Bundesstelle für
Flugunfalluntersuchung

German Federal Bureau of
Aircraft Accident Investigation

Investigation Report

Identification

Type of Occurrence:	Accident
Date:	27 May 2013
Location:	Wolfsbehringen
Aircraft:	Airplane
Manufacturer / Model:	Piper Aircraft Corporation / PA39
Injuries to Persons:	Pilot fatally injured
Damage:	Aircraft destroyed
Other Damage:	Crop damage
State File Number:	BFU CX006-13

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

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

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

Published by:

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Abbreviations

AMC	Aeromedical Centre (JAR-FCL 3)
AeMC	Aeromedical Centre (Commission Regulation (EU) No 1178/2011)
AME	Aeromedical Examiner
AMSL	Above Mean Sea Level
AP	Angina Pectoris
AV Node	The atrioventricular node, or AV node, is part of the electrical conduction system of the heart. It electrically connects the atrium level with the ventricular level.
BFU	Bundesstelle für Flugunfalluntersuchung (German Federal Bureau of Aircraft Accident Investigation)
BMVI	Bundesministerium für Verkehr und digitale Infrastruktur (Federal Ministry for Transport and Digital Infrastructure)
BVP	Biventricular Pacemaker
°C	Degrees Celsius
cm	Centimetres
CVR	Cockpit Voice Recorder
DDD	BVP mode: Stimulation of atrium and ventricle, sensing in atrium and ventricle, operating mode: inhibition and triggering
DFS	Deutsche Flugsicherung GmbH (German air traffic service provider)
DWD	Deutscher Wetterdienst (German Meteorological Service)
EASA	European Aviation Safety Agency
EDM	Engine Data Monitor
EGT	Exhaust Gas Temperature
ECG	Electrocardiogram
(EU)	European Union
FCL	Flight Crew Licence
FDR	Flight Data Recorder

FL	Flight Level
ft	Feet
g	Gram
GND	Ground
HCM	Hypertrophic cardiomyopathy
HR	Heart Rate
hPa	Hectopascal
IFR	Instrument Flight Rules
IMC	Instrument Meteorological Conditions
IR	Instrument Rating
JAR	Joint Aviation Requirements
kg	Kilogram
CAD	Coronary Artery Disease
km	Kilometre
kt	Knot
LAFB	Left Anterior Fascicular Block, also known as left anterior hemiblock (LAHB); blockage of one of the three fascicles of the heart
LuftVZO	Luftverkehrs-Zulassungs-Ordnung (Regulation on Certification and Licensing in Aviation)
m	Meter
ME	Multi Engine
min	Minutes
mmHg	Millimetre of mercury
NM	Nautical Mile
OML	Operational Multi-pilot Limitation (valid only as or with qualified co-pilot)
OPL	Operational Passenger Limitation (valid only without passengers, exclusively for PPL and LAPL)
OSL	Operational Safety Pilot Limitation (shall only operate an aircraft if

	another pilot fully qualified to act as pilot-in-command on the relevant class or type of aircraft is carried on board, the aircraft is fitted with dual controls and the other pilot occupies a seat at the controls)
PFD	Primary Flight Display
PIC	Pilot in Command
PPL(A)	Private Pilot License, Aeroplane
REV	Review: Limitation in the medical certificate: Combined with a REV No: referring to a necessary additional examination during fitness-to-fly assessment, which has occurred
RR	Riva Rocci, initials are used to indicate blood pressure measurements in texts
RBBB	Right Bundle Branch Block; heart block in the electrical conduction system
s	Second
SE	Single Engine
THR	Threshold
TML	Restriction of the period of validity of the medical certificate
TORA	Take Off Run Available
UTC	Universal Time Coordinated
VDL	Correction for defective distant vision
VFR	Visual Flight Rules
VML	Correction for defective distant, intermediate and near vision
QNH	Question Normal Height, Q code indicating the atmospheric pressure adjusted to sea level
QRS waves	A rapid succession of heart ventricle contractions (a form of cardiac arrhythmia)

Synopsis

On 27 May 2013 at 1040 hrs[1] the supervisor of the Regional Unit of the Deutsche Flugsicherung GmbH (DFS, German air traffic service provider) informed the BFU of an accident involving a Piper PA39, which had occurred close to Eisenach-Kindel Airfield. The BFU deployed a team of three investigators to the accident site.

Immediately after take-off from runway 28 the pilot lost control and the airplane crashed to the ground approximately 900 m north of the threshold of runway 10. The pilot was fatally injured and the aircraft destroyed.

The accident was due to the following: During the take-off phase the pilot had become incapacitated or lost consciousness due to tachycardic arrhythmia and therefore lost control over the airplane.

The following factors contributed to the accident:

- a chronic, progressive structural illness of the pilot's heart
- lack of self-reflection of the pilot regarding his illness and fitness to fly
- inaccurate aeromedical evaluation
- an unsuitable governmental organisational structure regarding the complexity of the underlying legal regulations.

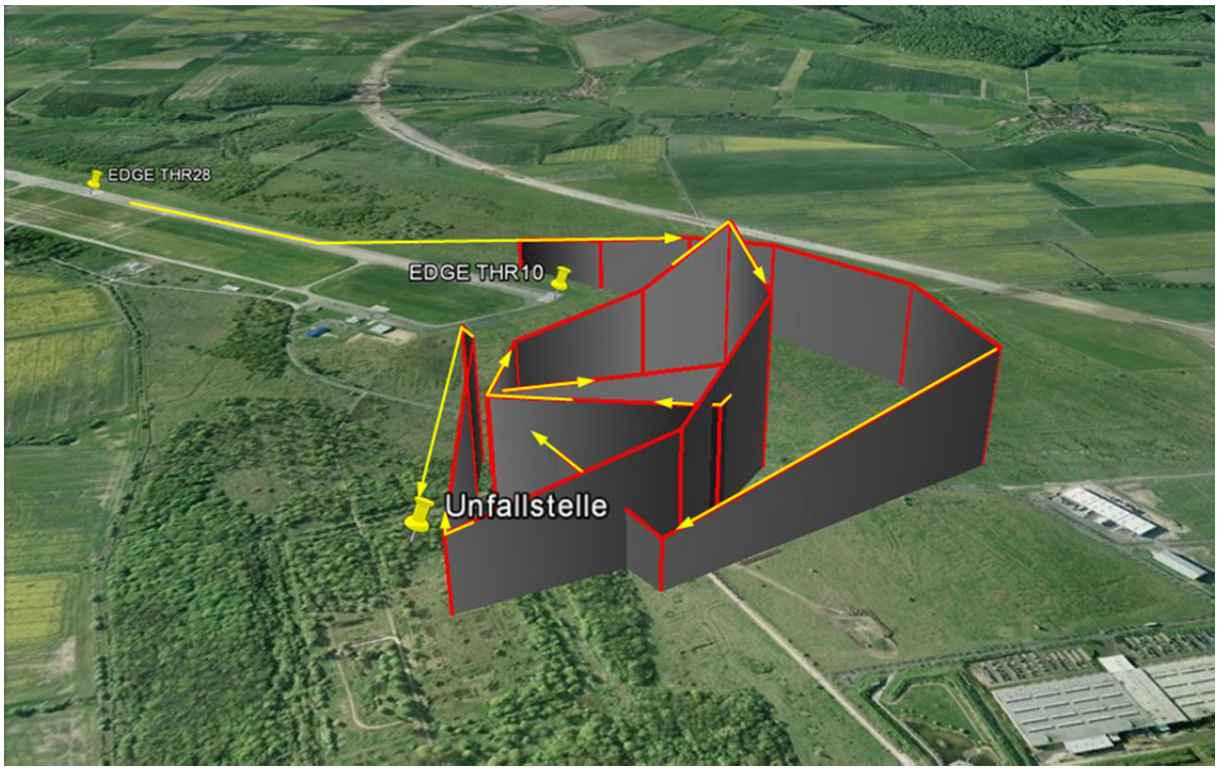
1 All times local, unless otherwise stated.

