Published March 2016

Final Report

Accident on **24 March 2015**
at **Prads-Haute-Bléone (Alpes-de-Haute-Provence, France)**
to the **Airbus A320-211**
registered **D-AIPX**
operated by **Germanwings**

BEA

Bureau d'Enquêtes et d'Analyses
pour la sécurité de l'aviation civile

Ministère de l'Ecologie, du Développement durable et de l'Energie

Safety Investigations

The BEA is the French Civil Aviation Safety Investigation Authority. Its investigations are conducted with the sole objective of improving aviation safety and are not intended to apportion blame or liability.

BEA investigations are independent, separate and conducted without prejudice to any judicial or administrative action that may be taken to determine blame or liability.

SPECIAL FOREWORD TO ENGLISH EDITION

This is a courtesy translation by the BEA of the Final Report on the Safety Investigation. As accurate as the translation may be, the original text in French is the work of reference.

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Glossary

ACP	*Audio Control Panel*
ACARS	*Aircraft Communication Addressing and Reporting System*
AeMC	*Aero-Medical Centre*
ALPA	*Air Line Pilots Association*
AME	*Aero-Medical Examiner*
AsMA	*Aerospace Medical Association*
ATC	*Air Traffic Control*
BÄK	*Bundesärztekammer (German Medical Association)*
BFU	*German Federal Bureau of Aircraft Accident Investigation (Bundesstelle für Flugunfalluntersuchung)*
BMVI	*Federal Ministry of Transport and Digital Infrastructure (Bundesministeriums für Verkehr und digitale Infrastruktur)*
CISM	*Critical Incident Stress Management*
CIAIAC	*Spanish safety investigation authority (Comisión de Investigación de Accidentes e Incidentes de Aviación Civil)*
CDLS	*Cockpit Door Locking System*
CVR	*Cockpit Voice Recorder*
DGAC	*French general civil aviation directorate* Direction Générale de l'Aviation Civile
EASA	*European Aviation Safety Agency*
FCU	*Flight Control Unit*
FDR	*Flight Data Recorder*
GPWS	*Ground Proximity Warning System*
IATA	*International Air Transport Association*
ICAO	*International Civil Aviation Organisation*
JAA	*Joint Aviation Authorities*
LBA	*German civil aviation authority (Luftfahrt-BundesAmt)*
LFT	*Lufthansa Training*
MEL	*Minimum Equipment List*
PF	*Pilot Flying*

PFD	*Primary Flight Display*
PM	*Pilot Monitoring*
QAR	*Quick Access Recorder*
REV	*Medical certificate issued after review procedure*
SSRI	*Selective Serotonin Re-uptake Inhibitors*
WG	*Working Group*
WHO	*World Health Organization*

Synopsis

Deliberate flight into terrain

Aircraft	Airbus A320-211 registered D-AIPX
Date and time	24 March 2015 at 09 h 41 (1)
Opertor	Germanwings
Place	Prads-Haute-Bléone (04)
Type of flight	Commercial Air Transport Revenue operations, Passenger
Persons on board	Captain (PM), co-pilot (PF), 4 cabin crew, 144 passengers
Consequences and damage	Crew and passengers fatally injured, aeroplane destroyed

(1) Except where otherwise indicated, all times in this report are UTC. One hour should be added to obtain the legal time in metropolitan France on the day of the event.

The co-pilot had been flying for Germanwings since June 2014 and was the holder a class 1 medical certificate that was first issued in April 2008 and had been revalidated or renewed every year. Since July 2009, this medical certificate had contained a waiver because of a severe depressive episode without psychotic symptoms that had lasted from August 2008 until July 2009. This waiver stated that it would become invalid if there was a relapse into depression.

In December 2014, approximately five months after the last revalidation of his class 1 medical certificate, the co-pilot started to show symptoms that could be consistent with a psychotic depressive episode. He consulted several doctors, including a psychiatrist on at least two occasions, who prescribed anti-depressant medication. The co-pilot did not contact any Aero-Medical Examiners (AME) between the beginning of his decrease in medical fitness in December 2014 and the day of the accident.

In February 2015, a private physician diagnosed a psychosomatic disorder and an anxiety disorder and referred the co-pilot to a psychotherapist and psychiatrist. On 10 March 2015, the same physician diagnosed a possible psychosis and recommended psychiatric hospital treatment. A psychiatrist prescribed anti-depressant and sleeping aid medication in February and March 2015. Neither of those health care providers informed any aviation authority, nor any other authority about the co-pilot's mental state. Several sick leave certificates were issued by these physicians, but not all of them were forwarded to Germanwings.

No action could have been taken by the authorities and/or his employer to prevent him from flying on the day of the accident, because they were informed by neither the co-pilot himself, nor by anybody else, such as a physician, a colleague, or family member.

In the cruise phase of the accident flight, the co-pilot waited until he was alone in the cockpit. He then intentionally modified the autopilot settings to order the aeroplane to descend. He kept the cockpit door locked during the descent, despite requests for access made via the keypad and the cabin interphone. He did not respond to the calls from the civil or military air traffic controllers, nor to knocks on the door. Security requirements that led to cockpit doors designed to resist forcible intrusion by unauthorized persons made it impossible to enter the flight compartment before the aircraft impacted the terrain in the French Alps.

The BEA investigation concluded that the process for medical certification of pilots, in particular self-reporting in case of decrease in medical fitness between two periodic medical evaluations, did not succeed in preventing the co-pilot, who was experiencing mental disorder with psychotic symptoms, from exercising the privilege of his licence. The following factors may have contributed to the failure of this principle:

- the co-pilot's probable fear of losing his right to fly as a professional pilot if he had reported his decrease in medical fitness to an AME;
- the potential financial consequences generated by the lack of specific insurance covering the risks of loss of income in case of unfitness to fly;
- the lack of clear guidelines in German regulations on when a threat to public safety outweighs the requirements of medical confidentiality.

The BEA has addressed eleven safety recommendations to the WHO, IATA, the European Commission, EASA, BMVI and BÄK relating to:

- medical evaluation of pilots with mental health issues;
- routine analysis of in-flight incapacitation;
- mitigation of the consequences of loss of licence;
- anti-depressant medication and flying status;
- balance between medical confidentiality and public safety;
- promotion of pilot support programmes.

ORGANISATION OF THE INVESTIGATION

On 24 March 2015, at around 10 h 15, the Marseille en-route control centre informed the BEA of the accident to an Airbus A320, registered D-AIPX that had occurred while overflying the French Alps. In accordance with the provisions of European regulation (EU) n°996/2010 of the European Parliament and Council of the 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation, a Safety Investigation was immediately initiated by the BEA.

A team of seven investigators from the BEA travelled to the accident site on the afternoon of 24 March. In coordination with the authorities in charge of the judicial investigation, and with helicopter transport provided by the Gendarmerie, the safety investigators were able to access the site the following day.

The CVR was found on the afternoon of 24 March 2015 and transferred the following day to the BEA for readout. After reading out the data, it appeared to the BEA that an act of unlawful interference was probably involved in the accident. European Regulation (EU) n°996/2010 and the advance arrangement relating to Safety Investigations between the French ministry of Justice and the BEA of 16 September 2014, specify that, in such a situation, the relevant elements gathered during the Safety Investigation must be communicated immediately to the judicial authorities, and the BEA can decide to continue the Safety Investigation, which it did.

The BEA associated the following foreign counterparts with the Safety Investigation, which then appointed Accredited Representatives:

- the BFU (Germany), the aeroplane being registered in Germany and operated by a German airline. This made it possible to obtain the assistance of technical advisers from Germanwings;
- the CIAIAC (Spain). This made it possible to obtain information relating to the aeroplane's stop at Barcelona and data from the Spanish ATC service;
- the AAIB (UK). This made it possible to obtain information on the aeromedical certification in the UK;
- the NTSB (USA). This made it possible to obtain information on the aeromedical certification in the USA and aerospace medical expertise from AsMA.

The BEA also associated:

- technical advisers from EASA, the DGAC, Snecma (on behalf of CFM) and Airbus;
- experts in medical certification from the Civil Aviation Authorities of Israel, Canada, Norway, and Spain as well as from EDF and SNCF;
- other medical experts, including psychiatrists.

The Safety Investigation was organised with three working groups in the following areas: aircraft, aeroplane systems and operations. The Accredited Representatives and the technical advisers were divided between the three groups.

Australia, Israel and Japan appointed experts to follow the Safety Investigation, in accordance with standards and recommended practices in ICAO Annex 13, since some of the victims came from these countries.

On 6 May 2015, the BEA published a preliminary report prepared on the basis of the initial information gathered in the course of the investigation.

The work performed by the working groups was included in the Draft Final Report, which was sent for consultation in December 2015 to the participants in the investigation.

Review and integration of the comments received led to the drafting, then the publication of the Final Report of the Safety Investigation on 13 March 2016 and the issuance of eleven safety recommendations.

1 - FACTUAL INFORMATION

1.1 History of flight

Note: the following elements are based on the flight recorders, as well as on recordings of radio communications. The main points in the history of the flight below are referenced by the numbers on figure 1.

On Tuesday 24 March 2015, the Airbus A320-211 registered D-AIPX operated by Germanwings was programmed to undertake scheduled flight 4U9525 between Barcelona (Spain) and Düsseldorf (Germany), with the callsign GWI18G. Six crew members (2 flight crew and 4 cabin crew) and 144 passengers were on board. The same crew had made the outbound flight, taking off from Düsseldorf at 6 h 01, and landing in Barcelona at 7 h 57.

The takeoff from Barcelona took place at 9 h 00 from runway 07R. The co-pilot was Pilot Flying (PF).

At 9 h 02 min 54, autopilot n°2 was engaged in CLIMB and NAV mode; autothrust had been engaged about a minute earlier.

At 9 h 12 min 15, during the climb, the buzzer to request access to the cockpit sounded for one second. Noises similar to the cockpit door opening and then closing were recorded, following which a flight attendant was present in the cockpit. The three crew members then started a conversation about how the stop at Barcelona had gone.

At 9 h 15 min 53, noises like those of the opening then the closing of the cockpit door were recorded. The flight attendant left the cockpit.

Following that, some discussions took place between the co-pilot and the Captain about managing the delay that resulted from late departure from Barcelona.

At 9 h 27 min 20, the aeroplane levelled off at a cruise altitude of 38,000 ft (FL380) (point ❶ on figure 1). The flight crew was then in contact with the Marseille en-route control centre on the 133.330 MHz frequency.

At 9 h 29 min 40, the flight crew was transferred to the 127.180 MHz frequency of the Marseille control centre.

At 9 h 30 min 00 (point ❷), the Captain read back the air traffic controller's clearance allowing him to fly direct to the IRMAR point: *"Direct IRMAR Merci Germanwings one eight Golf"*. This was the last communication between the flight crew and ATC.

At 9 h 30 min 08, the Captain told the co-pilot that he was leaving the cockpit and asked him to take over radio communications, which the co-pilot acknowledged.

At 9 h 30 min 11, the heading started to decrease and stabilised about a minute later around 23°, which is consistent with a route towards the IRMAR point.

At 9 h 30 min 13, noises of a pilot's seat movements were recorded.

At 9 h 30 min 24 (point ❸), noises of the opening then, three seconds later, the closing of the cockpit door were recorded. The Captain was then out of the cockpit.

At 9 h 30 min 53 (point❹), the selected altitude on the FCU changed in one second from 38,000 ft to 100 ft[2]. One second later, the autopilot changed to OPEN DES[3] mode and autothrust changed to THR IDLE mode. The aeroplane started to descend and both engines' speed decreased.

At 9 h 31 min 37, noises of a pilot's seat movements were recorded.

At 9 h 33 min 12 (point❺), the speed management changed from managed mode to selected[4] mode. One second later, the selected target speed became 308 kt while the aeroplane's speed was 273 kt. The aeroplane's speed started to increase along with the aeroplane's descent rate, which subsequently varied between 1,700 ft/min and 5,000 ft/min, then was on average about 3,500 ft/min.

At 9 h 33 min 35, the selected speed decreased to 288 kt. Then, over the following 13 seconds, the value of this target speed changed six times until it reached 302 kt.

At 9 h 33 min 47 (point❻), the controller asked the flight crew what cruise level they were cleared for. The aeroplane was then at an altitude of 30,000 ft in descent. There was no answer from the co-pilot. Over the following 30 seconds, the controller tried to contact the flight crew again on two occasions, without any answer.

At 9 h 34 min 23, the selected speed increased up to 323 kt. The aeroplane's speed was then 301 kt and started to increase towards the new target.

At 9 h 34 min 31 (point❼), the buzzer to request access to the cockpit was recorded for one second.

At 9 h 34 min 38, the controller again tried to contact the flight crew, without any answer.

At 9 h 34 min 47 then at 9 h 35 min 01, the Marseille control centre tried to contact the flight crew on 133.330 MHz, without any answer. The aeroplane was then at an altitude of 25,100 ft, in descent.

At 9 h 35 min 03 (point❽), the selected speed increased again to 350 kt[5].

Subsequently, and until the end of the recording:

- the selected speed remained at 350 kt and the aeroplane's speed stabilised around 345 kt;
- the autopilot and autothrust remained engaged;
- the cockpit call signal from the cabin, known as the cabin call, from the cabin interphone, was recorded on four occasions between 9 h 35 min 04 and 9 h 39 min 27 for about three seconds;
- noises similar to a person knocking on the cockpit door were recorded on six occasions between 9 h 35 min 32 (point❾) and 9 h 39 min 02 ;
- muffled voices were heard several times between 9 h 37 min 11 and 9 h 40 min 48, and at 9 h 37 min 13 a muffled voice asked for the door to be opened;
- between 9 h 35 min 07 and 9 h 37 min 54, the Marseille control centre tried to contact the flight crew on three occasions on 121.500 MHz, and on two occasions on 127.180 MHz, without any answer;
- between 9 h 38 min 38 (point❿) and 9 h 39 min 23, an air traffic controller from the French Air Defence system tried to contact the flight crew on three occasions on 121.500 MHz, without any answer;

[2] This is the minimum value that it is possible to select on the A320.

[3] This mode is described in paragraph 1.6.6.

[4] When the speed is said to be *"selected"*, the target speeds are chosen by the flight crew. When the speed is said to be *"managed"*, it is the flight management system (FMS) that automatically determines the target speeds based on the flight plan entered by the crew.

[5] This value is the maximum speed that the flight crew can select. It corresponds to VMO (maximum operating speed).

- noises similar to violent blows on the cockpit door were recorded on five occasions between 9 h 39 min 30 (point 11) and 9 h 40 min 28;
- low amplitude inputs on the co-pilot's sidestick were recorded between 9 h 39 min 33 and 9 h 40 min 07[6];
- the flight crew of another aeroplane tried to contact the flight crew of GWI18G at 9 h 39 min 54, without any answer.

At 9 h 40 min 41 (point 12), the *"Terrain, Terrain, Pull Up, Pull Up"* aural warning from the GPWS triggered and remained active until the end of the flight.

At 9 h 40 min 56, a Master Caution was recorded, then at 9 h 41 min 00 the Master Warning triggered and remained active until the end of the flight.

At 9 h 41 min 06, the CVR recording stopped at the moment of the collision with the terrain.

[6]The maximum amplitude of these movements remained lower than the disengagement threshold of the autopilot, which thus remained engaged. These actions consequently had no effect on the aeroplane's flight path.

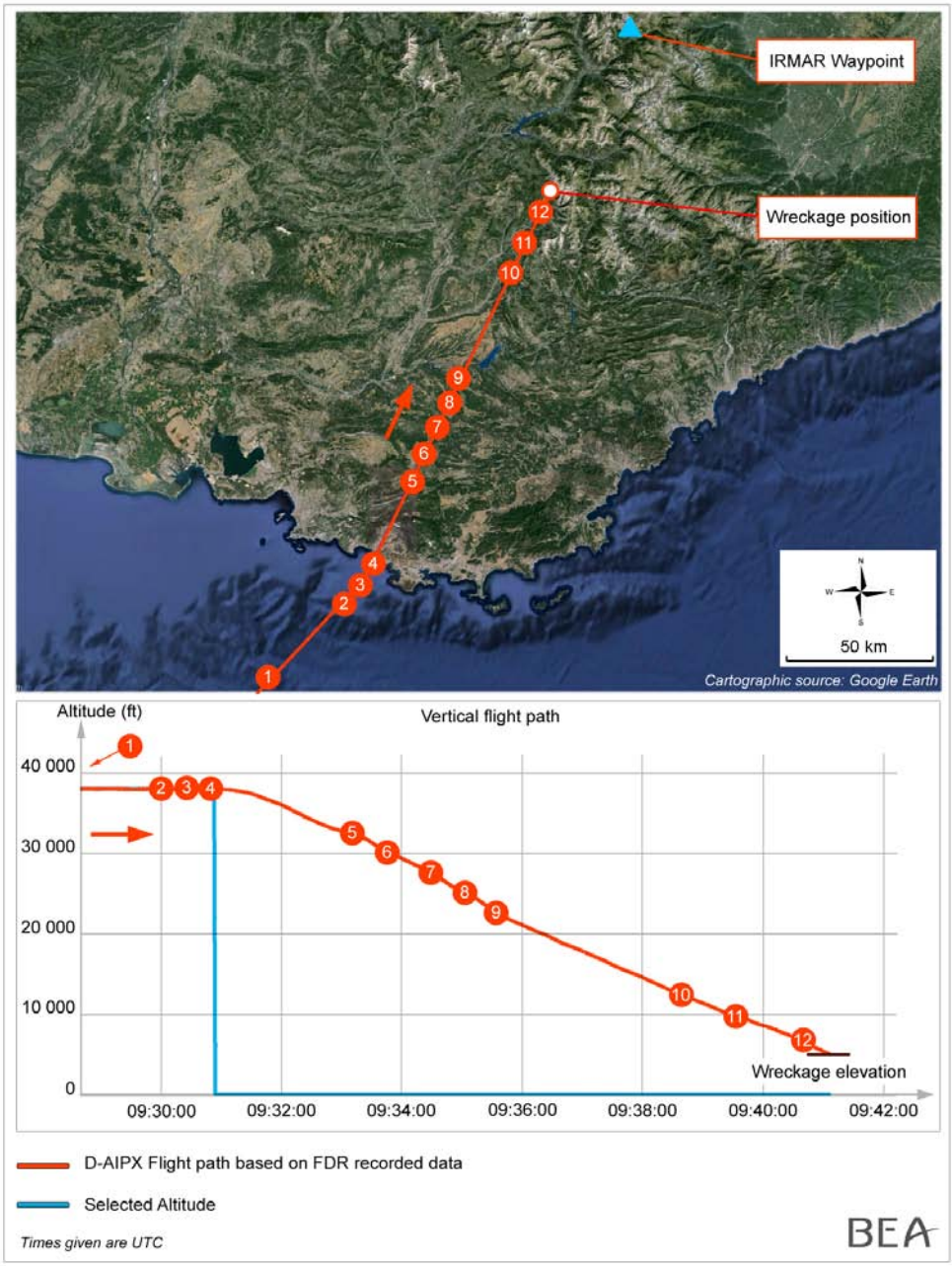

Figure 1 - accident flight trajectory

1.2 Injuries to persons

	Injuries		
	Fatal	**Serious**	**Minor/none**
Crew members	6	-	-
Passengers	144	-	-
Others	-	-	-

1.3 Damage to aircraft

The aeroplane was destroyed.

1.4 Other damage

None.

1.5 Personnel information

1.5.1 Captain

Male, aged 34, German nationality.

- Air transport pilot's licence ATPL(A) issued on 28 January 2014;
- A320 type rating revalidated on 9 July 2014;
- Last class 1 medical check-up performed on 31 October 2014 and valid until 12 December 2015.

Experience:

- total: 6,763 flying hours;
- on type: 3,811 flying hours, of which 259 as Captain;
- in the previous 3 months: 108 hours;
- in the previous month: 18 hours;
- in the last 24 hours: 8 hours.

Flying career:

- from March 2001 to June 2003, he undertook Air Transport pilot training at the Lufthansa Flight Training Pilot School in Bremen (Germany) and the Airline Training Centre in Phoenix (Arizona, USA);
- in March 2005, he obtained his A320 type rating;
- from June 2005 to January 2010, he worked as a co-pilot on Airbus A320 for the Condor Berlin airline;
- in April 2010, he obtained his A340 type rating, and his type rating for the A330 in February 2011;
- from April 2010 to May 2014, he worked as a co-pilot on Airbus A330/A340 for Lufthansa;
- on 6 May 2014, he joined Germanwings as a Captain on A320.

After joining Germanwings, he followed the operator's conversion training course as a Captain from May to September 2014. During his training and recurrent checks his professional level was judged by his instructors and examiners to be above standard. He passed his line check on 20 September 2014.

The last operator proficiency check (OPC) was performed on 14 January 2015.

His schedule shows that he had not flown between 14 and 22 March 2015. On 23 March 2015, the day before the accident, he flew two rotations from Düsseldorf to London-Heathrow: he took off from Düsseldorf at 6 h 09 for the first rotation and landed at Düsseldorf at 14 h 04 following the second rotation. On the day of the accident, he made the flight from Düsseldorf, taking off at 6 h 01, to Barcelona, landing there at 7 h 57.

1.5.2 Co-pilot

Male, aged 27, German nationality.

- Private Pilot Licence PPL(A) issued on 1 March 2011;
- Multi-crew Pilot Licence MPL(A) issued on 11 February 2014;
- A320 type rating revalidated on 28 October 2014.

Experience :

- total : 919 flying hours;
- on type : 540 flying hours;
- in the previous 3 months : 107 hours;
- in the previous month: 30 hours;
- in the previous 24 hours : 3 hours.

Flying career:

- between January and April 2008, he took entry selection courses with Lufthansa Flight Training (LFT);
- on 1 September 2008, he started his basic training at the Lufthansa Flight Training Pilot School in Bremen (Germany);
- on 5 November 2008 he suspended his training for medical reasons;
- on 26 August 2009 he restarted his training;
- on 13 October 2010, he passed his ATPL written exam;
- from 8 November 2010 to 2 March 2011, he continued his training at the Airline Training Centre in Phoenix (Arizona, USA);
- from 15 June 2011 to 31 December 2013, he was under contract as a flight attendant for Lufthansa while continuing his Air Transport pilot training;
- from 27 September to 23 December 2013, he took and passed his A320 type rating at Lufthansa in Munich (Germany);
- on 4 December 2013, he joined Germanwings;
- from 27 January 2014 to 21 June 2014, he undertook his operator's conversion training including his line flying under supervision at Germanwings;
- on 26 June 2014, he passed his proficiency check and was appointed as a co-pilot;
- on 28 October 2014, he passed his operator proficiency check.

During his training and recurrent checks, his professional level was judged to be above standard by his instructors and examiners.

None of the pilots or instructors interviewed during the investigation who flew with him in the months preceding the accident indicated any concern about his attitude or behaviour during flights.

On 9 April 2008, he obtained a class 1 medical certificate without restrictions and valid until 9 April 2009, issued by the Lufthansa aeromedical centre.

On 9 April 2009, his class 1 medical certificate was not revalidated by the Lufthansa aeromedical centre due to depression and the taking of medication to treat it.

On 14 July 2009, his request for renewal of his class 1 medical certificate was refused by the Lufthansa aeromedical centre. The latter informed the LBA of this.

On 28 July 2009, he obtained a new class 1 medical certificate valid until 9 April 2010, endorsed with the note *''Note the special conditions/restrictions of the waiver FRA 091/09 -REV-''*.

From July 2009, he obtained each year a class 1 medical certificate valid for one year that was endorsed with the note *''Note the special conditions/restrictions of the waiver FRA 091/09 -REV-''*.

The last valid class 1 medical certificate had been issued on 28 July 2014 and was valid until 14 August 2015.

His PPL(A) did not include any note or limitation. His MPL(A) included the limitation *"***SIC**incl. PPL*** "*, which means "*Specific regular medical examinations - contact the licence issuing authority*"[7]. This limitation requires that the aeromedical examiner (AME) contact the licence issuing authority before proceeding with a medical evaluation relating to any extension or renewal of the medical certificate. This may involve medical history about which the AME must be informed before undertaking the evaluation.

[7] According to European regulations, the limitation «SIC» refers to a medical certificate and not to a licence limitation. The LBA used to mention this limitation on pilot licenecs at that time (see 1.17.4.2).

The copilot had had to pay 60,000 € to finance his part of the costs of his training at LFT. He had taken out a loan for about 41,000 € to do so. A Loss-of-License (LOL) insurance contracted by Germanwings existed and would have provided the copilot with a one-time payment of 58,799 € in case he had become permanently unfit to fly in the first five years of employment.

This type of insurance is contracted for all Lufthansa and Germanwings pilots until they reach 35 years of age and complete 10 years of service.

The co-pilot did not have any additional insurance that would cover for potential future loss of income in case of unfitness to fly. In an e-mail he wrote in December 2014, he mentioned that having a waiver attached to his medical certificate was hindering his ability to get such an insurance policy.

His individual duty plan shows that:

- he flew as a co-pilot on Germanwings scheduled services eleven days in December 2014, nine in January 2015, seven in February 2015 and eight in March 2015. He flew on average 2 to 4 flights per day during these days;
- he was on sick leave from 22 to 24 February 2015, then from 16 to 22 March 2015;
- he was on standby on the 10 March 2015 and off duty from 13 to 15 March 2015.

On 23 March 2015, the day before the accident, he was in reserve from 03 h 00 and made a ferry flight from Düsseldorf to Berlin-Tegel between 04 h 57 and 05 h 56. He then returned to Düsseldorf at about 08 h 20 as a passenger. On the day of the accident, he made the flight from Düsseldorf, taking off at 6 h 01, to Barcelona, landing there at 7 h 57.

1.6 Aircraft information

1.6.1 Airframe

Manufacturer	Airbus
Type	A320-211
Serial number	147
Registration	D-AIPX
Entry into service	05/02/1991
Airworthiness certificate	N°16332 of 13/01/2014 issued by the LBA
Airworthiness Review Certificate	T512ARC4034/2014 of 23/03/2015 valid until 11/03/2016
Utilisation since last maintenance (72 h check on 23/03/2015)	6 hours and 3 cycles.
Utilisation as of 24/03/2015	58,313 hours and 46,748 cycles.

1.6.2 Engines

Manufacturer: CFM
Type: CFM56-5A1

	Engine n° 1	Engine n° 2
Serial number	731923	731482
Date of installation	30/06/2012	12/04/2011
Total run time	42,466 hours and 31,836 cycles	50,720 hours and 41,961 cycles
Run time since previous overhaul	6,031 hours and 4,528 cycles since 02/04/2012	9,258 hours and 6,963 cycles since 05/04/2011

1.6.3 Maintenance

The aeroplane flew under the Lufthansa banner from its entry into service until January 2014, when it joined the fleet of Germanwings.

The aircraft was maintained by the maintenance organisations of Germanwings and Lufthansa Technik in accordance with the Germanwings maintenance programme approved by the LBA. Its maintenance checks were up to date.

The last maintenance performed on the aircraft took place on 23 March 2015 at Düsseldorf Airport. It was a 4-month-check and a *"daily"* check made at the latest every 72 hours and involved checking the oil levels and visually inspecting the wheels and landing gear.

The following deferred defects were documented in accordance with Part M (*annex I*) of the Commission Regulation EC No. 2042/2003, M.A. 403 prior to the event flight:

- on 6 March 2015, cabin ready button on forward attendant panel missing, dispatched as per Minimum Equipment List (MEL);
- on 18 March 2015, R/H logo light unserviceable, dispatched as per MEL;
- on 23 March 2015, play on forward hinge of L/H nose gear door out of limit, released with Change Repair Approval Sheet for 50 FH since no airframe vibration reported during last 100 FH;
- on 24 March 2015 (in Dusseldorf), ENG 2 IGN fault during engine start, dispatched as per MEL.

On 24 March 2015, during the stop in Barcelona, before the accident flight, the Captain contacted the Germanwings maintenance control centre in Cologne about a problem concerning flushing of the front toilets on the aeroplane[8]. The correspondent on the telephone advised resetting the system circuit breaker located at the rear of the aeroplane. Since the disembarkation of the passengers had not finished, the Captain said he would carry out this operation as soon as possible and would contact the service again if the problem persisted. No other calls were recorded.

[8]During the flight between Düsseldorf and Barcelona, the crew had already informed maintenance via an ACARS message.

D check type scheduled maintenance was planned for April 2015.

1.6.4 Cockpit door locking system

Note: the following descriptions apply to D-AIPX and are based on information supplied by Airbus and Germanwings.

A door separates the cockpit and passenger cabin. Its core consists of a composite sandwich type structure made of prepreg sheets covering a honeycomb core. The outer prepreg sheets are designed to ensure bullet-proofing. A door escape hatch is pre-cut on its lower part. The latter can only be used from the cockpit. It is used in emergencies when the door is stuck. Unlike the cockpit door which opens towards the inside of the cockpit, the door escape hatch can only be opened in the opposite direction.

Three electrical release strikes are used to lock the door as soon as it is closed. A rotating handle system on the door is used to mechanically unlock it from the cockpit.

