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INVESTIGATION REPORT

Accident to the Van's Aircraft RV7 registered D-EIOI on 29 August 2018 at Bourg-Saint-Maurice (Savoie)

Time	At 19:06[1]
Operator	Private
Type of flight	Cross country
Persons on board	Pilot and passenger
Consequences and damage	Pilot and passenger fatally injured, aeroplane destroyed

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

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

Continuation of mountain flight in stormy weather conditions, icing of carburetion system, loss of control, collision with terrain

1 - HISTORY OF THE FLIGHT

Note: The history of the flight is based on the data transmitted by the Geneva air traffic unit (Switzerland), the data downloaded from one of the two DYNON AVIONICS D1000 EFIS installed in the aeroplane and the statement of the pilot who was initially flying in formation with the D-EIOI pilot.

The pilot, accompanied by a passenger, took off at 17:21 for a VFR flight from Fribourg-en-Brisgau aerodrome (Germany) where the aeroplane was usually based. The aim of the flight was to meet up with friends in the south of France for a week's holiday. The pilot initially headed towards the Feldberg[2] where he had arranged to meet, in flight, a friend piloting a Van's Aircraft RV7A registered D-EKPM. The plan was to fly over Switzerland and then continue to Cuers-Pierrefeu aerodrome (in the Var), on a transborder flight plan.

[2]One of the peaks of the Black Forest massif.

The two pilots coordinated together beforehand with respect to this formation flight and had agreed that D-EKPM, which was slower, would fly ahead of D-EIOI and that the D-EKPM pilot would be responsible for the exchanges with the air traffic units.

From 18:12, the D-EIOI pilot had difficulties with maintaining visual contact with D-EKPM due to the meteorological conditions encountered.

At 18:29, he lost sight of D-EKPM and disconnected the autopilot (AP) (point ❶ of Figure 1) before tracking south and starting to climb.

So as not to have to climb, the D-EKPM pilot headed south-west towards Chambéry (Savoie) and then the Rhône valley before arriving at the planned destination.

At 18:33, when the aeroplane was at an altitude of 8,045 ft, the EFIS data indicates the first icing phenomenon affecting the carburettor characterized by a decrease in the manifold pressure of the engine. This data also shows that a pilot input on the carburettor air intake heat control restored the engine power a few instants later (point❷ of Figure 1).

From 18:39, the D-EIOI pilot continued climbing and started manoeuvring above 10,000 ft (point❸ of Figure 1). A minute later, the EFIS data again shows an icing phenomenon affecting the carburettor managed by the pilot (point❹ of Figure 1).

At 18:49, he flew 360° to continue climbing and manoeuvred above 12,500 ft (point❺ of Figure 1).