1. Factual Information

The pilot had planned to conduct a 20-minute private flight from Eisenach-Kindel (EDGE) to Magdeburg-Cochstedt (EDBC). According to the flight plan, at mandatory reporting point MAXOT, approximately 11 NM north of the aerodrome of departure, at 5,000 ft AMSL a change of flight rules from Visual Flight Rules (VFR) to Instrument Flight Rules (IFR) should occur.

1.1 History of the Flight

One pilot and a dog were on board the airplane. According to the Flugleiter (A person required by German regulation at uncontrolled aerodromes to provide aerodrome information service to pilots) take off occurred at 0924 hrs.



Flight path according to the radar data

Source: DFS/Google Earth map service™

Adaption BFU

According to the radar data the airplane initially climbed to 1,750 ft AMSL and turned right after take-off from runway 28. After the turn had been completed by about 90° the airplane lost about 300 ft altitude and then continued the turn with more changes in altitude. Shortly before it had completed the second full turn it climbed to 2,250 ft AMSL and then lost about 700 ft in a steep descent.

At 0927:34 hrs the airplane reached about 2,000 ft AMSL after it had continued the full right turn and shifted once again into climb. At this point the radar recording ended.

At approximately 900 m north of the threshold of runway 10 of the aerodrome of departure the airplane crashed to the ground. The pilot was fatally injured and the dog died at the accident site. The aircraft was destroyed.

1.2 Injuries to Persons

Injuries	Crew	Passengers	Third Party
Fatal	1	-	-
Serious	-	-	-
Minor / None	-	-	-

1.3 Damage to Aircraft

The aircraft was destroyed.

1.4 Other damage

There was forest and crop damage.

1.5 Personnel Information

1.5.1 Licences and Ratings

The 62-year-old pilot held a Private Pilot's Licence (PPL(A)) in accordance with JAR-FCL German, first issued on 21 February 1996 and valid to 12 September 2016.

The licence allowed him to conduct radio transmissions in German and English for VFR and IFR flights and listed the following ratings:

- ME piston (land), PIC, IR, valid until 9 August 2013
- SE piston (land), PIC, valid until 31 July 2014, IR valid until 9 August 2013

He also held an American PPL with the type ratings for single and multi-engine piston land, issued on 16 August 2008.

1.5.2 Flying Experience

According to his personal pilot log book he had a total flying experience of 2,139 hours, of which 185 hours were flown in accordance with instrument flight rules. He had a flying experience on PA 30 of several hundred hours, of which 99 hours had been flown within the last 12 months and 24 of them in accordance with IFR.

Between 18 and 24 May 2013, the pilot had been familiarized with the newly bought PA39 by a flight instructor; especially with the new navigation system. The flight time amounted to 3:40 hours at 12 flight cycles. On 24 May 2013 he conducted his first flight as pilot in command with a flight time of 1:10 hours in accordance to visual flight rules. The flight instructor stated that he had recommended that for the time being the pilot should fly the airplane under VFR only. He also offered to accompany IFR flights as safety pilot.

1.5.3 Medical Certificate

For the time period February 1996 until January 2006 medical certificates of the pilot were not available to the BFU.

Except for the last medical certificate dated 6 May 2013, which had been issued in accordance with COMMISSION REGULATION (EU) No 1178/2011, all other medical certificates had been issued in accordance with JAR-FCL.

One physician (AME A) had issued three class 2 medical certificates between 23 January 2006 and 8 February 2008.

Another physician (AME B) issued a class 2 medical certificate with the restriction VDL on 8 February 2010.

A third physician (AME C) denied the fitness to fly on 29 October 2010 due to cardiological reasons. After examination in accordance with Para 24 LuftVZO (Regulation on Certification and Licensing in Aviation), on 3 February 2011 he issued a class 2 medical certificate with the restrictions TML, VML, REV and the respective REV-No.

On 17 February 2011 this AME added the restriction OML. The subsequent class 2 medical certificates issued on 18 May 2011 and on 22 November 2011 by this AME no longer listed this restriction. The last medical certificate issued by this AME was valid until 18 May 2012.

Then the pilot changed back to AME B and on 22 May 2012 received a class 2 medical certificate which only listed the restriction VML. The last medical certificate this AME issued on 6 May 2013 only listed the restriction VML.

Table of the issued medical certificates:

Date of issue	Physician	Class	Limitations
23 January 2006	AME A	2	Unknown
8 February 2007	AME A	2	Unknown
8 February 2008	AME A	2	Unknown
8 February 2010	AME B	2	VDL
29 October 2010	AME C	denied	-
3 February 2011	AME C	2	TML, VML, REV
17 February 2011	AME C	2	TML, VML, REV, OML
18 May 2011	AME C	2	TML, VML, REV
22 November 2011	AME C	2	TML, VML, REV
22 May 2012	AME B	2	VML
6 May 2013	AME B	2	VML

1.6 Aircraft Information

The PA39 Twin Comanche is an all-metal, low-wing aircraft with two counter-rotating engines and a retractable landing gear. Minimum crew was one pilot.

Manufacturer:	Piper Aircraft Corporation
Type:	PA 39
Manufacturer's Serial Number (MSN):	39-137
Year of manufacture:	1972
Total operating time:	3,981 hours
Engine type:	2 Lycoming IO-320C1A (operating time 517 hours each)
Propeller:	L/H Hartzell HC-E2YL-2BSF, R/H -2BLS (operating time 474 hours each)

The aircraft had an US American certificate of registration and was operated by a private operator.

Among other things, it was equipped with: a Primary Flight Display (PFD) Aspen Avionics EDF 1000, a satellite navigation system Garmin GNS 430, and a Moving Terrain (MT) VisionAir EP 3 (Moving Map).

The pilot's documentation, which had been on board of the aircraft, included handwritten instructions for use of the PFD, the Moving Terrain, and the autopilot.

On 29 April 2013, at 3,971 aircraft operating hours, a 100-hour check was conducted.