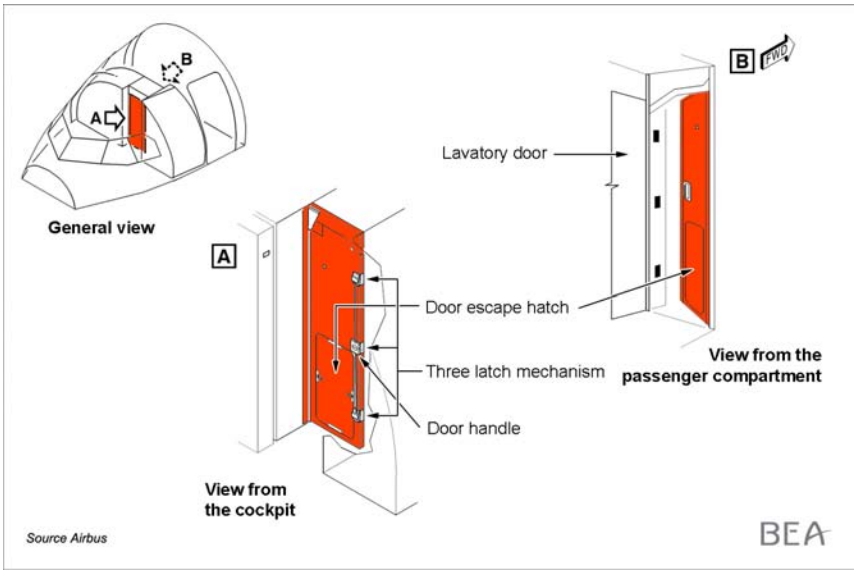

Figure 2 - cockpit access door

The cockpit door locking system (CDLS) is used to electrically control the locking and unlocking of the door.

Its main components are:

- A keypad with 12 keys (numbers 0 to 9, "*" and "#") located on the side wall of the control screen of the passenger compartment used by the cabin crew (the Forward Attendant Panel - FAP), in the passenger compartment. The keyboard also has two LEDs (one green and one red).
- A three-position toggle switch, located in the cockpit on the centre pedestal (see figures 3 and 5). A return spring keeps the switch in the NORM position. Manual input is used to select the UNLOCK or LOCK position. There is also an indicator next to the switch, labelled OPEN and FAULT.
- A control unit (CKPT DOOR CONT) located on the overhead panel of the cockpit. Two pressure sensors are installed on this display to measure the pressure in the cockpit and monitor any sudden change. It also has LEDs that light up in case of malfunctions involving the three door locks or the system computer.
- A buzzer, located in the cockpit on the overhead panel, which sends an acoustic signal.

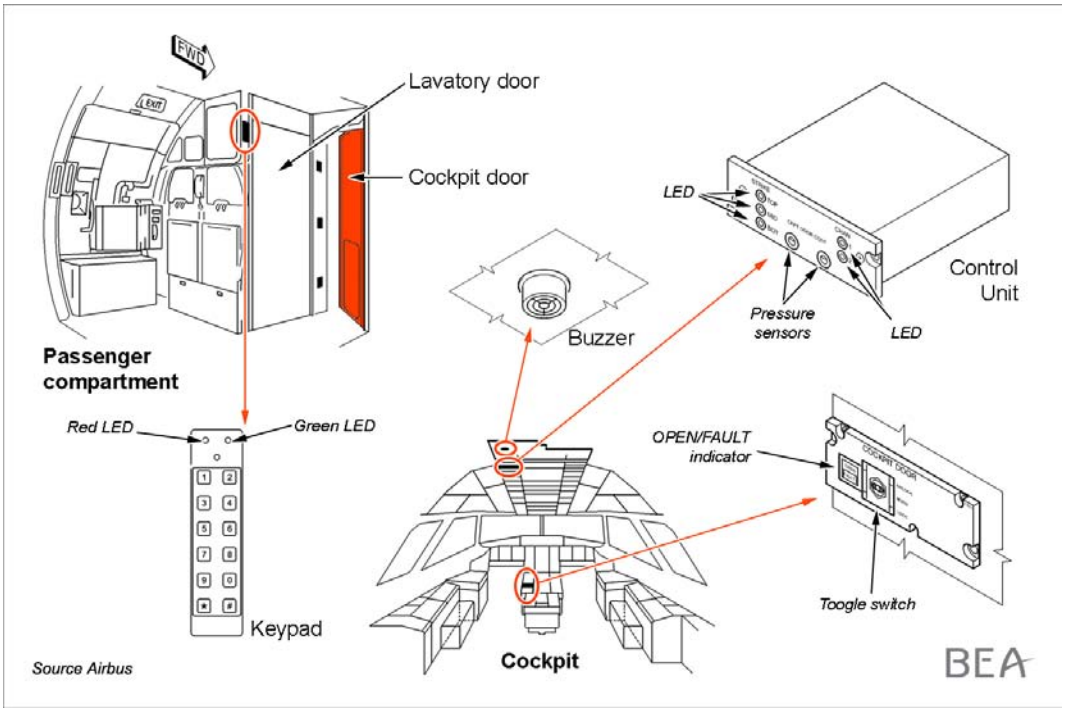

Figure 3 - cockpit door locking system

In the cockpit, the crew has two touchscreens located in front of the sidesticks. These screens retransmit the video from three cameras[9] filming:

- the access door area to the cockpit;
- the left front passenger door area of the aeroplane;
- the right front passenger door area of the aeroplane.

[9] Each crew member can select the camera they want to display on their screen.

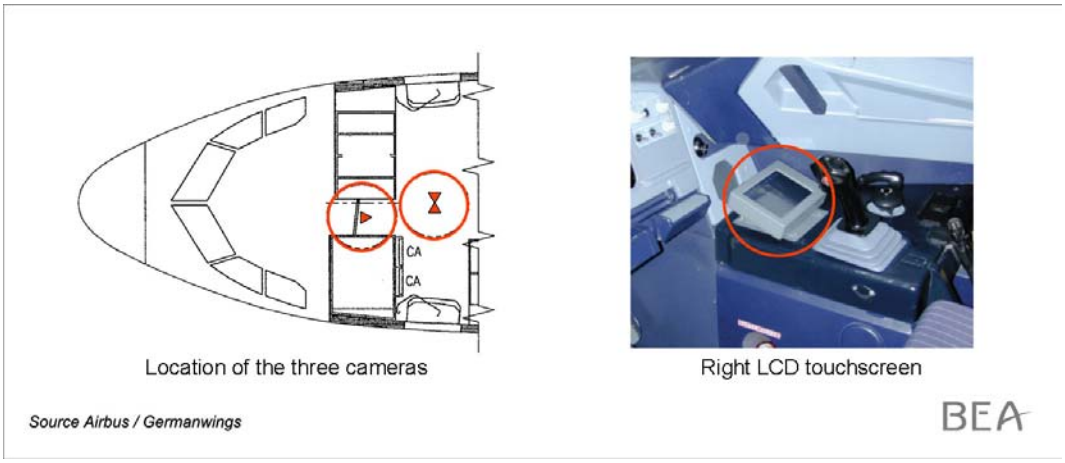

Figure 4 - surveillance cameras and monitor

The cockpit door locking system parameters can be set by each airline and for each aeroplane.

To request access to the cockpit from the passenger compartment, the normal access code must be entered on the keypad. A one-second acoustic signal from the buzzer sounds in the cockpit to indicate to the crew that someone wishes to enter. The pilots can then consult their monitoring screen.

The flight crew then moves the three-position toggle switch:

Figure 5 - cockpit door toggle switch

- If they pull and maintain the switch in the UNLOCK position, the door unlocks. The acoustic signal stops. The green LED lights up continuously on the keypad to indicate the door has been unlocked. The door must then be pushed in order to open it. A magnet in the cockpit is used to keep the door in the open position.
- If they move the switch to the LOCK position, the door is kept locked. The acoustic signal stops. The red LED lights up continuously on the keypad to indicate locking is voluntary. Any interaction with the keypad is then disabled for 5 minutes (until the extinction of the red LED)[10]. At any time, the crew in the cockpit may cancel this locking by placing the switch in the UNLOCK position. The door then immediately unlocks.
- In the absence of any input on the switch, the door remains locked. No LEDs light up on the keypad. The acoustic signal stops after one second.

[10] Any new selection of the LOCK position re-starts a 5-minute de-activation window.

In case of emergency (suspected flight crew incapacitation, for example), the emergency access code can be dialled on the digital keypad. The acoustic signal then sounds continuously in the cockpit for 15 seconds and the green LED on the keypad starts to flash.

If the flight crew does not respond within these 15 seconds, the door unlocks for 5 seconds. The green LED lights up continuously to indicate the door has been unlocked and the acoustic signal stops. The door only needs to be pushed in order to open it. After these five seconds have elapsed, the door locks again.

If the flight crew toggles the switch during those 15 seconds, the acoustic signal stops and the system reacts according to the command (UNLOCK/LOCK).

Note 1: Toggling the switch is not necessarily correlated with a request to access the cockpit. At any time, the crew can select the LOCK or UNLOCK position. The LOCK position overrides and resets any previous selection.

Note 2: In case of a power failure in this system, the access door to the cockpit is unlocked but remains closed.

When the door is open, the OPEN indicator lights up continuously. If an emergency request for access is made , the OPEN LED starts to flash.

1.6.5 Communication from the passenger cabin to the cockpit

Intercoms are present in the passenger compartment to allow the pilots and the flight attendants to communicate during the flight.

Each crew member can select the intercom they wish to contact. To get in touch with the cockpit, the «*CAPT*» key must be selected (figure 6).

When the «*CAPT*» key is selected:

- The ATT LED flashes on the three audio control panels (ACP) present in the cockpit,
- An acoustic signal, the «cabin call», lasting three seconds, sounds in the cockpit (it is inhibited during the take-off and landing phases);
- The message «*CAPTAIN*» is displayed on the monitor of the cabin crew (AIP – Attendant Indication Panel).

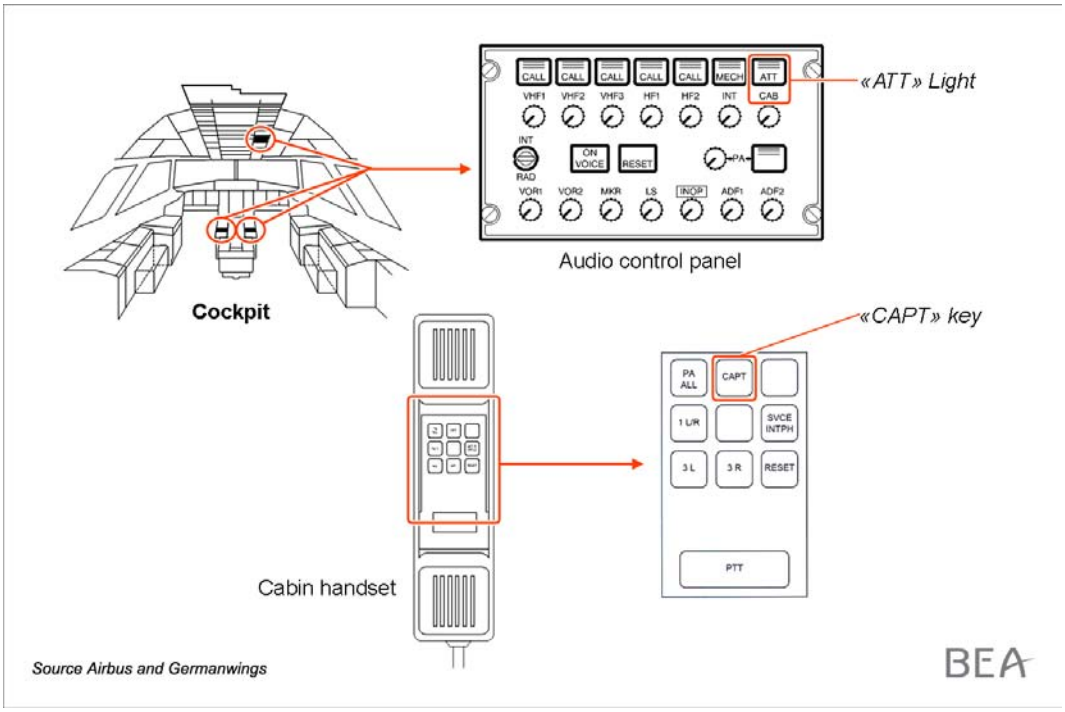

Figure 6 - intercom and communication system

1.6.6 OPEN DESCENT Mode

The automatic pilot on the Airbus A320 is equipped with a descent mode called *"OPEN DESCENT"*. This mode ensures the aeroplane guidance in the vertical plane. When active, the autopilot acts on the attitude of the aircraft to reach and maintain the target speed while the auto thrust, if engaged, commands idle.

The target speed is said to be "managed" when calculated automatically by the flight management system, based on the flight plan entered by the crew or *"selected"* when selected manually by the crew via the dedicated selector knob located on the FCU control panel (*figure 7*).

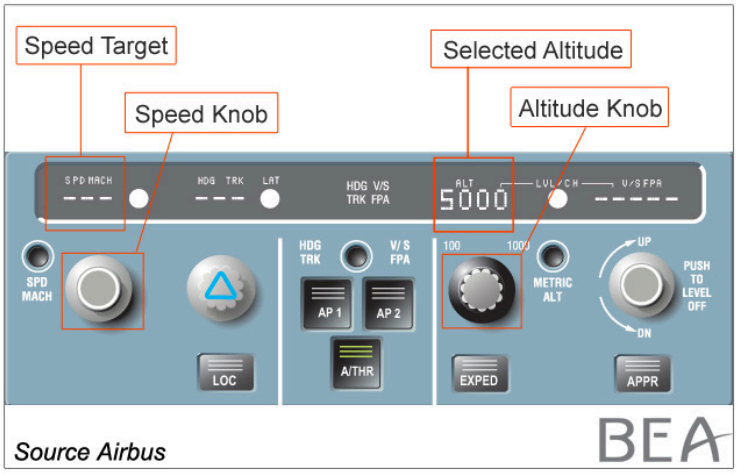

Figure 7 - FCU control panel

To engage this mode, the pilot must select an altitude below the current altitude and pull the altitude selector knob. During the descent, the modes displayed on the Flight Mode Annunciator (FMA) on the PFD screens were similar to the illustration below:

Figure 8 - FMA in OP DES mode

1.7 Meteorological information

The information supplied by Météo France shows that in cruise at flight level FL380, the aeroplane was flying in clear skies above some scattered cirrus type clouds whose peaks were located at about 32,000 ft. The wind from the southwest was at about 40 kt.

At the site of the accident, a few altocumulus clouds were observed above the high terrain, which could locally cover the highest south-facing peaks. There was no convection phenomenon and the southeast wind was weak. The visibility was greater than 10 km. The ground was covered in snow above 2,000 m altitude on the south-facing slopes, and above 1,700 m on the north-facing slopes.

During the descent, the aircraft passed through a fine layer of scattered cirrus then some altocumulus whose base was at an altitude above 15,000 ft. The rest of the descent was performed outside of any clouds in visual flight conditions with visibility greater than 10 km.

1.8 Aids to navigation

The aircraft was in radar contact while it was flying through Spanish and French airspaces. The on-board system was compliant with Mode S Enhanced Surveillance (EHS), which means that the radar data transmitted by the aircraft contained not only position information, but also a series of parameters like the selected altitude, roll angle, ground speed, magnetic heading. This allows controllers to have a visibility on upcoming evolutions of the aircraft they have under their control and to anticipate any deviations from the assigned trajectory.

All French civil radars are compliant with Mode-S EHS, but in March 2015, Mode-S downlinked parameters were not yet shown on French controllers' stations. The changes of selected altitude during the Düsseldorf to Barcelona flight (*see paragraph 1.11.4*) and the accident flight were therefore not displayed to the air traffic controllers in France.

1.9 Communications

During the climb towards its cruise altitude, the flight crew was in contact with the Barcelona en-route control centre. It then contacted the F1 sector (West region) at Marseille en-route control centre on the 133.330 MHz frequency and continued its climb towards flight level FL380. After its transfer to sector B3 (East region) on 127.180 MHz, the flight crew read back the clearance from ATC by saying *''Direct IRMAR Merci Germanwings one eight Golf''*. They did not re-contact ATC before the end of the flight.

The Marseille control centre tried on several occasions without success to establish contact with the aeroplane by using various frequencies: 127.180 MHz (sector B3 frequency and coupled with 132.490 MHz and 132.385 MHz), 133.330 MHz (sector FI frequency coupled with 118.415 MHz) and the 121.500 MHz (emergency frequency) and by asking another aircraft to establish a radio relay on 127.180 MHz and 121.500 MHz.

Taking into account the loss of radio and radar contact, the DETRESFA emergency phase was triggered at 9 h 40.

At 9 h 48, a fighter jet from the French Air Force took off from the military airbase of Orange, after having been ordered to do so by the national centre of aerial operations at 9 h 41. The military plane flew over the vicinity of the accident site at 10 h 01.

1.10 Aerodrome information

N/A

1.11 Flight recorders

1.11.1 Type of equipment

The aircraft was equipped with two flight recorders in accordance with the currently applicable regulations:

- FDR
  - Manufacturer: Loral;
  - Model: F1000;
  - Type number: S800-3000-00 (Germanwings source - nameplate absent from the recorder);
  - Serial number: 246 (Germanwings source - nameplate absent from the recorder).

It is a data recorder with a memory card with a recording capacity of at least 25 hours. The decoding document supplied for this aircraft provides information on approximately 600 parameters.

- CVR
  - Manufacturer: L3COM;
  - Model: FA2100;
  - Type number: 2100-1020-02;
  - Serial number: 00235.

This recorder is equipped with a memory card and has a recording capacity of at least 2 hours in standard quality and 30 minutes in high quality.

1.11.2 Opening and readout operations

CVR opening and readout

The CVR was sent to the BEA on 25 March 2015 under judicial seal.

Figure 9 - cockpit voice recorder (CVR) - D-AIPX

Given the significant damage to the CVR, the memory card was extracted from the protected module, visually inspected and tested electrically. Reading the data on the manufacturer's official equipment made it possible to obtain six audio tracks:

- four tracks lasting 31 minutes and 3 seconds
  - One track including radio communications and the co-pilot's microphone signal;
  - One track including radio communications and the Captain's microphone signal;
  - One track including the radio communications and the signal from the headset microphone of the jump seat;
  - One track including the signal from the cockpit area microphone in high-quality.
- two tracks lasting 2 hours and 4 minutes
  - One track including the first 3 mixed tracks;
  - One track including the signal from the cockpit area microphone in standard-quality.

Audio data contained in the recordings was from the event flight. Part of the previous flight is also recorded on the two-hour tracks.

A sound of breathing is recorded both on the co-pilot track and on that of the Captain throughout the accident flight. This breathing, though present on both tracks, corresponds to a single person's breathing. It can be heard several times while the Captain was talking (he was not making any breathing sound then) and is no longer heard when the co-pilot[11] was eating (which requires moving the microphone away or removing the headset). The sound of this breathing was therefore attributed to the co-pilot. It can be heard on the CVR until 7 seconds before the collision with the terrain.

[11] The copilot had his meal during the climb at around 9 h 15.

FDR opening and readout

The FDR was sent to the BEA on 2 April 2015 under judicial seal.

It showed significant mechanical and thermal damage. All of the equipment was covered in soot. After removing the protected module from the recorder casing, the memory card was removed from the protected module.

Figure 10 - flight data recorder (FDR) - D-AIPX

Reading out the FDR with the manufacturer's official equipment resulted in a file with 39 Mb of flight data, including the event flight.

A review of the recorded data brought to light no aircraft system failures or faults that could have contributed to the accident.

1.11.3 Synchronization of recordings

The CVR recordings were synchronized with the radio-communications from the Marseille control centre, the time at the control centre being used as a reference. The FDR recordings were then synchronized with those of the CVR using the radio communications with the control centre, the triggering of the GPWS alarms and the Master Warning parameter.

1.11.4 Previous Flight

All of the data from the previous flight, from Düsseldorf to Barcelona, was recorded on the FDR. The recordings from the CVR included the last 50 minutes of this flight. Synchronization of these recordings and the radio communications with the Bordeaux en-route control centre with which the crew was in contact was performed based on the same principle as for the accident flight.

On the previous flight, the following facts can be noted:

- at 7 h 19 min 59, noises like those of the cockpit door opening then closing were recorded and corresponded to when the Captain left the cockpit; the aeroplane was then at cruise speed at flight level FL370 (37,000 ft);
- at 7 h 20 min 29, the flight was transferred to the Bordeaux en-route control centre and the crew was instructed to descend to flight level FL350 (35,000 ft), an instruction read back by the co-pilot;
- at 7 h 20 min 32, the aircraft was put into a descent to flight level FL350 , selected a few seconds earlier;
- at 7 h 20 min 50, the selected altitude decreased to 100 ft for three seconds and then increased to the maximum value of 49,000 ft and stabilized again at 35,000 ft;
- at 7 h 21 min 10, the Bordeaux control centre gave the crew the instruction to continue the descent to flight level FL210;
- at 7 h 21 min 16, the selected altitude was 21,000 ft;
- from 7 h 22 min 27, the selected altitude was 100 ft most of the time and changed several times until it stabilized at 25,000 ft at 7 h 24 min 13;
- at 7 h 24 min 15, the buzzer to request access to the cockpit was recorded;
- at 7 h 24 min 29, noises like those of the unlocking of the cockpit door then its opening was recorded and corresponded to the Captain's return to the cockpit;

- at 7 h 25 min 32, the flight was transferred to the Barcelona en-route control centre and the crew was instructed to descend to FL170;
- at 7 h 26 min 16, the aircraft was put into a descent to its newly cleared flight level and the flight continued normally.

Due to the engaged autopilot modes, the changes in selected altitudes described above did not influence the aircraft descent flight path.

The following graphs were extracted from the FDR and illustrate the variations in selected altitude.

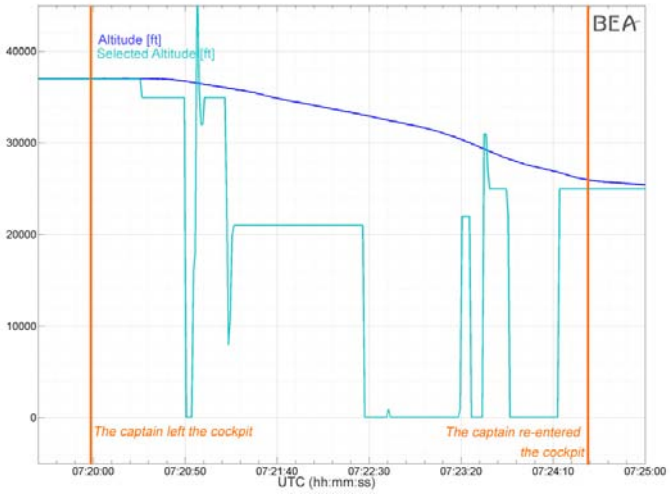

Figure 11 - descent during the previous flight

1.11.5 Work carried out on the Quick Access Recorder (QAR)

The aeroplane was equipped with the following QAR:

- Manufacturer: Teledyne
- Model: WQAR
- Type number: 2243800-362
- Serial number: RA00815

This equipment records the same data as the FDR on a Compact Flash card and on an SD card. The data is then used by the airline specifically for its flight analysis programme.

The QAR was brought to the BEA on 29 March 2015 under judicial seal. It had suffered significant mechanical damage. The compact flash card and the SD card containing the flight data were extracted from the computer. X-ray analysis of the memory components from the two cards showed that their damaged condition made it impossible to retrieve recorded data.

The FDR was found and its data analysed four days later.

1.12 Wreckage and impact information

The accident site was located in mountainous terrain, in the municipality of Prads-Haute-Bléone (04) 1,550 m above sea level[12]. The wreckage was fragmented with a large amount of debris spread over an area of 4 hectares in a sloping rocky ravine. The largest parts of the aeroplane were about 3 to 4 metres long.

[12] The geographical coordinates of the accident site are: 44°16'47.2''N / 006°26'19.1''E.

On the lower part of the site, about 20 m above the ravine, is an area where the vegetation had been torn up, tree trunks were uprooted, tree branches were broken and the ground churned up. Parts from the aeroplane's wings and fuselage were found in this area. Apart from this area and the final debris field, no other contact with the environment was observed around the accident site.

On site, elements belonging to various parts of the aeroplane were identified. One of the engines was broken into many pieces in the main east ravine. The debris of the other engine, concentrated in a small area, was found in the main west ravine.

The auxiliary power unit (APU) was located in the upper part of the site dozens of metres from the part of the rear fuselage to which the vertical stabilizer is attached. One of main landing gears was found near this part of the fuselage.

Parts from the cockpit (access door to the cockpit, sidestick, security camera) were also found in the upper part of the site.

The lower part of the site had a strong smell of kerosene.

The CVR, QAR and FDR were found respectively on 24/03/2015, 28/03/2015 and 02/04/2015 and were immediately transported to the BEA for readout.

Note: the front of the FDR was found separated from the rest of the recorder in which the crash module was located.

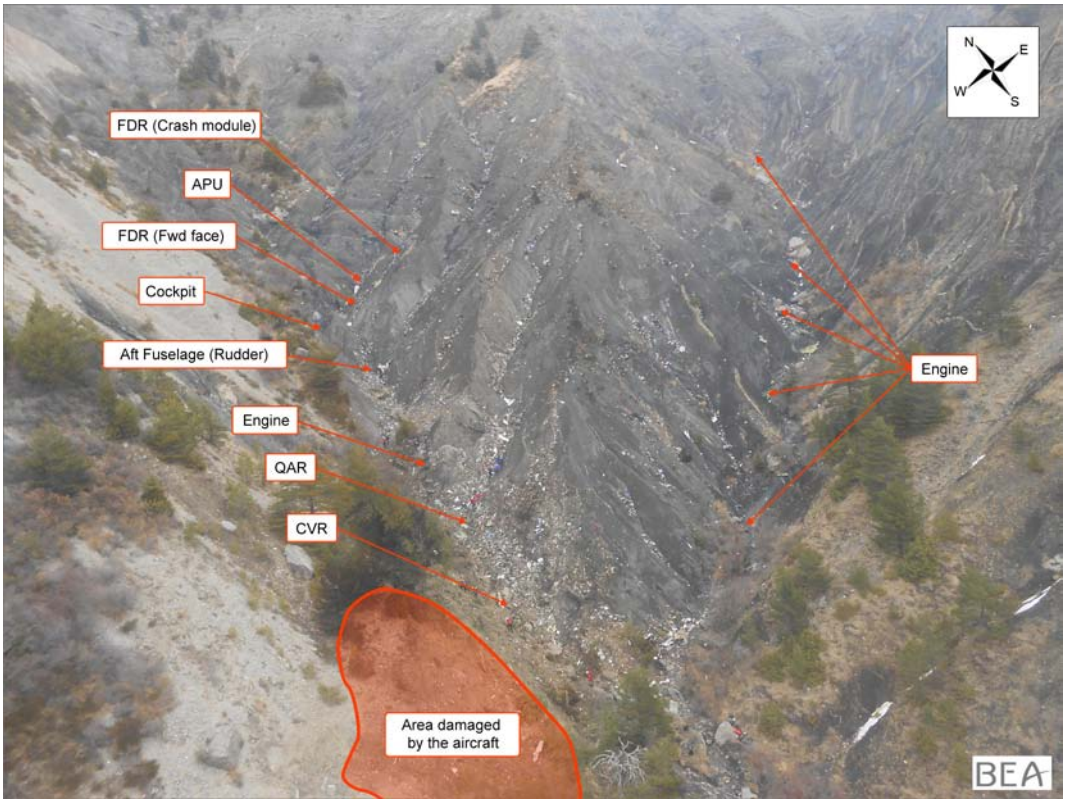

Figure 12 - general view of the accident site

Figure 13 - contact area with vegetation

1.13 Medical and pathological information

1.13.1 Medical history of the co-pilot

Note: see paragraph 1.16.2 for definitions of depression and psychosis.

In August 2008, the co-pilot started to suffer from a severe depressive episode without psychotic symptoms. During this depression, he had suicidal ideation, made several *"no suicide pacts"* with his treating psychiatrist and was hospitalized. He undertook anti-depressive medication between January and July 2009 and psychotherapeutic treatment from January 2009 until October 2009. His treating psychiatrist stated that the co-pilot had fully recovered in July 2009.

The medical visits that the co-pilot undertook and the relevant medical correspondence since 2008 included the following:

Date (dd/mm/yy)	**Type of doctor**	**Results / prescriptions**
09/04/2008	Lufthansa AeMC	Issuance of the first class 1 medical certificate (no restrictions).
04/02/2009	Treating psychiatrist	Report stating that the co-pilot was in regular treatment and that the expected duration of the disease was several months.
09/04/2009	Lufthansa AeMC	Application for the revalidation[13] of the class 1 medical certificate, on which the co-pilot declared he had been admitted to hospital. The issuance was postponed until further analysis from a specialist.
10/07/2009	Treating psychiatrist	Report stating that the co-pilot is *"entirely healthy" and that "the treatment has ended"*. The report was treated by the psychiatrist working for the AeMC on 15/07/2009.
14/07/2009	Lufthansa AeMC	Application for the renewal of the class 1 medical certificate. This renewal was refused by the Lufthansa AeMC and the LBA was informed of this AeMC.

[13] Examinations and/or assessments for the revalidation of a medical certificate may be undertaken up to 45 days prior to the expiry date of the medical certificate. Outside that time window, a renewal examination and/or assessment is required (see Part MED, MED.A.045 or JAR-FCL 3.105).

15/07/2009	Psychiatrist working for the Lufthansa AeMC	Report based on treating psychiatrist (written report, 10/07/2009) and treating psychotherapist reports (phone conversations) stating that the severe depressive episode was over and recommending providing class 1 medical certificate.
28/07/2009	Lufthansa AeMC	Issuance of the class 1 medical certificate with a waiver FRA 091/09, stating that it would become invalid if there were a relapse into depression.
11/08/2009	Treating psychotherapist	Letter from the treating psychotherapist to confirm that the pilot could resume his flight training. This letter mentioned a severe depression, but initially had the reference code for recurrent depressive disorder. After this anomaly was detected by the AeMC, the psychotherapist re-issued the same letter with the correct code.
23/02/2010	Treating psychotherapist	Certificate from the treating psychotherapist stating that the co-pilot was under his psychotherapeutic treatment from January to October 2009 and that the co-pilot's high motivation and active participation contributed to the successful completion of the treatment, after the management of symptoms.
24/02/2010	Lufthansa AeMC	Revalidation of class 1 medical certificate with the special conditions/restrictions of the FRA 091/09 waiver.
18/06/2010	Lufthansa AeMC	Renewal of class 1 medical certificate with the special conditions/restrictions of the waiver FRA 091/09.
18/06/2010	AME at the Lufthansa AeMC acting as an AME for the FAA	Application for a FAA third-class medical certificate.
08/07/2010	FAA Aerospace Medical Certification Division	Letter from the FAA to the co-pilot informing him that he was not eligible to hold an airman medical certificate at this time, due to his history of reactive depression. The FAA asked him to submit a report from his prescribing physician that should include diagnosis, prognosis without medication(s), follow-up plan and copies of treatment records.
21/07/2010	Treating psychotherapist and treating psychiatrist	The report from 10/07/2009 from the treating psychiatrist and the certificate from the treating psychotherapist of 23/02/2010 were translated from German to English and submitted to the FAA Aerospace Medical Certification Division for review.
28/07/2010	FAA Aerospace Medical Certification Division	Issuance of a FAA third-class medical certificate without any limitation. The letter from the FAA accompanying the certificate indicates that because of the history of reactive depression, *"operation of aircraft is prohibited at any time new symptoms or adverse changes occur or any time medication and/or treatment is required"*.