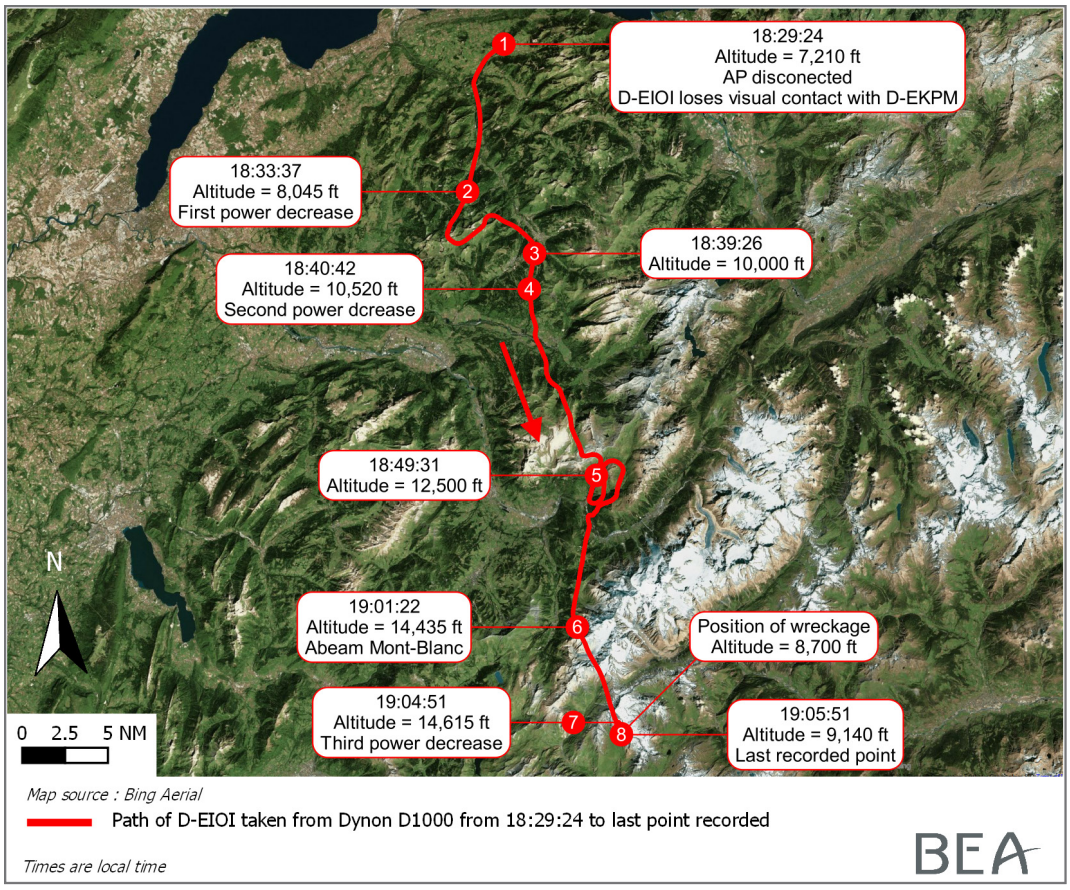


Figure 1: path of D-EIOI

At 18:56, the D-EIOI pilot said that he was "*in clouds*" and then "*out of clouds*" and that he was heading towards Megève altiport. Five minutes later, the aeroplane was abeam Mont Blanc (point❻ of Figure 1) at an altitude of 14,435 ft.

At around 19:05, when the aeroplane was banking around 45° to the right, with the bank angle increasing, its attitude was 15° nose down and the indicated airspeed was around 70 kt increasing to 120 kt, the manifold pressure of the engine decreased a third time, faster than the two previous times, again because of an icing phenomenon affecting the carburettor. The pilot lost control of the aeroplane which descended 4,600 ft in 35 s (point❼ of Figure 1). During this phase, the aeroplane was probably on its back with a nose-down attitude which reached 80 degrees. The path then stabilized and the aeroplane was momentarily flat with full power just before colliding with the terrain.

The Geneva Information air traffic controller[3] with whom the D-EIOI pilot was in radio and radar contact since flying over Switzerland lost contact with D-EIOI at 19:05.

The search operations which mobilized the French, Swiss, German and Italian Aeronautical Rescue Coordination Centres started at 19:28 but were suspended due to the meteorological conditions prevailing in the region. The following day at daybreak, the air search operations located the aeroplane wreckage at around 11:00 at 2,670 m on the south-west slope of a ridge with a summit at 3,000 m, north-east of Bourg-Saint-Maurice, near the Italian border.

[3] The control sector situated south of Lake Geneva over French territory is contractually delegated to the Swiss air traffic control service.

2 - ADDITIONAL INFORMATION

2.1 Pilot information

The pilot and owner of the aeroplane, aged 53 years had a private pilot aeroplane licence PPL (A). It was not possible to know exactly the total number of flight hours which he had logged. According to available information, it is believed that he had logged a total of around 1,000 flight hours of which 135 hours were declared in the two years preceding the accident. He did not have an instrument rating.

The pilot had already made the journey between Fribourg-en-Brisgau aerodrome and Cuers-Pierrefeu aerodrome at least ten times, generally with the pilot of the D-EKPM but on the same aeroplane (D-EIOI or D-EKPM).

The autopsy did not reveal any element likely to have contributed to the accident.

2.2 Aircraft information

The American-design Van's Aircraft RV7 with fixed tail wheel landing gear is equipped with two side-by-side seats. It is an amateur-build pre-assembled kit. D-EIOI was thus built by the pilot between 2013 and 2016. The Permit to Fly approval was issued to the pilot on 6 January 2016 by the German civil aviation authority[4].

