Bundesstelle für
Flugunfalluntersuchung

German Federal Bureau of
Aircraft Accident Investigation

Investigation Report

Identification

Type of Occurrence:	Accident
Date:	27 September 2012
Location:	Warbelow near Gnoien
Aircraft:	Airplane
Manufacturer / Model:	Pilatus / PC-9/B
Injuries to Persons:	Both pilots fatally injured
Damage:	Aircraft destroyed
Other Damage:	None
Information Source:	Investigation by BFU
State File Number:	BFU 3X146-12

Factual Information

During a military exercise a formation consisting of two civil Pilatus PC-9/B airplanes was to fly simulated attacks of Bundeswehr (German Federal Armed Forces) ground anti-aircraft forces. The PC-9/B flying in position two suffered a bird strike. The subsequent impact with the ground caused fatal injuries to the two pilots.

History of the Flight

At 1225 hrs[1] the two Pilatus PC-9 airplanes took off from Neubrandenburg Airport. The flight led to a Bundeswehr exercise area for anti-aircraft forces about 30 km north-east of Rostock-Laage Airport.

At 1229:23 hrs the Pilot in Command (PIC) and also formation leader flying in the leading PC-9/B radioed the Control and Reporting Centre (CRC). He told the aircraft controller: "[…] coming in as flight for stinger operation." The aircraft controller asked: "Okay […] copied, confirm you will stay in close formation all the time?" He received the answer: "That is affirmative, trailing formation by half a mile most of the time."

The recorded radar data of the CRC showed the flight path of the leading PC-9/B. Between 1230 hrs and 1306 hrs six approaches to the position of the anti-aircraft forces from different directions were recorded. At 1306:45 hrs the leading airplane was three kilometres south of the small town Gnoien in 1,450 ft AMSL (about 1,300 ft GND) during the seventh approach. According to the radar data the ground speed was approximately 215 kt. The flight direction was initially south-east. At 1308:36 hrs the airplane began to turn left towards north-north-west. At that time altitude was approximately 1,550 ft AMSL (1,500 ft GND) and speed was about 208 kt. Ten seconds later the aircraft began to descend. From 1309:06 hrs on in the area south of the small town Dargun it was for about twenty seconds in approximately 1,050 ft AMSL (1,000 ft GND) and then began to descend again. Within 55 seconds, at 1312:21 hrs, about one kilometre north of the small town Finkenthal, the airplane had an altitude of approximately 250 ft AMSL (200 ft GND). During the descent ground speed was about 245 kt. According to the radar data the leading PC-9/B flew for 15 seconds in 250 ft AMSL with a ground speed of approximately 270 kt. Between 1310:36 hrs and 1311:12 hrs, east of the emplacement of the anti-aircraft forces, the airplane climbed to approximately 1,850 ft AMSL and then descended again for 15 seconds to about 350 ft AMSL. At 1311:30 hrs the attack of the leading PC-9/B ended and the airplane initially climbed to 1,000 ft and then to approximately 1,500 ft AMSL.

At 1311:34 hrs radio conversations between ground stations began that one of the PC-9 had crashed. At 1313:05 hrs the aircraft controller informed the formation leader about the crash report and asked: " …confirm that's a fake?" The formation leader began the search for the other airplane and tried to establish radio contact. At

1 All times local, unless otherwise stated.

1320:41 hrs the formation leader informed the aircraft controller that he had discovered the crash site and passed on the coordinates.

The BFU has statements of three soldiers all of whom had been working as troop leaders for the anti-aircraft forces. One of the three soldiers had seen the approaching aircraft through his binoculars; the two others had seen them with their naked eyes. The two airplanes had been seen above a forest, had approached from the south, and the second airplane flew offset to the side behind the first. The left airplane - from the witnesses' point of view - turned east. At the same time, the right airplane turned west, pulled up briefly, rolled, and then crashed.