29/03/2011	Lufthansa AeMC	Renewal of class 1 medical certificate with the special conditions/restrictions of the waiver FRA 091/09.
07/11/2011	Lufthansa AeMC	Renewal of class 1 medical certificate with the special conditions/restrictions of the waiver FRA 091/09.
05/11/2012	Lufthansa AeMC	Revalidation of class 1 medical certificate with the special conditions/restrictions of the waiver FRA 091/09.
14/08/2013	Lufthansa AeMC	Renewal of class 1 medical certificate with the special conditions/restrictions of the waiver FRA 091/09.
28/07/2014	Lufthansa AeMC	Revalidation of class 1 medical certificate with the special conditions/restrictions of the waiver FRA 091/09.
24/11/2014	Private physician A	Co-pilot put on sick leave for 7 days.
December 2014	Various private physicians	Vision problems and sleep disorders. The impaired vision complained of repeatedly was examined by several eye specialists and all came to the conclusion that there was no organic reason for it.
17/02/2015	Private physician B	Issuance of a sick leave certificate for 8 days. This certificate was not forwarded to Germanwings.
17/02/2015	Private physician C	Referral to psychotherapist and psychiatrist for outpatient treatment of psychosomatic disorder and anxiety disorder. Prescription: Zopiclone 3,75 mg.
22/02/2015	Private physician C	Co-pilot put on sick leave for 3 days.
24/02/2015	Treating psychiatrist	First prescription of Mirtazapine.
09/03/2015	Private physician D	Issuance of a sick leave certificate (end date unknown). This certificate was not forwarded to Germanwings.
10/03/2015	Private physician C	Referral for psychiatric hospital treatment due to a possible psychosis.
12/03/2015	Private physician C	Issuance of a sick leave certificate for 19 days. This certificate was not forwarded to Germanwings.
16/03/2015	Treating psychiatrist	Further prescriptions: Escitalopram 20 mg/ml gtt, Dominal f. 80 mg, Zolpidem.
18/03/2015	Private physician E	Co-pilot put on sick leave for 5 days.

All the AMEs from the Lufthansa AeMC who examined the co-pilot for the revalidations of the class 1 medical certificate were aware of the waiver that the co-pilot had. They all assessed his psychological and psychiatrist fitness through observation of behaviour and discussions. None of the responses provided by the co-pilot raised any concern among the AMEs about a mood, neurotic, personality, mental or behavioural disorder that would have required further psychiatric evaluation.

In an e-mail sent by the co-pilot to his treating psychiatrist in March 2015, he mentioned having taken additional medication: Mirtazapine 15 mg and Lorazepam 1 mg.

The co-pilot's medical file obtained by the BFU, and shared with the BEA, compiles documents from aeromedical fitness examinations as well as from private physicians. The documentation was analysed in detail by a German expert in aviation medicine and a German psychiatrist. Their analysis was shared and discussed with a team of experts, formed by the BEA, and composed of British aeromedical and psychiatric experts as well as French psychiatrists. The limited medical and personal data available to the safety investigation did not make it possible for an unambiguous psychiatric diagnosis to be made. In particular an interview with the co-pilot's relatives and his private physicians was impossible, as they exercised their right to refuse to be interviewed by the BEA and/or the BFU. However, the majority of the team of experts consulted by the BEA agreed that the limited medical information available may be consistent with the co-pilot having suffered from a psychotic depressive episode that started in December 2014, which lasted until the day of the accident. Other forms of mental ill-health cannot be excluded and a personality disorder is also a possibility.

1.13.2 Results of post-mortem toxicological examinations

Toxicological examinations of the co-pilot's human tissue found at the accident site were conducted by the French judicial authorities. The presence of citalopram and mirtazapine, which are two antidepressant medications, as well as of zopiclone, which is a sleeping-aid medication was detected.

1.14 Fire

There was no evidence of fire in flight.

1.15 Survival aspects

The violence of the collision with the terrain caused the immediate death of all the aircraft's occupants.

1.16 Tests and research

1.16.1 Identification of sounds recorded on the CVR

In-flight testing was conducted on 12 May 2015 in the Hamburg area with a Germanwings Airbus A320 similar to D-AIPX. The part numbers of the main CDLS components of the test aircraft were identical to those of the accident aircraft. The objectives of these tests were to:

- ❒ check the functioning of the CDLS;
- ❒ record cockpit and cabin noises on a CVR to help noise identification recorded on the CVR from the accident aircraft.

The test programme included for the CDLS:

- ❒ various sequences of cockpit door toggle switch activation, with simple and multiple locking and unlocking actions;
- ❒ routine and emergency requests for access through the keypad, followed or not by action on the cockpit door toggle switch;
- ❒ cabin calls through the interphone, whether followed or not by action on the cockpit door toggle switch.

As for the acoustic tests, one focus of interest was an unidentified clacking noise recorded during the last buzzer sound at 09 h 34 min 31 when the co-pilot was alone in the cockpit. The acoustic tests were performed at FL280 and at a calibrated airspeed of 300 kt, both corresponding to the flight conditions when this noise was emitted during the accident flight. In order to build a noise library able to support the noise identification process, the test programme included the following noise recordings:

- all types of cockpit controls (knobs, switches, push buttons and rotary selectors) located on the different instrument areas of the cockpit (FCU, central pedestal and overhead panel);
- noises associated with the CDLS, namely routine and emergency requests for access, cockpit door unlocking and locking, cockpit door opening and closing;
- other miscellaneous cockpit noises (circuit breakers, seat buckles);
- cabin noises associated with passenger servicing and front toilet use.

As cockpit controls produce low noise, it was decided to repeat the corresponding acoustic tests during descent to have audio samples with a lower background noise.

The following graph shows the mission profile and the tests carried out:

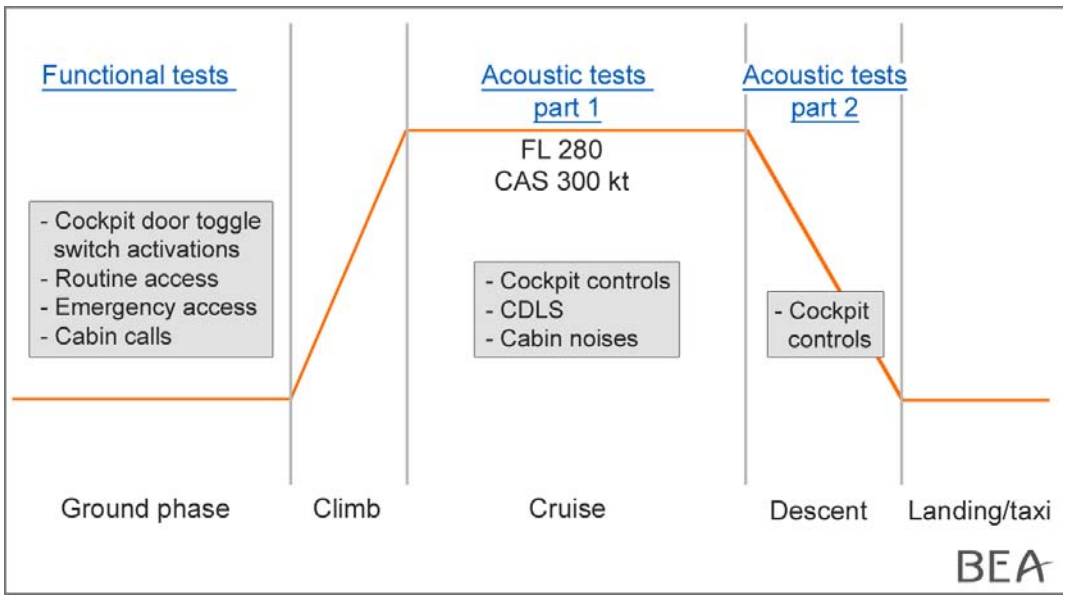

Figure 14 - in-flight testing overview

The CDLS behaviour during the tests confirmed the system description provided in the preliminary report and in chapter 1.6.4 of this report.

The CVR from the test aircraft was downloaded and the noises recorded enriched the BEA audio library with more than 50 additional audio samples.

The noises recorded on the cockpit area microphone (CAM) track of the event CVR were then compared to this audio library in order to identify them. The analysis was performed from the moment when the captain left the cockpit until the end of the flight.

More than a hundred noises were detected during this period. The vast majority of them could not be identified, being too weak and embedded in the background noise. Nevertheless, it was possible to characterize and identify noises associated with pilot seat movements, sliding table and arm rest. In addition, the acoustic analysis focused on the cockpit door toggle switch activation detection and the clacking noise which was heard during the last buzzer noise.

Cockpit door toggle switch activations

The in-flight testing CVR recordings of cockpit door toggle switch activations showed that this action could be audible on the CVR CAM track in certain conditions, but there was no recurrent acoustic signature as the noise produced depended on the way the pilot released the switch to neutral position. Spectral analysis of the event flight CVR CAM track did not make it possible to positively identify cockpit door toggle switch activations.

Clacking noise

The buzzer recorded at 09 h 34 min 31 during the descent, occurred 4 min 07 s after the captain left the cockpit. A clacking noise is recorded at the end of this buzzer and was subject to a deeper analysis in order to find the origin of this noise and any potential link with the CDLS.

The spectral analysis of the audio sequence comprising the buzzer and the clacking noise (see Figure 15 below) showed the following:

- the buzzer duration was the same as the duration of other routine buzzers recorded previously on the CVR: 980 ms;
- the clacking noise did not end the buzzer, as an action on the cockpit door toggle switch would. In addition, the noise was significantly louder than a switch activation;
- no match could be found between the clacking noise heard during the buzzer and the BEA audio library.

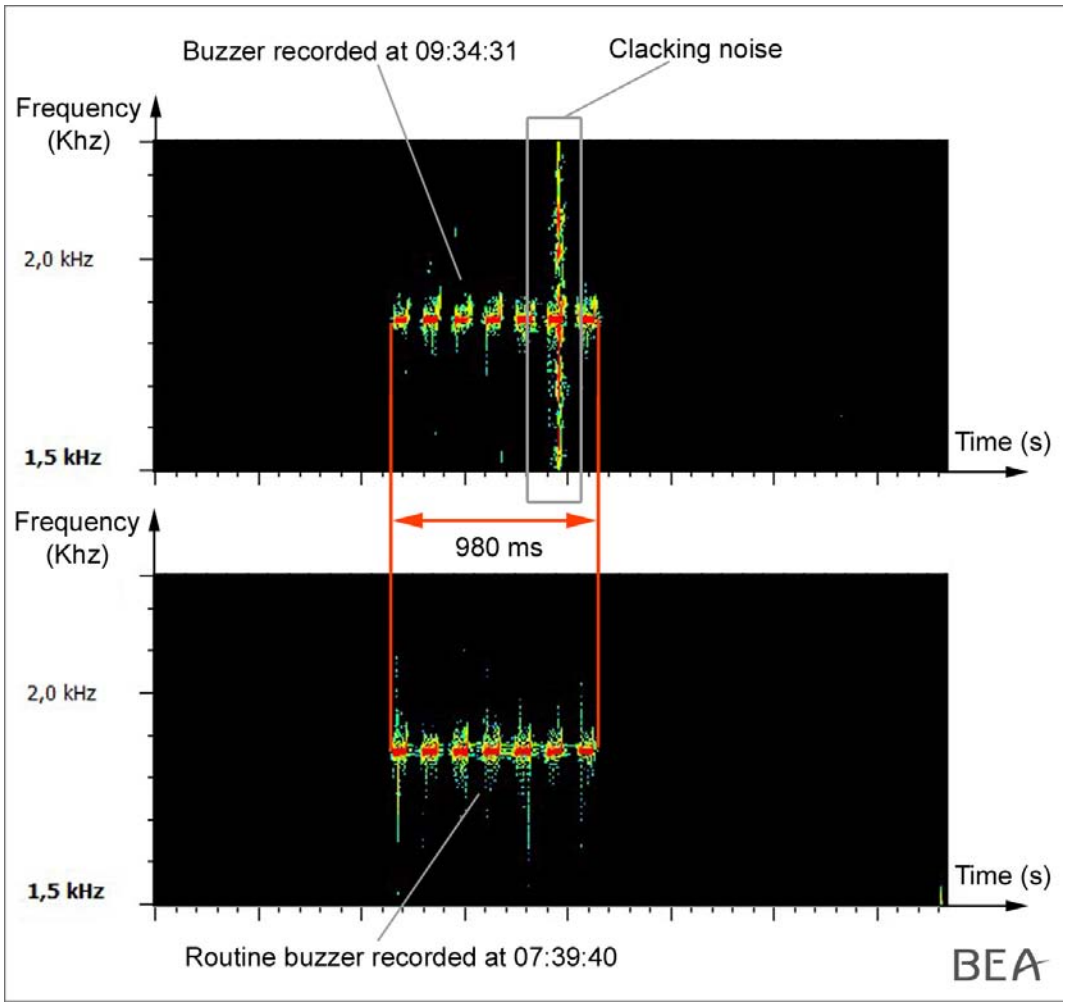

Figure 15 - buzzer spectral analysis

When the cockpit door is closed, the locking action is silent, except for the toggle switch activation if audible, and a door unlocking at 09 h 34 min 31 would not be consistent with the sequence of events. Consequently, the noise recorded during the buzzer was not consistent with an action on the CDLS, but its origin could not be determined.

Note: The buzzer recorded at 09 h 34 min 31 most probably corresponded to a routine access request because it is the first access request following the Captain's departure from the cockpit and because the operator's normal practice calls for trying the normal access code before dialling the emergency access code. Therefore, the possibility that it corresponds to an emergency access request cancelled after 980 ms by an action on the toggle switch is considered to be extremely remote.

1.16.2 Mental issues

Depressive disorder

The World Health Organisation defines depression as a common mental disorder, characterized by sadness, loss of interest or pleasure, feelings of guilt or low self-worth, disturbed sleep or appetite, feelings of tiredness and poor concentration. It can be long lasting or recurrent, substantially impairing a person's ability to function at work or school, or cope with daily life. At its most severe, depression can lead to suicide. When mild, depression can be treated without medicines but, when moderate or severe, people may need medication and professional talking treatments.

Depression is one of the most common psychiatric disorders. According to several studies, about 10% of the general population has reported having experienced a period of depression in their life. Depressive disorders can occur at any age, including in childhood, but it appears for the first time more often in late adolescence or early adulthood.

Depressive disorders and medications used to treat depression are usually medically disqualifying for pilots. Aviation authorities have not unified their approach on the consequences that the use of specific antidepressants and/or use of psychotherapy may have on pilot's medical certification. Some regulatory authorities allow air crew on specific antidepressants, like a selective serotonin reuptake inhibitor (SSRI), to fly, although close medical follow-up is mandatory.

Psychotic disorder

A psychotic disorder, or psychosis, is characterized by a loss of connectedness with reality, in the form of delusions, hallucinations, or disorganised thoughts. It may be chronic, intermittent, or occur in a single episode. It may also occur as accompanying symptoms in other psychiatric conditions including but not limited to bipolar disorder (e.g. bipolar disorder with psychotic features), major depression (e.g. major depression with psychotic features), or borderline personality disorder.

Episodes of psychosis may be relatively brief due to an acute medical condition or the taking of a psychoactive substance (illicit or prescribed medication). Psychotic symptoms may also be chronic, possibly fading with time, but present to some degree in an ongoing manner, as seen in schizophrenia or schizoaffective disorder. Onset of chronic psychotic illness can occur at any age, with schizophrenia's median onset age found to be in the mid-to-late 20s. Studies have shown that unless the patient shows evidence of a significant cognitive disorder in advance, the ability to identify these patients must wait until the onset of frank psychotic symptoms. The expert working group on mental health of the Aerospace Medical Association (AsMA) released recommendations in September 2012, and updated them in September 2015 after the Germanwings accident[(14)]. They stated that serious mental illness such as acute psychosis was relatively rare, and its onset was difficult to predict.

[(14)]See paragraph 1.18.5.1 for more information on the AsMA expert working group on mental health.

Acute psychotic disorders are generally addressed through a correction of the underlying cause. Brief courses of antipsychotic agents may be helpful if the patient represents a danger to self or others.

Patients with psychoses should not operate as aircrew because of unpredictable recurrences of psychotic episodes as well as the side effects of antipsychotic medications.

Cognitive constriction in suicides

The American suicidologist Edwin Shneidman has described several common characteristics of suicide in his book "*The Definition of Suicide*" (1985). In particular, he wrote that the common cognitive state in suicide is constriction. Suicidal thoughts and plans are frequently associated with a rigid and narrow pattern of thinking that is comparable to tunnel vision and narrowing of focus. The suicidal person is temporarily unable or unwilling to engage in effective problem-solving behaviour and may see his or her options in extreme, all or nothing terms.

According to Shneidman, people with high standards and expectations are especially vulnerable to ideas of suicide when progress toward these goals is suddenly frustrated. People who attribute failure or disappointment to their own shortcomings may come to view themselves as worthless, incompetent or unlovable.

1.16.3 Pilot assistance programmes

Several programmes exist within airlines to provide assistance to pilots, and sometimes more generally to airline employees, in case of personal, emotional or mental distress. These programmes offer referral service, peer support and advice in a "*safe zone*" to try to resolve the issue that an employee may have in a non-punitive fashion, while maintaining the same high level of safety for the airline. They are designed to help employees with personal matters that may adversely affect their careers, such as substance abuse, post-traumatic stress, ethical and professional standards, or maintenance of medical certification. The two following programmes were available to pilots of the Lufthansa group at the time of the accident :

- **Mayday Foundation**: Since 1994 the Mayday Foundation has been helping flight crew members from all German operators and their relatives who have encountered difficulties. Aircrews are occasionally exposed to situations that they may personally perceive as life threatening or stressful beyond their normal experience. After realizing that many cases where support was needed could be traced back to critical incidents, the foundation introduced CISM for flight crew members in Germany. CISM offers help in handling members' personal emotions and reactions after highly stressful events. The CISM model is based on close cooperation between peers and mental health professionals. CISM is designed to mitigate the impact of stress related trauma and expedite the recovery process. The CISM organisation has about 300 voluntary members who act as points of contact within airlines (not limited to Lufthansa group). To be able to react quickly, these members can be reached via an emergency hotline. All calls to CISM are confidential. Approximately 300 to 400 German airlines' pilots benefit from the Mayday programme every year. This service is available to Germanwings pilots.
- **Anti-Skid**: This programme is available for pilots who have alcohol abuse problems. Volunteers working for Anti-Skid coordinate the identification, treatment, and return to work process for affected crew members. A phone number is available on the airline's intranet and training on this programme is mandatory to become a Captain for Lufthansa.

Other similar programmes exist around the world:

- **Airline Employee Assistance Programmes (EAPs)**: EAPs are employee benefit programmes that provide consultation, information and referral services to airline employees and their eligible family members at many airlines. EAPs provide confidential help to employees who seek the service to address a variety of personal and professional challenges. Programmes vary between airlines. Most EAPs offer referral assistance and provide payment for limited medical and counselling services. Some EAPs provide legal and financial counselling services as well. EAPs are sometimes underutilized resources for reasons such as these: employees question the confidentiality of the service; they perceive a stigma attached to asking for professional help with personal matters; or, they are unaware of the programme and its capabilities. Employees usually receive general and contact information about the company's EAP benefits shortly after the start of employment. Additional information about the EAP may be provided periodically through the airline's employee communication structure. Employees, including crew members, are encouraged to self-refer, and in some cases, to refer fellow employees to the programme. Referrals may also come from family members, supervisors, or managers. With the caller on the line, the EAP will locate one or more service providers in a location convenient to the employee and place them in contact with the service provider. These EAPs also ensure continuity of care by following up on the progress of referrals made to other agencies or practitioners after direct client contact has ended. This is typically accomplished through a telephone call to crew members to ensure that they were able to schedule an appointment with the medical service provider. Because these programmes are generally available at no cost to crew members, financial barriers to advice, counselling, and treatment are eliminated.

- **ALPA's Critical Incident Response Programme (CIRP)**: This programme is to mitigate the adverse psychological impact of work-related traumatic events such as an incident or accident, and aid in the recovery from these events before harmful stress reactions affect job performance, careers, families, and health. The CIRP provides pre-event education and post-event crisis intervention services to airline crew members involved in critical events. Peer support volunteers (PSVs), who are fellow peer crew members, are specifically trained and certified to provide support in critical incident stress management. A *"critical incident"* is any event which has a stressful impact sufficient enough to overwhelm the usually effective coping skills of either an individual or a group. Almost all ALPA pilot groups have adopted the programme, which is credited with helping many pilots return to the cockpit after an accident or incident.

- **The Human Intervention and Motivation Study (HIMS)** and the Flight Attendant Drug and Alcohol Programme (FADAP): they are the occupational substance abuse treatment programmes for airline pilots and flight attendants in the USA. Their purpose is to effectively treat the disease of chemical dependency in the airline pilot and flight attendant population. HIMS and FADAP are industry-wide programmes in which managers, pilots, flight attendants, healthcare professionals, and the FAA work together to preserve careers and enhance air safety. They coordinate the identification, treatment, and return to work process for affected crew members. HIMS funding is provided by the FAA, which in turn subcontracts to ALPA to administer the programme.

- **Professional standards programmes (ProStans)**: they are volunteer, peer, conflict/behaviour-resolution programmes. The programme's purpose is to promote and maintain the highest degree of professional conduct among crew members. It enhances the margin of safety in daily flight operations, and protects and enhances the standing of the airline pilot profession, among other benefits. The airline/union ProStans Committee addresses problems of a professional or ethical nature involving crew members. Peer volunteers resolve allegations of misconduct, or conflicts between crew members, that may affect flight safety and/or professionalism. ProStans also addresses conflicts arising from conduct perceived as unfavourable to the aviation profession.

- **Pilot Assistance Network (PAN)**: The Delta Airlines Master Executive Council (MEC), which is a member of the Air Line Pilots Association, Int'l, operates the Pilot Assistance Network (PAN). According to the MEC, PAN provides *"support for pilots during difficult times. PAN is available for pilots seeking physiological, psychological, or medical assistance."* PAN is staffed by pilot volunteers who are available to provide confidential assistance to other Delta pilots who feel they may be in need of physiological, psychological, or other medical assistance. The committee members function as *"empathetic peers"* who refer pilots to appropriate resources, and provide any necessary follow-up support. The PAN utilizes a commercial answering service to provide around-the-clock response and service to the Delta pilots. PAN members undergo annual training conducted by the MEC Aeromedical Committee.

- **Project Wingman**: The Allied Pilots Association (APA), which represents pilots employed by American Airlines, operates Project Wingman with the airline's employee assistance programme (EAP). It is a joint venture between the Allied Pilots Association (APA), and American Airlines Employee Assistance Programmes (AA/EAP) which is *"designed to assist pilots experiencing mental health challenges."* Under this programme, pilots are encouraged to act as a *"wingman"* and look out for each other. Employees receive general and contact information about the programme and associated benefits shortly after beginning employment. Additional information about them may be provided periodically through the union and airline communication structure. Pilot volunteers advertise the programme informally by word-of-mouth, and with special volunteer identification badges. Crewmembers are encouraged to self-refer, and in some cases, to refer fellow employees to the programme. Referrals may also come from family members, supervisors, or managers. Crew members, managers, or others may call the programme phone number to receive services. Calls received are on a wide variety of matters, including medical problems, excessive sick calls, and mental health concerns. This programme receives approximately three to five calls per day.

The BEA was not able to collect precise quantitative data about the actual use of pilot assistance programmes and on their effectiveness. The fact that most of these programmes are confidential makes it more difficult to obtain such information.

Even if Crew Resource Management (CRM) is not a pilot assistance programme per se, it provides tools that can help identify an individual who is struggling with any type of emotional or mental problem that may hinder his/her ability to serve effectively as a crew member.

1.16.4 Studies on anti-depressant medication and flying status

The Aerospace Medical Association (AsMA) is an international professional organisation, with its headquarters in the USA. Members include of 2,500 physicians, nurses and scientists engaged in the clinical practice of aerospace medicine and related research and education activities. One of its objectives is to represent the discipline of Aerospace Medicine to professional, commercial and governmental organisations and to advocate policies and standards.

In 2004, AsMA took a position in favour of reconsidering policies on the absolute prohibitions against pilots flying while taking antidepressant medication. At that time, Canadian and Australian authorities had already established specific programmes but the USA had not yet done so.

The proposition is mainly based on the following: *"There is evidence of professional pilots refusing antidepressant medication and continuing to fly without undergoing treatment appropriate for their medical condition, because they would be grounded. There is evidence that a significant number of professional pilots are taking SSRI medication while continuing flying without informing the FAA"*.

As an example, the Aviation Medicine Advisory Service (AMAS)[15], a US-based company providing aeromedical advice for pilots, reviewed its database of telephone inquiries from pilots between 1992 and 1997. It had received 1,200 telephone inquiries from pilots who had been diagnosed as having clinical depressions and who had been advised by their physicians to take antidepressant medications. These pilots had called AMAS to discuss the aeromedical implications of their situations. On the 1,200 pilots, some 60% told the AMAS that they would refuse medication and continue to fly. About 15 % indicated an intention to take the medications and continue their flying duties without informing the FAA. And the remaining 25% said they would take sick leave, undergo the recommended treatment and return to work when aeromedically cleared to do so. As, the data was representative only of pilots who telephoned for information, AsMA underlined the fact that the presence of depressed and untreated pilots (or treated without aeromedical supervision) was undoubtedly underreported.

[15]See https://www.aviationmedicine.com/

This is also noted in a 2003 study, which showed the presence of SSRI anti-depressant residues for 61 pilot fatalities in U.S. civil aviation accidents that occurred between 1990 and 2001. The aeromedical history of the pilots was further retrieved from the FAA's Aerospace Medical Certification database and additional information was obtained from the NTSB's database. Disqualifying psychological conditions were self-reported by only seven pilots and the use of SSRI by three among them. In later examinations, six of the seven indicated that they were free from the conditions and not taking SSRIs. Among the remaining pilots, SSRIs were used by the pilots but were not reported in their last aeromedical examinations.

To sustain its proposal, AsMA also argues that *"new SSRIs have few side effects"*. AsMA emphasizes the fact that patients generally have their adverse reactions to SSRIs early in treatment; the side effects usually diminish as the patient becomes physiologically accustomed to the medication. Besides, the newer SSRIs have fewer side effects than older ones.

AsMA argues that *"Canadian and Australian experience shows that some pilots with depressive symptoms controlled by anti-depressant medications (and carefully followed by selected psychiatrists) may fly safely"*.

This was underlined in a 10-year study of Australian data concerning antidepressant use and safety in civil aviation published in the Journal of AsMA in 2007. Australian aviation medical certification authorities began allowing use of antidepressant medications by aviation personnel in 1987. The aim of the study was to identify significant safety issues related to this use of antidepressant medication. The study employed a matched cohort of 481 holders of Australian aviation medical certificates who were prescribed antidepressants from January 1993 to June 2004 and a matched comparison group. No significant differences between the two groups were found in any of the analyses (18 accidents for the antidepressant group versus 15 for the comparison group; 113 incidents for the antidepressant group versus 131 for the comparison group).

In September 2012, a commentary was published in the journal of the AsMA on *"Major depression and fitness to fly"* by different aviation authorities. The article draws up an inventory of different aviation policies (Australian, Canadian and American). The authors compared the different regulations and found that protocols differ between countries in terms of accepted medication, psychotherapy treatment and requirements for symptom stability before returning to flying, but all were based on close medical follow-up of pilots and of their medication.

In Europe, the JAA's policy was that no certification could be considered whilst using psychoactive medication. However, changes in European regulations occurred in April 2012 (see 1.17.3).

1.16.5 Management of medical issues in other industries

1.16.5.1 Nuclear industry

EDF is a French national company in charge of producing and distributing electricity in France. A significant portion of this production is obtained through nuclear technology. The risks posed by this activity result in the company having a close follow-up of their employees involved in the nuclear industry.

The BEA met with doctors from the company to discuss the management of medical issues concerning their employees, and especially those involved in the operation of a nuclear power plant.

There is no regulatory requirement for an employee involved in the operation of a nuclear power plant to hold a medical certificate. However, EDF requests their employees to be medically approved and hold an internal medical certificate[16].

[16] The employee's electronic access card is disabled when this certificate is no longer valid.

This medical fitness is checked during the employment process by EDF and throughout the employee's career. The follow-up is triggered both by the fact that employees are involved in nuclear activity, and by the fact that some of them work during night shifts. The periodicity of the follow-up varies with the position held and work shift, from every 6 months to every 2 years. The monitoring covers both physiological and psychological conditions.

The doctors interviewed by BEA indicated that they were confident of the fact that the organisation would be aware of sick or unfit employees because teams are rather small and the employees feel free to report their sickness or fatigue. The adherence of employees is fostered by the fact that there can be no loss of income due to unfitness. The company would offer another position to any unfit employee, with no modification of his/her salary.

Employees' awareness is raised through *"Safety Discussions"* organized by the company, and which involve employees, the management, and the unions.

