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INVESTIGATION REPORT

Accident to the ROBIN - DR400 - 140B registered F-GSBS

on 12 September 2020
at Col du Pas de la Coche, Belledonne Massif (Isère)

Time	Around 10:25[1]
Operator	Aéroclub du Dauphiné
Type of flight	Local
Persons on board	Pilot and two passengers
Consequences and damage	Pilot and passengers fatally injured, aeroplane destroyed

This is a courtesy translation by the BEA of the Final Report on the Safety Investigation published in January 2022. As accurate as the translation may be, the original text in French is the work of reference.

[1] Except where otherwise indicated, the times in this report are in local time.

Transition to the backside of the power curve, collision with the terrain, post-impact fire, during a mountain BIA flight

1 - HISTORY OF THE FLIGHT

Note: the following information is principally based on statements and data from the Private Radar application (see paragraph 2.7).

The pilot, accompanied by two passengers, took off at 10:15 from runway 04 of Grenoble Le Versoud aerodrome (Isère) (see Figure 1, point ❶). She intended to fly to Chamrousse (Isère) to the south by clearing the Pas de la Coche pass and then following the eastern slope of the Belledonne Massif.

At the end of the initial climb (see Figure 1, point ❷), the pilot turned right towards the south-east flying through an altitude of 4,500 ft (see Figure 1, point ❸), and made a 360° turn, at the end of which she had reached an altitude of 5,750 ft (see Figure 1, point ❹). She continued her route towards the south-east climbing for about three kilometres and entered the valley leading to the Pas de la Coche pass at an altitude of 6,150 ft (see Figure 1, point ❺). She flew through the centre of the valley below the ridge. She reached the bottom of the valley about thirty seconds later at an altitude of 6,400 ft. This altitude is lower than that of the pass. The aeroplane collided with the terrain about 100 metres below the pass (see Figure 1, point ❻), then caught fire.

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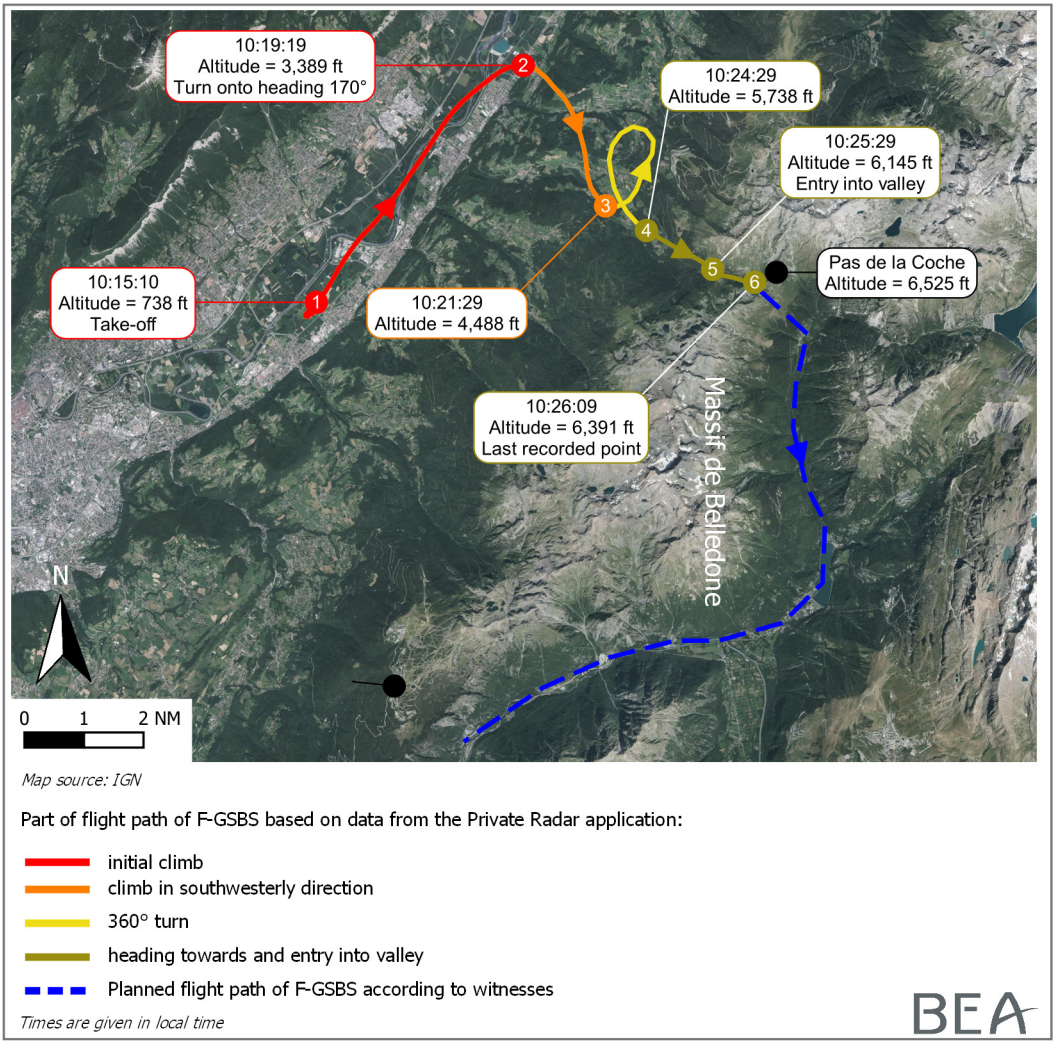

