

# Investigation Report

5X002-0/07  
May 2010

## Identification

Type of Occurrence:	Serious Incident
Date:	24. January 2007
Location:	En route
Aircraft:	Civil Air Transport
Manufacturer / Model:	Airbus Industrie / A 320
Injuries to Persons:	None
Damage:	Aircraft not damaged
Other Damage:	None
Source of Information:	Investigation by BFU

The take-off was uneventful. However, on passing through FL120 there was a sudden loud bang from the right hand side of the aircraft below the cockpit window immediately followed, the crew subsequently reported, by an ECAM (Electronic Centralised Aircraft Monitor) warning display: 'ADR1, ADR2 and ADR3 FAULT'. There was simultaneous failure of both Autopilots, Auto Thrust and both Flight Directors. The control system mode switched to Direct Law. All the protective mechanisms had disappeared from the airspeed indicator in the Primary Flight Display (PFD).

The pilot-in-command assumed manual control of the aircraft and terminated the climb at FL130. At this point the co-pilot's seat was occupied by a newly trained co-pilot, who was making his third flight on this type under supervision. The pilot-in-command instructed the second co-pilot to occupy the right hand seat.

## Factual Information

### History of the flight

During a flight from Nuremberg to London-Stansted the aircraft was established in the climb. When passing through Flight Level (FL) 120 there was a malfunction of all three airspeed indicators. After considering the situation, the crew decided upon a diversionary landing at Frankfurt/Main.

The Airbus A320 had taken off at 08:04<sup>1</sup> hrs in Nuremberg with a crew of seven and 52 passengers. During the night there had been a fall of approx. 20 cm new snow, for which reason, prior to departure, the aircraft wings and tailplane were treated with Type II de-icing fluid (holdover time 30 minutes).

All three airspeed indicators gave different values of from 230 to 260 knots.

In order to give the crew time to analyse the situation and work methodically through the appropriate procedures, the aircraft entered a holding pattern overhead Erlangen. During this period, the aircraft was constantly in clouds, sometimes with heavy snowfall.

After the crew had stabilised the aircraft attitude, the two Flight Augmentation Computers (FAC) were re-set in line with the ECAM-procedure, following which the control mode switched to Alternate Law with the commensurate Protections. The Autothrust was restored to operational condition. The Status-Display reported Autopilot Number One as being operational, but this was a faulty indication; both autopilots remained unusable. While manually flying the aircraft the pilot-in-command detected a noticeable tendency of the aircraft to drift towards the right. It was only

---

<sup>1</sup> Unless otherwise specified, all times are indicated in local time

possible to maintain a steady heading by massive use of corrective control inputs. The crew subsequently reported that, on account of the initial loud bang, they feared there might have been some structural damage to the right-hand side of the aircraft.

After considering the weather situation the pilot-in-command decided to abandon the intended flight and divert to Frankfurt. The aircraft landed on Runway 07/R in approach configuration Flaps Three. After lowering the gear, the control mode switched to Direct Law in accordance with system architecture. The aircraft landed without further event and was handed over to the local maintenance organisations.

The maintenance technicians subsequently reported that no examination was made of the system to identify the presence of water or other impurities. Following the Post Flight Report (PFR), ADR2 was replaced, because a fault had been reported the previous day.

#### Personnel Information

All three pilots had the necessary licenses and ratings for the flight in question.

The 43 year-old pilot-in-command occupied the left seat. His total flight time was about 15,500 hours, of which about 516 hours were on the A320. During the previous 90 days he had flown 188 hours, and 2:20 hours in the previous 24 hours. Prior to going on duty he had a rest period of 53 hours.

The 33 year-old co-pilot had a total flight time of 3,400 hours, of which 500 hours were on the A320. During the previous 90 days he had flown 205 hours, and 2:20 hours in the previous 24 hours. Prior to going on duty he had a rest period of 32 hours.

The 24 year-old trainee co-pilot had a total flight time of 250 hours, of which 19 hours were on the A320. During the previous 90 days he had flown 19 hours, and 2:20 hours were in the previous 24 hours. Prior to going on duty he had a rest period of 32 hours.

#### Aircraft Information

The Airbus A320-214 bore the manufacturer's serial number 2853 and was built in 2006. The aircraft was registered in Germany and in service with the operator since 10 August 2006. Since entering service, the aircraft had flown 1,474 hours.

In the A320 the airspeed indications are presented via the Air Data/Inertial Reference System (ADIRS), which consists of the following components:

- Three Air Data/Inertial Reference Units (ADIRU)
- A Control and Display Unit (CDU) for operation of the Air Data/Inertial Reference Systems
- Eight Air Data Modules (ADM)
- Three Angle of Attack (AOA) and two Total Air Temperature (TAT) Sensors.