1.7 Meteorological Information

1.7.1 Meteorological Pre-Flight Preparation

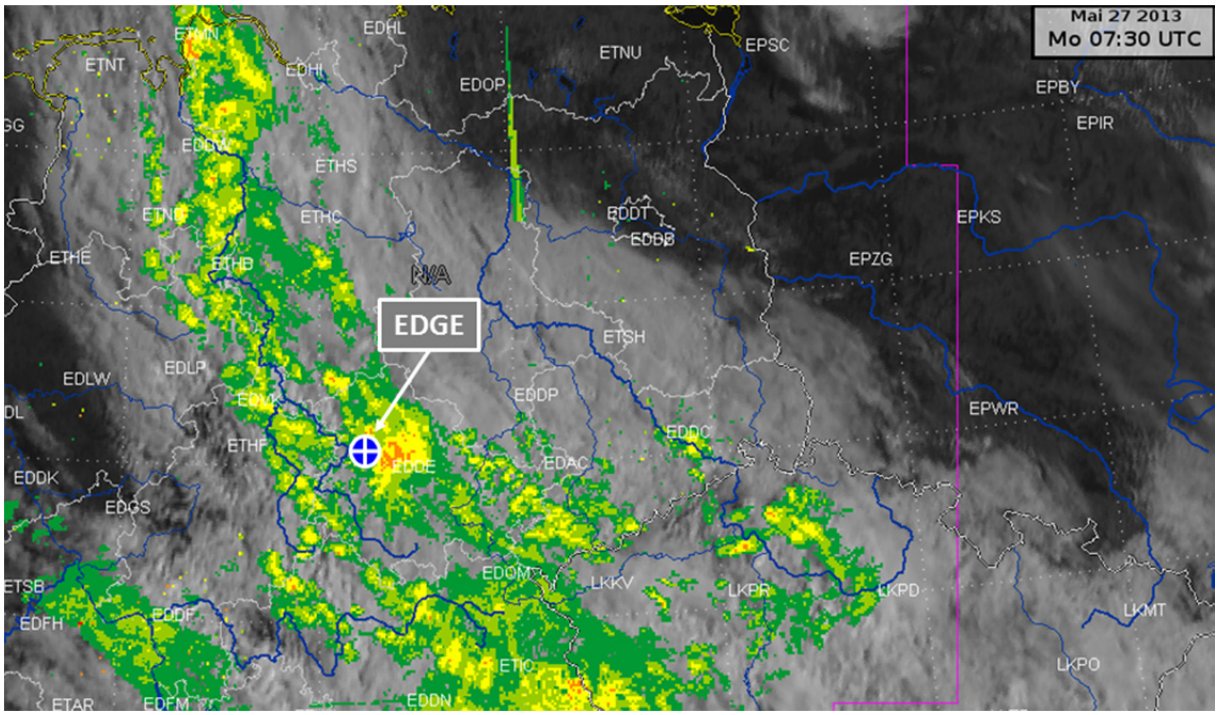
According to the expert opinion of the DWD on the eve of the day of the accident, the pilot had obtained the weather forecast for the following day from the Meteorological Advisory Centre for Aviation East in Berlin. Updated meteorological information was not obtained prior to the flight.

1.7.2 Weather at the Time of the Accident

According to the meteorological data recording the following weather conditions prevailed at Eisenach-Kindel Airfield at 0924 hrs: Wind 260°, 13 kt, visibility 7.5 km, cloud base at 800 ft, temperature 7°C, dewpoint 6°C, and QNH 1,008 hPa.

According to the expert opinion of the DWD prefrontal weather conditions prevailed. At 0930 hrs Eisenach was directly subject to the front area. At 0900 hrs the station in Eisenach reported visibility 3.3 km, and 5 to 8 oktas clouds at 600 ft and 900 ft GND. Moderate rain and drizzle occurred.

Cloud tops were probably above FL100 and could tower up to FL180. From 6,000 ft AMSL on moderate icing could occur.



Satellite image of western Thuringia: low clouds (grey) and precipitation (yellow-green)

Source: DWD, adapted by BFU

1.8 Aids to Navigation

The BFU had the DFS radar recording available for evaluation.

The radar recording (Appendix 1) had a duration of 95 s and the analysis showed the flight path of the aircraft. During circling the difference between the lowest and the highest altitude recorded was about 1,000 ft. The load factors were calculated and several times reached 2.5 times the acceleration of gravity.

The track speed oscillated between 30 kt minimum and 160 kt maximum. The calculated bank angle oscillated between 30° and 60°.

1.9 Radio Communications

Radio communications between the airplane and the flight information service at the aerodrome of departure were not recorded.

According to the statement of the DFS there was no radio contact with the air traffic control unit responsible after take-off.

1.10 Aerodrome Information

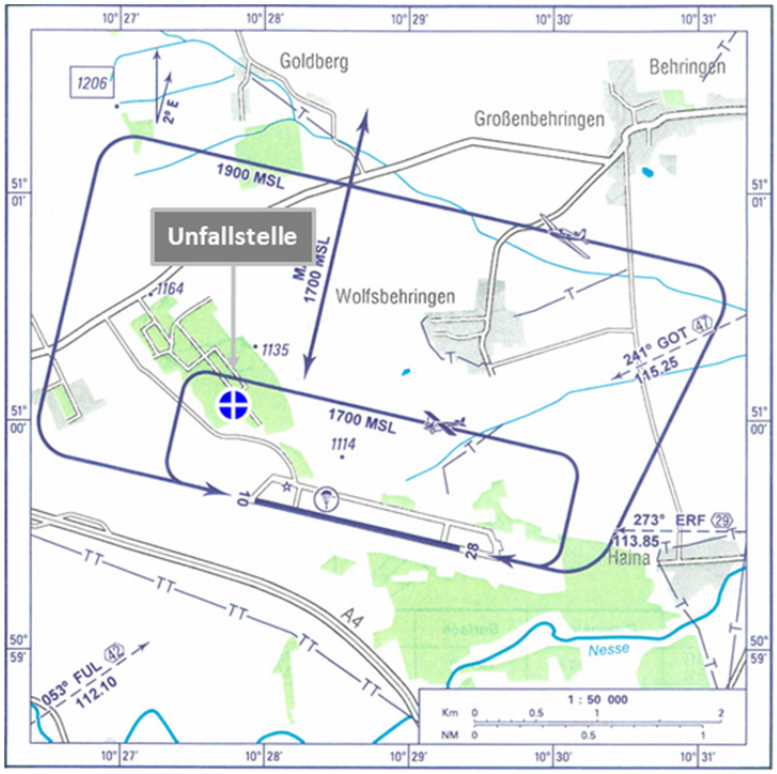
Eisenach-Kindel Airfield is located about 5.4 NM north-east of the city of Eisenach. Airport elevation is 1,101 ft AMSL. It has one asphalt runway oriented 101°/281° (10/28). The concrete runway is 1,720 m long and 55 m wide. The airfield is certified for VFR flights of aircraft of up to 5,700 kg maximum take-off mass. At the time of the accident runway 28 with a TORA of 1,720 m was in use.

1.11 Flight Recorders

The aircraft was not equipped with a Flight Data Recorder (FDR) or a Cockpit Voice Recorder (CVR). There were no legal requirements for such equipment to be fitted.

1.12 Wreckage and Impact Information

The accident site was located about 900 m north of the threshold of runway 10 of the aerodrome of departure.



Visual approach chart (excerpt, 4/2013) including location of the accident site

Source: DFS, adapted by BFU

The accident site was located on a clearing surrounded by deciduous forest with 15 to 20 m high trees; elevation was about 1,130 ft AMSL.

Lying on boggy ground, the wreckage was tilted forward by about 10°. The airplane's longitudinal axis was oriented to 320°. The cabin had split open in impact direction; all cockpit windows had burst. The fuselage and the tail section had been pushed into the aft part of the cabin. In this area the fuselage panelling had partially been torn. The wing leading edges of both wings had been indented. Deformation lines, running almost parallel to the main spar, were visible at the upper and lower wing surfaces. The aileron on the right outer wing section had been torn off. The engine struts in the wings had been compressed. Both engines, including propellers, stuck about 60 cm deep in the boggy ground.

Landing gear and flaps were retracted.

Wreckage and accident site Source: Police

The analysis of the engine data was based on the data of the EDM 700 (Appendix 2). Correlation of data and right or left engine or individual cylinders was no longer possible. The data showed that from 0739:30 UTC on the fuel flow and the operating

temperature increased continuously (The EDM has an internal clock which is subject to drift and may deviate from the radar time data.). At 0740:24 UTC the EGT value of engine B increased, which may have been caused by leaner fuel-air-mixture. In combination with the decrease in fuel flow at 0741:48 UTC operating temperature also decreased. The subsequent increase in fuel flow ran parallel to the temperature. At 0742:06 UTC rapid decrease of all parameters within 2 s was recorded. The recording ended at 0742:10 UTC.

The data recording showed that no limits were exceeded. There were no signs of engine malfunction.

1.13 Medical and Pathological Information

1.13.1 Post-Mortem Examination

A post-mortem examination of the pilot's body was conducted on behalf of the prosecution and revealed severe multiple trauma as cause of death.