The pilot leading the PC-9 formation stated the plan was that the second airplane should follow the first with a distance of about 0.5 to 1 Nautical Mile (NM) in order to fly independent attacks, and to give the ground anti-aircraft forces the chance of changing targets. The crew stated that after the aircraft controller had informed them of the observed crash they began the search for the second airplane. After they had found the accident site, they had reported the coordinates to air traffic control, and circled above the accident site until SAR and police helicopters arrived. Then the aircraft flew to the home base where it landed at 1408 hrs.

One witness was in a forest area. He saw the airplane flying in low altitude approaching from the south-east. The witness stated that in the forest close to a chicken farm two or three pairs of birds of prey (sea eagles) had their nests. He stated that about 5 to 6 of them flew in the flight path of the airplane. He then saw that the airplane collided with one bird and fell toward the ground until it disappeared behind the forest.

The aircraft impacted a field. The two occupants suffered fatal injuries; the airplane was destroyed.

Personnel Information

Pilot in Command (PIC)

The 57-year-old PIC held a Commercial Pilot's License (CPL(A)) initially issued on 11 February 1997 according to JAR-FCL German and valid until 22 November 2015. His license carried the type ratings for PC9/PC7MKII (valid until 16 April 2013) and the instrument rating. His class 1 medical certificate was issued on 6 October 2011 and valid until 10 October 2012.

The pilot had a total flying experience of 7,893 hours; 1,393 hours of which were on the type in question. In 2012 he had flown 251 hours on the type.

Second Pilot

The 59-year-old pilot held an Airline Transport Pilot's License (ATPL A)) issued in accordance with ICAO; initially issued on 7 September 1994 and valid until 28 December 2014. His license carried the type ratings for PC9/PC7MKII (valid until 28 December 2012), the instrument rating and the ratings for aerobatics and towing of targets.

His class 1 medical certificate was issued on 19 December 2011 and valid until 28 January 2013.

The pilot had a total flying experience of 8,996 hours; 2,052 hours of which were on the type in question. In 2012 he had flown about 270 hours on the type.

In addition to his tasks as pilot he was also responsible for quality assurance flight operations in the company of the aircraft operator.

Aircraft Information

According to the Type Certificate Data Sheet the Pilatus PC-9/B is a single-engine low-wing airplane in all-metal construction with a tiered two-seat cockpit in tandem arrangement and a retractable landing gear. The aircraft was powered by a turboprop engine. The aircraft type was certified in accordance with FAR 23 Category Acrobatic. Minimum crew was one pilot.

The aircraft had a valid German certificate of registration as civil airplane.

Manufacturer:	Pilatus
Type:	PC-9/B
Manufacturer's Serial Number (MSN):	167
Year of manufacture:	1990
MTOM:	2,500 kg
Engine:	Pratt & Whitney Canada PT6A-62
Propeller:	HC-D4N-2A/D9512

Total operating hours of the aircraft were 6,159 hours at 3,544 cycles.

On 22 November 2011 an Airworthiness Review Certificate was last issued. On 20 September 2012, at 6,142 aircraft operating hours, a 150-hour check was conducted.

The airplane was equipped with two Bendix/King KLN-900 satellite navigation systems. The aircraft was equipped with a Traffic and Collision Alert Device (TCAD). The operator stated that during formation flights the transponder of the following airplane was selected to Standby to prevent TCAD false alarms. A Kannad 406 AF was installed as Emergency Locater Transmitter (ELT). The ELT was installed in the aft fuselage and attached to an antenna located in the vertical tail.

Ejection Seats

The aircraft was equipped with two Martin Baker Mk11 ejection seats. According to the Type Certificate Data Sheet of the PC-9 of the Federal Office of Civil Aviation (FOCA) (Switzerland) the seats could be operated between 60 - 400 KIAS and between 0 and 40,000 ft.

The Command Selector Valve was located in the aft cockpit. The valve could be selected to the "ON" position so that both seats could be activated from the aft pilot seat. In the valve position "OFF" the ejection seats could be activated individually.

The Seat Firing Handle was located in the middle of the front of the seat. During ground operation it could be secured with a safety pin. For activation and ejection nine cartridges were installed in each seat.

Meteorological Information

At the time of the accident daylight and visual meteorological conditions prevailed.