Figure 1: Path of the accident flight

2 - ADDITIONAL INFORMATION

2.1 Site and wreckage information

The wreckage was found flat and across the slope, before the pass, at an altitude of 1,880 m (pass altitude: 1,989 m/6,525 ft). It was oriented northwards. On the axis of the path of the aeroplane, before the wreckage, there was sparse vegetation which did not show any indication of having been stuck by the aeroplane, and after the wreckage, power lines and a pylon. The examination of the site and the wreckage indicated that the aeroplane had probably hit the ground with a slight nose-down attitude during a left turn.

The wreckage was not dispersed and was destroyed to a large extent by the post-impact fire. The examination of the wreckage was limited due to the damage caused by the fire and was unable to determine if the aeroplane was intact before the collision with the ground. The examination established that at the time of the impact, the metal cables of the flight controls were continuous and the metal rods ensuring the flap control operation were intact. The examination of the ailerons, control surfaces and flaps - which were destroyed in the fire - was unable to determine their positions and condition at the time of the impact. The damage to the propeller would suggest that the engine was providing power, although it was not possible to quantify this power. The damage to the engine did not reveal any pre-impact technical malfunction.

2.2 Examination of the exhaust system

A detailed examination of the aeroplane's exhaust system revealed a crack in the exhaust outlet pipe, in line with its connection with the exhaust muffler (see Figures 2 and 3).