The examination also showed a properly implanted biventricular pacemaker (BVP). The myocardium showed mainly in the left ventricular finely striped callosities, indicating old tissue destruction as a result of preceding perfusion disturbances. Microscopic analysis showed evidence of hypertrophy and signs of recent oxygen deficiency. These were found disseminated across the entire myocardium. The coronary blood vessels were free, but with lipid deposits. The total weight of the heart was 420 g and therefore marginally above standard.

The chemical-toxicological examination showed a qualitative positive proof of the blood pressure medication the pilot had been prescribed.

1.13.2 Medical History of the Pilot

The medical documentation the BFU has available dated back to the year 2005, when a hypertrophic cardiomyopathy was diagnosed during electrocardiographic examination. The analysis of a 24-hour electrocardiography (ECG) showed several short phases of supraventricular tachycardias and isolated atrial fibrillation. Since then the pilot was under medical treatment in a centre specialising in cardiology and cardiac surgery, which had sporadic written contact with the respective AMEs. This correspondence was available to the BFU in form of written excerpts. In July 2007 the cardiological centre diagnosed a hypertensive heart disease and conducted an extensive cardiological and angiological examination. Due to the first appearance of

premature ventricular contractions in the form of salves during a 24-hour ECG, a left-heart catheter examination was conducted within the same month. This revealed a normal left-ventricular ejection fraction and no sign of a relevant Coronary Artery Disease (CAD). The ECG showed a clinical asymptomatic Right Bundle Branch Block (RBBB) and a first to second degree AV node blockage leading to an incomplete trifascicular block. An antihypertensive medical treatment was established due to the high blood pressure values.

The BFU has additional findings of the same centre available, dated May 2010, which showed a progression of the cardiac hypertrophy and aggravated blood pressure values towards a medium arterial hypertension as a result of a similarly extensive examination. The documentation states that in everyday life the pilot is less resilient which mainly manifests in shortness of breath. Angina pectoris complaints would not occur. Subsequently, the antihypertensive medication was supplemented by another drug. In August 2010 a spiroergometry showed the progression of the AV node to a Mobitz type 2 atrioventricular block. Consequently, the indication for a pacemaker implantation was given, especially since an incomplete trifascicular block already existed. In October 2010 the pacemaker was implanted. At the end of October 2010 an AME, who is also a specialist in internal medicine, rated to issue all classes of aeromedical certificates, denied the issue of an aeromedical certificate for cardiological reasons. Three months later, after extended revaluation in accordance with Para 24 LuftVZO (Regulation on Certification and Licensing in Aviation) it was issued with restrictions. Another cardiological examination in May 2012 showed a proper pacemaker function and a stable disease pattern with only slightly worsened ECG findings. The physical resilience of the pilot had improved. In April 2013 the pilot had visited the cardiological centre for the last time. According to the documentation of this examination the cardiological disease pattern remained stable in regard to identical resilience and clinical, electrocardiographical and electrophysiological findings. However, premature ventricular contractions occurred for the first time as couplets during ergometry. The patient reported about a self-limiting one-time episode with AP complaints a few weeks before. Once again his medication was amended. According to his prescription plan of spring 2013 the pilot had to take the following medication on a regular basis: every other day ASS 100 protect at noon, Codiovan 160/12.5 in the morning, and Diovan 80 in the evening.

Laboratory results and the examination as part of the patient-centred care of March 2013 corresponded with the previous findings. On 8 May 2013 a cardiologist

conducted a 24-hour blood pressure measurement, which showed normal values, so that the cardiologist recommended continuing taking Diovan 80 in the morning.

Among the personal items the pilot carried with him on the day of the accident, a blood pressure monitor and a handwritten documentation of the measured blood pressure values were found. Between 12 April 2013 and the morning of the day of the accident at 0715 hrs 32 values of blood pressure measurements were recorded; mostly one morning and one evening measurement. The ones in the evening had mostly occurred after midnight. The values showed a constant normotensive RR situation with HR values in normal range. In addition, instructions of a non-professional nature were found describing how a heart attack can be survived if no other person is around or how one can identify cerebral stroke symptoms.

1.13.3 Expert Opinion of the Medical Data

The BFU asked several experts to assess the medical data. Among others, the Fachgruppe Flugpsychologische und Flugmedizinische Flugunfalluntersuchung of the Zentrum für Luft- und Raumfahrtmedizin der Luftwaffe were charged to compile an expert opinion in regard to aeromedical-cardiological and forensic-aeromedical aspects.

In summary, the aeromedical-cardiological assessment states:

> *1. Already in 2007 the pilot was diagnosed with supraventricular tachycardia and ventricular quad waves, neither was pursued further.*
>
> *2. The developing Mobitz type 2 atrioventricular block resulted in pacemaker implantation. The follow-up care showed proper pacemaker function.*
>
> *3. In 2013 left-thoracic complaints and stress induced arrhythmia are documented.*
>
> *4. Exclusion of a structural myocardial disease or ischaemia diagnostic beyond a stress ECG as consequence of an ECG found pathological, e.g. MRI diagnostic or scintigraphy and under stress did not occur.*
>
> *5. At the time of the accident a supraventricular arrhythmia is documented. It is assumed that the system time of the pacemaker corresponds with the actual time.*
>
> *6. Atrial fibrillation results in a significant reduction of the cardiac output and therefore may have been a contributing factor to the accident.*

7. In view of the medical history a primary myocardial disease or an ischaemic cardiomyopathy has to be discussed as cause.

In regard to the cardiac medical history and the crucial acute event the forensic-aeromedical expert opinion comes to the following conclusion:

2. The macroscopic examination of the smashed heart showed finely spotted scar tissue and therefore changes, which indicate residues of past perfusion disturbances with resulting oxygen deficiency in the tissue. This was confirmed by microscopic examination of the myocardial tissue, which showed changes, similar to such caused by preceding perfusion disturbances. Myocardial tissue perished and was replaced by scar tissue. Changes of the myocardial fibres also indicated that myocardial hypertrophy was the result of a chronic arterial hypertension.

These findings match an ischaemic cardiomyopathy and confirm the clinical aeromedical cardiological diagnosis of the cardiological expert.

3. The microscopic analysis of the myocardium also showed signs of recent oxygen deficiency, which had occurred up to a few hours prior to the accident and was caused by acute circulatory disturbances. Therefore it has to be assumed that an acute myocardial tissue damage caused by oxygen deficiency occurred, which also resulted in reduction of the blood supply of the brain [...]. This in turn would go together with clouding of consciousness or even loss of consciousness and could therefore explain the accident.

The analysis of the pacemaker readout [...] (author's note: by the cardiological expert) *corresponds with the findings of a supraventricular arrhythmia*.

*4. In total, it has to be assumed that [...] (*author's note: the pilot's*) fitness to fly was at least significantly limited, if not revoked due to his cardiac medical history. The pathological morphologic changes of the myocardium documented at the time of the accident and substantiated by the results of the pacemaker analysis, indicate that fitness to fly was not given at the time of the accident [...] (*author's note: the pilot*) may not have been able to control the aircraft as pilot in command.*

The department L5 of the LBA was also asked to comment. In regard to the cardiac arrhythmia detected by the pacemaker at the time of the accident the following is noted:

*Due to the extremely high ventricular rate in terms of ventricular flutter at the beginning of the 20 s long ECG recording and the knowledge about the delayed pacemaker recording, it must be assumed that at that time [...] (*author's note: the pilot*) was limited in his awareness or even unconscious due to a frequency induced insufficient blood circulation. The subsequent frequency of 200/min does not contribute to an immediate improvement of limited awareness or loss of consciousness. At the end of the first recording period a tachycardic heart rhythm of about 150/min was documented. But it cannot be assumed that at that time [...] (*author's note: the pilot*) was able to control the aircraft as pilot in command. If loss of consciousness had occurred it must be assumed that [...] up until the end of the recording (*author's note: the pilot*) was not able to recover a possibly occurring uncontrolled flight attitude and safely continue the flight. It must be assumed that the main reason for the accident was the cardiac arrhythmia and the resulting clouding of consciousness. It is probably no longer possible to determine what caused the cardiac arrhythmia. The increase in myocardial diameter documented over the past years and the diagnosis of a hypertrophic cardiomyopathy as well as the episodes of tachycardic arrhythmia occurring in the past could have been the sole explanation of the cardiac arrhythmia. Based on the statement of [...] (*author's note: the pilot*) that in March and April of this year he had had stenocardiac complaints and the fact that the last coronary angiography was performed in 2007 and therefore a current coronary status is not available, it is possible, that [...] (*author's note: the pilot*) had experienced angina pectoris or a heart attack during the flight resulting in cardiac arrhythmia. The recorded cardiac arrhythmia has to be viewed as the reason for the accident.*

1.14 Fire

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

1.15 Survival Aspects

Immediately after he had witnessed the crash, at 09:30 hrs the Flugleiter at the aerodrome of departure informed the rescue coordination centre and the police.