[4] Luftfahrt-Bundesamt (LBA).

The aeroplane is restricted to VFR flights and is not designed for flight in icing conditions. Apart from the engine which was followed by a workshop, it was the pilot who carried out the maintenance of the aeroplane.

2.3 Site and wreckage information

The site was in a rocky high mountain environment with grass ledges. The wreckage was situated on one of these ledges, on the east slope of a small north-running valley.

The wreckage was all in one place and resting on the lower part of the fuselage, pointing in a 030° direction.

Observations of the site and the wreckage saw that the aeroplane had hit the ground with high horizontal energy with wings relatively level and flaps retracted. The flight controls had been violently broken in several places, consecutive with the impact with the ground and the loads generated. The AP was disengaged and the elevator trim control was in neutral. The examination of the wreckage did not reveal any technical anomaly conducive to the accident. The engine was producing power on impact.

No oxygen equipment was found on the aeroplane or nearby.

2.4 Meteorological information

2.4.1 Estimated meteorological conditions in the region

The meteorological conditions in the area at the time of the accident were estimated by Météo-France as:

- presence of cumulonimbus west of the accident site;
- a temperature of around 10°C;
- 90% humidity;
- an average westerly wind of 20 kt with gusts of 30 kt in variable directions due to the presence of storm cells generating a high risk of turbulence.

At the time of the accident, a highly unstable front was quickly travelling west to east with a lot of electrical activity recharging in the presence of high ground. The convective cell on the Mont Blanc massif was centred on the Aiguille du Goûter[5] (3,863 m). The meteorological data available for the Aiguille du Midi (3,842 m) which is in the immediate vicinity gave a temperature of 0°C and gusts of 30 kt, at the time of the aeroplane's passage.

[5] D-EIOI flew west abeam close to the Aguille du Goûter at 18:59 at 14,500 ft.

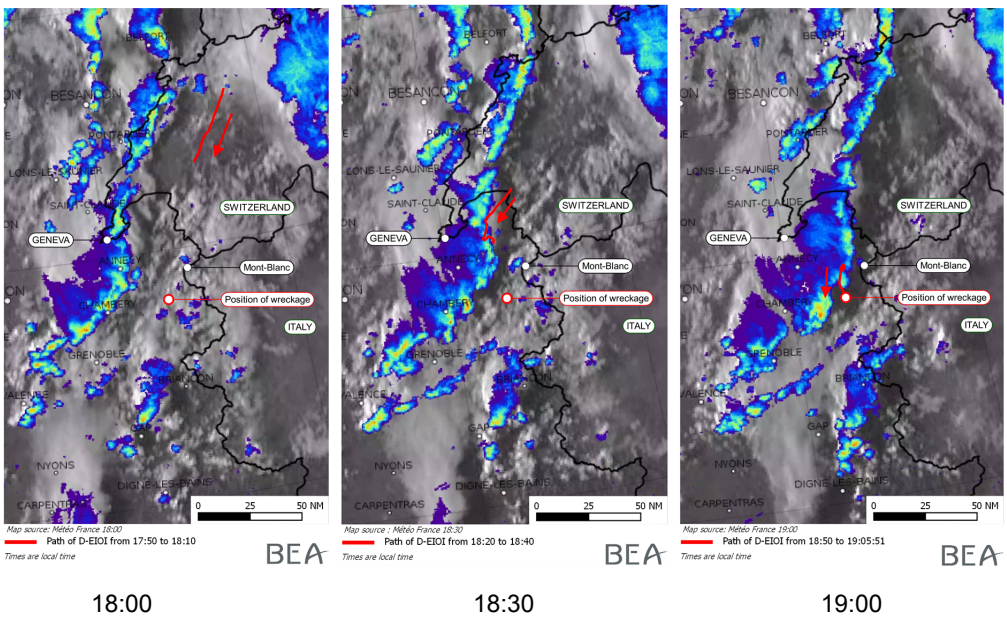
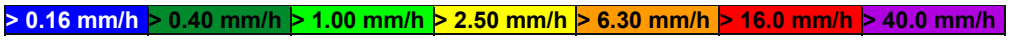


Figure 2: Météo France radar maps

The three radar maps (Figure 2) show the quick travel of the front whose most active part was at the latitude of the accident site. The overlaid red marks represent portions of the aeroplane's flight path during the few minutes around the time at which each weather map was issued.