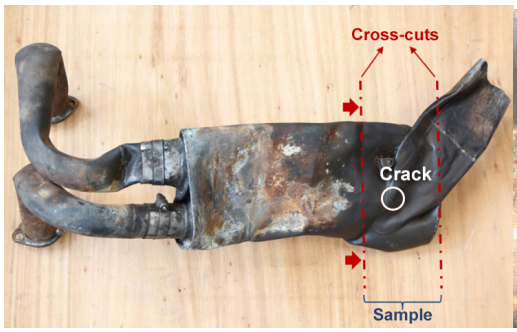

Figure 2: General view of the F-GSBS exhaust system

Figure 3: View of the crack

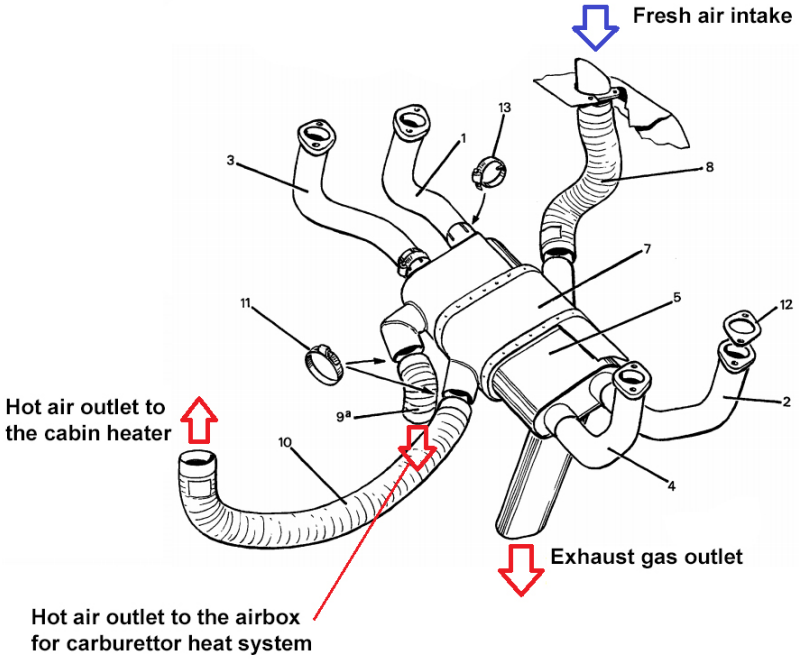

Figure 4: Diagram of the DR400 exhaust system

Item	Part
1, 2, 3, 4	Exhaust pipes
5	Heating exchanger casing
6	Exhaust muffler

The metallographic examinations and chemical analysis of the area around the crack showed the initiation of a corrosion phenomenon which had then progressively developed during use of the exhaust pipe. This phenomenon most likely led to an incipient crack which then grew. It was not possible to determine when this crack appeared or its dimensions prior to the impact.

The opening resulting from this crack may have caused exhaust gases to leak into the aeroplane's engine compartment during the flight, possibly leading to a higher-than-normal carbon monoxide (CO) level.

2.3 Aeroplane information

2.3.1 Maintenance of the exhaust system

The aeroplane was equipped with a 160 hp Lycoming O-320-D2A engine fitted with a carburettor. It was maintained by the Aéroclub du Dauphiné maintenance workshop.

The maintenance documentation indicated that the exhaust system was maintained in accordance with the manufacturer's specifications. The reports from the maintenance inspections performed in 2020, the last of which being a "*100-hour*" inspection carried out on 31 August 2020, did not mention any damage to the exhaust.

The documentation further indicated that the exhaust system had been replaced in May 2016 during a "*100-hour*" inspection.

2.3.2 CO level measurement

EASA recommends the installation of a CO detector on board light aviation aircraft[(2)]. This detector is usually in the form of a circular patch made of a chemical that changes colour as a result of a reaction with CO. A CO detection patch had been installed on the aeroplane's instrument panel by the maintenance workshop in January 2020. The accident occurred before the end of the patch's life (18 months according to the manufacturer's instructions). It burned during the aeroplane fire.

The aeroplane's maintenance program specifies that the level of CO in the cabin must be measured after any operation giving rise to a check flight[(3)]. According to the documentation, the last such operation was on 24 July 2018.

The pilots and instructors of the three flights performed the day before the accident had not observed any malfunction or unusual behaviour of the aeroplane, nor had they experienced any abnormal physical symptoms.

2.4 Meteorological information

The weather conditions estimated by the French Met Office, Météo-France, in the area and at the time of the accident were as follows: light wind, visibility greater than 10 km, few clouds, sky locally veiled by cirrus-type high clouds, with a few clouds clinging to the Alps.

The METAR report at 10:30 for Grenoble-Isère airport indicated:

- variable wind of 2 to 3 kt on the ground;
- CAVOK;
- temperature 22°C.

A photograph taken by a hiker a few minutes after the accident showed that the weather was sunny with a few clouds which did not hide the terrain.

(2) SIB No. 2020-01R1

(3) According to the recommendations issued by Robin (SB No. 041204), this measurement must be taken in climb, in level flight and in descent. The CO level must never exceed 50 ppm (CS23).

2.5 Pilot information

The 48-year-old pilot held a Private Pilot Licence - Aeroplanes (PPL(A)) issued in 1994 and had been a member of the Aéroclub du Dauphiné since 2002. According to the statements collected, she had logged approximately 300 flight hours, mainly in a DR400.

She had logged around 13 flight hours in 2019, her last flight being in November, and around 2.5 flight hours in 2020, including two instruction flights in July (flight over low-lying areas bound for Chambéry and runway circuits) after which she had been signed off to fly again, as well as solo runway circuits on F-GSBS in August.