At 1035 hrs a police helicopter localised the accident site. A few minutes later rescue personnel reached the accident site.

Due to high impact forces the accident was non-survivable for the pilot. It is not possible to determine whether the cardiological occurrence would have had a lethal effect without any additional outer influence.

1.16 Tests and Research

Not applicable.

1.17 Organisational and Management Information

1.17.1 Aero Medicine

In Germany fitness to fly is being determined either by an AME or in an AMC/AeMC. An AME is either rated to issue all types of medical certificates or only for certain types. Compared to an AME an AMC/AeMC has extended personnel and technical resources and is rated to issue all types of medical certificates.

The department L5 of the Luftfahrt-Bundesamt (German civil aviation authority, LBA) was the supervisory authority over all AMEs and AMCs and their ratings.

If a pilot changed from one AME to another, the AME was not obliged to pass on all available medical data.

In this case, three different AMEs assessed the pilot's fitness to fly. AME B, the last responsible AME, was only rated to issue class 2 medical certificates.

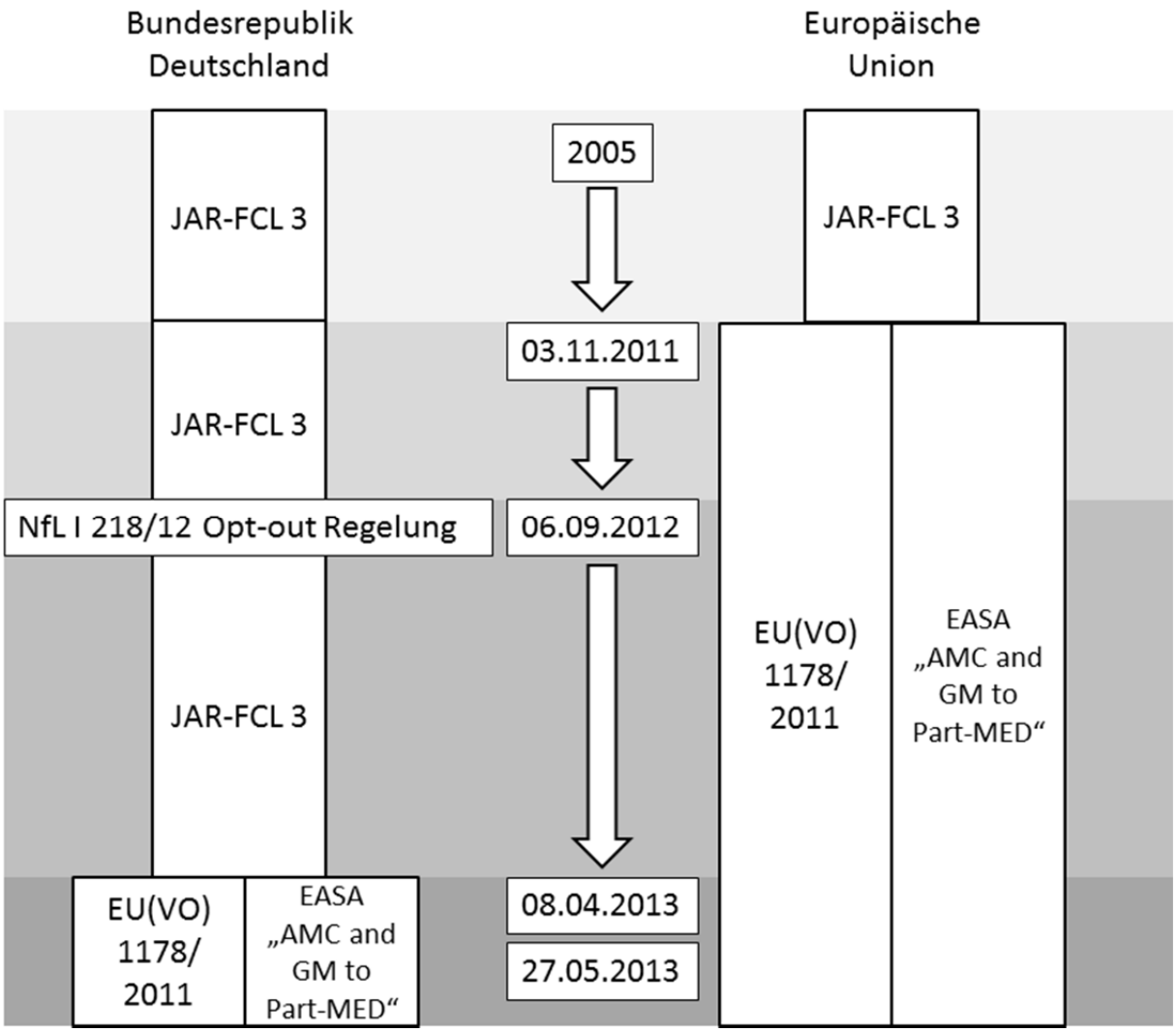
Up until 8 April 2013 the assessment of the fitness to fly was determined in accordance with JAR-FCL 3 Medical Requirements for Flight Crew Licensing. The last assessment of the fitness to fly in May 2013 was conducted in accordance with COMMISSION REGULATION (EU) No 1178/2011. Already at the end of 2011 the European Union had published this regulation. Germany had made use of an opt-out option, whereby the implementation of the new regulation was postponed to 8 April 2013.

Parallel to the (EU) No 1178/2011 issued in November 2011 but not then effective in Germany, existed the document "Acceptable Means of Compliance and Guidance Material to Part-MED" published by EASA also at the end of 2011. This document was recommended to the AMEs as course of action for the implementation of the EU regulation. The LBA stated that this document contained changes of medical therapy standards, which could not be included into the EU regulation on short notice, due to

considerable administrative time and effort. When assessing fitness to fly and issuing medical certificates it was mandatory to apply the contents of the EASA document.

These guidelines not only described the assessment criteria, by means of which the decision whether someone was fit to fly or not was made in the presence of certain disease patterns, but also procedures for medical counsel and extended examinations, which had to be applied for the assessment of the fitness to fly in the presence of complex disease patterns. In addition, the process for the entry of restrictions in the medical certificate was described.

The consequences of pre-existing medical conditions regarding the fitness to fly may vary due to changing assessment criteria. Political considerations and progress in medical diagnostic and therapy also play a part.



Legal specifications for aero medicine and their implementation Source: BFU

1.17.2 Legal requirements regarding the Relevant Disease Patterns

1.17.2.1 Arterial Hypertension

JAR–FCL 3.135 Cardiovascular System – Blood pressure

(b) When the blood pressure at examination consistently exceeds 160 mmHg systolic and/or 95 mmHg diastolic, with or without treatment, the applicant shall be assessed as unfit.