According to the Deutscher Wetterdienst (German meteorological service provider, DWD) the following weather conditions prevailed at Rostock-Laage Airport at 1300 hrs:

Wind:	210°/ 9 kt
Visibility:	20 km
Clouds:	4 oktas in 3,000 ft AGL
Temperature:	15°C
Barometric air pressure (QNH):	1,004 hPa

At Neubrandenburg Airport the following weather conditions prevailed at 1300 hrs:

Wind:	230°/ 13 kt
Visibility:	18 km
Clouds:	5 oktas in 2,100 ft AGL and 6 oktas in 2,600 ft AGL
Temperature:	14°C

Aids to Navigation

The ICAO Aeronautical Chart 1:500 000 showed Aircraft Relevant Bird Areas (ARA). Directly to the north-east of the accident site the ARA Trebeltal (ID92) (active all year round) was located. The ARA Kumerower See (ID 91) (active August to April) was located south-east of the accident site.

Excerpt ICAO chart with Aircraft Relevant Bird Areas 91 and 92 Source: Air Navigation Service Provider

Radio Communications

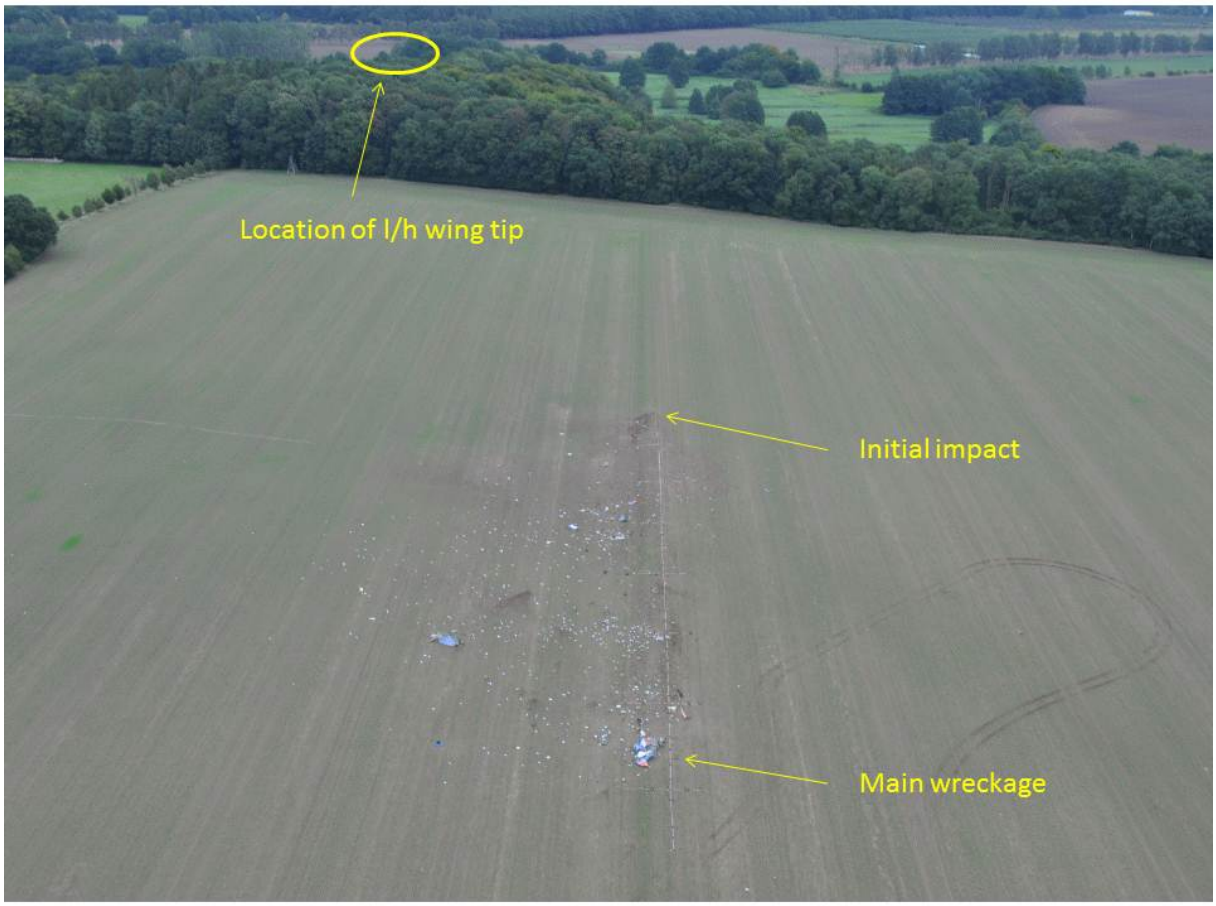
Radio communications between the formation leader and the aircraft controller and the coordination between the CRC and the military exercise instructor were recorded and made available to the BFU for investigation purposes.