She had not received any specific training or awareness information on mountain flying from a training organisation.

She flew regularly with her husband who was generally at the controls of the aeroplane. The latter stated that she knew the area well, and in particular the Pas de la Coche pass that she had cleared several times as a pilot and that they had cleared during a flight in the summer. He stated that he had been very surprised by the altitude at which she had entered the valley, which was lower than the recommended altitude and that this was known to her.

She was a citizen reservist at the Grenoble military school (EPA), as well as the president of the departmental section of the National Association of Air Force reserve officers (ANORAA). She regularly carried passengers, and in the last few years especially, she carried EPA students within the framework of the flight offered in their training for the BIA.

2.6 Organisation of BIA flights and context of the accident flight

2.6.1 Organisation of BIA flights at national and academic levels

The BIA is a certificate delivered by the French national education system. It is the result of a cooperation with the French general civil aviation authority (DGAC) and the French national council of aeronautical and sports federations (CNFAS). A national agreement between these three organisations provides a framework for schools and the federation-affiliated structures. In particular, it stipulates that these entities can establish local partnership agreements in order to organise practical training courses which may include air experience courses.

The French Air Force and Space Agency also takes part in BIA training and has a partnership agreement with the French national education system. It uses military airbases and relies on partners such as the ANORAA to promote and organise training. It also works with French aviation activity federations, as provided for in the general memorandum of agreement with the French Aeronautic Federation (FFA).

BIA air experience flights can be offered as part of the programme and are funded by grants and schools.

2.6.2 Status of BIA flights

BIA flights are not clearly defined in the regulations. The DGAC considers that they can be:

- A flight within the framework of flight training given by the flying club. This flight, which can be local or not, is carried out with an instructor.
- A circular introductory flight provided by an organisation, of a maximum duration of 30 minutes and a maximum distance of 40 km. The pilot must hold a PPL or LAPL and have logged a minimum of 200 flight hours in total, 25 of which in the last 12 months[(4)].

2.6.3 FFA's involvement in BIA training

The FFA launched a programme called "*Objectif BIA*" to follow and support young people, with the help of flying clubs, so that they obtain this certificate, and to encourage them to proceed with pilot training. Every year, at the beginning of the school year, the FFA sends a "BIA circular" to flying clubs, reminding them of the principles governing the organisation of BIA flights (programme membership, subsidies, reminders of the regulatory requirements, etc.). A template agreement between the school and the flying club is attached to this circular.

2.6.4 Organisation of BIA flights by the Aéroclub du Dauphiné

The Aéroclub du Dauphiné is affiliated to the FFA and has an agreement with the Isère Association for the promotion of the BIA (AIPBIA) regarding the training of the students who attend the association's BIA courses. The EPA is not a member of this association. The president of the flying club stated that the pilots who perform the BIA flights must meet the minimum experience requirements for the performance of introductory flights (see paragraph 2.6.2). The pilots who perform the introductory flights are officially authorised by the president through a jointly-signed annual form.

2.6.5 Context of the accident flight

Both passengers were high school students at the EPA and attended the BIA preparation courses offered by the school.

The EPA reported that each year since 2018, BIA students have had the opportunity to take part in an air experience flight on board an aeroplane. Within the EPA, a "*BIA contact*" plans the flights in coordination with a representative of the ANORAA. The latter is a pilot at the Aéroclub du Dauphiné and acts as the interface with the other pilots of BIA flights. These pilots are also reservists at the EPA, members of the ANORAA and members of the Aéroclub du Dauphiné. The EPA considers that they must have a valid PPL and must have completed an annual check flight with an instructor. The flights are partly subsidised by the French Air Force and Space Agency and by associations such as the ANORAA. The pilots performing these private flights finance the flights and then receive a reimbursement from the ANORAA.

(4) Order of 18 August 2016 concerning the elements left to the discretion of the competent national authority by Commission Regulation No 965/2012 of 5 October 2012 laying down technical requirements and administrative procedures related to air operations pursuant to Regulation (EC) No 216/2008 of the European Parliament and of the Council (Version in force on the date of the accident).