In terms of medical data exchange, there is a central database for the company's doctors to check an employee's fitness coming from another production site. These doctors can also exchange information on a case by case basis with doctors from the French national health service system.

It should be noted that employees in the nuclear industry also go through a police investigation during which their judicial records are checked.

1.16.5.2 Railway industry

The SNCF is a French public company in charge, among other activities, of train operations for cargo and passenger transportation.

Several positions are qualified as safety positions among the company. Employees holding those positions, which include train drivers, need to hold a medical certificate.

The train driver's position is regulated by the Directive 2007/59/EC of the European Parliament and of the Council of 23 October 2007, which applies to all Member States. This document states that train drivers need to be physically and mentally fit to be given their license.

Medical requirements for the initial application include the applicant's history, medical examinations and interviews with doctors and psychologists. In particular, it includes tests for psychotropic substances such as drugs or psychotropic medication.

Medical fitness has to be renewed every three years until the age of 55, then every year. The renewal examinations include tests for the detection of psychotropic substances or drugs but do not systematically include any psychological evaluation.

SNCF has medical centres (similar to AeroMedical Centres) in charge of assessing applicants' medical fitness (both initial and recurrent) and delivering medical certificates for train drivers and all safety positions[17]. These centres aggregate the individual medical data of their employees. These centres have a centralised data system containing the fit/unfit medical status of its agents. This enables access to anyone from these SNCF centres. Medical data can be exchanged with an occupational health doctor or a private doctor, but only through the employee, and therefore with his/her consent.

[17] The issuance of the driver's licence is the responsibility of the Licensing Authority, EPSF (Etablissement Public de Sécurité Ferroviaire) in France.

An executive and a medical doctor from SNCF indicated that it is always possible to require a driver or any holder of a safety position in the company to consult the medical department of the company. Due to the structure of the company and the work organisation, they indicated that they felt confident in their ability to detect a sick or an unfit employee. They indicated however, that a driver declared unfit would be offered a different position (which may include loss of income) but could theoretically be dismissed. It is possible for employees to subscribe to a loss of license insurance, but this is not covered by the company.

They added that employees were rather worried by this medical assessment as it is quite thorough and can impact their careers.

A psychological support group is available 24/7 for every employee feeling the need to share or receive advice on any concern.

1.17 Organisational and management information

1.17.1 ICAO's medical provisions for licensing

ICAO's Annex 1 *"Personnel Licensing"* contains the provisions on medical fitness for pilots. It states that holders of an aeroplane's commercial, multi-crew or airline transport pilot licence shall not exercise the privileges of the licence unless they hold a current Class 1 Medical Assessment. Applicants for a Class 1 Medical Assessment must meet certain physical and mental requirements, in order to ensure that they do not suffer from any disease or disability which could render them likely to become suddenly unable either to operate an aircraft safely or to perform assigned duties safely. In particular, as stated in paragraph 6.3.2.2 of ICAO's Annex 1:

- *"The applicant shall have no established medical history or clinical diagnosis of:*
  a) an organic mental disorder;
  b) a mental or behavioural disorder due to use of psychoactive substances; this includes dependence syndrome induced by alcohol or other psychoactive substances;
  c) schizophrenia or a schizotypal or delusional disorder;
  d) a mood (affective) disorder;
  e) a neurotic, stress-related or somatoform disorder;
  f) a behavioural syndrome associated with physiological disturbances or physical factors;
  g) a disorder of adult personality or behaviour, particularly if manifested by repeated overt acts;
  h) mental retardation;
  i) a disorder of psychological development;
  j) a behavioural or emotional disorder, with onset in childhood or adolescence; or
  k) a mental disorder not otherwise specified;

  such as might render the applicant unable to safely exercise the privileges of the licence applied for or held."

Medical examinations are to be conducted by Medical Examiners designated by the Licensing Authority. They must have received training in aviation medicine. In cases where the applicant does not fully meet the medical requirements and in complicated and/or unusual cases, the evaluation may have to be deferred and the case submitted to Medical Assessors[18] of the Licensing Authority for final evaluation. For this evaluation to take place, the Medical Examiner must report to the Licensing Authority any individual case where, in the examiner's judgement, an applicant's failure to meet any requirement, whether numerical or otherwise, is such that exercise of the privileges of the licence being applied for, or held, is not likely to jeopardize flight safety.

Regarding depression, ICAO's Annex 1 recommends that:

- *"An applicant with depression, being treated with antidepressant medication, should be assessed as unfit unless the medical assessor, having access to the details of the case concerned, considers the applicant's condition as unlikely to interfere with the safe exercise of the applicant's licence and rating privileges."*

[18] According to ICAO's Annex 1, a Medical Assessor is "*a physician, appointed by the Licensing Authority, qualified and experienced in the practice of aviation medicine and competent in evaluating and assessing medical conditions of flight safety significance*".

Paragraph 3.2 of the Appendix 2 of the ICAO Manual of Civil Aviation Medicine (Chapter 9) provides guidelines on the assessment of pilot applicants treated with antidepressant:

- *"States may, on a case-by-case basis, certificate applicants who are prescribed (and are taking) an approved SSRI antidepressant medication for an established diagnosis of depression which is in remission. Conditions necessary for air safety may be imposed on the certificate as appropriate, for example "holder to fly as or with co-pilot", thus limiting operations to multi-crew aircraft. Pilots (…) taking other types of antidepressants should not usually be considered for certification.*

- *States' certification of pilots (…) taking medications accepted by the Licensing Authority should be conditional on the following:*
  a) The applicant should be under the care of a medical practitioner experienced in the management of depression;
  b) The applicant should:
  - *1) be stable on an established and appropriate dose of medication for at least four weeks before returning to flying(…) duties and exhibiting:*
    i) minimal, acceptable side-effects;
    ii) no medication interactions or allergic response;
  - *2) be subject to regular clinical review by the medical practitioner with progress reports provided to the medical section of the Licensing Authority. The applicant may be involved in other concurrent treatment (e.g. psychotherapy);*
  - *3) have no other significant psychiatric co-morbidities;*
  - *4) require no other psychoactive medications;*

  c) demonstrate symptoms of depression being well controlled,without evidence of psychomotor retardation;
  d) have no suicidal ideation or intent;
  e) have no history of psychotic symptoms;
  f) have no features of arousal (e.g. irritability or anger);
  g) have a normal sleep pattern;
  h) have resolution of any significant precipitating factors of the depression.

Ongoing cognitive-behavioural, rational-emotive or similar therapy is desirable, but not necessarily required for certification.

Pilots (…) authorized to fly or perform duties when taking SSRIs or related antidepressant medications must cease exercising the privileges of their licences if their antidepressant medication is altered or if the dose changes. Their supervising medical practitioner may return them to duty when they are assessed as stable and without unacceptable side effects.

Pilots (…) whose medication is being reduced with a view to cessation should stop exercising the privileges of their licences for the entire period during which they are weaned off medication, plus an additional period of at least two weeks. Their supervising medical practitioner may return them to duty when they are assessed as stable and without unacceptable side effects or evidence of withdrawal syndrome.

The use of objective assessment tools in the monitoring of these certificate holders is encouraged. The Hamilton rating scale is one such tool and formal neuropsychological testing is another option. Simulator or other functional-based testing can also be utilized to assess performance. States should provide guidance on preferred medications with lower side-effect profiles such as sertraline, citalopram, and escitalopram.

Outcome criteria/data on the cohort returned to work should be established prospectively and captured for review of the programme."

Provisions about decrease in medical fitness (in paragraph 1.2.6 of ICAO's Annex 1) state that:

- *"Holders of licences provided for in this Annex shall not exercise the privileges of their licences and related ratings at any time when they are aware of any decrease in their medical fitness which might render them unable to safely and properly exercise these privileges."*

It also recommends that:

"States should ensure that licence holders are provided with clear guidelines on medical conditions that may be relevant to flight safety and when to seek clarification or guidance from a medical examiner or Licensing Authority."

1.17.2 The "1% rule"

One of the major purposes of medical examinations and determination of medical fitness of a pilot is to assess the probability of a medical condition resulting in in-flight incapacitation. ICAO's Manual of Civil Aviation Medicine (Doc 8984) defines a level of acceptable risk for flight crew incapacitation.

A risk of 10^{-7} per flying hour is seen as *"extremely remote"* in terms of airworthiness of aircraft and deemed as acceptable. Not more than 10% of that risk should be due to a single system failure (for example pilot failure), and not more than 10% of system failures should be due to a single subsystem failure (for ex medical incapacitation). Consequently, an incapacitation risk of 10^{-9} per flying hour was regarded as acceptable and as a target rate. Critical phases are thought to comprise a maximum 10 % of a flight. Therefore the target rate can be increased to 10^{-9} x 10, which is 10^{-8}. In the case of two-pilot operations, the risk of the second pilot failing to take over from an incapacitated pilot flying is a maximum of 1 % (this rate was actually measured at 0.25 % in simulator studies). The target risk rate can therefore be increased to 10^{-8} x 100, which is 10^{-6}. This figure of 10^{-6} is equal to 0.01 / 10,000. Taking into account that a year has 8,760 hours, which can be rounded up to 10^{-4} hours, the target of 10^{-9} per flying hour is achieved if a medical condition occurred with a probability of 10^{-2} within that year. Therefore, the acceptable risk would be 1% per year.

This statistical computation shows that a risk of pilot incapacitation limited to 1% per year is compatible with a fatal accident rate of one in 10^{-7} flying hours. Pilot incapacitation risk of 1% per year implies that out of 100 pilots with an identical condition, one of them would be predicted to become incapacitated at some time during the following year (and 99 would not). This risk of 1% per year, which has become known as the *"1% rule"*, is based on two-pilot operations where a second pilot is available to take over in the event of one pilot becoming incapacitated.

The "*1% rule*" aims at providing an objective method of assessing the fitness of pilots and improving global harmonisation of medical standards. It is used by some European States as a threshold of acceptable risk for aeromedical events above which continued flight duties or training should not be permitted. However, other limits of acceptable risk, such as 2% per year, or even greater, have been suggested.

This "*1% rule*" can be difficult to apply because adequate predictive epidemiological data are not always available for every condition, or if they are, they cannot be readily applied to the flight environment. This makes the expression of risk of in-flight incapacitation in numerical terms not easy to determine, particularly for conditions that are uncommon. However, for a number of conditions such as certain cardiovascular diseases, good data exist concerning the risk of a future related event, and the "*1% rule*" could be used for developing and assessing medical fitness criteria for commercial pilots.

ICAO's Annex 1 recommends (in paragraph 1.2.4.2) that:

- *"Recommendation. From 18 November 2010 States should apply, as part of their State safety programme, basic safety management principles to the medical assessment process of licence holders, that as a minimum include:*
  a) routine analysis of in-flight incapacitation events and medical findings during medical assessments to identify areas of increased medical risk; and
  b) continuous re-evaluation of the medical assessment process to concentrate on identified areas of increased medical risk."

Note: ICAO State Letter AN 5/22.1-15/56 dated 17 July 2015 on "Health promotion and the medical assessment", proposes to amend Annex 1 by upgrading this Recommendation to a Standard, as it is considered mature and acceptable to States.

1.17.3 EU's medical certification process for flight crews

Licensing and medical requirements for air crews in EU Member States are set out in:

- Regulation: (EC) No 216/2008 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 20 February 2008 and in
- Implementing Rules: COMMISSION REGULATION (EU) No 1178/2011 of 3 November 2011 and in COMMISSION REGULATION (EU) No 290/2012 of 30 March 2012.

All authorities, persons, organisations in all 28 EU Member States as well as in Iceland, Liechtenstein, Norway and Switzerland must comply with the provisions of these regulations.

Regulation (EC) No 216/2008 states in its Article 7.2 that

"Except when under training, a person may only act as a pilot if he or she holds a licence and a medical certificate appropriate to the operation to be performed."

(EU) regulation No 1178/2011, also known as *"Aircrew Regulation"*, includes the general requirements for medical aspects in its Annex IV, called *"Part-MED"*.

(EU) regulation No 290/2012, also part of the *"Aircrew Regulation"*, contains authority requirements for aircrew in its Annex VI, called *"Part-ARA"*.

For class 1 and class 2 medical certification, both Part-MED and Part-ARA are applicable from 8 April 2012 and must be applied at the latest on 8 April 2013. Most European countries elected to opt-out by postponing the application of Part-MED and Part-ARA on their territory until 8 April 2013. This is the case for Germany, France and Spain. In the United Kingdom they have been applicable since 17 September 2012.

The "*Aircrew Regulation*" establishes requirements for aero-medical examiners (AME), aero-medical centres (AeMC), General Medical Practitioners (GMP) and Occupational Health Medical Practitioners (OHMP). This regulation does not give any obligation to private physicians or other medical specialists.

Paragraph MED.A.040 specifies that the initial issue of Class 1 medical certificates shall be performed by an AeMC only, whereas they can be revalidated or renewed by an AeMC or an AME.

Before the application date of the *"Aircrew Regulation"*, JAR-FCL 3, containing the provisions for aero medical fitness were adopted in JAA Member States, which included Germany. However, JARs were not binding unless adopted by the individual Member State and incorporated into national law. Unlike (EU) regulations today, national regulations or laws could therefore prevail over the JARs.

The process for the issuance of a Class 1 medical certificate[19] laid out in the Aircrew Regulation is similar to what is described in ICAO's Annex 1 and almost identical to what was prescribed in JAR-FCL 3. This process can be divided into four steps:

- 1. **Application**: the applicant fills out a form to apply for a class 1 medical certificate and has to provide information on his/her medical history, including psychological/psychiatric trouble of any sort.
- 2. **Examination**:
  - a. The AME performs the clinical examinations according to the requirements of Subpart B of Part-MED, including a psychological and a psychiatric evaluation;
  - b. The AME advises the applicant whether he/she is fit, unfit or referred (see step 3 below);
  - c. In case of unfitness, the AME informs the applicant about the possibility of a secondary review;
  - d. If the applicant is found fit, the AME issues the medical certificate and submits without delay a signed report to include the assessment result and a copy of the medical certificate to the licensing authority.
- 3. **Referral**: in borderline cases indicated in Subpart B of Part-MED (when the applicant does not fully comply with the class 1 medical requirements but is considered to be not likely to jeopardise flight safety), the AeMC or the AME shall refer[20] the decision on fitness to the licensing authority.
- **Decrease in medical fitness**: if, in-between two medical examinations, a pilot realizes a decrease in medical fitness which might interfere with flight safety, he/she shall no longer exercise the privileges of his/her license and shall seek the advice of an AeMC or AME, who will decide whether he/she is fit to resume flying.

[19] The term "Medical Assessment" used in ICAO documentation has been replaced by "medical certificate" in EU terminology.

[20] The term "defer" used in ICAO documentation has been replaced by "refer" in EU terminology.

A more detailed description of the process, with the appropriate references to the "*Aircrew Regulation*" as well as the related Acceptable Means of Compliance and Guidance Material is shown below:

Application		
1.	Applicants for or holders of CPL, MPL or ATPL shall hold a Class 1 medical certificate.	MED.A.030 (f)
2.	Applications for a medical certificate shall be made in a format established by the competent authority.	MED.A.035
3.	The AME provides the application form.	ARA.MED.135(a)
4.	The AME asks to see the previous medical certificate.	MED.A.035 (c)
5.	The applicant shall provide a signed declaration of medical history.	MED.A.035 (b) (2) (i)
6.	The applicant shall provide a signed declaration of previous examination for medical certificate and with what result.	MED.A.035 (b) (2) (ii)
7.	The applicant shall provide a signed declaration as to whether he has ever been assessed as unfit or had a medical certificate suspended or revoked.	MED.A.035 (b) (2) (iii)
8.	The applicant signs the application and consents to the release of medical information: *"I hereby authorize the release of all information contained in this report and any or all attachments to the AME and, where necessary, to the medical assessor of the licensing authority, recognizing that these documents or electronically stored data are to be used for completion of a medical assessment and will become and remain the property of the licensing authority, providing that I or my physician may have access to them according to national law. Medical confidentiality will be respected at all times."*	AMC1 ARA.MED.135(a)
Examination		
9.	The AME performs the medical examination to check: ❒ if the applicant is free from any side effect of any medication that would entail a degree of functional incapacity which is likely to interfere with the safe exercise of the pilot license; ❒ cardiovascular system, respiratory system, digestive system, metabolic and endocrine systems, haematology, genitourinary system, infectious disease, obstetrics and gynaecology, musculoskeletal system; ❒ psychiatry (see steps 10 to 14); ❒ psychology; ❒ neurology, visual system, colour vision, otorhino-laryngology, dermatology, oncology.	MED.B.005 MED.B.010 to 050 MED.B.055 MED.B.060 MED.B.065 to 090
10.	Applicants shall have no established medical history or clinical diagnosis of any psychiatric disease or disability, condition or disorder, acute or chronic, congenital or acquired, which is likely to interfere with the safe exercise of the privileges of the applicable licence(s).	MED.B.055 (a)
11.	Applicants with a mood, neurotic, personality, mental or behavioural disorder shall undergo psychiatric evaluation before a fit assessment can be made. Such applicants shall be referred to the licensing authority	MED.B.055 (c) MED.B055 (e) (1)

12.	Applicants with a history of deliberate self-harm shall be assessed as unfit. Such applicants shall be referred to the licensing authority	MED.B.055 (d) MED.B055 (e) (1)
13.	Applicants with a history of schizophrenia, schizotypal or delusional disorder shall be assessed as unfit.	MED.B.055 (f)
14.	(a) Psychotic disorder A history, or the occurrence, of a functional psychotic disorder is disqualifying unless a cause can be unequivocally identified as one which is transient, has ceased and will not recur. (b) Organic mental disorder An organic mental disorder is disqualifying. Once the cause has been treated, an applicant may be assessed as fit following satisfactory psychiatric review. (c) Psychotropic substances Use or abuse of psychotropic substances likely to affect flight safety is disqualifying. (d) Schizophrenia, schizotypal or delusional disorder Applicants with an established schizophrenia, schizotypal or delusional disorder should only be considered for a fit assessment if the licensing authority concludes that the original diagnosis was inappropriate or inaccurate or, in the case of a single episode of delirium, provided that the applicant has suffered no permanent impairment. (e) Mood disorder An established mood disorder is disqualifying. After full recovery and after full consideration of an individual case a fit assessment may be considered, depending on the characteristics and gravity of the mood disorder. If a stable maintenance psychotropic medication is confirmed, a fit assessment should require a multi-pilot limitation. (f) Neurotic, stress-related or somatoform disorder Where there is suspicion or established evidence that an applicant has a neurotic, stress-related or somatoform disorder, the applicant should be referred for psychiatric opinion and advice. (g) Personality or behavioural disorder Where there is suspicion or established evidence that an applicant has a personality or behavioural disorder, the applicant should be referred for psychiatric opinion and advice. (…)	AMC1 MED.B.055
15.	Applicants shall have no established psychological deficiencies, which are likely to interfere with the safe exercise of the privileges of the applicable licence(s).	MED.B.060 (a)
16.	Where there is suspicion or established evidence that an applicant has a psychological disorder, the applicant should be referred for psychological opinion and advice.	AMC1 MED.B.060 (a)
17.	The psychologist should submit a written report to the AME, AeMC or licensing authority as appropriate, detailing his/her opinion and recommendation.	AMC1 MED.B.060 (d)
18.	The AME fills out an examination report. See AMC1 for report format.	ARA.MED.135(b)

19.	After completion of the examination, the AeMC, or the AME shall: ❒ (1) advise the person whether fit or unfit ; ❒ (2) inform the person of any limitation ; ❒ (3) if unfit, inform the person of his right for secondary review ; ❒ (4) submit without delay a signed report to include the assessment result and a copy of the medical certificate to the licensing authority.	MED.A.025 (b)
20.	The report required in MED.A.025 (b)(4) should detail the results of the examination and the evaluation of the findings with regard to medical fitness.	AMC1 MED.A.025
21.	For secondary reviews mentioned in MED.A.025 (b)(3), the competent authority shall establish a procedure for the review of borderline and contentious cases with independent medical advisors, experienced in the practice of aviation medicine, to consider and advise on an applicant's fitness for medical certification.	ARA.MED.325
If Referral to the licensing authority		
22.	If the applicant does not fully comply with the requirements but is considered to be not likely to jeopardize flight safety, the AeMC or AME shall refer the decision on fitness of the applicant to the licensing authority as indicated in Subpart B of Part MED	MED.B.001 (a) (1) (i)
23.	In cases where a referral to the licensing authority is not indicated in Subpart B of Part MED, the AeMC or the AME shall evaluate whether the applicant is able to perform his/her duties safely when complying with one or more limitations endorsed on the medical certificate, and issue the medical certificate with limitation(s) as necessary	MED.B.001 (a) (1) (ii)
24.	An AeMC or AME may refer the decision on fitness of the applicant to the licensing authority in borderline cases or where fitness is in doubt.	AMC1 MED.B.001 (a)
25.	In cases where a fit assessment can only be considered with a limitation, the AeMC, AME or the licensing authority should evaluate the medical condition of the applicant in consultation with flight operations and other experts, if necessary.	AMC1 MED.B.001 (b)
26.	Limitations 5 to 15 (which include #14 *"SIC"* - specific regular medical examination(s) - contact licensing authority) should only be imposed: (i) for class 1 medical certificates by the licensing authority **SIC Specific regular medical examination(s) contact licensing authority** This limitation requires the AME to contact the licensing authority before embarking upon renewal or recertification medical assessment. It is likely to concern a medical history of which the AME should be aware prior to undertaking the assessment.	AMC1 MED.B.001 (d) (2) (i) GM1 MED.B.001
27.	The competent authority shall establish a procedure for the review of borderline and contentious cases with independent medical advisors, experienced in the practice of aviation medicine, to consider and advise on an applicant's fitness for medical certification	ARA.MED.325
28.	The AeMC or AME may revalidate or renew a medical certificate with the same limitation without referring the applicant to the licensing authority.	MED.B.001 (a) (1) (iv)

29.	If an applicant for a Class 1 or Class 2 medical certificate is referred to the licensing authority in accordance with MED. B.001, the AeMC or AME shall transfer the relevant medical documentation to the licensing authority	MED.A.050
30.	When an AeMC, or aero-medical examiner (AME) has referred the decision on the fitness of an applicant to the licensing authority: ❒ (a) the medical assessor or medical staff designated by the competent authority shall evaluate the relevant medical documentation and request further medical documentation, examinations and tests where necessary; and ❒ (b) the medical assessor shall determine the applicant's fitness for the issue of a medical certificate with one or more limitation(s) as necessary.	ARA.MED.125
31.	In cases where the decision on medical fitness of an applicant for a Class 1 medical certificate is referred to the licensing authority, this authority may delegate such a decision to an AeMC, except in cases where an OML (*) is needed. (*) OML=Operational Multi-pilot Limitation	MED.B.005 (b)
If Decrease in medical fitness		
32.	Decrease in medical fitness: License holders shall not exercise the privileges of their licence and related ratings or certificates at any time when they: ❒ (1) are aware of any decrease in their medical fitness which might render them unable to safely exercise those privileges; ❒ (2) take or use any prescribed or non-prescribed medication which is likely to interfere with the safe exercise of the privileges of the applicable licence; ❒ (3) receive any medical, surgical or other treatment that is likely to interfere with flight safety.	MED.A.020 (a)
33.	License holders shall, without undue delay, seek aero-medical advice when they have commenced the regular use of any medication	MED.A.020 (b) (2)
34.	If there is a decrease in medical fitness, holders of Class 1 and Class 2 medical certificates shall seek the advice of an AeMC or AME. The AeMC or AME shall assess the medical fitness of the license holder and decide whether they are fit to resume the exercise of their privileges	MED.A.020 (c) (1)

MED.D.030 states that an AME must undertake refresher training in aviation medicine at least every 3 years, and perform at least 10 aero-medical examinations every year.

Note: European Regulation 45/2001 of the European Parliament and of the Council of 18 December 2000 deals with the "Protection of individuals with regard to the processing of personal data by the Community institutions and bodies and on the free movement of such data". This regulation, binding for all Member States, applies to the processing of personal data by all Community institutions and bodies insofar as such processing is carried out in the exercise of activities all or part of which fall within the scope of Community law. As far as medical data are concerned, this regulation authorizes their processing as long as it is required for the purpose of preventive medicine and medical diagnosis for example, and as long as the person processing is acting under an obligation of secrecy.

1.17.4 Medical certification process for flight crews in Germany

1.17.4.1 Authorities in charge for Civil Aviation in Germany

The authority in charge of oversight of civil aviation in Germany is the Luftahrt-Bundesamt (LBA). Its functions include the oversight of the medical certification of airline transport pilots. The LBA is directly subordinated to the Federal Ministry of Transport and Digital Infrastructure (BMVI), which is divided in nine Directorates-General, including one for aviation. The Aviation Directorate-General deals with national and international aviation and aviation policy matters, airports and safety in air transport.

The LBA participates in the elaboration of aviation regulations, which are enacted by the BMVI. Implementation orders (DVO) of the regulations are issued by the LBA.

A standardisation inspection was performed by EASA in July 2014 at the LBA, covering the domains of Aircrew / Flight Crew Licensing and Medical.

This inspection concluded that the LBA lacked powers to fulfil its responsibilities in the medical domain and that no process for internal audits or safety risk management was in place.

The inspection also indicated that the LBA was often required to consult the BMVI and sometimes had to follow instructions from the BMVI[21].

[21] EASA has indicated that, as of February 2016, the related findings were still open.

1.17.4.2 Regulatory framework before 8 April 2013

In 2008 and until 8 April 2013, the requirements for aero medical fitness in Germany were published in the regulation Luftverkehrs-Zulassungs-Ordnung, called *"LuftVZO"*. These provisions were based on the JAR-FCL 3, with however significant differences in the referral mechanism. Paragraph JAR-FCL 3.125 (a) (1) about *"Delegation of fit assessment*" stated:

- *"If the medical requirements prescribed in JAR–FCL Part 3 (Medical) for a particular licence are not fully met by an applicant, the appropriate medical certificate shall not be issued, revalidated or renewed by the AMC or AME but the decision shall be referred to the Authority (…)".*

Note: "AMC" in the JARs stands for aero-medical centre, which is now designated as "AeMC" in the current European regulations.

Section 24e of the LuftVZO defines the conditions for aero-medical centres and aero-medical specialists to be recognised by the LBA. Once recognized, they are allowed to issue Class 1 medical certificates. The Lufthansa aero-medical centre is a recognised aero-medical centre.

Section 24c of the LuftVZO about further verification of medical fitness states that, if a recognized aero-medical centre or an aero-medical specialist recognized according to section 24e finds that an applicant for a Class 1 medical certificate is unfit or finds facts which substantiate doubts as to the medical fitness, the applicant may have this finding further verified by a recognised aero-medical centre. The verifying aero-medical specialist or the verifying aero-medical centre shall examine, by applying the provisions of JAR-FCL 3, whether it is possible to issue a medical certificate or a medical certificate with limitations or whether the unfitness has to be confirmed. The verifying aero-medical specialist or the verifying aero-medical centre can consult medical specialists, other aero-medical specialists and psychologists and transmit, with the consent of the applicant, the medical findings required for verification to them. The medical certificate or the confirmation of the unfitness shall, after completion of the verification, be handed over to the applicant and a copy transmitted to the entity responsible for issuing the licence. If, after this verification a medical certificate is issued, it shall bear an endorsement (*"REV"*) stating that the medical fitness was determined after a further verification. Per section 24e (7), the reports of medical findings and the certificates based on them shall be transmitted to the licensing authority in a way which makes it impossible to allocate the medical report to the person to whom the medical certificate was issued.

Section 24d of the LuftVZO states that if, within the framework of a fitness examination, restrictions or conditions have to be endorsed on the medical certificate, these entries shall be made by the recognized aero-medical centre or aero-medical specialist.

Until 8 April 2013 and in accordance with German regulations, the Lufthansa aero-medical centre was therefore re-checking the fitness of applicants, who when examined a first time, did not fully comply with the medical requirements. Without having to refer to the LBA, this AeMC could then issue a class 1 medical certificate if it found that flight safety would not be jeopardised, and decide, still without any LBA involvement, whether a limitation needed to be endorsed on the medical certificate.

Note : the LBA has indicated that, in the past, "SIC" limitations were endorsed on pilot licenses, even though EU regulations state that these limitations should be endorsed on medical certificates. The LBA also indicated that the "REV" endorsement on medical certificates and the "SIC" limitation have comparable purposes.

The LBA could not provide any data on the number of class 1 medical certificates issued, revawlidated or denied every year. At the time of the publication of this report (March 2016), it still did not have an IT system that would be able to provide such data.

1.17.4.3 Regulatory framework after 8 April 2013

Starting 8 April 2013, at the end of the German opt-out period, the EU *"Aircrew Regulation"* came into force in Germany and took precedence over any German law. The LuftVZO regulation was amended on 17 December 2014, repealing sections 20 to 37.

The requirements of the *"Aircrew Regulation"* which were not considered clear enough by Germany have been specified in the national regulations. In particular, for aero-medical matters, the order concerning aviation personnel Verordnung über Luftfahrtpersonal, called *"LuftPersV"*, was last amended on 17 December 2014.

Section 21 of the LuftPersV states that aero-medical centres or aero-medical experts submit, in accordance with Part-MED paragraph MED.A.025 (b) (4), a report including the assessment result of the medical certificate to the LBA in a form that the correlation to an examined applicant is not possible. This process of rendering the personal data partially anonymized is referred as *"pseudonymisation"*. Section 21 also specifies that the medical experts of the LBA decide in case of referral whether possible limitations need to be entered on the medical certificate. This *"pseudonymised"* information is sent to the medical department of the LBA, while the medical certificates (with the names of the applicants) are sent to the licensing department of the LBA. Those two departments are not allowed to cross-check information to access medical information of an applicant whose name is on a medical certificate.