The ADIRUs at the heart of the Air Data/Inertial Reference System consist of two channels

- Air Data Reference (ADR)
- Inertial Reference (IR)

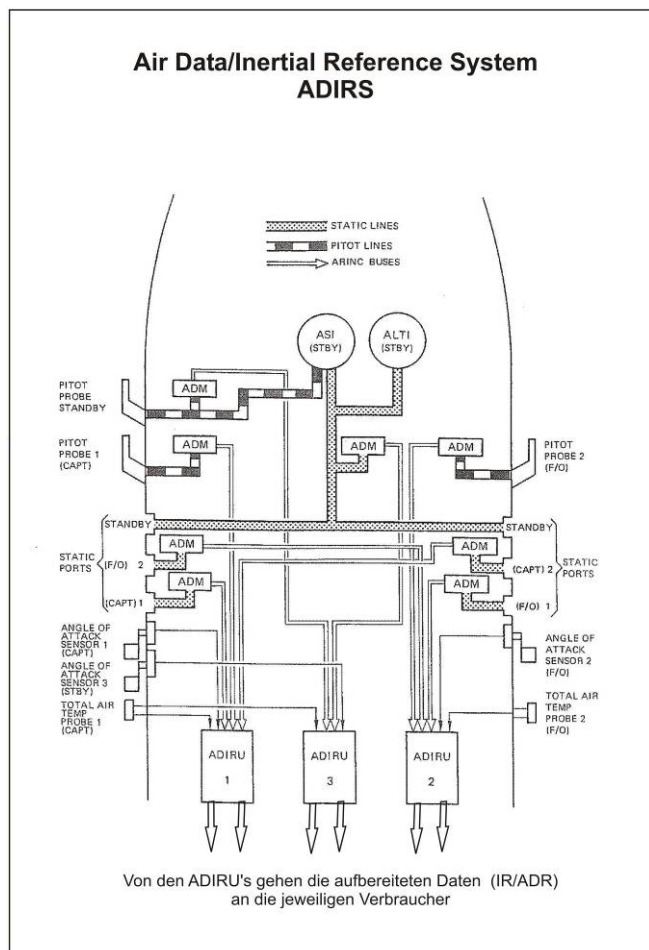
and a joint electrical power supply.

The ADIRUs receive air data information from a number of probes and sensors, such as Pitot Probes, Static Ports, Total Air Temperature Sensor and Angle of Attack Sensor.

Three Pitot Probes register the total pressure. The three Air Data Modules in the immediate vicinity of the Pitot Probes convert the pressure measured into an ARNIC-format digital signal.

The Standby Pitot Probe is connected both to the ADM and Standby Airspeed Indicator, which receives the pressure values in analogue form.

The aircraft was fitted with Pitot Probe PN C16195AA manufactured by Thales; the unit was of the latest type.



Source: Operations Manual A320, Part B – System Description

*The processed data (IR/ADR) are passed from the ADIRUs to the respective user points*

#### Meteorological Information

The meteorological information used for pre-flight preparation reported Germany as being under the influence of a depression with air pressure 996 hPa. About 20 cm of snow had fallen during the night. The wind blew from a northerly direction at about 9 kt. The temperature and dew point were both -5 °C. The cloud base was at about 600 ft. Further snowfall was likely, and visibility was forecast to reduce to 2,000 m, temporarily reducing to 800 m.

#### Communications

Radio communications were conducted in the English language.

#### Aerodrome Information

Frankfurt am Main was selected as the diversion airport. It has two parallel 4,000 m runways (25R / 07L and 25L / 07R). Runway 25R is 60 m wide and 25L is 45 m wide.

#### Flight recorders

The Flight data Recorder and the Cockpit Voice Recorder were surrendered for examination by the BFU. A section of the trace from the relevant parameters is appended to this report (Appendices 1 and 2).

Appendix 1 shows the speed differences in the period 06:08 UTC to 06:10 UTC. The value displayed by the Standby Airspeed Indicator (ISIS, red line) exceeded that of the COMPUTED AIRSPEED (CAS, green line).

The failure of FAC1 and 2 at 06:08 UTC can be seen from Appendix 2; simultaneously, the control mode switched to Alternate Law (yellow line). Autopilot Number 1 and Autothrust switched themselves off. Between 06:08 UTC and 06:19 UTC, there were internal automatic switching operations between FAC1 and FAC2, also between FGC1 (Flight Guidance Computer) and FGC2.

At 06:19 UTC, the FAC1 was once again operational, but FAC2 remained switched off and the control system remained in ALTERNATE LAW until 07:02 UTC. When the gear was lowered, the control system mode switched to DIRECT LAW.