The pilot of the accident flight was not on the list of pilots authorised to perform introductory flights for and within the flying club. Moreover, at the time of the accident, there was no agreement between the flying club and the EPA. The managers of these two entities stated that the flying club was not involved in the organisation of the flights, which were carried out as private flights and not within the context of introductory flights. The president of the flying club and the chief-pilot stated that they had had no knowledge of the flight before the accident. Since the accident, an agreement between the flying club and the EPA was being studied so as to prepare a possible resumption of flights.

2.7 Read-out of path data

The aeroplane's path data was transmitted in real time and recorded at the flying club using the Private Radar application. This application communicated the aircraft's positions (latitude, longitude and altitude) from a computer installed on the aeroplane with a frequency of one point every four seconds.

The reconstruction of the path was possible based on this data (see Figure 1), and a ground speed could be calculated (see Figures 5 and 6).

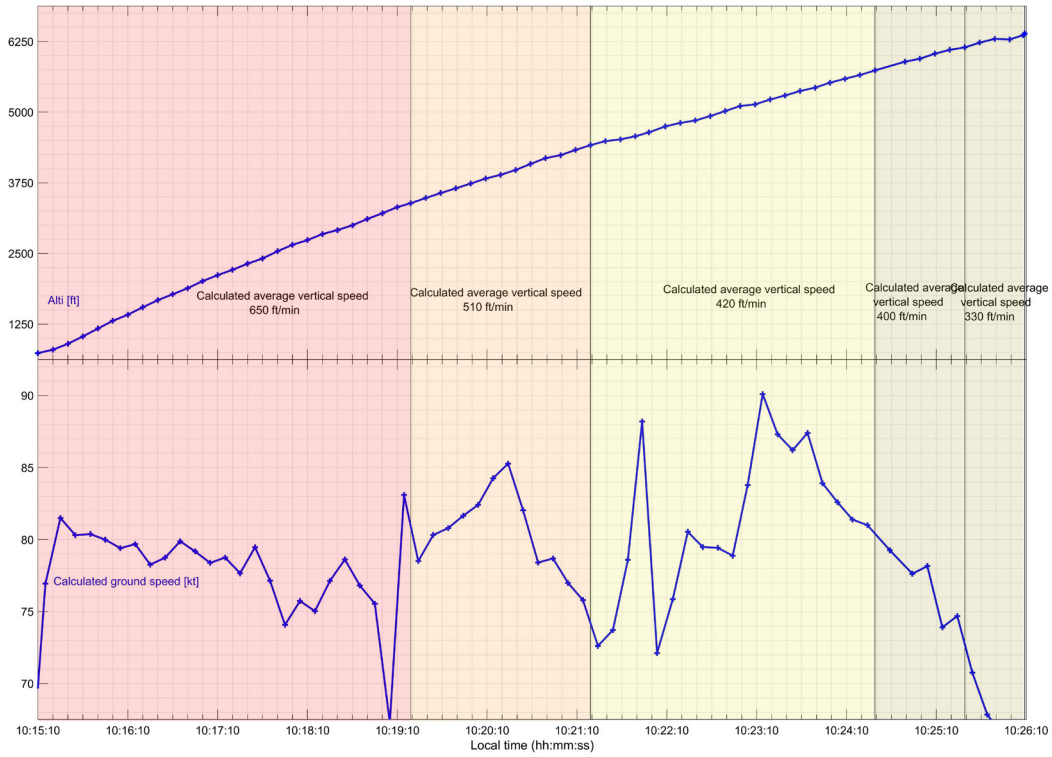

Figure 5: Parameters of the accident flight

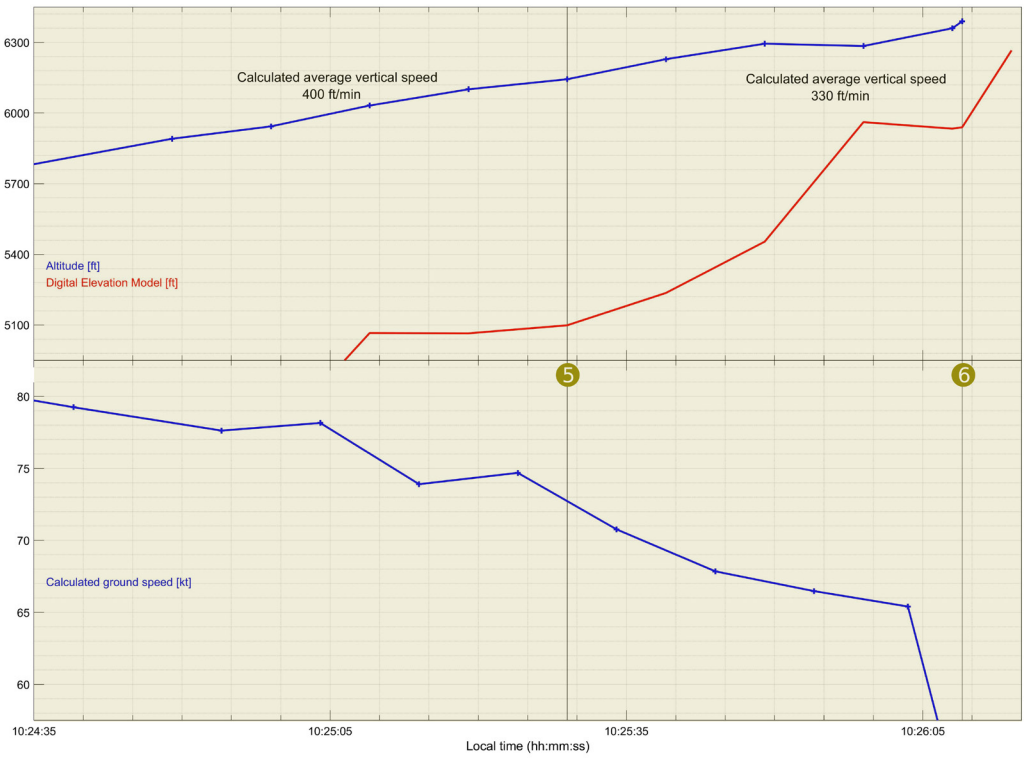

Figure 6: Parameters of the end of the accident flight

At the end of the 360° turn (see Figure 5, point ❹), the pilot headed in a straight line towards Pas de la Coche. During the last two minutes of flight, the ground speed of the aeroplane decreased gradually from about 80 kt (see Figure 5, point ❹) to 65 kt (see Figure 6, point ❻). Assuming there was no wind influence and taking an altitude of 6,000 ft, the indicated airspeed of the aeroplane therefore decreased from 70 kt to about 55 kt[(5)].

In addition, the average vertical speed, which was 420 ft/min during the 360° turn, dropped to 330 ft/min in the last 30 seconds[(6)] to reach a value close to zero in the last seconds of the flight.