Flight Recorders

The Bundeswehr made the recorded radar data available to the BFU for analysis purposes. This was secondary radar information of the airplane leading the formation.

Wreckage and Impact Information

With a heading of about 290° the airplane impacted a tilled field about 225 m north-west of a mixed forest. The initial ground contact occurred with the left wing.



Accident site viewed against the approach direction Photo: Police/BFU

In this area the left aileron, parts of the left horizontal tail and one propeller blade were found, among others. The cadaver of a bird of prey measuring 56 x 20 x 10 cm and weighing 1.26 kg was found next to the left aileron. The bird of prey was identified as an osprey.

Accident site, view to the south-east, bird cadaver, left aileron and propeller blade Photo: Police

About 50 m from the initial point of impact the right aileron, parts of the upper surface of the left wing, and the left main landing gear leg were found. The elevator and parts of the right outer wing were found about 60 m north-west of the point of initial impact.

The instrument panel of the front cockpit was found about 80 m from the initial point of impact.

The two ejection seats with the deceased pilots were found about 125 m from the initial point of impact; about 5 and 10 m, respectively, south-east of the main wreckage.

The main wreckage with the engine, the nose landing gear, fuselage, and the vertical tail were found about 130 m from the initial point of impact. The instrument panel of the aft cockpit was found about 5 m north of the main wreckage.

Part of the wing with traces of blood on the inner surface Photo: BFU

Part of the left wing was found in a mixed forest about 500 m east of the initial point of impact of the main wreckage. It was the wing tip which had been torn off along a row of rivets about 0.70 m from the tip. The upper surface of the wing leading edge showed a dent of about 15 x 15 cm with a depth of approximately 5 cm. The wing covering was severed along a row of rivets which ran along a rib. The main spar was fractured. The inside of the wing upper surface showed traces of blood. The aileron hinge mounted to the aft beam had been severed.

The safety pins on the firing handle of both ejection seats had been removed. One of the safety pins was found in the holder on the frame of the canopy as was intended. The Command Selector Valve in the aft cockpit for the activation of the ejection seats was in the "OFF" position. All cartridges found in the airplane and the two ejection seats carried the hand-written sign 06/14.

The firing handle of the front ejection seat had been torn off. None of the nine cartridges had fired.

The switch for the ELT in the cockpit was in the "ARMED" position. The ELT was found about 8 m south-east of the main wreckage and broadcasting. The antenna cable had been torn off.

Fire

There was no evidence of in-flight fire or fire after the impact.

Survival Aspects

The bodies of the two pilots showed severe mechanical injuries.

Organisations and their Procedures

Conduct of Aerial Target Demonstration

For years the Bundeswehr has been contracting civil companies to conduct various aerial target demonstrations. For manned target demonstrations these were companies who operated Pilatus PC-9, Learjet, or Douglas A-4 airplanes. The selection of the company was based on the speed range of the target required for the training task.

At the time of the accident, in accordance with the Grundsätzlichen Weisung Flugzieldarstellung Bundeswehr (Basic order aerial target demonstration armed forces of 20 February 2007), the Streitkräfteunterstützungskommando (SKUKdo) der Bundswehr (joint support command) was responsible for the complete planning of the aerial target demonstration. The SKUKdo was responsible for the process management of the manned and unmanned aerial target demonstrations including planning, command, conduct, and supervision.