Secondary reviews, mentioned in MED.A.025 (b)(3) as a right if a person is assessed as unfit, are performed in Germany, per section 21 of the LuftPersV, by an aero-medical commission. Section 34 of LuftPersV states that this aero-medical commission consists of five aero-medical experts appointed by the BMVI based on their suitability and experience[22]. The aero-medical experts or aero-medical centres submit the necessary medical data to this aero-medical commission in *"pseudonymised"* form. The aero-medical committee does not therefore examine or discuss with the candidate in person. It makes a decision regarding the medical fitness within four weeks of receiving the application and informs the aero-medical experts or aero-medical centre accordingly. For Class 1 medical certificates, they inform the LBA and the applicant of the decision. The LBA is bound to the decision and has to implement it immediately.

[22]The aero-medical commission can also call in other aero-medical experts, specialist physicians, and psychologists for the clarification of aero-medical professional questions.

The evolution of the regulatory framework of German medical certification is shown in the following chart:

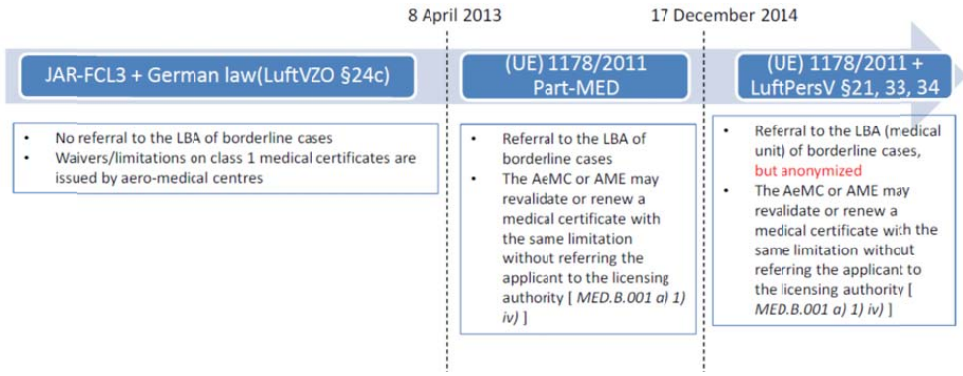

Figure 16 - regulatory framework of German medical certification

1.17.4.4 Data protection laws

The Federal Commissioner for Data Protection and Freedom of Information (*Bundesbeauftragte für den Datenschutz und die Informationsfreiheit*) is responsible for the implementation of the data protection law in Germany. Medical documentation is subject to the data protection law and medical confidentiality. According to the German criminal code (*Stafgesetzbuch*) violation of medical confidentiality has penal consequences.

Section 203 (1) of the German criminal code applies to health care personnel whose vocational training and professional title is state-approved (e.g. psychotherapists, physical therapists, care professions). It states that whosoever unlawfully discloses a secret of another, in particular, a secret which belongs to the sphere of personal privacy, which was confided to or otherwise made known to him in his capacity as a physician or member of another healthcare profession shall be liable to imprisonment not exceeding one year or a fine.

Exceptions from this medical confidentiality exist. The physician is entitled to pass on information if the patient gives his explicit or implied consent. The explicitly-given consent is only effective if it is based on free decision making of the patient. The patient has to know for which purpose he authorizes the physician to pass on patient-related information. When neither a legal authorization nor disclosure consent exists, there are exceptions where disclosure of patient-related data to third parties is possible. Such exceptions come into consideration if trust in medical confidentiality comes second to other legal interests or if the physician protects legitimate interests. Section 34 of the German criminal code, which is not specific to the protection of medical data, states that:

- "*A person who, faced with an imminent danger to life, limb, freedom, honour, property or another legal interest which cannot otherwise be averted, commits an act to avert the danger from himself or another, does not act unlawfully, if, upon weighing the conflicting interests, in particular the affected legal interests and the degree of the danger facing them, the protected interest substantially outweighs the one interfered with. This shall apply only if and to the extent that the act committed is an adequate means to avert the danger.*"

If a holder of a medical certificate contacts his family doctor (GMP, etc.) or another physician, who detects an illness not compatible with the pilot duties or with flight safety, the contacted physician is not obliged to inform the responsible AME nor the employer nor the aviation authority. Due to medical confidentiality reasons, the information of third parties is impeded. The possibility to disclose aeromedical data depends upon the imminent danger resulting from the illness of the pilot concerned. Nevertheless the principle of confidentiality can prevent the treating doctor from disclosing such information.

The inspection performed by EASA in July 2014 highlighted possible conflicts between German data protection laws and the application of Part-MED. It was found that the German data protection laws interfered with the oversight of AMEs and AeMCs, in particular:

- the personal medical data of aero-medical examinations performed by AMEs or AeMCs were not available to the LBA;
- the medical personnel from the LBA were prevented from examining and taking copies of the medical records or data relevant to the execution of the oversight task.

The LBA responded to these findings and the December 2014's amendment of the LuftPersV now allows the transfer of medical data to the LBA but it has to be done in an anonymous way (see paragraph 1.17.4.3).

1.17.5 Medical certification process for flight crews in France

(EU) regulation No 1178/2011, Annex IV (Part-MED) has applied in France since 8 April 2013.

Approximately 17,000 Class 1 medical certificates are issued, revalidated or renewed every year in France, and approximately 380 Class 1 applicants are assessed as unfit every year.

In France no AME has ever issued any medical certificate to a pilot who has declared using anti-depressant medication.

Article R4127-4 of the Public Health Code states that professional secrecy is imposed on all physicians, under the conditions established by law and in the interest of patients. This secrecy covers all the information gathered by the physician during the course of his/her work. This information includes what was revealed to the physician, but also what he/she saw, heard or understood.

Article R4127-44 of the Public Health Code states that a physician must notify the judicial or administrative authorities if a person, whom this physician has examined, is unable to protect himself or herself because his/her age, or because of his/her physical or psychological state, except in particular circumstances left to the appreciation of the physician.

Article 226-14 of the French Penal Code states that professional secrecy does not apply to physicians who notify the judicial authorities if they are aware of the dangerous nature of a person for himself/herself or for others and who is in possession of a weapon or intends to acquire one. Notification in such cases cannot lead to disciplinary sanctions against the physician.

Article 122-7 of the French Penal Code states that nobody can be held liable if, when faced with a present or imminent danger for himself/herself, for others or a piece of goods, he or she takes the necessary actions to safeguard the person or the piece of goods in danger, except if the means used to do so are disproportionate in comparison with the gravity of the threat.

In April 2015, the French national council of doctors released a statement[23], in reaction to the Germanwings accident of 24 March 2015, to clarify the position of physicians with regard to medical confidentiality. This statement suggests that physicians may breach medical confidentiality to notify the doctor in charge of health at work or judicial authorities in exceptional cases when there is an imminent and high risk of harm to others, that the physician cannot otherwise prevent and after having tried all other possible solutions. In such a case, the physician would be able to justify this notification by referring to article 122-7 of the French penal Code (see above).

[23] See (French only) : Appendix 1 or http://www.conseil-national.medecin.fr/node/1584

1.17.6 Medical certification process for flight crews in the United Kingdom

Since September 2012, medical assessment of pilots in the United Kingdom has been performed according to Part-MED regulation (see paragraph 1.17.3 for a description of Part-MED provisions). Before this date, it was performed according to JAR-FCL3, without any UK regulation taking precedence.

Approximately 20,000 Class 1 medical certificates are issued, revalidated or renewed every year in the UK, and approximately 1,200 applicants are assessed as unfit at some point during each year (this figure includes temporary episodes of unfitness).

In January 2015, the UK CAA issued a procedure for medical assessment reviews and appeals, which is added to the provisions of Part-MED. This procedure describes the different steps that may take place at the request of an applicant if he or she is assessed as unfit during the primary assessment of fitness. In that case, a secondary review can be undertaken by a Medical Assessor of the Authority Medical Section (AMS) of the CAA. If, following a secondary review, a certificate has been denied, or limited, the applicant is advised of his/her right to request a final appeal to the CAA's Chief Medical Officer. The latter appoints two or more specialist advisers to form a panel that will provide expert advice to assist the Chief Medical Officer in making the CAA's decision. The applicant is notified of the outcome of the appeal in writing. The reasons for the decision are set out in that decision letter.

The UK CAA runs an online database system for medical information, called *"AME online"*. This system allows UK AMEs to connect to the CAA to access the medical file of any pilot, with the consent of the latter. The database contains not only medico-administrative information, but also medical information linked to the previous medical assessments (blood pressure readings, eye sight results...). The ability to access this system is compulsory to be an AME in the UK. The AME has to have the pilot's consent to access his/her data in the AME online system.

Class 1 applicants with a mental or behavioural disorder due to alcohol or other use or abuse of psychotropic substances, mood, neurotic, personality, mental or behavioural disorder or a history of a single or repeated acts of deliberate self-harm have to be referred to the UK CAA.

Pilots with a history of depression are reviewed by a UK CAA psychiatric specialist once they have recovered and their symptoms have been fully resolved for at least 4 weeks. Reports from the pilot's treating physicians/psychiatrists are required. Ongoing cognitive behavioural therapy or interpersonal psychotherapy and the Selective Serotonin Reuptake Inhibitor (SSRI) anti-depressants sertraline, citalopram and escitalopram are permitted for Class 1 medical certification provided full recovery has been achieved. Pilots who are on a SSRI undergo a medical flight test to ensure that the medication has no effect on operational performance prior to being assessed as fit for Class 1 certification with an Operational Multi pilot Limitation. They are regularly followed up at the UK CAA, initially every 3 months whilst being treated.

The General Medical Council (GMC) publishes guidelines about confidentiality[24] for all UK physicians. These guidelines state that medical confidentiality is a key principle to ensure trust between doctors and patients. The fact that people are encouraged to seek advice and treatment, with the guarantee that their personal information will be held in confidence, benefits society as a whole as well as the individual. Confidential medical care is recognized in UK law as being in the public interest. However, articles 36, 37, 53 and 55 of the GMC guidelines also state that:

[24] See http://www.gmc-uk.org/guidance/ethical_guidance/confidentiality.asp

- *"36 (…) there can also be a public interest in disclosing information: to protect individuals or society from risks of serious harm, such as serious communicable diseases or serious crime; or to enable medical research, education or other secondary uses of information that will benefit society over time.*
- *37 Personal information may, therefore, be disclosed in the public interest without patients' consent and in exceptional cases where patients have withheld consent, if the benefits to an individual or to society of the disclosure outweigh both the public and the patient's interest in keeping the information confidential. (…)*
- *53 Disclosure of personal information about a patient without consent may be justified in the public interest if failure to disclose may expose others to a risk of death or serious harm. You should still seek the patient's consent to disclosure if practicable and consider any reasons given for refusal.*
- *55 If a patient's refusal to consent to disclosure leaves others exposed to a risk so serious that it outweighs the patient's and the public interest in maintaining confidentiality, or if it is not practicable or safe to seek the patient's consent, you should disclose information promptly to an appropriate person or authority. You should inform the patient before disclosing the information, if practicable and safe, even if you intend to disclose without their consent."*

These provisions are most often used when reporting concerns about patients to the Driver & Vehicle Licensing Agency (DVLA), for example in cases of alcohol or drug abuse.

If a physician is in doubt about when it is appropriate to breach medical confidentiality in the name of the public interest, they are encouraged to seek advice from experienced colleagues, the British Medical Association (BMA), their medical indemnity organisation or their regulatory body.

Article 5 of the GMC guidance on confidentiality states that persistent failure to follow it will put the physician's registration at risk. Therefore, the GMC guidelines do not legally oblige doctors to report a patient in the case of a threat to public safety, but they are ethically obliged to do so.

1.17.7 Medical certification process for flight crews in the USA

Medical standards and certification procedures for issuing medical certificates in the USA are set out in federal regulations 14 C.F.R. Part 67. There are three classes of medical certificates:

- Airline transport pilots who serve as pilots in command of scheduled air-carrier operations must hold first-class medical certificates (Class 1).
- Pilots who fly for compensation or hire generally must hold second-class medical certificates (Class 2).
- Private pilots must hold third-class medical certificates (Class 3).

Approximately 450,000 applications for airman medical certification are received and processed each year in the USA. In 2014, the FAA received a total of 376,295 applications (initial and renewal) of pilots to certify that they are physically and mentally fit to fly, of which 208,245 were for class 1 medical certificates. Approximately 1.2% of applicants are assessed as unfit every year, which makes about 2,500 denials for Class 1.

The FAA designates medical certification authority to approximately 3,300 AMEs. The AMEs review applicants' medical histories and perform physical examinations to ensure that applicants meet FAA's medical standards and are medically fit to operate an aircraft at the time of their medical exam.

Note: there are no AeMC in the USA and especially no AeMC within airlines, as they are not allowed to perform FAA medical exams for fear of conflict of interest.

All applicants for medical certificates and renewals follow a similar process. Applicants begin the medical certification process by completing Form 8500-8, *"Application for Airman Medical Certificate or Airman Medical & Student Pilot Certificate"*, in an online application system called MedXPress. This application form contains a block about medical history, including any mental disorders of any sort, depression, anxiety or suicide attempt. For applicants with a disqualifying medical condition, the Federal Air Surgeon, the manager of the Office of Aerospace Medicine of the FAA, may, on a case-by-case basis, authorize a special issuance medical certificate (*"Special Issuance"* or SI) for a specified period. To process the deferrals, the FAA employs 40 physicians working as Regional Flight Surgeons and/or working at the Aerospace Medical Certification Division (AMCD) in Oklahoma City. An authorization for a SI requires the applicant to show to the satisfaction of the Federal Air Surgeon that the required operations can be performed without endangering public safety during the period of the special issuance. Medical conditions that generally disqualify applicants from medical certification to fly include certain heart conditions, diabetes, epilepsy, impaired hearing or vision, psychosis, drug and alcohol dependence, and also generally any disease, defect, or treatment that could prevent a pilot from safely operating an aircraft. A special issuance may be subject to operational limitations for safety reasons, or may be valid for a shorter time period than an unrestricted medical certificate. As a provision of the special issuance, FAA may authorize AMEs to make future medical determinations of the applicant—separate from the centralized special issuance process—under the AME Assisted Special Issuance (AASI) process.

All applicants with any of the following conditions must be denied or deferred to the FAA's Federal Air Surgeon: attention deficit/hyperactivity, bipolar disorder, personality disorder, psychosis, substance abuse, substance dependence, suicide attempt. In some instances, the following conditions may also warrant denial or deferral: adjustment disorder; bereavement; dysthymic; minor depression; use of psychotropic medications for smoking cessation.

The FAA has determined that airmen requesting first, second, or third class medical certificates while being treated with one of four specific antidepressant medications (Selective Serotonin Reuptake Inhibitors - SSRI) may be considered. The decision is made on a case-by-case basis. AMEs may not issue in those cases, it has to be done by the FAA.

An applicant under SSRI may be considered for SI of a Medical Certificate if:

- ❒ 1) The applicant has one of the following diagnoses:
  - ■ Major depressive disorder (mild to moderate) either single episode or recurrent episode
  - ■ Dysthymic disorder
  - ■ Adjustment disorder with depressed mood
  - ■ Any non-depression related condition for which the SSRI is used
- ❒ 2) For a minimum of six continuous months prior, the applicant has been clinically stable as well as on a stable dose of medication without any aeromedically significant side effects and/or an increase in symptoms. If the applicant has been on the medication under six months, the AME must advise that six months of continuous use is required before SI consideration.
- ❒ 3) The SSRI used is one the following (single use only):
  - ■ Fluoxetine (Prozac)
  - ■ Sertraline (Zoloft)
  - ■ Citalopram (Celexa)
  - ■ Escitalopram (Lexapro)

If the applicant is on an SSRI that is not listed above, the AME must advise that the medication is not acceptable for SI consideration.

- ❒ 4) The applicant does not have symptoms or history of:
  - ■ Psychosis
  - ■ Suicidal ideation
  - ■ Electro convulsive therapy
  - ■ Treatment with multiple SSRIs concurrently
  - ■ Multi-agent drug protocol use (prior use of other psychiatric drugs in conjunction with SSRIs)

If the applicant meets all of the above criteria and wishes to continue use of the SSRI, he/she must be further evaluated by a Human Intervention Motivation Study (HIMS) AME. The HIMS[25] AME will also conduct the follow up evaluation after initial issuance

[25]See paragraph 1.16.3 for more information on HIMS.

If the applicant opts to discontinue use of the SSRI, the AME must note this on the medical examination report (FAA Form 8500-8) and defer issuance. To reapply for regular issuance, the applicant must be off the SSRI for a minimum of 60 days with a favourable report from the treating physician indicating stable mood and no aeromedically significant side effects.

In 2014, 191 special issuances were granted by the FAA for Class 1 medical certificates for the following psychiatric conditions: depression, or anxiety, or post-traumatic stress, or obsessive compulsive disorder or personality disorder. In that same year, the FAA denied issuance of 160 Class 1 medical certificates for the same psychiatric reasons.

Applicants who are denied medical certification by an AME or the FAA may appeal the decision (14 C.F.R. § 67.409); however, according to FAA officials most applicants who are denied medical certification do not pursue an appeal or do not provide FAA with additional requested information necessary for a special issuance. A denial is considered a *"final"* action by the FAA and is subject to review by the NTSB. The Manager of AMCD and Regional Flight Surgeons may also issue a final denial to an applicant who fails to provide additional requested information within the time frame specified by FAA.

A holder of a class 1 medical certificate must renew it every year if under 40 years of age, and every 6 months if above. As indicated in Paragraph 14 C.F.R. § 61.53(a), after obtaining a medical certificate, and between renewal periods, pilots are prohibited from performing pilot operations when they know or have reason to know of a medical deficiency that would make them unable to fulfil their pilot operations:

- *"§61.53 Prohibition on operations during medical deficiency.*
- *(a) Operations that require a medical certificate. (…), no person who holds a medical certificate issued under part 67 of this chapter may act as pilot in command, or in any other capacity as a required pilot flight crewmember, while that person:*
  - *(1) Knows or has reason to know of any medical condition that would make the person unable to meet the requirements for the medical certificate necessary for the pilot operation; or*
  - *(2) Is taking medication or receiving other treatment for a medical condition that results in the person being unable to meet the requirements for the medical certificate necessary for the pilot operation."*

The FAA attaches fines up to $250,000 for omitting or providing false information concealing health issues that could affect fitness to fly.

AMEs are trained in aviation medicine by the FAA and entrusted to make medical eligibility determinations of applicants, on behalf of the FAA, except in the case of deferrals. In order to become an AME and be authorized to administer medical exams, FAA requires AMEs to complete online courses in clinical aerospace physiology and medical certification standards and procedures before attending a one-week basic AME seminar. AMEs must also complete at least ten pilot medical exams each year and subsequent refresher courses every three years.

A US federal law sets rules for health care providers and health insurance companies about who can look at and receive health information. This law, called the Health Insurance Portability and Accountability Act of 1996 (HIPAA) Privacy Rule, provides federal protections for individually identifiable health information held by health care providers and their business associates and gives patients an array of rights with respect to that information. At the same time, this Privacy Rule is balanced so that it permits the disclosure of health information needed for patient care and other important purposes.

Patient privacy rules vary from state to state in the USA, but all require that any physician should disclose personal information about a patient to the appropriate authority if failure to disclose may cause harm to the patient himself or to others. Federal regulation 45 C.F.R. 164.512 (j) states the following about health care providers, who are designated here as *"covered entity"*:

- *"(j) Standard: Uses and disclosures to avert a serious threat to health or safety*

  (1) Permitted disclosures. A covered entity may, consistent with applicable law and standards of ethical conduct, use or disclose protected health information, if the covered entity, in good faith, believes the use or disclosure:

  (i)

  (A) Is necessary to prevent or lessen a serious and imminent threat to the health or safety of a person or the public; and

  (B) Is to a person or persons reasonably able to prevent or lessen the threat, including the target of the threat; (…)"

1.17.8 Medical certification process for flight crews in Canada

Medical standards and certification procedures for issuing medical certificates in Canada are set out in Canadian Aviation Regulations (CAR) 404.

A Category 1 medical certificate is required for airline transport pilot licenses. Approximately 35,000 Category 1 medical certificates are issued every year in Canada and, in 2014, 177 applicants for such certificates were assessed as unfit.

When a Civil Aviation Medical Examiner (or *"CAME"*) conducts a medical examination of an applicant for the issuance or renewal of a medical certificate, the physician must conduct the medical examination in accordance with the procedures set out in the personnel licensing standards. He/she must submit a medical report to the Minister that specifies the results of the medical examination and contains, if warranted by those results, the physician's recommendation that the medical certificate be restricted to a validity period that is shorter than the standard validity period. Depending on the disease or past history, the applicant may be asked for any relevant test to determine the aeromedical risk including reports from consulted specialists and hospitalization records. Anything received is retained in the licensing authority medical records.

There are six full time equivalent positions in Transport Canada Civil Aviation Medicine dedicated to the assessment function. Assessments are done by the Regional Aviation Medical Officers (RAMOs) who are all qualified in Aerospace Medicine. CAMEs are requested to defer difficult decisions to Transport Canada (TC). TC has the ability to place a *"not CAME renewable"* limitation on a medical certificate. CAMEs are not authorized to add restrictions, change restrictions or lift restrictions on their own. Only the RAMOs can do so. Difficult cases are referred to the Aviation Medical Review Board (AMRB) which meets via teleconference each month. The Board membership is all the RAMOs, the HQ's medical staff and clinical consultants in Cardiology, General Internal Medicine, Neurology, Oncology, Ophthalmology, Otolaryngology, Psychiatry and an external Aerospace Medicine Specialist.

All pilots on SSRI medication are assessed by one of the senior medical assessors before they are renewed.

Aeronautics Act (R.S.C., 1985, c, A-2) paragraph 6.5 places an obligation on all Canadian physicians and optometrists to report to Transport Canada:

- *"Minister to be provided with information*
  6.5 (1) Where a physician or an optometrist believes on reasonable grounds that a patient is a flight crew member, an air traffic controller or other holder of a Canadian aviation document that imposes standards of medical or optometric fitness, the physician or optometrist shall, if in his opinion the patient has a medical or optometric condition that is likely to constitute a hazard to aviation safety, inform a medical adviser designated by the Minister forthwith of that opinion and the reasons therefor.

  Patient to advise
  (2) The holder of a Canadian aviation document that imposes standards of medical or optometric fitness shall, prior to any medical or optometric examination of his person by a physician or optometrist, advise the physician or optometrist that he is the holder of such a document.

Use by Minister
(3) The Minister may make such use of any information provided pursuant to subsection (1) as the Minister considers necessary in the interests of aviation safety.

No proceedings shall lie
(4) No legal, disciplinary or other proceedings lie against a physician or optometrist for anything done by him in good faith in compliance with this section.

Information privileged
(5) Notwithstanding subsection (3), information provided pursuant to subsection (1) is privileged and no person shall be required to disclose it or give evidence relating to it in any legal, disciplinary or other proceedings and the information so provided shall not be used in any such proceedings.

Deemed consent
(6) The holder of a Canadian aviation document that imposes standards of medical or optometric fitness shall be deemed, for the purposes of this section, to have consented to the giving of information to a medical adviser designated by the Minister under subsection (1) in the circumstances referred to in that subsection."

1.17.9 Medical certification process for flight crews in other States

The following information about the medical certification process in various States is worth noting:

In Australia	Within Australia, CASA issues Aviation medical certificates to applicants who meet the relevant medical standard. Designated medical practitioners (Designated Aviation Medical Examiners, DAMEs or Designated Aviation Ophthalmologists, DAOs) perform the necessary medical examinations for the Aviation Medicine Section of the Civil Aviation Safety Authority. The National Privacy Principles extracted from Schedule 3 of the Privacy Act 1988 state that *"An organisation must not use or disclose personal information about an individual for a purpose (the secondary purpose) other than the primary purpose of collection unless (…) the organisation reasonably believes that the use or disclosure is necessary to lessen or prevent:* *(i) a serious and imminent threat to an individual's life, health or safety; or* *(ii) a serious threat to public health or public safety".* The Australian Civil Aviation safety Authority has adopted a specific programme on depression since 2002. Currently, the handbook of DAMEs indicates that depression is one of the leading causes of disability worldwide. However, well-managed depression is compatible with medical certification. Several minimal conditions must be fulfilled to obtain a favorable issue: a confirmed diagnosis of unipolar depression with exclusion of other diagnoses, only mono-therapy within a predefined list of medication. This list contains SSRIs (Fluoxetine, Sertraline, Citalopram, Escitalopram) and other antidepressant medication (Venlafaxine (low-dose only), Desvenlafaxine). Besides, pilots must notify any change to medication to DAME, which will require grounding for 2 - 4 weeks. Any relapse in depressive symptoms must also be reported to the DAME. Additional information may be required from family, treating doctors and flying colleagues. CASA may use multi-crew endorsements as a means of risk mitigation. Their use enables pilots to continue flying and air traffic control staff to continue duty despite the presence of medically-significant conditions which would otherwise pose an unacceptable risk to the safety of air navigation.

In Israel	The regulation for medical certification of pilots in Israel states that: ❒ An airman who holds an airman's license or specification of a type designated by the Minister with the approval of the Committee, may not perform his function in accordance with the license or the specification. (1) Unless he holds a valid medical certificate certifying that he is medically fit to perform his function in accordance with the license or the specification, issued to him as provided in this section by the Authority's Medical Officer or by a physician trained in aviation medicine and certified for purposes of this section by the Director on the recommendation of the Authority's Medical Officer and he acts in accordance with the terms of such certificate. (2) If after the issuance of the medical certificate a change occurs in the airman's medical condition that could affect his ability to perform his function in accordance with the license of the specification, and the airman knows that such change could affect his said ability. (…) ❒ A physician treating an airman who holds an airman's license or specification of a type designated by the Minister, who knows that the patient is an airman and believes that in using his license such airman is liable to endanger himself or others due to his medical condition, will make a report to that effect to the Authority's Medical Officer or to a certified physician and inform the airman about such report. Following the investigations into two fatal accidents that occurred in August 2013 and July 2015, the safety investigation authority of Israel issued a set of recommendations regarding medical certification aspects. One of them recommends to "instruct air crew members to deliver to the aviation physician chosen by them for the periodic check or initial check, a short letter from his/her family physician, stating, of his/her awareness to their proficiency as holding an airmen license, either commercial or private, which describe actual medical diagnosis and list of medications that the pilot is consuming and all known medical background». In response to this safety recommendation, the Israeli Civil Aviation Authority is considering implementing provisions requiring that before the initial medical certification as well as subsequent periodic medical certifications the pilot provides the AME with a brief medical report from the treating physician specifying: a) Medical diagnoses b) Current and previous medications.
In Norway	(EU) regulation No 1178/2011, Annex IV (Part-MED) applies in Norway since 9 April 2013. Approximately 3,000 Class 1 medical certificates are issued, revalidated or renewed every year in Norway, and approximately 60 Class 1 applicants are assessed as unfit every year. A software system is used by AMEs in Norway and by the licensing authority for processing and issuing medical certificates. This system also provides data, including validity and limitations of medical certificates of Norwegian pilot license holders. Norwegian regulation *"Helsepersonelloven"* states in its paragraph 34 that physicians, psychologists or optometrists who find that a patient with a driving license for motor vehicles or a license to fly an aircraft does not meet the health requirements, should encourage the patient to hand in his license. If the patient's health conditions are likely to last, physicians shall notify authorities. The above rules also apply to patients who serve outside aircraft, if it is important for aviation safety.

In Spain	(EU) regulation No 1178/2011, Annex IV (Part-MED) has applied in Spain since 8 April 2013. Approximately 9,000 Class 1 medical certificates are issued, revalidated or renewed every year in Spain, and approximately 150 of Class 1 applicants are assessed as unfit every year. The psychiatric evaluation for the initial issuance of Class 1 medical certificates is performed in Spain by psychiatric specialists. The Spanish civil aviation authority took part in a roundtable at the annual SEMA (Sociedad Española de Medicina Aeroespacial – Spanish Society of Aviation Medicine) seminar on having AMEs conduct a psychological evaluation of pilots as part of the medical certificate renewal process. A software system is used by AMEs in Spain and by the licensing authority for processing and issuing medical certificates. This system also provides data, including validity and limitations of medical certificates of Spanish pilot license holders. Spanish regulations state that medical confidentiality should not be breached. Article 199 of the Spanish penal code states that a professional who discloses confidential information about another person shall be punished with imprisonment of one to four years. However, exceptions exist if maintaining confidentiality would cause harm to the patient or to others, or would present a collective danger.

1.17.10 Psychiatric evaluation during medical certification of flight crews

In Europe, the first step for an applicant for a medical certificate is to fill out an application, in accordance with Part-MED. The forms used in the European countries are compliant with EU regulations and contain a part concerning medical history, including a *"yes/no"* answer to provide to the question 118 *"Do you have, or have you ever had (…)Psychological/psychiatric trouble of any sort"*.

It is expected that the AME will go through the applicant's answers and discuss any current or previous medical issues with the applicant. The application form can then be amended to reflect the results of this discussion.

A psychiatric assessment is performed at every examination. This is performed by the AME through general discussion and by observing behaviour, appearance, speech, mood, thinking, perception, cognition and insight. For example, the instructions for completion of the medical examination report forms in the UK state that the psychiatric assessment should include appearance, appropriate mood/thought, and unusual behaviour. Further guidance is provided in the *"Standards for Performing Aviation Examinations on Behalf of the UK Civil Aviation Authority"* for performing the psychiatric evaluation:

- *"(225) Psychiatric*
  During assessment of the applicant's history, the doctor should make a general enquiry about mental health which may include mood, sleep and alcohol use. The doctor should observe the applicant during the process of the examination and assess the mental state of the applicant under the broad headings of appearance/ speech/ mood/ thinking/ perception/ cognition/ insight. The doctor should also be looking out for any signs of alcohol or drug misuse".