The decrease in speed combined with the low vertical speed value is characteristic of a transition to the backside of the power curve.

2.8 Specificities of mountain flying

During visual flight training, the instructor trains the student pilot to assess the pitch attitude and bank angle of the aeroplane using the natural horizon. When flying in valleys, pilots who are not aware of the specificities of mountain flying expose themselves to a danger that is often not well known. During the flight, due to the presence of terrain, they may no longer have this horizon, which is their flying reference. As a result, they will no longer be able to assess the aeroplane's pitch attitude based solely on external visual references. An error of perception may lead to an excessive attitude which, if it is held, brings the aeroplane to the backside of the power curve.

Moreover, in mountain flight, flying on one side of the valley can increase the safety margins should the pilots need to turn around.

(5) At sea level with flaps retracted, the aeroplane's flight manual indicates a best angle-of-climb speed of 70 kt, a best rate of climb airspeed of 86 kt, and a stall speed of 53 kt.

(6) The flight manual indicates that in daylight conditions, the theoretical vertical speed at an altitude of 6,000 ft with a weight of 1,000 kg (maximum allowable weight) is about 600 ft/min.

2.9 Training principles of the flying club

[7] Declared Training Organisation.

As a DTO[7], the Aéroclub du Dauphiné offers its pilots mountain rating training. The president and the chief-pilot of the club stated that pilots training to obtain their standard LAPL or PPL are trained in low-lying areas. Due to the presence of terrain in the region, these courses include awareness information on the specificities of mountain flying. The chief-pilot reminds each pilot of the basic principles during their annual check flight. These practices are not formalised in the flying club's documents. Before the accident, there were no special requirements for pilots wishing to fly over mountainous areas.