(c)Treatment for the control of blood pressure shall be compatible with the safe exercise of the privileges of the applicable licence(s) and be compliant with paragraph 4 Appendix 1 to Subparts B and C. The initiation of [ ][medication]

shall require a period of temporary suspension of the medical certificate to establish the absence of significant side effects.

Appendix 1 to the Subparts B and C

(4) Antihypertensive medication shall be approved by an aeromedical centre or an aeromedical examiner. [...] Antihypertensive medication may basically require the entry [...] of the restriction "OSL" in the class 2 medical certificate.

1.17.2.2 Cardiac Hypertrophy

JAR–FCL 3.150 Cardiovascular System – General

(e) Applicants with any abnormality of the pericardium, myocardium or endocardium shall be assessed as unfit. After complete recovery and sufficient cardiological assessment fitness may be checked by an aeromedical centre in accordance with Appendix 1 (11) to the Subparts B and C.

Appendix 1 to the Subparts B and C

(11) Applicants with primary or secondary abnormalities of the pericardium, myocardium or endocardium shall be assessed as unfit until complete clinical recovery. The cardio-vascular diagnostic performed by an aeromedical centre or an aeromedical expert may include: 2D-doppler-electrocardiography, exercise ECG and/or myocardial scintigraphy or stress echocardiography, and a 24h ECG. A coronary angiography may be indicated. Frequent reviews shall be conducted in the required temporal intervals. […]

For applicants for a class 2 medical certificate the restriction "OSL" may generally be entered in the certificate.

Regulation (EU) No 1178/2011 Appendix IV [Part-MED] Subpart B Section 2

MED.B.010 Cardiovascular System

(b) Cardiovascular System — General

(3) Applicants for a Class 1 medical certificate with an established history or diagnosis of any of the following conditions shall be referred to the licensing authority: […]

(v) abnormality of the pericardium, myocardium or endocardium;

(4) Applicants for a Class 2 medical certificate with an established diagnosis of one of the conditions specified in (2) and (3) above shall be assessed by a

cardiologist before a fit assessment may be considered in consultation with the licensing authority.

1.17.2.3 Cardiac Arrhythmia and Pacemaker

JAR–FCL 3.265 Cardiovascular System Rhythm – Conduction Disturbances

(a) Applicants with significant intermittent or permanent significant supraventricular rhythm disturbances including sinu-atrial dysfunction shall be assessed as unfit. Fitness to fly may be reviewed by an aeromedical centre or a class 1 aeromedical expert in accordance with Appendix 1(7) to the Subparts B and C.

(b) Applicants with incomplete bundle branch block [...] may be assessed as fit to fly if no pathological change is the cause.

(c) Applicants with complete right bundle branch block need a cardiological assessment for the first diagnosis and later in accordance with Appendix 1(7) to the Subparts B and C.

(d) Applicants with Mobitz I type 1 atrioventricular block and Mobitz I type 2 atrioventricular block, may be assessed as fit to fly, if no pathological change is the cause. Applicants with Mobitz II type 2 atrioventricular block or complete atrioventricular block shall be assessed as unfit to fly.

Fitness to fly may be reviewed by an aeromedical centre or a class 1 aeromedical expert in accordance with Appendix 1(7) to the Subparts B and C.

(e) Applicants with pacemakers shall be assessed as unfit to fly. Fitness to fly may be reviewed by an aeromedical centre or a class 1 aeromedical expert in accordance with Appendix 1(7) to the Subparts B and C.

Appendix 1 to the Subparts B and C

(7) Each significant cardiac arrhythmia or conduction disturbance requires a cardiological assessment and in case of fitness to fly regular check-ups.

(c) Review of the class 1 medical certificate by an aeromedical centre

2. Complete right bundle branch block:

ii) Revalidation or renewal examinations of an applicant for a class 1 medical certificate may be performed by an aeromedical centre. For applicants, who have completed their 40th year, the restriction "OML" shall

generally be entered in the medical certificate for the duration of at least 12 months.

5. Pacemaker

After implantation of a permanent subendocardial pacemaker the review of the fitness to fly is only possible after three months after the implantation, if the following requirements are met:

no other reason for unfitness

[…]

v) For revalidation and renewal examinations the restriction "OML" shall be noted in the medical certificate.

(d) Review of the class 2 medical certificate by an aeromedical centre or a class 1 medical expert:

Assessments of class 2 fitness to fly is identical to class 1. Entering the restrictions "OSL" or "OPL" (valid only without passengers) in the medical certificate may be necessary.

Regulation (EU) No 1178/2011 Appendix IV [Part-MED] Subpart B Section 2 MED.B.010 Cardiovascular System

(e) Rhythm/Conduction Disturbances

(1) Applicants for a Class 1 medical certificate shall be referred to the licensing authority when they have any significant disturbance of cardiac conduction or rhythm, including any of the following:

disturbance of supraventricular rhythm, including intermittent or established sinoatrial dysfunction, atrial fibrillation and/or flutter and asymptomatic sinus pauses;

Mobitz type 2 atrioventricular block

broad and/or narrow complex tachycardia

(2) Applicants for a Class 2 medical certificate with any of the conditions detailed in (1) shall undergo satisfactory cardiological evaluation before a fit assessment in consultation with the licensing authority may be considered.

(3) Applicants with any of the following:

(i) incomplete bundle branch block

(ii) complete right bundle branch block

may be assessed as fit in the absence of any other abnormality and subject to satisfactory cardiological evaluation.

(4) Applicants with a history of:

[…]

(ii) pacemaker implantation

shall undergo satisfactory cardiovascular evaluation before a fit assessment may be considered. Applicants for a Class 1 medical certificate shall be referred to the licensing authority.

[...] Applicants for a Class 2 medical certificate shall be assessed in consultation with the licensing authority.

(5) Applicants with any of the following conditions shall be assessed as unfit:

[…]

(iv) an automatic implantable defibrillating system;

(v) a ventricular anti-tachycardia pacemaker.

EASA Acceptable Means of Compliance and Guidance Material to Part-MED Section 3 Specific requirements for class 2 medical certificates AMC2 MED.B.010 Cardiovascular System

(l) Rhythm and conduction disturbances

Any significant rhythm or conduction disturbance should require cardiological evaluation and an appropriate follow-up before a fit assessment may be considered. An OSL or OPL limitation should be considered as appropriate.

1.17.2.4 Angina Pectoris

Regulation (EU) No 1178/2011 Appendix IV [Part-MED] Subpart B Section 2 MED.A.020 Decrease in medical fitness

(a) Licence holders shall not exercise the privileges of their licence and related ratings or certificates at any time when they:

are aware of any decrease in their medical fitness which might render them unable to safely exercise those privileges;

MED.B.010 Cardiovascular System

(d) Coronary Artery Disease

(3) Applicants with any of the following conditions shall be assessed as unfit:

[…]

(ii) symptomatic coronary artery disease

EASA Acceptable Means of Compliance and Guidance Material to Part-MED Section 3 Specific requirements for class 2 medical certificates AMC2 MED.B.010 Cardiovascular System

(k) Coronary artery disease

(1) Chest pain of uncertain cause requires full investigation

(2) In suspected asymptomatic coronary artery disease cardiological evaluation should show no evidence of myocardial ischaemia or significant coronary artery stenosis.

(4) Angina pectoris is disqualifying, whether or not it is abolished by medication.

1.18 Additional Information

Not applicable.

1.19 Useful or Effective Investigation Techniques

Not applicable.

2. Analysis

2.1 Accident / General

The airplane was configured for cruise flight and impacted the ground due to an uncontrolled flight attitude.

The aircraft had a valid certificate of registration and was properly maintained. The technical findings of the wreckage examination did not reveal any malfunction of components, control equipment, or engines.