From 06:09 UTC to 06:52 UTC the ISIS remained an average of 20 kt below the CAS, the indication was sometimes quite irregular. At 06:53 UTC the ISIS again exceeded the CAS value. Between 6,000 ft and 4,000 ft the two indications readjusted.

#### Wreckage and impact information

After the precautionary landing in Frankfurt the aircraft was handed over to the local maintenance organisation.

The following system faults were recorded in the Post Flight Report:

06:04 UTC	Fault ADR 3
06:06 UTC	Report ADIRU 1/2/3 DISAGREE
06:08 UTC	Fault FAC1 and DMC2 also ADR1 and ADR2

The following ECAM reports in the cockpit:

06:06 UTC MAINTENANCE STATUS F/CTL  
 06:08 UTC F/CTL ALTN LAW  
 AUTO FLT RUD TRV LIM SYS  
 AUTO FLT A/THR OFF  
 AUTO FLT AP OFF  
 NAV ADR DISAGREE  
 06:18 UTC AUTO FLT RUD TRIM1 FAULT  
 06:19 UTC AUTO FLT RUD TRV LIM2  
 AUTO FLT YAW DAMPER 1  
 07:01 UTC F/CTL DIRECT LAW  
 07:05 UTC F/CTL ALTN LAW

From the PFR it could be seen that ADR2 had previously been reported on January 15 and 21, for which reason the ADR2 was then replaced in Frankfurt.

## Analysis

The wings and tailplane had been de-iced prior to the flight. There had been no intention to de-ice the fuselage, for which reason there was residual snow and ice on top of the fuselage nose. It is therefore quite possible that water melted from snow or ice into the apertures for the Pitot Probes and Static Ports.

Given the fact that the PFR recorded fault reports for ADR2 on 15 and 21 January and that the ADR2 was replaced after the landing in Frankfurt, it is therefore almost certain that this fault report was in no way associated with the incident which is the subject of this investigation.

Shortly after take-off at 06:04 UTC, ADR3 detected and logged a fault in the PFR system. When passing through 11,160 ft at 06:08 UTC, there was a *Disagree* condition between all three ADIRUs and a simultaneous fault report of ADR1 and ADR2, combined with further consequences such as the Autopilot switch to ALTERNATE LAW mode, failure of both autopilots and Autothrust. From this point on the system was unable to undertake any plausibility checks, because all three ADRs indicated faulty operation and the system was no longer able to identify which ADR was operating correctly.

The BFU draws the inference, that this was the time at which the crew heard the loud bang, probably caused by detachment of a sheet of ice from the fuselage nose.

The possibility cannot be excluded that ice, snow or water had migrated into one or more probes, or had accumulated in their immediate vicinity. There is no clear indication as to which airspeed instrument was giving the correct indication, or which was wrong.

At this time the aircraft was passing through an inversion layer between FL100 and FL120 in which the temperature increased from -3 °C to +1 °C; at the same time, the aircraft was flying through clouds with heavy snowfall.

The BFU draws the inference that the different speeds indicated were not due to an internal system failure, but to different pressure measurements by the sensors.



After the landing in Frankfurt, ice was still visible on the aircraft nose over the Static Ports and Pitot Probes.



Snow and residual ice on the aircraft nose below the cockpit windscreen after the landing in Frankfurt.

Photos: BFU

It is highly probable that the different pressure measurements arose from impurities in the Pitot Static System pressure lines; this in turn caused the ADIRUs

to present different speed values. As a consequence, the internal comparison of data between all three ADIRUs resulted in a *DISAGREE* warning and a fault report by all three ADRs on the overhead panel.

However, illumination of all three ADR FAULT LIGHTS in the overhead panel did not mean that all three ADRs had failed; they had simply detected and signalled a system fault. This resulted in a control mode change from NORMAL LAW to ALTERNATE LAW.

The crew statement that the control mode had switched to DIRECT LAW was not confirmed by the FDR trace. The traces simply indicate a control mode switch to ALTERNATE LAW. Only when the landing gear was lowered during the approach did the control mode switch to DIRECT LAW, as would be expected.

## Conclusions

### Findings

- All three pilots were in possession of the necessary licenses and ratings for the conduct of this flight. The second co-pilot was undergoing training.
- The aircraft was correctly registered and maintained in accordance with the regulations and procedures then in force.
- Due to the fact that 20 cm of snow had fallen during the night, the aircraft had a covering of snow and had to be de-iced prior to the flight.
- The wings and tailplane were de-iced in Nuremberg before take-off. The fuselage was not de-iced, which may have had an effect on the subsequent irregular speed indications.
- There was an approximately 30 kt discrepancy between the values displayed by all three airspeed indicators, which points to erroneous input parameters. Shortly after take-off all three ADRs signalled faults, one after the other.
- The different speed indications were very probably due to impurities in the Pitot Static System.
- The switch of the control system mode to ALTERNATE LAW and the failure of further systems was due to internal fault analysis between the three ADRs.
- Based on evaluation of the FDR, it was not possible to confirm a switch in the control mode to DIRECT

LAW during the flight.