Similar methods for the assessment of psychiatric condition of pilots are used at the Lufthansa AeMC. This is done by asking questions like:

- How do you feel?
- Do you sleep well?
- Do you have nightmares?
- Are you taking any medication?
- Have you experienced any significant life events, such as a divorce, a death in the family?

EU regulations require that applicants with a mood, neurotic, personality, mental or behavioural disorder must undergo psychiatric evaluation before a fit assessment can be made. Such applicants shall be referred to the licensing authority.

The examination techniques for the psychiatric assessment of pilots in the USA are described the FAA's *"Guide for Aviation Medical Examiners"*. The 2015's edition of this guide states:

- *"The FAA does not expect the Examiner to perform a formal psychiatric examination. However, the Examiner should form a general impression of the emotional stability and mental state of the applicant. (…) Review of the applicant's history as provided on the application form may alert the Examiner to gather further important factual information. (…)*
  Psychiatric information can be derived from the individual items in medical history (Item 18). Any affirmative answers to Item 18.m., " Mental disorders of any sort; depression, anxiety, etc.," or Item 18.p., "Suicide attempt," are significant. (…). Reporting symptoms such as headaches or dizziness, or even heart or stomach trouble, may reflect a history of anxiety rather than a primary medical problem in these areas. (…) Valuable information can be derived from the casual conversation that occurs during the physical examination. Some of this conversation will reveal information about the family, the job, and special interests. Even some personal troubles may be revealed at this time. (…) Information about the flow of associations, mood, and memory, is generally available from the usual interactions during the examination. Indication of cognitive problems may become apparent during the examination. Such problems with concentration, attention, or confusion during the examination or slower, vague responses should be noted and may be cause for deferral.

The Examiner should make observations about the following specific elements and should note on the form any gross or notable deviations from normal:

1. Appearance (abnormal if dirty, disheveled, odoriferous, or unkempt);
2. Behavior (abnormal if uncooperative, bizarre, or inexplicable);
3. Mood (abnormal if excessively angry, sad, euphoric, or labile);
4. Communication (abnormal if incomprehensible, does not answer questions directly);
5. Memory (abnormal if unable to recall recent events); and
6. Cognition (abnormal if unable to engage in abstract thought, or if delusional or hallucinating).
(…). The Examiner, upon identifying any significant problems, should defer issuance of the medical certificate and report findings to the FAA. This could be accomplished by contacting a RFS or the Manager of the AMCD."

ICAO Manual of Civil Aviation Medicine provides guidelines on mental health and behavioural questions for use by medical examiners. See appendix 2 for an extract from this Manual. Additional literature on how to assess the psychiatric state of a patient is available in aviation medicine and psychiatry literature[26]. The mental status examination may be carried out while conducting other portions of the overall physical exam, by observing the patient's appearance, attitude, behaviour, mood, speech, thought process, thought content, perceptions, cognition, insight and judgment. A patient presenting depressed mood, anxiety or insomnia does not, by virtue of that information alone, have a psychiatric illness nor require medical treatment.

[26] For instance the book *"Rayman's Clinical Aviation Medecine"*, supported by the Aerospace Medical Association (AsMA).

AsMA believes that in-depth psychological testing for detecting serious mental illness as part of the routine periodic pilot aeromedical assessment is neither productive nor cost effective and therefore not warranted. See paragraph 1.18.5.1 for more information about AsMA's expert working group on pilot mental health.

1.17.11 Germanwings organisation

Germanwings GmbH (GWI) was set up in 2002. It is a subsidiary of Lufthansa Group, which has owned 100% of its shares since January 2009. The Air Operator's Certificate (AOC), valid on the date of the accident, was issued by the LBA on 20 October 2014.

As of the date of the accident, GWI was operating 62 Airbus (43 A319 and 19 A320) and undertaking flights from Germany bound for many countries in Europe. Germanwings employed about 780 flight crew and 972 cabin crew.

Placement of student pilots for employment is undertaken by Lufthansa. At the end of their training at LFT, the management decides where to allocate the personnel between Lufthansa or Germanwings.

1.17.12 Human resource management of pilots at the Lufthansa Group

In 2008, 384 pilots out of a total of 6,530 applicants were selected to start training at the LFT centre. The selection process is done in collaboration with the German national aeronautics and space research centre (DLR) and consists of several steps. These steps aim at evaluating applicants on a set of defined criteria (see figure below), including mental abilities, logical reasoning, interpersonal skills and personality traits. The pass/fail decision is performed using four methods: psychometric performance tests, assessment centre, work sample test (simulator, dyadic cooperation test) and/or interviews (including with psychologists).

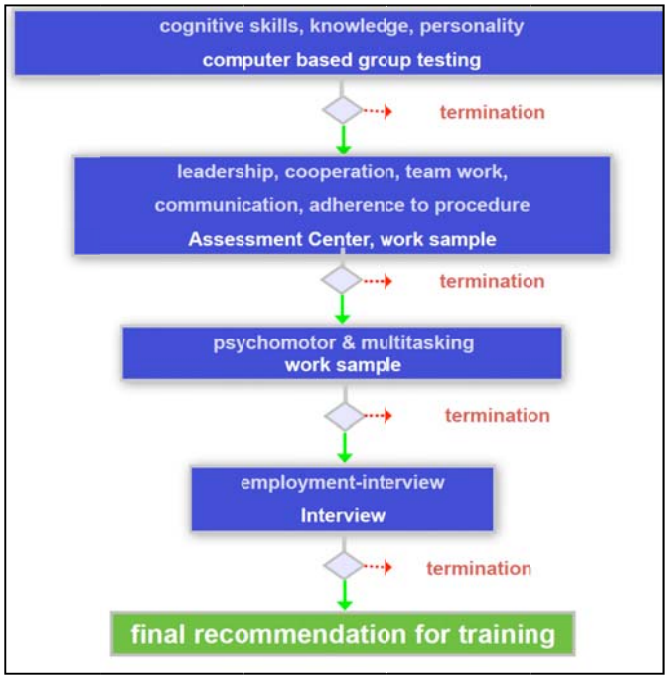

Figure 17 - LFT selection process *(Source: Lufthansa)*

Once selected to attend training at LFT, pilots need to apply for a class 1 medical certificate and take classes to pass the PPL[27] , and MPL(A). If they pass, then they start their Type Rating and line training. This curriculum takes on average 750 hours of theory classes and 240 flying hours (including on flight simulators). A trainee might be called for an interview with the head of the Flight Crew Selection department in case of irregularities, like driving under the influence of alcohol, or if in case of an insufficient performance level that generates:

- at least 10 hours of additional training, or
- more than two failed practical tests, or
- more than three failed theoretical tests

[27] Lufthansa pilot cadets can take their PPL training in a flight school in Phoenix (Arizona, USA).

The total cost of training per pilot is about 150,000€, of which 60,000€ is funded by the pilot, generally through a loan. Pilots are not required to reimburse their loan until they are hired by one of the entities of the Lufthansa Group.

Pilots of the Lufthansa group are provided with a company insurance, which provides a minimum coverage against the risk of loss of licence. This "Loss of Licence" insurance is an integrated part of a labour contract and provides early retirement benefits if a pilot losing his licence has been employed for at least 10 years and is at least 35 years old. Prior to that, a single payment benefit can be provided. The amount depends on the age of the pilot: 58,799€ if the pilot has been employed for less than 5 years and 79,250 € otherwise. Although not required, most pilots have an additional insurance to be covered more comprehensively.

1.17.13 Cockpit door security

Historical background

The terrorist attacks of 11 September 2001 in the USA shook the aviation economy, and above all the public's trust in this means of transportation. This context led Civil Aviation organisations to react quickly.

In the USA, the Secretary of Transportation formed a Rapid Response Team for Aircraft Security. The Team included representatives of airplane designers, airline operators, airline pilots, and flight attendants. There was a clear consensus from this group, and agreement by the FAA, that immediate actions had to be taken to strengthen the flightcrew compartment door. The Rapid Response Team addressed the design issues and found the relative safety risks to be small in view of the emergent security risk of unauthorized flightcrew compartment entry. The FAA agreed with this conclusion.

This situation was also addressed by the High-level, Ministerial Conference on Aviation Security held in Montreal on 19 and 20 February 2002, during which recommendations were made in order to improve aviation security. One of the most practical conclusions was the need to reinforce cockpit doors to prevent unauthorized people from entering the cockpit. This resulted in the amendment of current regulations, starting with the ICAO annexes.

Current regulations and installations

Annex 6 states that large passenger transport aircraft *"shall be equipped with an approved flight crew compartment door that is designed to resist penetration by small arms fire and grenade shrapnel and to resist forcible intrusions by unauthorized persons. This door shall be capable of being locked and unlocked from either pilot's station"*.
This set the ground for additional regulation at the FAA or EU levels, among others.

FAA was historically the first to require reinforced cockpit doors for aircraft operating in U.S. airspace, including the Airbus A320 in its Federal Aviation Regulations. In Europe, EASA addressed the cockpit door security issue in the EU Air OPS Regulation (EU) 965/2012 (ORO.SEC.100), as well as EU Certification Specifications (CS-25).

In line with ICAO Annex 6, these regulations state that, beyond the resistance of the cockpit door, the latter can be locked or unlocked from either pilot station. Safety concerns in case of crew incapacitation are covered by a provision for emergency access (FAR/CS 25.772).

Most operators have opted for a reinforced cockpit door locked by an electro-mechanical lock. A keypad enables a request for access to the cockpit by authorised persons, or the dialling of an emergency code in case of crew incapacitation, bypassing unlocking from the inside (see §1.6.4).

1.18 Additional information

1.18.1 Previous Events

A search undertaken in the ICAO and BEA databases since 1980 brought to light the existence of 12 public transport accidents or incidents:

- caused by intentional manoeuvres by one of the flight crew members, or
- for which it is not possible to rule out the hypothesis of intentional manoeuvres by one of the crew members that was intended to lead to the loss of the aircraft and its occupants, or
- where the behaviour of one crew member was significantly affected by a mental disorder and had an impact on the safety of the flight.

This list does not include events due to terrorist attacks.

Date	Aircraft	Operator	State of Occurrence	Deaths	Circumstances
18/01/2015	A320	Condor	Portugal	0	The airplane was in cruise at FL370 approximately 60 NM from Lisbon when the co-pilot became incapacitated, and could no longer perform his duties. The Captain diverted to Faro, where the plane landed uneventfully. The copilot was then transported to the hospital, where he exhibited behaviour during the following days that raised psychiatric concerns.
29/11/2013	ERJ 190	LAM	Namibia	33	The aeroplane was in cruise at flight level FL380 when the co-pilot left the cockpit to go to the toilet, leaving the Captain alone. On three occasions, different altitudes were selected to order a descent to the ground with autopilot. The CVR showed variable levels of aural warnings, as well as noises of repeated knocking and calls, corresponding to attempts to get into the cockpit.
27/03/2012	A320	JetBlue	USA	0	As the plane was leaving New York-JFK and climbing in altitude in its scheduled five-hour flight to Las Vegas, the Captain said something to the first officer (FO) about being evaluated by someone, but the FO did not know what he meant. The Captain then talked about his church and the need to "focus" and asked the FO to take the controls and work the radios. The Captain began talking about religion, but, according to the FO, his statements were not coherent. The FO became concerned when the Captain said "things just don't matter." According to the FO, the Captain yelled over the radio to air traffic control and instructed them to be quiet. The Captain turned off the radios in the aircraft, dimmed his monitors, and sternly admonished the FO for trying to talk on the radio. When the captain said "we need to take a leap of faith," the FO stated that he became very worried. The Captain told the FO that "we're not going to Vegas" and began giving what the FO described as a sermon. The FO suggested to the Captain that they invite the off-duty JetBlue captain who was on board the flight into the cockpit. However, the Captain abruptly left the cockpit to go to the forward lavatory, alarming the rest of the flight crew when he didn't follow the company's protocol for leaving the cockpit. When flight attendants met the Captain and asked him what was wrong, he became aggressive and banged on the door of the occupied lavatory, saying he needed to get inside. While the Captain was in the lavatory, at the request of the FO, a flight attendant brought the off-duty captain to the cockpit, where he assisted the FO with the remainder of the flight. When the Captain exited the lavatory, he began talking to flight attendants, mentioning "150 souls on board." The Captain walked to the rear of the aircraft but along the way stopped and asked a male passenger if he had a problem. The Captain then sprinted back to the forward galley and tried to enter his code to re-enter the cockpit. When the FO announced over the public address system an order to restrain the Captain, several passengers assisted and brought him down in the forward galley, where he continued to yell comments about Jesus, September 11, Iraq, Iran, and terrorists. The FO declared an emergency and diverted the aircraft to Amarillo (Texas), landing with passengers still restraining the Captain in the galley. He was removed from the aircraft and taken to a facility in Amarillo for medical evaluation. This incident is being investigated by the FBI.
30/07/2009	Saab 340B	Mesaba	USA	0	The flight was in cruise with 33 passengers on board when the cockpit crew was alerted by a passenger that the single flight attendant had become "no longer coherent" and was performing "numerous unusual activities." The captain instructed the passenger to get the flight attendant seated and the beverage cart stowed, and then diverted to a nearby airport. The flight attendant was transported to a local emergency room and diagnosed with "acute anxiety." There were no indications that the flight attendant had any pre-existing medical or psychiatric conditions.
28/01/2008	B767	Air Canada	North Atlantic Ocean	0	The aircraft was operating a scheduled passenger service from Toronto (Pearson) to London (Heathrow). On first contact with Shannon ATC the Commander made a PAN call and requested a diversion to Shannon Airport due to a medical emergency. The First Officer's behaviour became belligerent and uncooperative which convinced the Commander he was now dealing with a crewmember who was effectively incapacitated The aircraft landed safety at Shannon where medical assistance was waiting to meet the aircraft.

23/01/2001	DC-3	Galaxy Air Cargo	USA	2	The airplane departed an island runway in Alaska during dark night VFR conditions without filing a flight plan. The airplane collided with a volcanic mountain at 1,500 feet msl on the runway heading, 4.5 miles from the airport. The captain's medical certificate had previously been considered for denial after serving 49 months in federal prison for cocaine distribution, but after review, the FAA issued the captain a first class medical. FAA medical records for the captain do not contain any record of monitoring for substance abuse. The first officer's medical had also been considered for denial after an episode of a loss of consciousness. After a lengthy review and an appeal to the NTSB, the FAA issued the first officer a second-class medical. A toxicological examination of the captain, conducted by the FAA, found cocaine and metabolites of cocaine. A toxicological examination of the first officer found two different prescription antidepressant drugs.
31/10/1999	B767	EgyptAir	North Atlantic Ocean	217	The aeroplane was in cruise at flight level FL330 with a flight crew consisting of a Captain, a duty co-pilot and a relief co-pilot. The duty co-pilot left the cockpit, and the relief co-pilot took his place in the right seat. Eight minutes later, the Captain left the cockpit in turn, leaving the relief co-pilot alone. The autopilot was then disengaged and nose-down inputs were recorded on the FDR. The aeroplane descended. The engines were shut down. The Captain returned to the cockpit and tried to take back control of the aeroplane. The Captain repeatedly asked the co-pilot to help him to pitch up the aeroplane ("pull with me") but the latter continued to command the elevator to pitch nose down. The aeroplane regained altitude before descending again. It collided with the surface of the ocean. The reasons that led the co-pilot to take these actions could not be determined.
11/10/1999	ATR-42	Air Botswana	Botswana	1	The pilot, the only person on board, deliberately flew the aeroplane into the ground by crashing at Gaborone airport. The validity of his licence had been revoked for medical reasons.
19/12/1997	B737	Silk Air	Indonesia	104	While the aircraft was in cruise at 35,000 ft, the flight recorders stopped recording one after the other. The aeroplane suddenly started to descend. No Mayday message was transmitted before or during the descent. The aircraft crashed into a river. The safety investigation was not able to identify any technical problem that would make it possible to explain the accident.
09/05/1996	BAC 1-11	British Airways	France	0	The airplane was in cruise between Birmingham (UK) and Milan (Italy) when the first officer complained of feeling unwell, stating that he was "frightened of the altitude". The commander summoned the purser onto the flight deck using a single chime of the cabin staff call system. The first officer refused the offer of oxygen and a soft drink. He continued to show symptoms of anxiety and stress, such that the purser felt unable to comply with the standard incapacitation drill which calls for the crew member to be slid back in the seat with the harness locked. The Captain decided to divert to Lyon, France where the plane landed without further incident. The interviews conducted after the incident revealed that it was not the first time this first officer acted like this, and he admitted having taken psychotropic medication, without declaring it to the aeromedical authorities.
21/08/1994	ATR42	Royal Air Maroc	Morocco	44	The Captain disengaged the autopilot and deliberately directed the aircraft towards the ground. The co-pilot was in the cockpit but was not able to counter the Captain's actions.
09/02/1982	DC-8	Japan Airlines	Japan	24	After having disengaged the autopilot on final approach at a height of 164 ft, the pilot pushed the control column forward and set the thrust levers on idle. He then moved the thrust levers of engines 2 and 3 to the reverse idle position. While the aircraft's attitude decreased, the co-pilot tried to pull on the control column. The co-pilot was unable to raise the nose of the aeroplane because the Captain was pushing forward on the control column with both hands. The aircraft crashed into the sea 510 m short of the runway. The investigation led by a Commission of the Ministry of Transport of Japan showed that the captain's actions resulted from a mental problem. He was suffering from schizophrenia.

1.18.2 Example of a system design to access the cockpit

One operator contacted by the BEA during the investigation uses a system that includes a panel that isolates the toilet door from the passenger compartment and creates an airlock between the cockpit and the passenger compartment. The panel is not electrically locked or reinforced. It is maintained closed by a mechanical stop operable by the flight attendant in the airlock. The panel is used only when one flight crew member wishes to use the bathroom. In that case, the crew member warns the flight attendant, who closes the panel and remains present in the airlock while the crew member is in the toilet (see figure below). As such, the panel isolates the forward galley from the passenger cabin, therefore creating a large space which is free from intruders, before opening the cockpit door. During this time, the cockpit door can remain unlocked, but it is feasible for the remaining crew member to close it both electrically and mechanically.

Therefore, this design would not have prevented this accident from occurring.

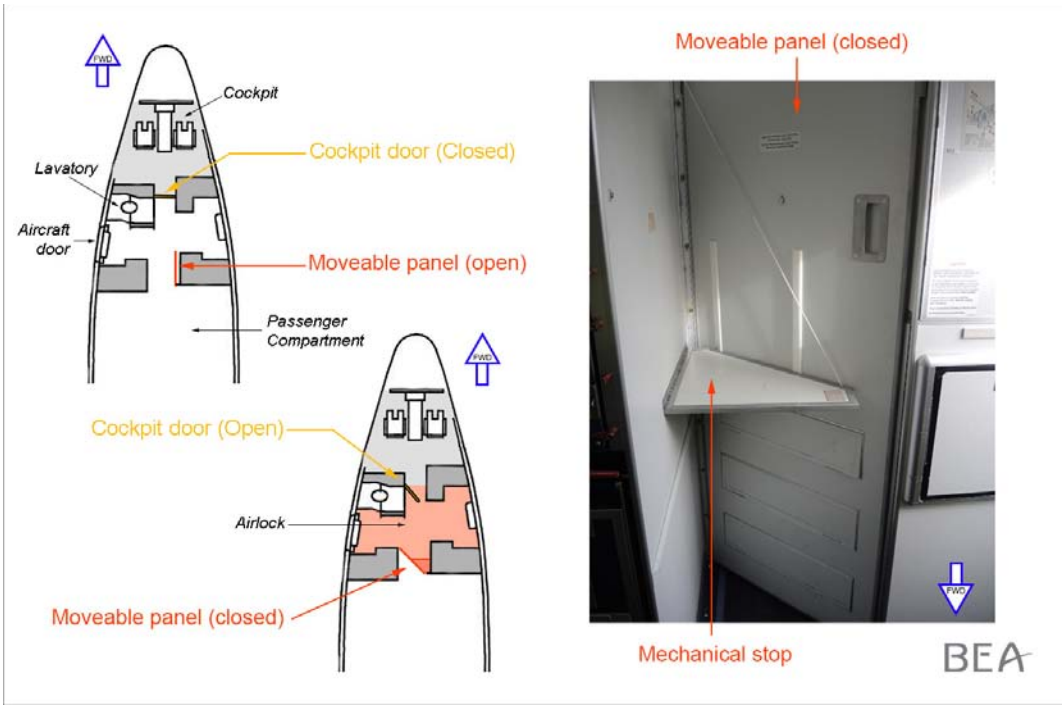

Figure 18 - second cockpit door (closed)

1.18.3 Actions taken by EASA following the accident

EASA issued, on 27 March 2015, a Safety Information Bulletin[28] (SIB n°2015-04) relating to authorised persons in the cockpit. This bulletin recommends that operators re-assess the safety and security risks associated with flight crew members leaving the flight crew compartment due to operational or physiological needs during non-critical phases of flight. Based on this assessment, it is recommended that operators implement procedures requiring at least two authorised persons to be in the flight crew compartment at all times, or other equivalent mitigating measures to address risks identified by the operator's revised assessment.

[28] http://ad.easa.europa.eu/ad/2015-04

On 6 May 2015, EASA was tasked by the European Commission with establishing a Task Force to look into the accident to Germanwings flight 9525 including the findings of the BEA's preliminary investigation report. The Task Force brought together 14 senior representatives from airlines, flight crew associations, medical advisors and authorities. The chairmanship was undertaken by the EASA's Executive Director. Additional presentations and contributions were delivered by invited experts and representative bodies, including the BEA.

The Task Force analysed possible additional risks stemming from the 2-persons-in-the-cockpit recommendation, including but not limited to the possibility that it allows access by other persons to the flight deck. The Task Force noted that the procedure had been extensively used by airlines in many countries prior to the EASA recommendation and no issues were reported because of it. EASA was not aware of any reported incidents due to a member of cabin crew being on the flight deck. EASA also reported on the FAA's information that it was unaware of any known related security or safety incidents.

A number of airlines have implemented supplemental measures to complement the requirement. Crew may be subject to additional security screening, and temporary staff excluded from the task. In addition, training may be provided so that crew are fully aware of the requirements of the role, which is limited to facilitating the opening and closing of the cockpit door.

EASA stated that operators should ensure that appropriate measures are used to mitigate any new risk. The measures could include additional training for crew asked to enter the cockpit and tasking only selected crew with this role.

The Task Force noted that the greatest scope for change was not related to cockpit doors but to wider issues including medical aspects such as aeromedical checks. The Task Force focussed on the initial and continuous medical assessments of pilots including psychological evaluation, the aeromedical examiner framework and aeromedical data systems.

The Task Force also addressed the pilot work environment and drugs and alcohol testing. The Task Force recognised that the abuse of drugs and alcohol is one of the disorders potentially affecting the mental health of pilots for which screening tests are readily available.

As a result of its work, the Task Force delivered six recommendations to the European Commission on 16 July 2015:

- "*Recommendation 1: The Task Force recommends that the 2-persons-in-the-cockpit recommendation is maintained. Its benefits should be evaluated after one year. Operators should introduce appropriate supplemental measures including training for crew to ensure any associated risks are mitigated*."

- "*Recommendation 2: The Task Force recommends that all airline pilots should undergo psychological evaluation as part of training or before entering service. The airline shall verify that a satisfactory evaluation has been carried out. The psychological part of the initial and recurrent aeromedical assessment and the related training for aero-medical examiners should be strengthened. EASA will prepare guidance material for this purpose*."

- *"Recommendation 3: The Task Force recommends to mandate drugs and alcohol testing as part of a random programme of testing by the operator and at least in the following cases: initial Class 1 medical assessment or when employed by an airline, post-incident/accident, with due cause, and as part of follow-up after a positive test result."*

- *"Recommendation 4: The Task Force recommends the establishment of robust oversight programme over the performance of aero-medical examiners including the practical application of their knowledge. In addition, national authorities should strengthen the psychological and communication aspects of aero-medical examiners training and practice. Networks of aero-medical examiners should be created to foster peer support."*

- "*Recommendation 5: The Task Force recommends that national regulations ensure that an appropriate balance is found between patient confidentiality and the protection of public safety.*

  The Task Force recommends the creation of a European aeromedical data repository as a first step to facilitate the sharing of aeromedical information and tackle the issue of pilot non-declaration. EASA will lead the project to deliver the necessary software tool"

- *"Recommendation 6: The Task Force recommends the implementation of pilot support and reporting systems, linked to the employer Safety Management System within the framework of a non-punitive work environment and without compromising Just Culture principles. Requirements should be adapted to different organisation sizes and maturity levels, and provide provisions that take into account the range of work arrangements and contract types*"

For further details, see the final report of the EASA' s Task Force[29].

On 7 October 2015, EASA released an action plan for the implementation of these recommendations. These actions include the creation of an Aircrew Medical Fitness workshop composed of experts from all the interested parties: European Commission, EASA, airlines, crews, doctors, etc. This workshop took place in Cologne (Germany) on 7 and 8 December 2015.

See the dedicated EASA's web page for further details[30].

[29] http://ec.europa.eu/transport/modes/air/news/doc/2015-07-17-germanwings-report/germanwings-task-force-final-report.pdf

[30] http://www.easa.europa.eu/easa-and-you/aircrew-and-medical/follow-up-germanwings-flight-9525-accident

1.18.4 Actions taken by other authorities following the accident

1.18.4.1 Task force on aviation safety appointed by the BMVI

The German Federal Ministry of Transport and Digital Infrastructure (BMVI) appointed on 2 April 2015 a task force to determine what conclusions could be drawn from the crash on 24 March 2015 in the French Alps. This task force was set up under the auspices of the German Aviation Association (BDL) and included:

- Airlines as well as associations such as the German Airports Association (ADV) and the German Airline Association (BDF);
- The German Federal Ministry of Transport (BMVI), the Federal Aviation Office (LBA) and the German Military Aviation Authority (LufABw);
- The following professional associations in Germany: the Association of Pilots (VC) and the Association of Flight Attendants (UFO);
- Aero-medical examiners as well as experts in the field of psychology and psychiatry;
- Manufacturers (German Aerospace Industries Association – BDLI);
- German air navigation service provider (DFS).

The task force concluded that the greatest potential for further improving safety lay in a greater focus on diagnostic awareness of psychological/mental health problems and the provisions of "*contact points*", which have proven successful in German airline companies. A final report of the task force was published in November 2015 and includes the following conclusions about cockpit doors, aeromedical expertise, and pilot support groups[31].

Topic	Conclusions of the BMVI task force
Cockpit doors	• "*The working groups recommend that no changes be made over the short term to the locking system of the cockpit door.* • *The cockpit and cabin crew must maintain a high level of safety awareness at all times, especially with regard to the careful execution of the applicable access procedures and avoiding opening the door/leaving the cockpit unnecessarily. It is recommended that the respective aviation companies conduct regular awareness campaigns on this point.* • *Structural options (locks between cabin and cockpit door, WC installation in the protected area) should be examined over the long term when new aircraft are being developed.* • *It was feasible to implement the "Two person" rule on short notice in all German airline companies (the right to give the final decision on opening the door remains in the cockpit).* • *The "Two person" rule increases safety. Any additional risks can be compensated by taking concurrent measures. These measures are being continuously re-assessed in day-to-day operations. Experiences gathered during operation of the "Two person" rule should be evaluated after the rule has been in place for one year. By way of contrast, the professional associations/pilot and flight attendant unions suggest on the basis of their overall assessment that the "Two person" rule could be abolished."*

[31] More details and conclusions on other topics, like randomized drug and alcohol tests or transparency of examinations are available at: https://www.bdl.aero/de/themen-positionen/sicherheit/taskforce-airline-safety/

Aeromedical expertise	• *"The trust between pilot and aero-medical examiner is of fundamental importance for safety in airline operations.* • *The psychological and psychiatric expertise of aero-medical examiners and examining experts in the field of mental illnesses is always available and accessible.* • *In making scientific and social findings on mental illnesses, however, a greater awareness, as well as a greater diagnostic awareness, of these illnesses is required on the part of all involved. More and better information should be provided to the examining aero-medical examiners on suitable contact points in detecting mental disorders/evidence."*
Pilot support groups	• *"The existing contact points have proved their worth in every respect in prevention and providing advice on treatment and help. They are accepted by the crews and should be increased in scope and size.* • *The Task Force therefore calls on the European legislators to make such contact points a mandatory requirement. The Task Force has defined the (…) minimum requirements which contact points should meet and which should enable pilots to access such a contact point.* • *The BDL member airlines have already agreed on this standard and they enable their crews to access appropriate contact points."*

1.18.4.2 UK's DfT/CAA Mental Health Working Group

In April 2015, the Department for Transport (DfT) of the UK tasked the Civil Aviation Authority to review the assessment of mental health in pilots and to consider whether any changes to the current assessment system should be proposed. A working group was therefore established. Its members include staff from the CAA's Safety and Airspace Regulation Group, psychiatrists, advisers in psycho-affective disorders and in drugs and alcohol misuse.

The working group formed in August 2015 eleven recommendations concerning the following topics. The CAA is taking these recommendations forward in conjunction with the DfT.

Topic	Recommendation of the UK's DfT/CAA Mental Health Working Group
The Aviation Medicine System and Psychiatric risk assessment and mitigation	Recommendation 1 Review of airline business models for their relationships with, and holistic care of, their pilots as a key part of safe operations. Recommendation 2 Discuss with operators how the management of decrease in fitness can be optimised, to include peer intervention and sickness absence procedures. Recommendation 3 Discuss amending guidance on breaching confidentiality with the GMC to include reporting to the CAA if a commercial pilot presents a potential public safety risk. Recommendation 4 Explore mechanisms to expand the medical profession's understanding of aviation medicine through the Royal Colleges and publicise the importance of doctors reporting concerns about pilots to the CAA through the Royal Colleges and medical conferences.
Flight Safety Risk of Psychiatric Conditions	Recommendation 5 Meet with British Psychological Society (BPS) to explore credentialing in Aviation Psychology. Recommendation 6 Carry out a further study of psychological testing in the research cohort to include medical and psychiatric outcomes. Recommendation 7 Propose suggested changes to EASA for the MED 160 application form to specifically include questions on *(120) Attempted suicide or self-harm* and (*174) Family History of mental illness or suicide*. Recommendation 8 To improve AME capability and performance, the next CAA refresher training programme should include mental health assessment and appropriate use of questionnaire tools as secondary screening. Emphasis on the legal aspects of the declaration, truthfulness and international culture training (as AMEs are undertaking mental health assessments on worldwide applicants) should be included. Recommendation 9 The CAA website should give clearer signposting of mechanism for individuals to report potential public safety issues.