The Bundeswehr stated that they had not issued any special certification for, or conducted any supervision, or analysis of the flight safety hazards at the civil company.

Operator

Operator of the airplane was a private limited company. The operations manual showed the purpose of the company as conduct of aerial target demonstrations, and test flights on behalf of the minister of defence for the army, navy, and air force as well as for Departments of Military Technology. The company was not certified as air operator. A flight operations manual existed. The preface of the manual stated that it had been compiled in accordance with JAR-OPS1.

The company employed pilots who, in general, had been military pilots in the Bundeswehr.

Additional Information

Bird Strikes in Germany

According to the statistics of the Deutscher Ausschuss zur Verhütung von Vogelschlägen im Luftverkehr (DAVVL) (German Bird Strike Committee) between 2000 and 2010 an average of 654 bird strikes per year occurred in Germany. This equals an average of 4.34 bird strikes per 10,000 flights during this time period. Between 2000 and 2010 an average of 0.65 bird strikes per 10,000 flights resulted in damages.

The DAVVL stated that about 80% of the bird strikes occur in altitudes below 1,000 ft above ground.

Osprey (Pandion haliaetus)

Its size is between 55 - 58 cm and the wingspan between 145 cm and 170 cm. Male birds can weigh between 1,120 g and 1,740 g (Ø 1,450 g) and females between 1,500 g and 2,100 g (Ø 1 812 g).[2]

[2] Source: Bauer, H.-G., Bezzel, E., Fiedler, W. (2005): Das Kompendium der Vögel Mitteleuropas. Alles über Biologie, Gefährdung und Schutz - Band 1: Nonpasseriformes – Nichtsperlingsvögel. 2. Auflage, Wiebelsheim: Aula-Verlag, 808 S.

Bird Strike Tests by the Aircraft Manufacturer

The certification specifications in FAR/JAR/CS23 did not list any requirements in regard to bird strike tolerance for the categories Normal, Utility, and Acrobatic.

The aircraft manufacturer conducted PC-9 canopy bird strike resistance tests. The manufacturer determined the following results:

> *Based on the test results it is possible to predict the following bird strike resistance of the PC-9 canopy*
>
> *a) 144 KTAS with a 4 lb bird (this speed corresponds to the optimum climb speed at sea level)*
>
> *b) 204 KTAS with a 2 lb bird (this speed corresponds nearly to the design manoeuvring speed v_A at sea level)*
>
> c) *288 KTAS with a 1 lb bird (this speed is 20 kt above the maximum horizontal speed at sea level)*

Calculations by the BFU

The impact energy of a bird strike is calculated using the formula for the kinetic energy: $E = ½mv^2$. At the accident site part of a bird carcass with a mass of 1.26 kg was found. The BFU has no information regarding the estimated weight and gender of the bird. Assuming an average weight of an osprey of 1.45 kg (male) or 1.812 kg (female) and the airplane's speed of 270 kt calculated from the radar data, the impact energy would have been 13,987 J or 17,480 J, respectively.

Analysis

Since the outer part of the left wing had been found in great distance to the main wreckage it is clear that it had already been severed in flight. That a bird strike had occurred at the left wing is shown unambiguously by: the damages from the wing leading edge backwards, the traces of blood on the inside of the wing structure, and the remains of a bird of prey found at the accident site.

The bird strike occurred at the rivetting of the wing. Subsequently the outer wing part and the aileron hinge were severed. The loss of the wing part resulted in a change in lift behaviour in combination with a rapid roll movement and the severely damaged aileron affected the controls.

The very distinct traces of the initial point of impact at the accident site and the fan-shaped wreckage distribution are typical for an impact with great horizontal velocity and low impact angle.

Due to the severity of the sustained injuries on impact the occupants could not survive the accident.

Flight Operations Aspects

The available radar data documented a total of seven approaches to the position of the anti-aircraft forces. The radar data only documented the flight path of the leading PC-9/B. The reason is that the transponder of the accident aircraft was selected to Standby. The information on the planned exercise, the radio communication of the pilot and witness' statements are aspects in favour of the BFU's opinion that during the seventh approach, airspeed and vertical profile of the accident PC-9/B were identical to the one of the leading airplane. Shortly before reaching the emplacement of the anti-aircraft forces the two flight paths parted.