The weather conditions were not suited for a change of flight rules from VFR to IFR. Even immediately after take-off the airplane was in Instrument Meteorological Conditions (IMC).

The pilot held the required licence and ratings to conduct the flight and was experienced. He had still little experience with the navigation system and the avionics of this aircraft.

He had a valid medical certificate.

2.2 Health Condition of the Pilot

For several years, the pilot had been suffering from a chronic progressive structural heart disease. In spite of continuous treatment the course of the disease merely slowed. In addition attending ills developed. In the last weeks prior to the accident the pilot reported at least two episodes of angina pectoris including shortness of breath. The read-out of his pacemaker showed several episodes of tachycardic arrhythmia, which partially lasted several minutes. The pacemaker was not suited to terminate those episodes.

For the time period of several minutes around the time of the accident the pacemaker also recorded tachycardic arrhythmia. This resulted in decreased cardiac pump performance with subsequent lower blood pressure, so that sufficient blood supply to the organs, especially the brain, was no longer guaranteed. Therefore, the pilot was not able to control the airplane. It is highly likely that he had been unconscious at least part of the time.

The pilot had realised that his health condition had decreased over the past few weeks prior to the accident. This was indicated by the documents found in the airplane, with notes how to help oneself in case of cardiac or neurological

emergency. The BFU was able to reconstruct that he had talked with his physicians about the newly developed episodes of angina pectoris and shortness of breath. It was not possible, however, to reconstruct whether he had talked about it with the AME during the last fitness-to-fly examination on 6 May 2013. In the last weeks prior to the accident the cardiac illness progressed which changed its characteristics and the resulting physical capacity. The progressive nature of the illness was not adequately diagnosed. Contributing factor was the fact that the pilot did not consult his cardiologist and his general practitioner as pilot but as non-flying patient. It is likely that the medical counsel of the pilot might have differed from the one for a non-flying patient.

The available documentation showed that the pilot only obeyed the change towards a healthier lifestyle, the physician had suggested several times, to some extent. It was not possible to determine whether this had to be correlated with his personal attitude or the requirements of his occupational environment.

2.3 Aeromedical Aspects

At the time of his last fitness-to-fly examination until the day of the accident the pilot was unfit to fly. The AME did not realise this. The BFU could not reconstruct whether the pilot had told the AME about the newly developed episodes of angina pectoris and shortness of breath. It is highly likely that the pilot was aware of his declining physical fitness. In addition, he was obliged to inform his AME accordingly. Until the necessary medical examinations were completed he would not have been permitted to fly. During the examinations, his fitness to fly would have been suspended at once and extensive additional examinations initiated suited to identify the severity of his illness. The consequence would have been a permanent unfitness to fly.

However, due to the combination of his individual illnesses the AME should not have issued a medical certificate after the pilot's last examination in accordance with Regulation (EU) No 1178/2011, even without further details.

The crucial factor was that in the presence of incomplete bundle branch block or a complete right bundle branch block, a medical certificate can only be issued after satisfactory cardiac assessment, if no other norm deviations exist (Regulation (EU) No 1178/2011 Appendix IV Subpart B Section 2 MED.B.010 e) (3)). Since in this case arterial hypertension, an implanted pacemaker, and cardiac hypertrophy existed, fitness to fly was impossible.

In addition, due to the complexity of the illnesses the assessment of the fitness to fly should not have been made solely by the AME. The Regulation (EU) No 1178/2011 stipulated that for the disease patterns "abnormality of the myocardium, disturbance of supraventricular rhythm, Mobitz type 2 atrioventricular block, tachycardia, pacemaker implantation" it was mandatory to consult the licensing authority before a medical certificate is issued (Regulation (EU) No 1178/2011 Appendix IV Subpart B Section 2 MED.B.010 b) (4); e) (1),(2),(4)). This did not occur. A consultation would also have resulted in a denial of the fitness to fly.

Even if the issue of the medical certificate did occur contrary to these regulations a necessary additional step in accordance with EASA AMC2 MED.B.010 would have been the entry of the restrictions OSL or OPL. This also did not occur.

Issue of the medical certificate should have been denied had the respective regulations valid since May 2013 been fully applied.

This is also true for the examinations in accordance with JAR-FCL 3 of the previous years. Even then the pilot had diagnostic findings which:

a) should have resulted in the expiration of the medical certificate

b) would have made the long-term restriction OSL necessary

c) would have resulted in transfer of the pilot to either an AME 1 or an AMC

Between 2005 and 2013 the following medical findings should have resulted in either suspension or expiration of the medical certificate as soon as another reason for unfitness to fly existed: arterial hypertension; start of the antihypertensive medication; cardiac hypertrophy; supraventricular tachycardia; left anterior hemiblock with hypertrophy; Mobitz type 1 atrioventricular block II with hypertrophy; Mobitz type 2 atrioventricular block II; pacemaker implantation.

The following disease patterns would have made it necessary to transfer the patient to an AME class 1 or to an AMC: cardiac hypertrophy; cardiac arrhythmia; atrioventricular block; pacemaker implantation.

For the following disease patterns the entry OSL was either required or optional: Antihypertensive medication ("optional"); cardiac hypertrophy ("basically optional"); complete right bundle branch block ("generally for at least 12 months"); pacemaker implantation ("the restriction OSL is to be noted").

The documentation the BFU has available does not show any interruption of the fitness to fly for any period of time, except for three months of suspension right after the pacemaker implantation.

The entry OML occurred only once for three months - which is not correct for private pilots. During the entire time the pilot received counsel from AME B, who was only certified to issue class 2 medical certificates, transferral to an AME 1 or AMC did not occur.

It must be assumed that assessment of the fitness to fly by the AMEs did not occur with sufficient adherence to valid regulations.

Had the stipulations in accordance with JAR-FCL 3 been applied, it is highly likely that the pilot would not have received a medical certificate or it would at least have carried additional restrictions, such as a safety pilot. Both alternatives would have been suitable to prevent or at least substantially minimise the risk of the accident.

It must be taken into consideration, however, that since at least after the implementation of the Regulation (EU) No 1178/2011 the applicable regulation for the assessment of the fitness to fly had become very complex. From that moment on two different documents existed which had to be applied by the AMEs to assess the fitness to fly. Whereas the Regulation (EU) No 1178/2011 as bill is mandatory, the Acceptable Means of Compliance and Guidance Material to Part-MED by EASA is from a medical standpoint like a commentary of the bill and therefore binding as "best clinical practise". Short-term changes of medical standards were entered into the Acceptable Means of Compliance and Guidance Material to Part-MED. Contrary to the Regulation (EU) No 1178/2011 there was no German translation available for this document. Therefore the AMEs had to check for each individual disease pattern if the assessment criteria had changed after the implementation of the Regulation (EU) No 1178/2011 compared to JAR-FCL 3. They also had to check whether the information in the EU regulation was still congruent with the EASA stipulations.

On a European level the Regulation (EU) No 1178/2011 and the corresponding EASA document Acceptable Means of Compliance and Guidance Material to Part-MED had already become effective in November 2011 and therefore their contents been available for aeromedical examiners. Ten months later Germany issued NfL218/12 stating the delay of the implementation of Regulation (EU) No 1178/2011 until 8 April 2013 claiming the opt-out option.

During these ten months the AMEs had to reckon with the implementation of the Regulation (EU) No 1178/2011 in Germany at any time. Therefore it has to be assumed that they had studied the changes so that they would be prepared once Regulation (EU) No 1178/2011 would replace JAR-FCL 3. This means the AMEs had to study all three possible assessment criteria (JAR-FCL 3, Regulation (EU) No 1178/2011, EASA), which significantly increased the risk of incorrect assessments in accordance with no longer valid or not yet valid assessment criteria. Already in November 2011 the BMVI responsible for the implementation of the EU regulation knew that a timely implementation was not realisable due to insufficient resources. The same reason applied for the announcement delayed by a few months that they would make use of the opt-out provision. A timelier announcement would have meant more planning reliability for the AMEs.