With the weather radar it is possible to identify precipitations, to calculate their travel and to define their type (rain, snow, hail). Rain drops, snowflakes and hailstones reflect the electromagnetic waves sent by the radar in proportion to their size. This return signal is called an echo. The depiction of the echoes on a map show the geographical distribution of the precipitations along with their intensity by means of the following colour codes.



A yellow, orange or red patch represents a precipitating cumulonimbus, red indicating probability of hail in most cases.

2.4.2 Meteorological information available before the flight

The weather forecasts available before the flight (SIGWX chart valid for 17:00, Annecy and Chambéry TAF) were consistent with the estimated and observed weather conditions in the region and at the time of the accident.

After the rapid departure of this front to the east, the weather forecasts available before take-off, for the next day indicated favourable improvements for carrying out a flight under VFR.

The investigation was not able to determine what weather information was obtained by the pilot before starting the flight.

2.5 Icing phenomenon affecting piston engine carburetion systems

D-EIOI was equipped with an uncertified Lycoming YO-360-A1A piston engine and carburettor along with a variable-pitch propeller. The carburettor of this engine was associated with a mixing unit allowing the pilot to select an alternate hot air source to the cold air directly coming from the air intake. This system is a means of preventing or clearing the icing phenomenon.

In addition, the pilot had a "*carburettor*" temperature display showing the measured temperature just before the carburettor throttle valve. When the pilot selected the hot air source, this measured temperature changed accordingly.

The European Aviation Safety Agency (EASA) has published a document[(6)] called "*Piston Engine Icing*" which describes the various icing phenomena which may occur in piston engine carburetion systems. It specifies the contributing factors, conducive weather conditions, parameters available to the pilot to identify the incipient icing and the actions to be taken to prevent or stop it.

For the same type of engine as on D-EIOI, the EASA document specifies:

- that the onset of icing in the engine carburetion system is shown by a drop in manifold pressure;
- that when icing has started and the hot air source has been selected to remedy this, the engine's nominal power may only return after an interval which may exceed 15 s;
- that warm temperatures and high humidity were conducive to a severe risk of icing of the carburetion system.

[(6)] Available at the following address: https://www.easa.europa.eu/document-library/general-publications/egast-leaflet-ga-5-piston-engine-icing