Among other things, the manoeuvres of both PC-9/B pilots aimed at high angular velocities to make target capture harder for the anti-aircraft forces.

The leading PC-9/B initially climbed steeply east of the emplacement and then conducted a steep descent; the accident PC-9/B made a left-hand turn toward the west. The radar data showed that at the time of the accident the airplane was in about 200 ft above ground and had a speed of approximately 270 kt.

Based on the distance between the location of the severed part of the left wing, and the initial point of impact, and the speed of the airplane, the crash of the airplane occurred 3.6 - 3.9 seconds after the collision with the bird.

Specific Conditions

Both pilots had the licenses and ratings required for the conduct of the flight. The two pilots had great flying experiences both on the type and in total. Due to their military training and experience within the company they were familiar with the conduct of such aerial target demonstrations and the respective procedures.

The prevailing very good visual meteorological conditions had no causal effect on the course of events.

The accident site was located close to an Aircraft Relevant Bird Area (ARA) depicted in the ICAO Aeronautical Chart 1:500,000.

The BFU is of the opinion that this flight was very different from the VFR flight operations common in commercial and private aviation. The flight profile corresponded with that of military aircraft. At the time of the bird strike the airplane was in a very low altitude and therefore in an altitude in which most bird strikes occur. Compared to other civil aircraft, the airplane flew in this low altitude with a very high speed. This, in connection with the mass of the bird, resulted in high impact energy and therefore in the high degree of destruction.

Due to the high speed the reaction times for pilot and bird were very short to recognise an impending collision and yield.

Defences

The two safety pins, which prevent an inadvertent activation on the ground, on the ejection seats had been removed prior to flight. Therefore the seats had been ready for operation. In general, at the time of the bird strike the airplane was within the operating range of the ejection seats where altitude and speed were concerned. No indications were found, however, that the pilots had tried to activate the ejection seats. The BFU is of the opinion that due to the low altitude and the rapid roll movement the time was not sufficient to activate the ejections seats.

Organisational Influencing Factors

The Bundeswehr does not have high performance turboprop airplanes comparable to the PC-9/B which could be used e.g. as training airplane or for certain aerial target demonstrations. In addition, the use of civilian aircraft is more cost-efficient than fighter jets. Therefore, the Bundeswehr used several service companies.

In regard to strength requirements, airplanes certified in accordance with FAR/JAR/CS23 have a significant lower bird strike tolerance compared to fighter jets.

Conclusions

The causes of the flight accident were:

Immediate Causes:

- The airplane's wing was severely damaged by a bird strike. This resulted in a faulty lift distribution and aileron control failure which subsequently led to loss of control.
- Due to the low altitude and the rapid roll movement the time was not sufficient to activate the ejection seats.

Systemic Causes

- Flight in an altitude with high bird concentration
- Flight with high speeds
- Use of CS-23 airplanes in military flight profiles

Safety Recommendations

The BFU issued the following safety recommendation to prevent further accidents:

Recommendation No 05/2015

The Luftfahrtamt der Bundeswehr (LufABw) (military aviation authority) should ensure that companies acting as civil contracting partners for the Bundeswehr conducting aerial target demonstrations, meet the highest Bundeswehr standards in regard to their flight operations and flight safety organisations.

In case the civil contracting partner does not hold an Air Operator Certificate (AOC) issued by a civil aviation authority, the LufABw should ensure that the civil contracting partner is organised such that hazard analyses are conducted in regard to their aerial target demonstrations operations which are suited to ensure a high degree of operational safety.

In case the civil contracting partner is a civil air operator certified by the Luftfahrt-Bundesamt (LBA), regular information exchange should take place between the LufABw and the LBA in regard to special operational and flight safety issues in order to support the LBA.

Investigator in charge:	Jens Friedemann
Field investigation:	Jens Eisenreich, Dietmar Nehmsch, Andreas Seidemann
Braunschweig:	13 August 2015

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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