- On lowering the landing gear during the approach, the control system mode change to DIRECT LAW was system-dependent and expected.

### Causes

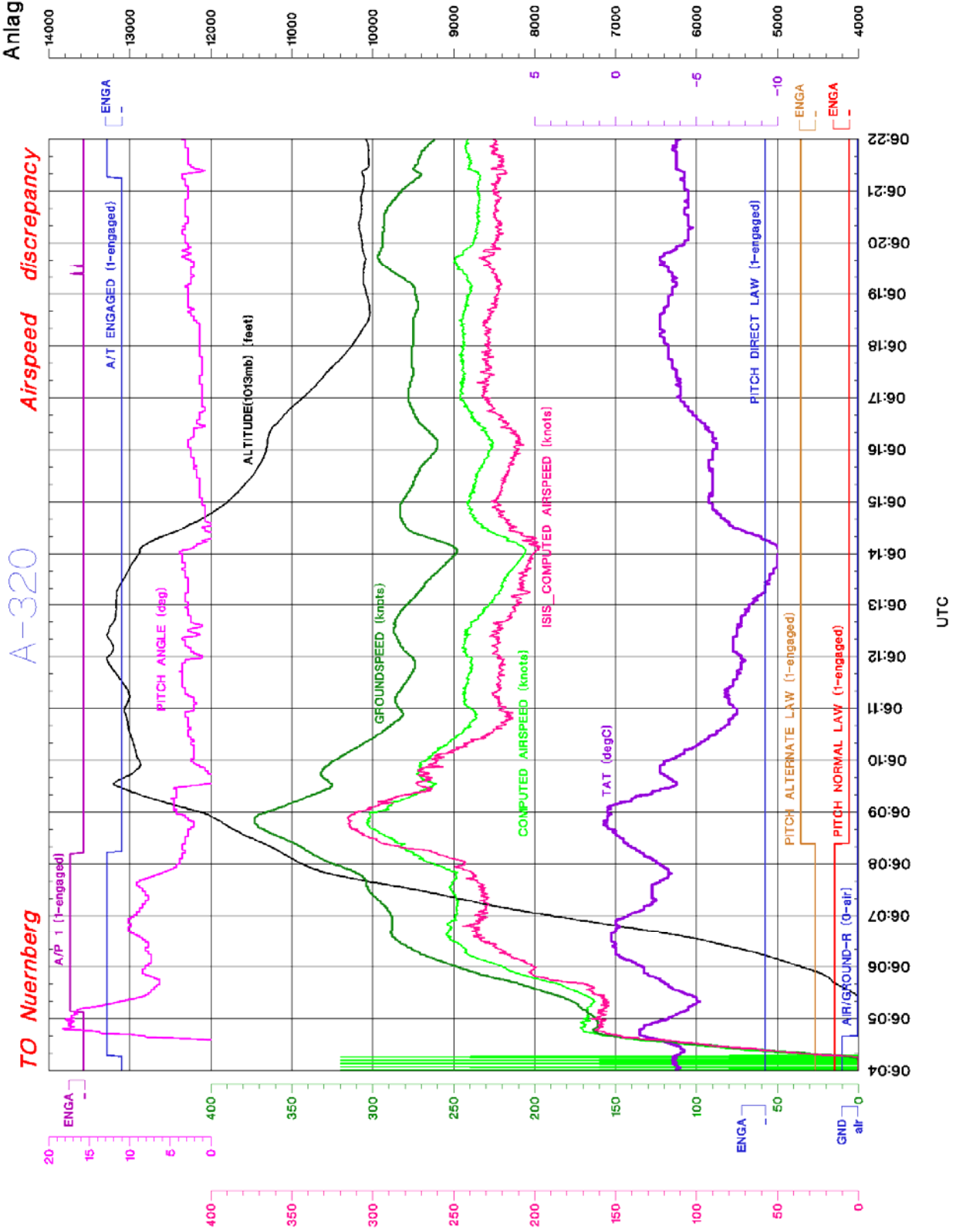
- It was not possible to clearly determine the reasons for the unreliable airspeed indications. However, the BFU draws the conclusion that the different speed indications resulted from impurities in the Pitot Static System, with the commensurate consequences.

Investigator in charge      Mueller

## Appendices

Extracts from the Flight Data Recorder

Anlage 1



BFU Germany

Created: July 12, 2007