Medical risk factors for development of a psychological condition or psychiatric disorder and mitigation factors	Recommendation 10 Meet with training providers to better understand pathways to the commercial cockpit, assessment techniques used and ways of identifying and managing risks. Explore opportunities for early recognition of personality and behavioural issues that might pose issues in the future. Recommendation 11 Liaise with BALPA on how to improve the education of pilots, on how to include mental health awareness in their training including self-awareness, self-help, recognising problems in colleagues and reporting mechanisms.

1.18.4.3 FAA's Pilot Fitness Aviation Rulemaking Committee

In the aftermath of Malaysia Flight 370 and Germanwings Flight 9525 accidents, the FAA established in May 2015 the Pilot Fitness Aviation Rulemaking Committee (ARC), with the commercial aviation and medical communities to study the emotional and mental health of U.S. commercial pilots.

The Pilot Fitness ARC provided the FAA with recommendations. The group included U.S. and international government and industry aviation experts, including a working group of medical professionals who specialize in aerospace medicine.

The ARC examined issues including the awareness and reporting of emotional and mental health issues, the methods used to evaluate pilot emotional and mental health, and barriers to reporting such issues. As of March 2016, the report from the ARC has not been released by the FAA Administrator.

Based on the group's recommendations, the FAA may consider changes to medical methods, aircraft design, policies and procedures, pilot training and testing, training for Aerospace Medical Examiners, or potential actions that may be taken by professional, airline, or union groups.

1.18.5 Actions taken by medical associations

1.18.5.1 AsMA Pilot Mental Health Expert Working Group

Following a March 27, 2012, incident in which a pilot of a major commercial airline experienced a serious mental health disturbance (see paragraph 1.18.1 about previous events), AsMA formed a working group on pilot mental health. The result of the working group was a letter sent in September 2012 to the FAA and other organisations worldwide interested in medical standards. It was found that it is neither productive nor cost effective to perform extensive psychiatric evaluations as part of the routine pilot aeromedical assessment. However the AsMA did recommend that greater attention should be given to mental health issues by aeromedical examiners, especially to the more common and detectable mental health conditions and life stressors that can affect pilots and flight performance. They encouraged this through increased education and global recognition of the importance of mental health in aviation safety.

Following the Germanwings accident, the AsMA's Pilot Mental Health Expert Working Group reconvened to review the recommendations. The working group updated the recommendations and made them publicly available on 21 September 2015[32].

These recommendations are addressed to all organisation involved in flight safety and include the following:

- *"Serious mental illness such as acute psychosis is relatively rare, and its onset is difficult to predict.*
  - *AsMA believes that in-depth psychological testing for detecting serious mental illness as part of the routine periodic pilot aeromedical assessment is neither productive nor cost effective and therefore not warranted.*
  - *An initial appropriate psychological evaluation established by subject matter experts is recommended for pilots entering airline employment and recurrently for pilots with a history of mental illness.*
- *However, more attention should be given to less serious and more common mental health issues and conditions during the aeromedical assessment of pilots.*
  - *There are many other mental health conditions, such as grief, psychosocial stress, depression, anxiety, panic disorders, personality disorders, and substance misuse/abuse, which are far more common, show patterns that facilitate early detection, and have proven effective treatment strategies.*
- *Methods should be utilized to build rapport and trust with the pilot in a nonthreatening environment.*
  - *Questions and interview techniques can be used to assess mental health that will have a minor impact on the current examination and should not prove burdensome for the pilot or examining physician (see references). Asking questions regarding mood, quality of sleep, current sources of stress (such as work, fatigue, financial, home and family), alcohol and/or substance use are recommended. These questions should be woven into the conversation with the pilot during the aeromedical examination as part of a general health promotion discussion that addresses a variety of health issues, both mental and physical. Training demonstrations or videos may be helpful.*
- *It is recognized that there may be barriers affecting a frank discussion of mental health issues between an aeromedical examiner and a pilot.*
  - *Cultural barriers exist – Pilots are highly independent, value control, and fear losing their medical certification.*
  - *Successful approaches that improve rates of reporting, discussion, and participation aim to provide a "safe zone" for such activities. These approaches enhance aviation safety and optimize pilot mental health while minimizing career jeopardy and the stigma of seeking mental health assistance.*
    (…)
- *Physicians performing aeromedical assessments should receive additional training in aviation mental health issues.*
  - *This should be emphasized as part of the initial and periodic aeromedical examiner training programs.*
  - *This training would also include guidance for when an aeromedical examiner should consult/refer to a mental health specialist provider or other aeromedical resource.*

[32] See: http://www.asma.org/asma/media/AsMA/pdf-policy/2015/AsMA-Pilot-Mental-Health-Working-Group-Recommendations-September-2015.pdf

- *Clinicians not trained in aeromedical assessment should be provided guidance for when to seek aeromedical expertise.*
  - *Aerospace medicine is a unique area of expertise related to optimizing the health, safety and performance of aircrews.*
- *Similarly, aircrew, their families and flight organizations (civil and military) should be made more aware of mental health issues in aviation.*
  - *Extended awareness beyond the physician should facilitate greater recognition, reporting and discussion.*
  - *Pilot training to improve management of impairment or incapacitation due to mental health conditions can be emphasized and incorporated into Crew Resource Management (CRM) education.*
  - *To the extent possible, such training should be standardized throughout the global aviation community.*

  (…)
- *There should be clear and universally accepted guidelines provided to health care providers on when their obligation to report aeromedical concerns to authorities supersedes their responsibility to patient confidentiality.*
  - *This reporting should be similar to other mandatory medical reporting such as for infectious diseases in public health laws.*
  - *The risk to public safety should be clearly evident.*
  - *The reporting should be anonymous where this approach is acceptable.*
  - *The reporting should be without legal risk to the health care provider."*

1.18.5.2 Statement from the French national council of doctors

The French national council of doctors, the *"Ordre National des Médecins"*, is responsible in France, by law, for ensuring the maintenance of the principles of morality, probity, competence and dedication necessary for the practice of medicine and compliance with the principles of the code of medical ethics by all physicians. It is also responsible for the quality of care provided to the population. As such, it is the privileged interlocutor of patients. It works on a daily basis to preserve the quality and uniqueness of the patient-physician relationship.

On 3 April 2015, the council released a statement[33], in reaction to the accident, about medical privacy and serious and imminent risk of endangering others. This statement clarified the position of physicians with regards to medical confidentiality. This statement suggests that physicians could breach medical confidentiality to notify the doctor in charge of health at work or judicial authorities in exceptional cases when there is a serious and imminent risk of harm to others, that the physician cannot otherwise prevent and after having tried all other possible solutions. In such a case, the physician would be able to justify his notification by referring to article 122-7 of the French penal Code, which states that nobody can be held liable if, when faced with a present or imminent danger for himself/herself, for others or a piece of goods, he or she takes the necessary actions to safeguard the person or the piece of goods in danger, except if the means used to do so are disproportionate in comparison with the gravity of the threat.

[33] See (French only) :Appendix 1 or https://www.conseil-national.medecin.fr/node/1584

1.19 Useful or effective investigation techniques

French doctors were contacted and asked about their understanding and use of medical confidentiality, and provided insight into this question.

The following relevant points were mentioned:

- the occupation of the patient is almost always known, though not checked ; It is up to the doctor to adapt his prescriptions to the patient's occupation;
- the quality of the relationship between the patient and the doctor is determined by the patient's confidence in the confidentiality of the information exchanged;
- there is a general knowledge of the legal framework that allows them to go beyond medical confidentiality, but no *"acceptable Means of compliance"*;
- doctors may be sued and prosecuted by a patient who considers that medical confidentiality has been violated by their practitioner. Doctors are then exposed to sanctions from both the judicial authorities and from the French national council of doctors which could result in them being suspended from practising medicine.

2 - ANALYSIS

2.1 Scenario

In April 2008, at the age of 20, the co-pilot of the accident flight was selected to start the ab-initio training at Lufthansa, after having passed the required tests, including the ones for mental abilities, logical reasoning, interpersonal skills and personality traits.

On 9 April 2008, he obtained his initial class 1 medical certificate, issued without any limitation, from the Lufthansa AeMC. The psychological and the psychiatric evaluation, required by regulations to be performed during medical examinations, did not indicate any condition that would have made him unfit to fly.

He started his flight training in September 2008 in Bremen (Germany) at the Lufthansa Training centre. Soon after, in November 2008, he interrupted his training because of the onset of a depression and the taking of medication to treat it. He consulted a psychiatrist, who treated him for this depression and expected the illness to last several months.

On 9 April 2009, although he was still suffering from depression, he applied to the Lufthansa AeMC for revalidation of his class 1 medical certificate, exactly one year after it had been issued for the first time. On the application form, he declared having been admitted to hospital. The medical certificate was not issued at that time by this AeMC and the co-pilot was notified that further analysis from a specialist needed to be carried out. In July 2009, a psychiatrist working for the same AeMC reported that the depressive episode was over and that the class 1 medical certificate could again be recommended. A few days later, the same AeMC issued a class 1 medical certificate with a waiver stating that it would become invalid if there was a relapse into depression. A *"-REV-"* endorsement stated that the medical fitness was determined after a further check. At the time this medical certificate was issued, no referral to the LBA was made by the AMEs of the Lufthansa AeMC, nor was this required by the regulations in force in Germany. It is notable that this class 1 medical certificate was issued shortly after the discontinuation of the anti-depressant medication. If the German regulation at that time had been fully compliant with Part-MED, the decision to issue the certificate would have been referred to the LBA. This independent assessment by the LBA would have been based on the same documents and possibly on advice from other independent psychiatric experts. Though the outcome may have been the same, as the decision of the FAA to issue a class 3 medical certificate in 2010 may suggest, it was nonetheless an opportunity for a different decision to be taken.

Between 2010 and 2014, the co-pilot had his class 1 medical certificate renewed or revalidated regularly. All the AMEs who examined him during that period were aware of the waiver and were informed of his medical history of depression. They assessed his psychological and psychiatric fitness through observation of behaviour and discussions. This process of assessment of the mental state of applicants is in line with what is prescribed by Aviation Authorities and by aeromedical associations. None of the responses provided by the co-pilot raised any concern for the AMEs that would have prompted them to require further examination by a psychiatrist. Therefore the co-pilot was found fit to fly at each class 1 revalidation or renewal examination visits. No referral to the LBA was made by the Lufthansa AeMC, nor was this required by the applicable regulations. Before 8 April 2013, it was not required to refer any case to the licensing authority in Germany. After that date, it was also not required in the co-pilot's case because his limitation (or waiver) already existed.

In December 2014, approximately five months after the last revalidation of his class 1 medical certificate, the co-pilot started to exhibit symptoms, possibly associated to a psychotic depressive episode. He consulted several doctors, including the psychiatrist treating him on at least two occasions, who prescribed anti-depressant medication. EU regulations (MED.A.020) require that licence holders should not exercise the privileges of their licence and related ratings or certificates at any time when they take or use any prescribed or non-prescribed medication that is likely with interfere with the safe exercise of the privileges of the applicable licence. It also requires that licence holders should seek, without undue delay, aero-medical advice when they have commenced the regular use of any medication and that holders of Class 1 medical certificates should seek the advice of an AeMC or AME. The co-pilot did not contact any AMEs between the beginning of his decrease in medical fitness in December 2014 and the day of the accident. Instead, he flew as a commercial pilot carrying passengers during dozens of flights over that same time period.

The mental state of the co-pilot during these flights did not generate any reported concern from the pilots who flew with him. No record was found that the co-pilot sought any support from peers, for instance through the Mayday foundation or the Anti-Skid programme, although these are available to Germanwings pilots.

In February 2015, a private physician diagnosed a psychosomatic disorder and an anxiety disorder and referred the co-pilot to a psychotherapist and psychiatrist. On 10 March 2015, the same physician diagnosed a possible psychosis and recommended psychiatric hospital treatment. A psychiatrist prescribed anti-depressant and sleeping aid medication in February and March 2015. Neither of those health care providers, who were probably aware of the co-pilot's profession, informed any aviation authority, nor any other authority about the co-pilot's mental state.

On the day of the accident, the pilot was still suffering from a psychiatric disorder, which was possibly a psychotic depressive episode and was taking psychotropic medication. This made him unfit to fly. No action could have been taken by authorities and/or his employer to prevent him from flying that day, because they were informed by neither the co-pilot himself, nor by anybody else, such as a physician, a colleague, or family member.

Actions on the autopilot system during the first flight of the day may be interpreted as a rehearsal for suicide.

During cruise on the second flight of the day, the co-pilot waited until he was alone in the cockpit. He then intentionally modified the autopilot settings to order the aeroplane to descend until it collided with the ground. He kept the cockpit door locked during the descent, despite requests for access made via the keypad and the cabin interphone. He did not respond to the calls from the civil or military air traffic controllers, nor to knocks on the door, possibly because of cognitive constriction common when a person is committing suicide.

The reinforced structure of the cockpit doors, designed for security reasons to resist penetration, could not be broken from outside to enable somebody to enter before the aircraft impacted the terrain in the French Alps.

2.2 Mental health assessment of professional pilots

Airline transport pilots must hold a valid Class 1 medical certificate to exercise the privileges of their licence. For pilots in the co-pilot's age group, class 1 medical certificates are valid for a period of 12 months. During yearly examinations, pilots undergo physical and mental examinations defined by the regulation and assessments are made by certified AMEs to determine the fit or unfit status of applicants.

Pilots must declare on their class 1 application form whether they have or have ever had any history of psychological or psychiatric trouble of any sort. The psychiatric assessment of pilots during medical certification is then performed through general discussion and by observing behaviour, appearance, speech, mood, thinking, perception, cognition and insight. When in doubt about the psychiatric state of an applicant, an AME can request an expert opinion from a specialist before making a fit or unfit determination.

The depression episode experienced by the co-pilot in 2008 was correctly identified by the Lufthansa AeMC during the revalidation process of his class 1 medical certificate in April 2009. A waiver based on the assessment from a psychiatrist allowed the pilot to hold a class 1 medical certificate again in July 2009. Every year after that, his class 1 medical certificate was revalidated or renewed. All of the AMEs who examined him during that period were aware of the waiver and were informed of his medical history of depression. The waiver FRA 091/09 neither included the requirement for regular specific assessments by a psychiatrist nor reduced the time in-between two assessments. Therefore, all the AMEs assessed his psychological and psychiatric fitness, through the usual discussions and observation of behaviour, to determine whether any signs of depression were reappearing, which would have made the waiver invalid and would have required further examination from a specialist. They did not detect any signs of this.

The calculation of the acceptable risk for pilots' in-flight incapacitation is based on the *"1% rule"* which relies on the presence of a second pilot to take over all the flight duties in the event of the incapacitation of the other pilot. However this is possible only if the second pilot is physically present in the cockpit and if the incapacitation of the other pilot is not due to a mental disorder that results in inadequate or deliberate actions that can put the aircraft into an unsafe condition. Consequently, mental incapacitation should not be treated the same way as physical incapacitation because the risks they generate cannot be mitigated in the same way by the two-pilot operation principle. Therefore, the target of acceptable risk for non-detection of a mental disorder that may result in a voluntary attempt to put the aircraft into an unsafe condition should be more ambitious than the one usually accepted for *"classical"* physical incapacitation risk. If one follows the calculation methodology developed in ICAO's Manual of Civil Aviation Medicine (Doc 8984) and described in paragraph 1.17.2, a quantitative target should be lower by at least two orders of magnitude, or 0.01%.

The review of previous accidents and incidents confirms that actions by a mentally disturbed pilot to purposely crash the aircraft could sometimes not be averted by the other pilot. The review of incidents also shows that the psychological incapacitation of a pilot, even if it does not lead to a deliberate attempt to crash the aircraft, is difficult to control by other crew members and can lead to an unsafe situation. This is why more attention should be paid to the prevention of mental incapacitation, even though the aforementioned quantitative target may be difficult to reach.

Specialists in aerospace medicine and psychiatrists contacted by the BEA generally agree that serious mental illnesses involving sudden psychosis are relatively rare, and their onset is impossible to predict. Moreover, for recurrent mental disorders that come in cycles, crises can leave no traces and when medical visits occur in the calm period of a cycle, the disorders can go undetected. Furthermore, detection tools and methods can remain ineffective in cases where the patient is intentionally hiding any history of mental disorder and/or is faking being in good health. This is why most believe that putting in place extensive psychiatric evaluation as part of routine aeromedical assessments of all pilots would not be productive or cost effective. That would risk generating situations where pilots who are perfectly fit to fly would be kept away from exercising the privilege of their licences for extended periods of time while waiting for long and pointless psychiatric verification.

However it might be useful to reinforce them for pilots with an identified history of mental illness. This was recommended by AsMA in its Pilot Mental Health Working Group. More thorough and/or more frequent psychiatric assessment of those pilots during annual revalidation visits could improve the detection and reduce the risk of possible mental incapacitation in flight. This would probably make it possible to control the risk at a level similar to or better than the currently accepted "1% rule". It is however not demonstrated that this would make it possible to reach the target of 0.01% suggested above. The thoroughness of mental assessment could be increased:

- by improving the training of AMEs in assessing mental health, which was recommended by EASA in the Task Force launched after the accident, by the DfT/CAA Mental Health Working Group and by AsMA in its Pilot Mental Health Working Group;
- by providing guidance for when an AME should seek expert opinion from mental health specialists before making a fit or unfit determination, which was recommended by the BMVI Task Force after the accident, and by AsMA in its Pilot Mental Health Working Group;
- by referring to an independent expert review each time an applicant has a history of mental illness, even in cases when a limitation already exists.

The expression of the risk of in-flight incapacitation in numerical terms is not easy to determine, particularly for conditions that are uncommon, because adequate predictive epidemiological data are not always available for every medical condition. This is particularly true for mental disorders that are still considered as sensitive and somewhat taboo, and therefore under-reported. The search for similar events that was undertaken by the investigation suffered from this reluctance to report as well as from judicial proceedings that were ongoing for some events, which blocked access to certain medical information that would have been useful. Nevertheless and as already recommended by ICAO in its Annex 1, a routine analysis of in-flight incapacitation would help the continuous re-evaluation of the medical assessment criteria and improve the expression of the risk of in-flight incapacitation in numerical terms. This would also make it possible to draw lessons from these events in terms of good operational practices and is particularly relevant to incapacitation related to psychological or psychiatric issues.

2.3 Reliability of self-declaration

Managing the risk of having an unfit pilot on board is partially based on the safety assumption that the pilot will self-declare his decrease in medical fitness. The EU Part-MED regulation states that if, in-between two medical examinations, a pilot suffers from a decrease in medical fitness or takes any prescribed or non-prescribed medication which might interfere with flight safety, he/she shall seek the advice of an AME, who will decide whether he/she is fit to resume flying.

Several elements show that the co-pilot was effectively aware of his own decrease in fitness. In December 2014, the co-pilot started to consult various private physicians for vision problems and sleep disorders. These problems could in themselves have decreased his medical fitness. In February 2015, a private physician referred him to a psychotherapist and psychiatrist, and issued him a sick leave certificate. In March 2015, the same private physician recommended him for psychiatric hospital treatment, and issued him another sick leave certificate. The co-pilot had also several sick leave certificates from various physicians in February and March 2015. However, not all of these sick leave certificates were forwarded to Germanwings. Therefore there are times when the co-pilot flew during some of these periods of sick leave, in particular on the day of the accident

Several elements also show that the co-pilot was aware of the potential interference of his medication with flight safety. He was aware of the risks of this medication, as revealed by the email he sent to his psychiatrist mentioning additional medication.

In spite of this awareness of unfitness to fly and his medication, the co-pilot did not seek any advice from an AME nor did he inform his employer.

Three main factors might have contributed to his failure to self-declare. First, the co-pilot, while suffering from a disease with symptoms of psychiatric disorder, possibly a psychotic depressive episode, had altered mental abilities with a probable loss of connectedness with reality and therefore a lack of discernment. Secondly, the financial consequences of losing his licence would have reached a total of 60,000 €. In addition that would have caused the loss of his income, which was not covered by his loss-of-licence insurance. Moreover, he had not yet fulfilled the conditions to have his full coverage paid for by the airline. Thirdly, the consequence of losing his license would tend to destroy his professional ambitions. Like most professional pilots, the decision to become an airline pilot was probably not solely motivated by the desire to earn a salary but also by a passion for flying aircraft, and also by the positive image conveyed by this profession.

The safety assumption stating that "*the pilot will self-declare his unfitness*" failed in this event.

This raises the question of the relevance of this assumption when the illness affects the person's psyche. The assumption is based on evaluation and decision-making capacity, which are directly affected by the illness itself. The self-declaration principle is therefore weakened when it applies to people consuming psychoactive substances or suffering from psychotic episodes.

The robustness of self-declaration is also questionable when the negative consequences for the pilot seem higher for him/her than the potential impact of a lack of declaration. Pilots are selected for their high motivation, their passion for flying, and their need for achievement. Therefore losing their right to fly might be difficult to accept for pilots, not only in financial terms, but also in terms of self-esteem, social recognition and job motivation. Moreover, the potential impact in terms of safety may be underestimated by pilots, who may overestimate their ability to compensate their decrease in fitness.

Airlines might have different strategies that impact the consequences of unfitness to fly, depending on their size, and on their human resource management organisation. Different strategies are adopted by some organisations in high-risk industries to limit the consequences of unfitness of their agents and to reinforce self-declaration. For example, in the French nuclear industry, employee implication is fostered by the fact that there can be no loss of income due to unfitness. The company would offer another position to an employee who was found unfit, with no modification of his/her salary. In railway transportation, the French company indicated that a train driver declared unfit would be offered a different position, though that might lead to a loss of income. The higher financial investments and the attractiveness linked to a pilot's work exacerbate this issue, and increase the need for measures to limit the consequences of unfitness to fly.

Some regulatory Aviation Authorities adopt another strategy and act on the fitness criteria. They allow aircrew on specific medication treating depression to fly. Such programmes exist in Australia, the UK, Canada and the USA. The modalities differ between countries but all include specific medical assessments, a list of accepted medication (among Selective Serotonin Reuptake Inhibitors, named SSRI), clinical reviews and requirements for stability before being allowed to return to flying duties.

Studies have shown that having programmes allowing pilots to take anti-depressants, under specific conditions and with close medical supervision, is beneficial to flight safety. It counteracts the fact that pilots might choose to fly while depressed, with or without medication. By authorising controlled medication, pilots can be monitored more closely medically. This may also reinforce self-declaration by allowing pilots to declare their depression without fear of being grounded for an excessively long time.

2.4 Balance between patient confidentiality and public safety

In December 2014, the co-pilot started to suffer from what was possibly a psychotic depressive episode. He went to see several doctors, including:

- a private physician, who referred him to a psychotherapist and psychiatrist one month before the accident, who then diagnosed a possible psychosis two weeks before the accident, and who issued sick leave certificates;
- the psychiatrist treating him, who prescribed anti-depressant medication one month before the accident and other anti-depressants along with sleeping aid medication, eight days before the accident.

None of these health care providers reported any aeromedical concerns to authorities. They abided by the universally-accepted principle of medical confidentiality, which ensures trust between patients and doctors. This principle encourages people to seek medical advice and treatment, with the guarantee that their personal information will be kept confidential. This principle is particularly developed in Germany, where it is specified in the German data protection laws and in the German criminal code. It led them to address the health issues the co-pilot was facing by attempting to convince him to seek additional help and by issuing sick leave certificates. They probably assumed that he would not go to work.

On the one hand, German regulations contain specific provisions to punish doctors violating medical confidentiality, including occupational consequences and imprisonment up to one year. On the other hand, the German criminal code has very general provisions stating that any person who acts to avert an imminent danger does not act unlawfully, if the act committed is an adequate means to avert the danger and if the protected interest substantially outweighs the one interfered with. Consequently, and assuming that a situation where a professional pilot with symptoms of a psychotic disorder is an *"imminent danger"*, it could have been possible, at least theoretically, to prevent the copilot from flying, by reporting him to the Aviation Authorities which would then have had to suspend his medical certificate. This supposes however, that doctors were able to report the situation to an authority or organisation which could have declared the pilot unfit to fly.

Legal frameworks in most countries allow doctors to breach medical confidentially and warn authorities if the disclosure of personal information would lessen or prevent a serious and/or imminent danger or a threat to public safety. In some countries, like Canada, Israel, or Norway, it is even compulsory for health care providers to do so, even without the consent of the patient. A survey conducted by the BEA shows that the absence of formal definition of *"imminent danger"* and *"threat to public safety"* drives doctors to adopt a conservative approach. They will not report any medical information to authorities until there is an obvious and unequivocal threat to third parties or to the patient himself. They adopt such a position, not only because they are strongly attached to the principle of preserving their patients' trust, but also because they fear being sued, exposed to sanctions from judicial authorities and/or losing their right to practice medicine.

The possibility of breaching medical confidentiality is specified in most countries, including Germany, in the general criminal code or penal code. Therefore this applies to the privacy rights of all types of patients, not specifically of pilots. However some countries, like Canada, Israel and Norway have privacy disclosure regulations specifically dedicated to pilots. Having such regulations or guidelines draws more attention to the nature of the risks generated by an unfit pilot and provides a clearer and more secure legal framework for health care providers. An unfit pilot can generate risks not only to his/her own health and personal safety, but also, in the case of airline pilots, to that of the passengers being transported. This can then become a threat to public safety.

Knowing their patient's occupation is a general good practice shared by health care providers. In some countries, it is even compulsory for pilots to inform their doctor about their profession.

Combining the guarantee of knowing the occupation of their patients who are pilots, with regulations allowing and/or mandating health care providers to inform authorities in case pilot unfitness threatens public safety, would create an environment favourable for doctors to report to authorities. The method for reporting to authorities would need to be defined in clear guidelines and reporting should be without legal risk to health care providers.

The various questions relating to the balance between public good and confidentiality favour a global approach that addresses every area of concern, in order to provide better protection for all parties (the patient, the doctor, the public). It is therefore important that evolutions in the regulations address the overall issue of medical confidentiality, but also specifically aviation safety.

2.5 Contribution of the social and professional environment in assessing fitness to fly

The principle of self-declaration in case of pilots experiencing a decrease in medical fitness or commencing regular use of medication was not effective in the case of this accident.

In order to disclose concerns over mental illness, pilots need to overcome the stigma that is attached to mental illness, and the prospects of losing their medical certification and therefore their positions as pilots. Pilots value highly the recognition and support of their peers. The close-knit relationships in the pilot community allow for an understanding and trust between them, which others in their organisation do not necessarily share.

A number of airlines, including Germanwings, have psychological support programmes available to their crews to self-report medical conditions, including emotional and mental health issues, and then seek assistance to find a solution. In theory, these programs, staffed by peers, provide a *"safe zone"* for pilots by minimizing career jeopardy and the stigma of seeking mental health assistance. The idea is to foster trust in pilots by setting up a non-threatening and confidential environment, with the assurance that fellow pilots are there to help, and do not intend to apportion blame or responsibility.

No record was found that the co-pilot sought any support from peers, for instance through the Mayday foundation or the Anti-Skid programme, although they are available to Germanwings pilots. It could not be determined clearly why he did not use any of these programs. His lack of confidence or knowledge of how they worked, along with his probable fear of losing his privileges to fly, may have prevented him from using these programs.

The professional environment can be effective, in certain circumstances, in detecting psychological issues. Absenteeism or changes in the relationships with colleagues can be used as an indicator of a possible decrease in well-being. Airline pilots work as crewmembers. Interacting with each other and working as a team is a normal part of their flying duties. The use of standard procedures, check-lists and CRM techniques mean that it is expected that pilots work and behave in a shared manner. This enables the recognition of deviations from the anticipated behaviour before, during or after a flight. Interaction between the crew members during flights or during simulator training can help identify an individual who is struggling with any type of emotional or mental problem that may hinder their ability to professionally and effectively serve as a working member of the crew. However, this team work cannot detect pilots suffering from mental illness without obvious symptoms. Its efficiency also relies on the ability of a pilot to associate any unexpected performance or marginal behaviour by another pilot with a possible abnormal mental situation, this being beyond the normal skills of pilots, except in clearly identifiable situations.

The management of decrease in fitness can also be optimized to include peer intervention. Programmes, like ProStans, enable the reporting of pilots who display behavioural or other issues via their peers. The ProStans Committee addresses problems of a professional or ethical nature involving crew members. Peer volunteers resolve allegations of misconduct, or conflicts between crew members, that may affect flight safety and/or professionalism.

The co-pilot had had six documented periods of sickness during the previous three months and had flown on 35 days over that same period. However, none of his colleagues or his manager was able to detect his decrease in fitness. The organisation of an airline and the specificity of pilot duties make subtle changes in behaviour or depression hard to detect. Pilots may fly only a few times with the same pilot.

The personal environment of pilots could also be a means of helping with detection of mental health issues. AsMA recommends that the families of aircrews should be made more aware of mental health issues in aviation, as extended awareness beyond the physician should facilitate greater recognition, reporting and discussion. Pilot support groups could be made known to the families of pilots. Family members could use these groups if they knew they existed and they had the assurance that any mental health issues their loved ones may have would be handled appropriately, with the interests of their career in mind.