In this case the timely implementation of the Regulation (EU) No 1178/2011 would have prevented the deletion of the restrictions "TML" and REV" in the medical certificate after the pilot had changed from AME C back to AME B in May 2012. No new medical certificate could be issued without submission of the last certificate. The AME B stated during the interview that he had had no knowledge about the previously entered restrictions, because the last medical certificate had not been submitted. Differently to JAR-FCL 3 the Regulation (EU) No 1178/2011 permits the deletion of restrictions only with prior consultation with the responsible licensing authority.

The BFU could not reconstruct to what extent the AME had at that time studied the differences between JAR-FCL 3 and Regulation (EU) No 1178/2011 and EASA Acceptable Means of Compliance and Guidance Material to Part-MED.

De facto, the responsible department L5 at the LBA was legally and infrastructurally put in a position to actively exercise supervision and counsel functions for fitness-to-fly examinations after the Airbus A320 crash in Prads-Haute-Bléone, France, in March 2015. Since then the AMEs are sending all examination reports to the LBA, where they are recorded and, if applicable, also assessed. This procedure would have been suitable to recognise the unfitness to fly of the pilot, to discuss this with the responsible AME and then deny the fitness to fly.

3. Conclusions

3.1 Findings

- The PIC held the required licence and ratings to conduct the flight and was experienced. He had still little experience with the electronic equipment.
- At the time of the accident the pilot held a valid class 2 medical certificate.
- The pilot suffered from a heart disease and was not fit to fly.
- During the pilot's last fitness-to-fly assessment, the applicable decision criteria were not adequately considered.
- During several previous fitness-to-fly examinations the decision criteria were not applied correctly.
- The complexity and the existence of several regulations which had to be considered contributed to incorrect assessments.
- The higher-ranking organisational structure was not suited to identify incorrect assessments and intervene.
- No indications for technical irregularities were found on the aircraft.
- The airplane was equipped for IFR flights.
- The weather conditions were not suitable for a change of flight rules from VFR to IFR.

3.2 Causes

The accident was due to the following: During the take-off phase the pilot had become incapacitated or lost consciousness due to tachycardic arrhythmia and therefore lost control over the airplane.

The following factors contributed to the accident:

- a chronic, progressive structural illness of the pilot's heart
- lack of self-reflection of the pilot regarding his illness and fitness to fly
- inaccurate aeromedical evaluation
- an unsuitable governmental organisational structure regarding the complexity of the underlying legal regulations.

4. Safety Recommendations

During this accident investigation and as a result of another air accident investigation the Luftfahrt-Bundesamt has implemented the following procedural changes, which the BFU considers as safety actions:

- According to Regulation (EC) No 1178/2011 deletion of limitations in medical certificates is only permissible after consultation with the responsible authority.
- The Luftfahrt-Bundesamt has imposed an active supervisory and advisory function toward the AeMCs and the AeMEs.
- All examinations reports of every fitness-to-fly examination by the AeMCs and AeMEs will be transmitted to the Luftfahrt-Bundesamt, where they are collected and, if applicable, assessed.

Due to these actions the BFU abstains from issuing suitable safety recommendations

Investigator in charge:	Jens Eisenreich
Field investigation:	Wolfgang Berger, Frank Stahlkopf, Jens Eisenreich
Medical analysis:	Dr. Thomas Harendza
Engine examination:	Thomas Karge
Flight path analysis:	Klaus Himmler

Braunschweig, 12 January 2018

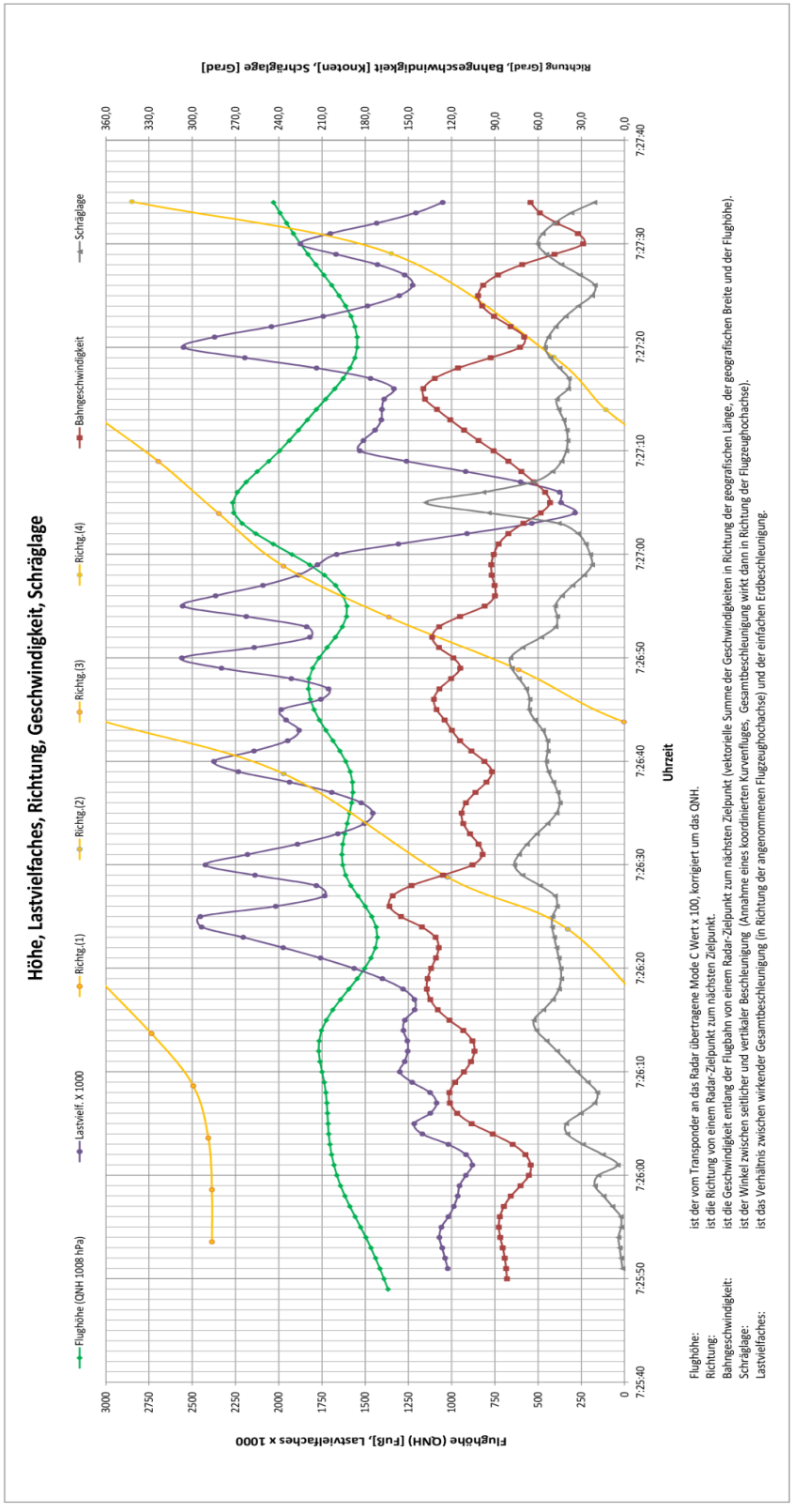
5. Appendix

Appendix 1: Radar data analysis

Appendix 2: Engine data analysis

Appendix 1

Radar data analysis



Appendix 2

Engine data analysis