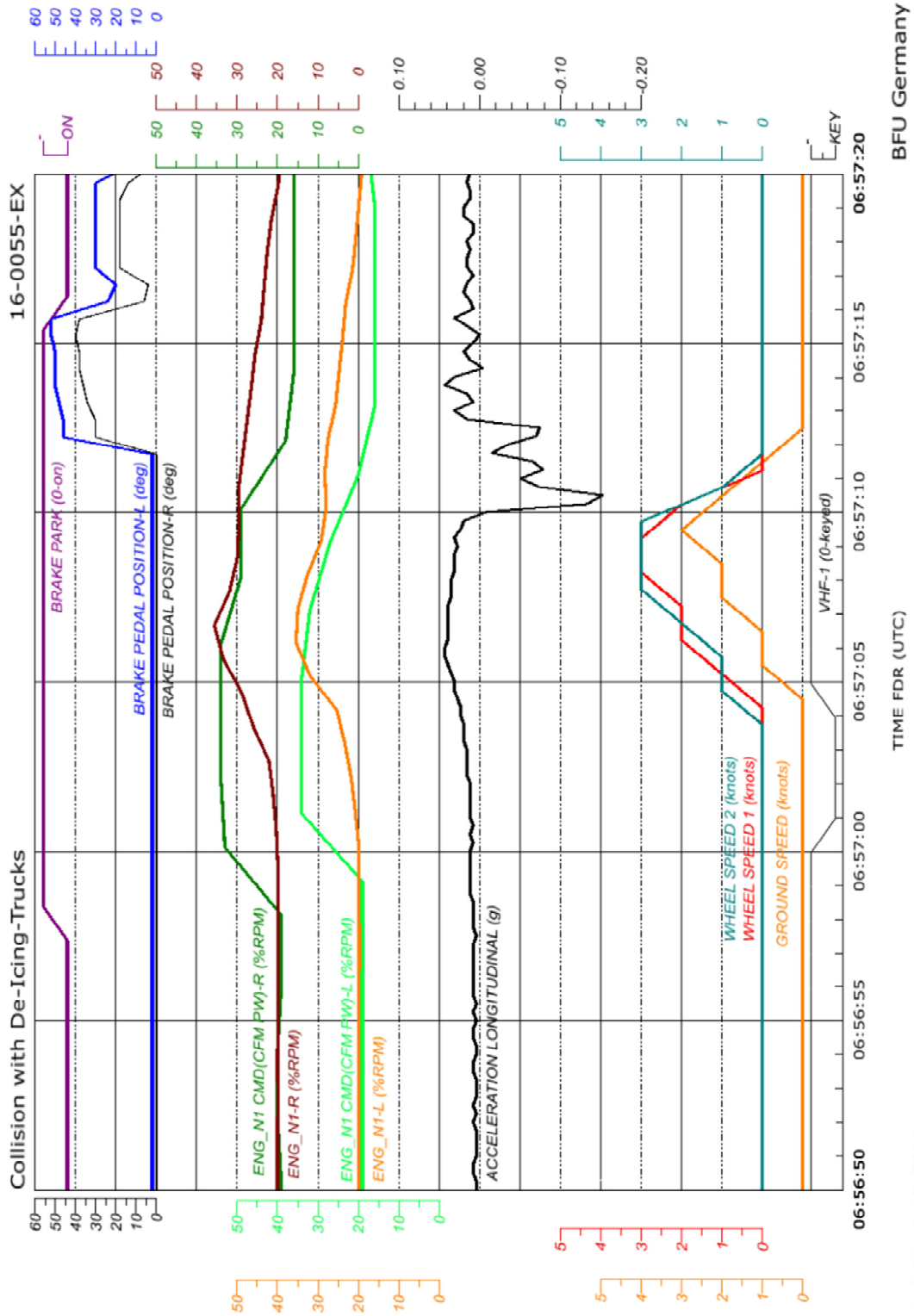
Norman Kretschmer

Braunschweig 4 December 2017

## Appendices

Excerpt FDR recording

FDR data



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 - FIUUG*) 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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