After the accident, the club decided:

- To formally introduce, in the student-pilots' training record, a specific lesson on flying in a mountainous environment. This lesson must be given by an instructor holding a mountain rating and includes in particular an introduction to crossing a pass.
- To introduce a "*Mont-Blanc Certification*" granted following a flight in the sector with an instructor who holds a mountain rating. This initiative had previously been discussed during an internal safety meeting in July 2020.

2.10 CO poisoning

Autopsies of the aeroplane's occupants showed no evidence of respiratory activity in the fire. The toxicological analyses revealed high levels of CO-contaminated haemoglobin in the blood of the pilot (26%) and the passengers (13%). At the level estimated for the pilot, the latter may have experienced symptoms of toxic hypoxia likely to have impaired her capacity to make decisions and to perform manoeuvres. As with any hypoxia, the insidious onset of impairments and the sensitivity of the brain to the first manifestations can deprive the pilots of sound judgement. These symptoms may vary greatly from one person to another.

3 - CONCLUSIONS

The conclusions are solely based on the information which came to the knowledge of the BEA during the investigation. They are not intended to apportion blame or liability.

Scenario

During a flight in a mountainous area, the pilot, accompanied by two passengers as part of their preparation for the BIA, entered a valley at an altitude below the ridge line and the pass located at the end of the valley. Moreover, the environment, in particular the presence of power lines in the centre of the valley, interfered with a turn-around manoeuvre. Needing to gain altitude to be able to clear the pass, the pilot most probably gradually increased the aeroplane's pitch attitude. This action led to a gradual decrease in the aeroplane's speed and climb performance. The evolution in the calculated flight parameters showed that the aeroplane was probably flying on the backside of the power curve during the last two minutes of flight. When arriving at the pass at the end of the valley, and realising that she would not be able to clear it, the pilot probably attempted to turn around to the left, a manoeuvre during which she lost control of the aeroplane.

Contributing factors

The following factors may have contributed to the transition to the backside of the power curve, then to the collision with the terrain:

- ❒ The pilot's lack of knowledge of the specificities of mountain flying.
- ❒ The pilot's lack of recent flight experience.
- ❒ The carbon monoxide (CO) poisoning likely to have altered the pilot's perception of the path and her capacity to monitor the flight parameters; the crack found in the exhaust pipe most likely resulted from corrosion and led to a leak of CO into the aeroplane's engine compartment during the flight. The cause of the transfer of this gas from the engine compartment to the cabin could not be determined.

Safety lessons

Mountain flying

The proximity of an aerodrome to mountainous areas can spontaneously encourage the pilots based there to fly over the terrain or in the valleys.

Even if the regulations do not require any particular training, mountain flying has specificities due to the environment, in particular: unusual visual references due to the loss of the natural horizon, reduced operation performance, complex and changing aerological conditions and restricted space. Specific knowledge and techniques are required to fly safely in this hostile and demanding environment. Awareness-raising flights performed with instructors who have the necessary skills for this type of flight would allow pilots to better understand the risks of flying in mountainous areas.

Identification of and attention paid to particular activities in flying clubs

This accident shows that particular activities such as BIA flights, which normally require a framework and authorisations from the flying club, may be carried out by pilots who are members of the club, with the club's aeroplanes, without the club managers having any knowledge of it.

By introducing greater vigilance, club managers would be able to identify or anticipate potential abuses in this type of activity.

Detection of CO

The use of CO detection systems in the cabin (electronic device or patch on the instrument panel) can guard against the risk of accidental exposure to this toxic gas found in the engine exhaust gases. When a patch is installed, it requires regular visual monitoring during the flight so as to react quickly before CO inhalation results in physical and/or cognitive incapacitation. The serious incident to the DR400-120 registered F-GOVA[8] is a good example: patch monitoring led the instructor to abort the flight and ventilate the cabin as soon as he started to feel symptoms of poisoning.

[8] https://www.bea.aero/en/investigation-reports/notified-events/detail/serious-incident-to-the-robin-dr400-120-registered-f-gova-on-06-12-2014-at-cambrai-nord/