Because these programmes work on a confidential basis, without any detailed written reports to preserve pilot's trust, it is hard to determine how well and how frequently they are used by pilots around the world. Peer support systems are well implemented in major airlines, particularly in North America, where just culture principles are well known. However, these types of systems may pose significant implementation challenges when they are applied to organisations of smaller sizes, lower maturity levels and different cultural history. For these peer support groups to be effective, crews need to be assured that mental health issues will not be stigmatized, concerns raised will be handled confidentially, and that pilots will be well-supported with the aim of allowing them to return to flying duties. Within smaller airlines, especially where job security can be in question, more effort could be made to promote successful approaches that improve rates of reporting, discussion and participation.

2.6 Security of cockpit access

Following the 11 September 2001 attacks, several measures were introduced to reduce the risk of unwanted persons entering the cockpit. Reinforced cockpit door systems were mandated at international and European levels, and rules were subsequently fine-tuned to address the safety risks in the areas of rapid aircraft depressurisation, pilot incapacitation, post-crash cockpit access, and door system failure including manual lock use. The vast majority of passenger transport aircraft are compliant with the current set of regulations.

This reinforcement of cockpit doors was motivated by security reasons, assuming that the threat to public security came from outside the cockpit. The consensus worldwide was therefore that security would be tightened by preventing people from entering the flight deck. A potential security threat from inside the cockpit was not fully considered in either the initial phase or the period that followed, when the regulations were fine-tuned. It was assumed moreover that security threats outweighed safety concerns, given the fact that crew incapacitation was already taken into account. The risk of terrorist attack was considered to be more threatening than pilot suicide.

The scenario of this accident and previous events identified during the investigation bring to light the threat within the cockpit, which current cockpit door systems and procedures are not designed to address. A door cannot address a risk that could be present from both sides.

Shortly after the accident EASA issued an SIB recommending that airlines ensure that at least two crew, including at least one qualified pilot, are in the cockpit at all times throughout the flight, in order to address the risks associated with flight crew members leaving the cockpit during non-critical phases of flight. This *"2-person in the cockpit"* rule could enable a trained flight attendant to unlock the door in case of an emergency situation like the one experienced during the accident. In addition, this rule means that a person is physically present next to a pilot who might want to commit suicide, which could contribute to breaking the cognitive constriction of the suicidal person, and therefore could prevent the suicide. However, some of the previous events listed in 1.18.1 show that even with two persons in the cockpit (i.e. two pilots), a suicide remains possible. This *"2-person in the cockpit*" rule cannot fully mitigate the risk of suicide, although it is likely to make it more difficult. In addition, this rule may introduce new security risks by allowing an additional person inside the flight deck. Consequently, the BEA acknowledges the potential safety benefits of the *"2-person in the cockpit"* rule, although the security risks and training needs for the staff performing the tasks of that second person have to be carefully assessed.

Several new cockpit door designs could be imagined to improve safety by allowing the door to be unlocked from outside the cockpit, even if the pilot(s) inside wanted to block the access in particular:

- the use of pre-recorded finger prints for the flight crew to gain access to the cockpit in case of emergency;
- the use of keys located in the flight deck to open the cockpit door from the passenger compartment when one of the pilots leaves and takes out a key with him/her;
- the displacement of the reinforced cockpit door aft of the lavatory compartment to include the lavatory in the cockpit area. This would enable one of the pilots to access the lavatory while preventing unauthorized people from accessing the cockpit. This would remove one of the lavatory required for passenger use.

However, these examples are all at the detriment of security or bring additional cost with little or no additional benefit to security. The risk of illicit attacks in flight being considered more threatening than the scenario of this accident, the BEA has not issued any safety recommendation concerning the modification of cockpit door designs.

3 - CONCLUSIONS

3.1 Findings

General findings

- the aeroplane had a valid Certificate of Airworthiness;
- A review of the FDR and CVR data brought to light no aircraft system failures or faults that could have contributed to the accident;
- the aeroplane's maintenance documentation did not mention any system failures that were incompatible with the flight as planned;
- the flight crew possessed the licences and ratings required to perform the flight;
- the co-pilot obtained his class 1 medical certificate without restrictions in April 2008, valid for one year;
- a depressive episode and the taking of medication to treat it delayed the renewal of the copilot's class 1 medical certificate between April and July 2009;
- from July 2009, the co-pilot's medical certificate was endorsed with the note « *Note the special conditions/restrictions of the waiver FRA 091/09 -REV-*»;
- the co-pilot's MPL(A), issued in February 2014, was endorsed with the remark *"***SIC**incl. PPL***"*;
- the co-pilot class 1 medical certificate was regularly revalidated or renewed from 2010 to 2014 at the Lufthansa AeMC. All the AMEs who examined him during that period were aware of the waiver FRA 091/09 and his history of depression;
- the waiver FRA 091/09 neither included the requirement for regular specific assessments by a psychiatrist nor reduced the time in-between two assessments;
- his last class 1 medical examination took place on 28 July 2014;
- no psychiatrist or psychologist was involved in the copilot's class 1 medical certificate revalidation/renewal process after the issuance of the waiver FRA 091/09;
- the co-pilot had a loss of licence insurance that would have given him a one-time payment of about 60,000€ which corresponds approximately to his pilot training expenses, but he did not have any additional insurance covering the risk of loss of income resulting from unfitness to fly;
- peer support groups are available to Germanwings pilots.

Findings relevant to the period between December 2014 and the day of the accident

- the copilot suffered from a mental disorder with psychotic symptoms;
- anti-depressant and sleeping aid medication was prescribed to the co-pilot;
- the co-pilot did not contact any AME;
- no record was found that the co-pilot sought any support from peers;
- the co-pilot went on flying as a commercial pilot carrying passengers;
- the mental state of the co-pilot did not generate any reported concern from the pilots who flew with him;
- a private physician referred the co-pilot to a psychotherapist and psychiatrist one month before the accident and diagnosed a possible psychosis two weeks before the accident;
- the psychiatrist treating the co-pilot prescribed anti-depressant medication one month before the accident and other anti-depressants along with sleeping aid medication eight days before the accident;
- no health care providers reported any aeromedical concerns to authorities;
- no aviation authority, or any other authority, was informed of the mental state of the co-pilot.

Findings relevant to the first flight of the day of the accident (from Düsseldorf to Barcelona)

- the aircraft took off from Düsseldorf at 6 h 01;
- several altitude selections towards 100 ft were recorded during descent on the flight that preceded the accident flight, while the co-pilot was alone in the cockpit;
- the aircraft landed in Barcelona at 7 h 57.

Findings relevant to the second flight of the day of the accident (from Barcelona to Düsseldorf)

- the aeroplane took off from Barcelona bound for Düsseldorf at 9 h 00, with flight number 4U9525, and callsign GWI18G;
- the autopilot and autothrust were engaged during the climb;
- the Captain left the cockpit at the beginning of the cruise at FL380;
- the selected altitude changed from 38,000 ft to 100 ft while the co-pilot was alone in the cockpit. The aeroplane then started a continuous and controlled descent on autopilot;
- during the descent, the Marseille control centre called flight GWI18G on eleven occasions on three different frequencies, without any answer being transmitted;
- the French military defence system tried to contact flight GWI18G on three occasions during the descent, without any answer;
- the buzzer to request access to the cockpit sounded once during the descent, 4 min 07 s after the Captain had left;
- the intercom sounded in the cockpit, 4 min 40 s after the Captain had left;
- three other calls on the interphone sounded in the cockpit;
- none of the calls using the interphone elicited any answer;
- noises similar to violent blows on the cockpit doors were recorded on five occasions;
- the cockpit doors of the aircraft are designed for security reasons to resist penetration by small arms fire and grenade shrapnel and to resist forcible intrusions by unauthorized persons;
- an input on the right sidestick was recorded for about 30 seconds on the FDR 1 min 33 s before the impact, not enough to disengage the autopilot;
- the autopilot and autothrust remained engaged until the end of the CVR and FDR recordings;
- the sound of breathing was recorded on the CVR until a few seconds before the end of the flight;
- before the collision with the terrain, warnings from the GPWS, Master Caution and Master Warning sounded;
- the aeroplane collided with the terrain at 9 h 41 min 06.

3.2 Causes

The collision with the ground was due to the deliberate and planned action of the co-pilot who decided to commit suicide while alone in the cockpit. The process for medical certification of pilots, in particular self-reporting in case of decrease in medical fitness between two periodic medical evaluations, did not succeed in preventing the co-pilot, who was experiencing mental disorder with psychotic symptoms, from exercising the privilege of his licence.

The following factors may have contributed to the failure of this principle:

- the co-pilot's probable fear of losing his ability to fly as a professional pilot if he had reported his decrease in medical fitness to an AME;
- the potential financial consequences generated by the lack of specific insurance covering the risks of loss of income in case of unfitness to fly;
- the lack of clear guidelines in German regulations on when a threat to public safety outweighs the requirements of medical confidentiality.

Security requirements led to cockpit doors designed to resist forcible intrusion by unauthorized persons. This made it impossible to enter the flight compartment before the aircraft impacted the terrain in the French Alps.

4 - SAFETY RECOMMENDATIONS

Note: in accordance with the provisions of Article 17.3 of Regulation 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, a safety recommendation in no case creates a presumption of fault or liability in an accident, serious incident or incident. The recipients of safety recommendations report to the authority in charge of safety investigations that have issued them, on the measures taken or being studied for their implementation, as provided for in Article 18 of the aforementioned regulation.

Due to the strong interdependency between matters related to the aeromedical certification of pilots, and matters related to the assistance to pilots in situations where there is risk of loss of licence, the following safety recommendations should be viewed as a single comprehensive package, and should be implemented together. Treating them in isolation, or implementing only part of them, could be counter-productive and would not generate the expected safety benefits.

4.1 Medical evaluation of pilots with mental health issues

Mitigation of the risks that pilot in-flight incapacitation represent to flight safety relies on the presence of a second pilot to take over all flying duties in the event of incapacitation of the other pilot. Mental incapacitation can make this principle fail, in particular when one pilot decides to purposely put the aircraft into an unsafe condition. This accident and other similar events identified during the investigation, including some with two crew members in the cockpit, illustrate this failure. Consequently, mental incapacitation should not be treated in the same way as physical incapacitation and a more stringent target for detecting potentially unsafe mental disorders should be targeted. Most aeromedical experts consider that in depth psychological testing to detect serious mental illness is inappropriate and that testing for psychological disorders as part of the routine periodic pilot aeromedical assessment is neither productive nor cost effective. However, it might be useful to regularly evaluate the mental health of pilots with an identified history of mental illness.

Identifying pilots who would require additional psychiatric evaluation would be improved if AMEs received additional training in mental health issues in aviation. This additional training has been already recommended by the AsMA Expert WG, UK DfT/CAA WG, BMVI WG, and the EASA Task Force.

The short time between the discontinuation of the medication and the issuance of the first medical certificate with a waiver may not have offered all the tangible elements to confirm that the mental state of the pilot was fully stabilised in July 2009. From 2010 to 2014, and in compliance with EU regulations, the co-pilot revalidated or renewed his class 1 medical certificate, which contained a limitation related to his past depressive episode, without any additional specific psychiatric evaluation.

Consequently the BEA recommends that:

- **EASA require that when a class 1 medical certificate is issued to an applicant with a history of psychological/psychiatric trouble of any sort, conditions for the follow-up of his/her fitness to fly be defined. This may include restrictions on the duration of the certificate or other operational limitations and the need for a specific psychiatric evaluation for subsequent revalidations or renewals. [Recommendation FRAN-2016-011]**

4.2 Routine analysis of in-flight incapacitation

Currently available data does not provide accurate awareness of in-flight incapacitation risks, especially in relation to mental health issues. This lack of data, confirmed by the difficulties experienced during the investigation in collecting data on previous similar incidents or accidents, can be explained by the reluctance to report this type of event, by the lack of investigations being carried out, by ongoing judicial proceedings, and/or restrictions linked to medical confidentiality.

ICAO recommends that States should, as part of their State Safety Programme, apply basic safety management principles to the process of medical assessment of licence holders, to include as a minimum:

- a) routine analysis of in-flight incapacitation events and medical findings during medical assessments to identify areas of increased medical risk; and
- b) continuous re-evaluation of the medical assessment process to concentrate on identified areas of increased medical risk.

The Network of Analysts defined in article 14.2 of EU regulation 376/2014 may provide an appropriate forum for gathering and assessing data on medical risks at the EU level.

Consequently the BEA recommends that:

- **EASA include in the European Plan for Aviation Safety an action for the EU Member States to perform a routine analysis of in-flight incapacitation, with particular reference but not limited to psychological or psychiatric issues, to help with continuous re-evaluation of the medical assessment criteria, to improve the expression of risk of in-flight incapacitation in numerical terms and to encourage data collection to validate the effectiveness of these criteria. [Recommendation FRAN-2016-012]**

- **EASA, in coordination with the Network of Analysts, perform routine analysis of in-flight incapacitation, with particular reference but not limited to psychological or psychiatric issues, to help with continuous re-evaluation of the medical assessment criteria, to improve the expression of risk of in-flight incapacitation in numerical terms and to encourage data collection to validate the effectiveness of these criteria [Recommendation FRAN-2016-013]**

4.3 Mitigation of the consequences of loss of licence

The co-pilot was aware of the decrease in his own medical fitness and of the potential impact of his medication. However, he did not seek any advice from an AME, nor did he inform his employer. One of the explanations lays in the financial consequences he would have faced in case of the loss of his licence. His limited Loss of License insurance could not cover his loss of income resulting from unfitness to fly. More generally, the principle of self-declaration in case of a decrease in medical fitness is weakened when the negative consequences for a pilot of self-declaration, in terms of career, financial consequences, and loss of self-esteem, are higher than the perceived impact on safety that failing to declare would have.

Organisations, especially airlines, can reinforce self-declaration of a decrease in medical fitness of their staff, by acting on some of the consequences of unfitness, by offering motivating alternative positions and by limiting the financial consequences of a loss of licence, for example through extending loss of licence coverage.

Consequently the BEA recommends that:

- **EASA ensure that European operators include in their Management Systems measures to mitigate socio-economic risks related to a loss of licence by one of their pilots for medical reasons. [Recommendation FRAN-2016-014]**

- **IATA encourage its Member Airlines to implement measures to mitigate the socio-economic risks related to pilots' loss of licence for medical reasons. [Recommendation FRAN-2016-015]**

4.4 Anti-depressant medication and flying status

The co-pilot did not seek any advice from an AME nor did he inform his employer in spite of his ongoing depression and associated medication.

In Germany, as in most European countries, depression is a clear reason for declaring a pilot to be unfit to fly. There is evidence of depressed professional pilots refusing medication because they would be grounded if they did so. There is also evidence of pilots taking anti-depressant medication without declaring it to aeromedical authorities, while continuing to fly.

ICAO recommends that pilots with depression, being treated with antidepressant medication, may be assessed as fit to fly if the medical assessor considers the applicant's condition as unlikely to interfere with the safe exercise of the applicants licence and rating privileges. Similarly, (EU) regulations state that after full recovery from a mood disorder, if stable maintenance psychotropic medication is confirmed, a fit assessment should require a multi-pilot limitation. Some National Aviation Authorities allow aircrew to continue to fly while taking specific medication to treat depression. Such programs exist in Australia, the UK, Canada and the USA. The modalities differ between countries but all include specific medical assessment, a list of accepted medication (among selective serotonin reuptake inhibitors named SSRI), whose possible side effects have been shown to be compatible with flying duties, clinical reviews and requirements for mental stability before being allowed to return to flying duties. Authorising controlled medication ensures that pilots can be monitored more closely. It reinforces self-declaration by allowing pilots to declare any depression without fear being grounded for an excessively long time. This counteracts the possibility that pilots might choose, if left to their own devices, to fly while depressed, with or without adapted medication. However, even if allowed by EU regulations, not all European countries have clearly-established policies and technical guidance for the use by pilots of anti-depressant medication.

Consequently the BEA recommends that:

- **EASA define the modalities under which EU regulations would allow pilots to be declared fit to fly while taking anti-depressant medication under medical supervision. [Recommendation FRAN-2016-016]**

4.5 Balance between medical confidentiality and public safety

Medical confidentiality is a key principle in ensuring trust between doctors and patients. The fact that people are encouraged to seek advice and treatment, with the guarantee that their personal information will be kept confidential, benefits society as a whole as well as the individual. However, the public interest may also be served by disclosing information to protect individuals or society from risks of serious harm. Personal information should, therefore, be disclosed in the public interest even without patients' consent, if the benefits to an individual or to society of the disclosure outweigh both the public and the patient's interest in keeping the information confidential. The investigation has shown that provisions allowing health care providers to breach medical confidentiality exist in most States, in particular in Europe, under certain conditions and when it is in the interest of preserving public safety or preventing imminent danger. EU regulations authorize the processing of medical data if it is required for the purpose of medical diagnosis and if the person processing the data is under an obligation of secrecy. Some States have dedicated provisions applying to pilots whose health issues need to be reported to the relevant authorities if they threaten public safety. Other States, like Germany, have only general provisions applying to any citizen and to any imminent danger. In those States, such provisions are regularly outweighed, in the decision process of doctors, by provisions related to medical confidentiality, which are perceived as more important and which contain possible legal consequences if they are violated. Furthermore, the absence of a formal definition of "imminent danger" and "threat to public safety" drives doctors to adopt a conservative approach and may lead them not to report their potential concerns to authorities.

The investigation has shown that a private physician referred the co-pilot to a psychotherapist and psychiatrist one month before the accident and diagnosed possible psychosis two weeks before the accident. It also showed that the psychiatrist treating him prescribed anti-depressant medication one month before the accident and other anti-depressants, along with sleeping aid medication, eight days before the accident. None of these health care providers reported any aeromedical concerns to authorities. It is likely that breaching medical confidentiality was perceived by these doctors as presenting more risks, in particular for themselves, than not reporting the co-pilot to authorities.

Combining the guarantee of knowing the occupation of their patients who are pilots, with regulations allowing and/or mandating health care providers to inform authorities in case pilot unfitness threatens public safety, would create an environment favourable for doctors to report to authorities. The various questions relating to the balance between public good and confidentiality favour a global approach that addresses every area of concern, in order to provide better protection for all parties (the patient, the doctor, the public). It is therefore important that evolutions in the regulations address the overall issue of medical confidentiality, but also the risks that pilots' health issues may pose to public safety. Recommendations about the appropriate balance between patient confidentiality and the protection of public safety have already been made by the AsMA Expert WG, UK DfT/CAA WG, and the EASA Task Force.

Consequently the BEA recommends that:

- **The World Health Organization develop guidelines for its Member States in order to help them define clear rules to require health care providers to inform the appropriate authorities when a specific patient's health is very likely to impact public safety, including when the patient refuses to consent, without legal risk to the health care provider, while still protecting patients' private data from unnecessary disclosure. [Recommendation FRAN-2016-017]**

- **The European Commission in coordination with EU Member States define clear rules to require health care providers to inform the appropriate authorities when a specific patient's health is very likely to impact public safety, including when the patient refuses to consent, without legal risk to the health care provider, while still protecting patients' private data from unnecessary disclosure. These rules should take into account the specificities of pilots, for whom the risk of losing their medical certificate, being not only a financial matter but also a matter related to their passion for flying, may deter them from seeking appropriate health care [Recommendation FRAN-2016-018]**

- **Without waiting for action at EU level, the BMVI and the Bundesärztekammer (BÄK) edit guidelines for all German health care providers to:**
  - **remind them of the possibility of breaching medical confidentiality and reporting to the LBA or another appropriate authority if the health of a commercial pilot presents a potential public safety risk.**
  - **define what can be considered as "imminent danger" and "threat to public safety" when dealing with pilots' health issues**
  - **limit the legal consequence for health care providers breaching medical confidentiality in good faith to lessen or prevent a threat to public safety [Recommendation FRAN-2016-019 and FRAN-2016-020]**

4.6 Promotion of pilot support programmes

The investigation has shown that in spite of the onset of symptoms that could be consistent with a psychotic depressive episode and the fact that he was taking medication that made him unfit to fly, the co-pilot did not seek any aeromedical advice before exercising the privilege of his licence. This is likely the result of difficulties in overcoming the stigma that is attached to mental illness, and the prospects of losing his medical certification and therefore his job as a pilot. Self-declaration in case pilots experience a decrease in medical fitness or starting a regular course of medication can be fostered if psychological support programs are available to crews who experience emotional or mental health issues. Existing programs, overseen by peers, provide a *"safe zone"* for pilots by minimizing career jeopardy as well as the stigma of seeking mental health assistance. These programs are sometimes underutilized for reasons such as: employees questioning the confidentiality of the service; the perception that a stigma is attached to asking for professional help with personal matters; or lack of unawareness of the program and its capabilities. Management of a decrease in medical fitness can be optimized by including the intervention of peers and/or family members. AsMA recommends extending awareness of mental health issues beyond the physician to facilitate greater recognition, reporting and discussion. Peer support systems are well implemented in major airlines, particularly in North America, where just culture principles are well known. However, these types of systems may pose significant implementation challenges when they are applied to smaller sized organisations that are less mature and have a different cultural background. For these peer support groups to be efficient, crews and/or their families need to be reassured that mental health issues will not be stigmatized, concerns raised will be handled confidentially and that pilots will be well supported, with the aim of allowing them to return to flying duties. The promotion of pilot support programs has already been recommended by AsMA Expert WG, UK DfT/CAA WG, BMVI WG, and the EASA Task Force.

Consequently the BEA recommends that:

- **EASA ensure that European operators promote the implementation of peer support groups to provide a process for pilots, their families and peers to report and discuss personal and mental health issues, with the assurance that information will be kept in-confidence in a just-culture work environment, and that pilots will be supported as well as guided with the aim of providing them with help, ensuring flight safety and allowing them to return to flying duties, where applicable. [Recommendation FRAN-2016-021]**

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Appendix 1

Press Release of 3 April 2015 from the French National Council of Doctors

3 AVRIL 2015
COMMUNIQUE DE PRESSE

Secret Médical et risque grave et imminent de mise en danger d'autrui

Le dramatique crash aérien du 24 mars 2015 soulève de nouveau la question du respect du secret médical par le médecin.

L'Ordre rappelle que le secret médical, instauré dans l'intérêt des patients, est une condition indispensable à leur confiance. L'obligation de respect du secret est générale et absolue (article 226-13 du code pénal et articles L.1110-4 et R.4127-4 du code de la santé publique).

En l'état actuel, les dérogations possibles au secret médical sont limitées, en application de l'article 226-14 du code pénal, à l'initiative du médecin, à trois hypothèses : les sévices ou privations sur mineurs et personnes vulnérables ; avec leur accord, les sévices ou privations sur des personnes majeures ; le caractère dangereux de personnes qui détiennent une arme ou envisagent d'en acquérir une.

Toutefois, à titre exceptionnel et en cas de risque grave et imminent de mise en danger d'autrui, qu'il ne peut prévenir autrement, et après qu'il ait épuisé toute autre solution, le médecin peut selon le Conseil national de l'Ordre s'affranchir du secret médical en informant le médecin chargé de la santé au travail sinon en saisissant le Procureur de la République. Le médecin serait alors justifié à invoquer l'état de nécessité absolue, par analogie avec les dispositions de l'article 122-7 du code pénal, qui exonère de toute responsabilité pénale la personne qui accomplit « face à un danger actuel et imminent » un acte nécessaire et proportionné à la gravité de la menace.

En toute hypothèse, l'information doit être proportionnée à la gravité du danger.

Le Conseil national de l'Ordre des médecins souligne l'importance des questions soulevées qui concernent une grande variété de situations, allant bien au-delà du cas à l'origine des interrogations actuelles et il lui paraît souhaitable de ne pas légiférer dans l'urgence et l'émotion.

www.conseil-national.medecin.fr

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Appendix 2

ICAO guidelines for mental health and behavioural questions
for use by medical examiners

ICAO Manual of Civil Aviation Medicine extract:

- 2.2.16 There are various questionnaires with various degrees of complexity available for assessing mental health and behavioural aspects of an individual's health. The questions below may serve to promote a relevant discussion between the medical examiner and the pilot. To encourage dialogue, it is recommended that no written record of the conversation is retained (other than a record that mental health and behavioural topics were discussed) unless some item of immediate flight safety risk is uncovered — this understanding should be made clear to the pilot at the outset, thus increasing the likelihood of a frank discussion. It is to be expected that only rarely will any formal action need to be considered by the medical examiner to protect flight safety in the light of response to such questions, since the main aim is to discover behavioural patterns or mental aspects that are amenable to change before they become sufficiently severe to affect the medical fitness.

- 2.2.17 The questions suggested address those conditions that are most common in the age range of professional pilots and those which are most likely to affect performance on the flight deck. Statistics show that the main psychiatric conditions in this context are mood disorders and certain anxiety disorders, especially panic episodes. Additionally, in many Contracting States, excessive alcohol intake and use of illicit drugs in the general population are occurring with increasing frequency, and pilots are not immune from these social pressures. Questions have been developed to address these issues as well.

- 2.2.19 The questions below may not represent the most suitable questions for the pilot populations of all States, but they offer guidance — a starting point — for States that intend to implement 6.3.1.2.1 and wish to develop an approach that includes these important aspects of medical fitness.

- 2.2.20 The questions do not necessarily have to be posed verbally by the medical examiner but could, for example, be given to the applicant to read prior to the examination.

Suggested questions for depression:

- 1) During the past three months, have you often been bothered by feeling down, depressed or hopeless?
- 2) During the past three months, have you often been bothered by having little interest or pleasure in doing things?
- 3) During the past three months, have you been bothered by having problems falling asleep, staying asleep, or sleeping too much, that is unrelated to sleep disruption from night flying or transmeridian operations?
- 4) In the past three months, has there been a marked elevation in your mood lasting for more than one week?

Suggested questions for anxiety/panic attack:

- ❒ 1) In the past three months, have you had an episode of feeling sudden anxiety, fearfulness, or uneasiness?
- ❒ 2) In the past three months, have you experienced sensations of shortness of breath, palpita-tions (racing heart beat) or shaking while at rest without reasonable cause?
- ❒ 3) In the past year have you needed to seek urgent medical advice because of anxiety?

Appendix 3

BFU Statement

Bundesstelle für
Flugunfalluntersuchung
German Federal Bureau of Aircraft Accident Investigation

Bureau d'Enquêtes et d'Analyses
pour la sécurité de l'aviation civile

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Our reference: UF2 2X001-15

Date: 26.02.2016

Accident involving Airbus A320-211, D-AIPX, 24 March 2015 at Prads-Haute-Bléone (France)

The German Federal Bureau of Aircraft Accident Investigation (BFU) appreciates the comprehensive Final Report including the consideration of the systemic background. The BFU is in agreement with the factual information, the cause and the issued safety recommendatons presented in the Final Report. In regard to the analysis of certain facts the BFU is of the opinion that the following aspects have to be pointed out.

1. Actions of the co-pilot

The recordings of the Flight Data Recorder (FDR), and the Cockpit Voice Recorder (CVR), as well as the facts described in the Final Report show that the airplane was airworthy. The BFU is of the opinion that based on the above-mentioned recordings technical failures can be ruled out. These recordings and the system design also rule out an influence of an outside interference with the controls of the airplane.

Furthermore, in our opinion the below assessments, whose issues were considered in the Final Report from different viewpoints and can be found in various places, result in the immediate conclusion of an intended action by the co-pilot. The recorded selections on the Flight Control Unit (FCU) during the flight from Düsseldorf to Barcelona were selections which were not plausible for the cruise flight, but explain "trying something out". These and the interference with the control of the vertical profile executed by the co-pilot and documented by the FDR during the flight from Barcelona to Düsseldorf and the changes in airspeed indicate the capacity to act of the co-pilot as well as a specific interference with the flight path of the airplane The BFU is of the opinion that it is highly unlikely that such selections on the FCU could have been conducted if the co-pilot had been incapable of action.

This assessment of the capability to act combined with the factual information, that the co-pilot

- has interfered with the flight path of the flight while he was alone in the cockpit,
- did not unlock the cockpit door and has therefore prevented access by other persons, has made similar selections on the FCU during the previous flight, and
- has made enquiries concerning the function of the door system and suicides, according to documents available to the BFU

resulted in the above-mentioned conclusion.

2. Diagnosis of the co-pilot's illness

As stated in the Final Report, the BFU had medical documentation available, which provided information about the co-pilot's health condition. The BFU consulted an aero medical examiner and a psychiatrist requesting their assessment. The documentation including the assessment of the specialists were then made available to the BEA.

The BFU is of the opinion that due to the limitations encountered during the investigation a distinguished consideration has to be applied to possible diagnoses. The specialists the BFU has consulted came to the following conclusion:

At the time of the accident the co-pilot was adversely affected by severe mental illness. According to valid aero-medical regulations he had already been unfit to fly due to use of an anti-depressant and massive sleep deprivation.

It was not possible to come to a clear psychiatric diagnosis because the medical documentation the BFU could review and therefore provide to the specialists the BFU had commissioned were not sufficient. The BFU could not interview relatives and physicians and therapists involved because they exercised their right to refuse to give evidence and referred to medical confidentiality, respectively. The Deutsche Zentrum für Luft- und Raumfahrt e. V. (DLR), which had conducted the initial psychological examination of the co-pilot, also referred to confidentiality.

On the basis of the medical case history, the available medical documentation, and the course of the accident several mental disorders come into consideration from which the co-pilot could have suffered; such as severe depression including delusional symptoms, decompensation of a personality disorder, or a combination thereof.

A clear diagnosis could not be established with sufficient accuracy because the documentation showed information arguing for and also against certain mental illnesses. These contradictions could not be clarified due to the limited interview options.

The specialists commissioned for the safety investigation are of the opinion that whether the mental illness of the co-pilot in 2015 has to be viewed as relapse of the illness in 2009 depends primarily on the diagnostic classification. The diagnostic classification could not be conclusively assessed due to the limited possibilities to interview relatives, physicians and therapists involved. The psychiatric experiences of the specialists rather argue for a connection between the episode in 2009 and the ones in 2014/2015, even if the symptoms most likely differed.

Accredited Representative

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