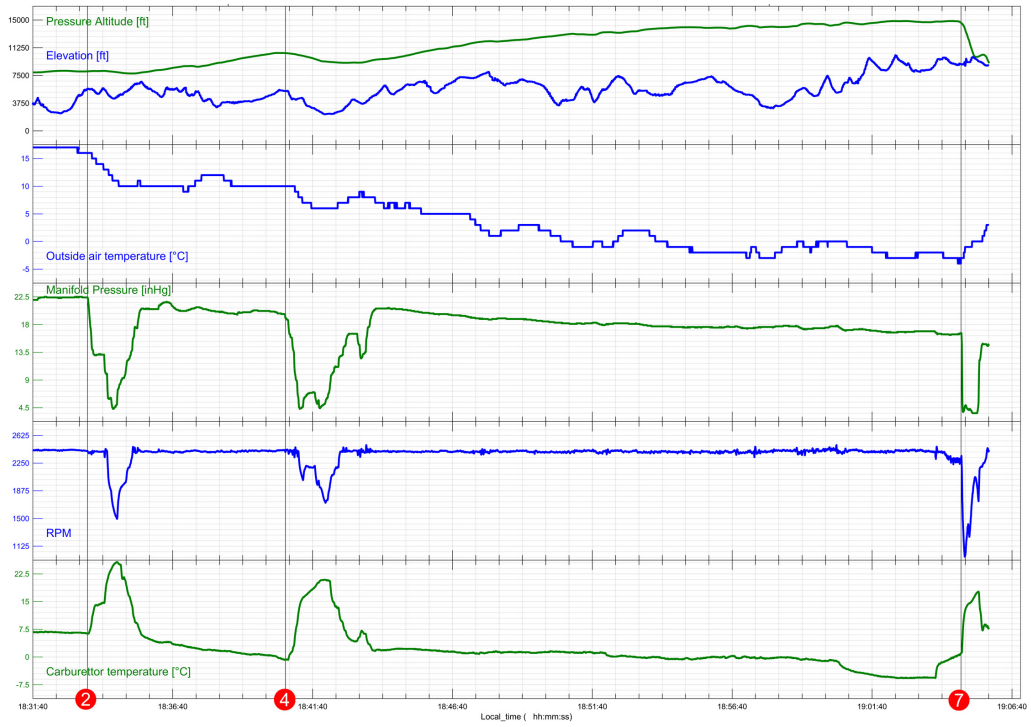


Figure 3: Readout of parameters recorded during flight

Based on this information, the readout of the parameters recorded during the flight show three icing phases of the carburetion system. For each phase, the parameter curves show that the hot air source was indeed selected to remedy this. The third and last phase shows that the pilot selected the hot air source a few seconds before the manifold pressure dropped (Figure 3) and that a more sudden onset of the phenomenon occurred doubtlessly due to the more severe icing conditions. The return of engine power was identified around one minute 50 s after this action, i.e. less than 30 s before the impact with the ground.

The parameters seem to show that the pilot was monitoring the occurrence of the icing phenomenon using the aircraft instruments by acting in a quick and suitable way to recover the manifold pressure.

2.6 High altitude flight and risk of hypoxia

Altitude hypoxia is a major risk during high-altitude flights. It can lead to a progressive impairment of physical and mental abilities due to the implementation of the organism's natural mechanisms to compensate for the insufficient oxygen. Documents available on the subject indicate that the first symptoms can appear at 5,000 ft.

The French regulations applying to amateur-built aircraft[7] specify:

- For any flight at a flight level above 125 (pressure altitude 3,800 m), each member of the flight crew must have a breathing system and a sufficient supply of oxygen for the duration of the flight at this level.
- For any flight at a flight level above 145 (pressure altitude 4,400 m), each person onboard must have a breathing system and a sufficient supply of oxygen for the duration of the flight at this level.

[7] French decree of 24 July 1991 regarding the conditions of use of aircraft with unpressurised cockpits in general aviation and French decree of 8 January 2018 regarding the operation in France of foreign amateur built aircraft which sets out the required conditions to fly over French territory.

During the accident flight, the aeroplane reached 14,615 ft shortly before colliding with the terrain. Before this, it had manoeuvred:

- 1 h 37 min above 5,000 ft;
- of which ten minutes between FL100 and FL125;
- and 15 minutes above FL125.

The pilot and passenger did not have oxygen equipment onboard. The D-EKPM pilot said that the D-EIOI pilot owned oxygen equipment for high altitude flying and specified that he thought that the equipment was on the aircraft the day of the accident.

The time spent at high altitude during the accident flight is consistent with the risk of altitude hypoxia. However, the messages transmitted on the frequency and the recorded parameters which show pertinent flight management inputs mean that it is not possible to determine that there was a reduction in the pilot's performance levels characteristic of hypoxia, despite difficult conditions, even in the last moments of the flight.

2.7 Witness statement

The D-EKPM pilot said that they had prepared the flight together by telephone and that they considered that the flight was feasible in VMC conditions.

On leaving Lake Geneva, he described the conditions as being very black and stormy over Geneva and the Jura and specified that there were chimneys surrounding Morzine. He added that he then decided to modify his path to Chambéry to avoid climbing in a high-mountain area, in order to pass by the Rhône valley and keep sight of the ground.

He also added that the D-EIOI pilot asked him to join him close to Mont Blanc when he was at an altitude of 12,500 ft, with "blue sky and VMC." The D-EKPM pilot explained that he did not manage to join him due to the clouds and that consequently he continued his route to Chambéry. He descended from an altitude of 12,600 ft to 6,500 ft due to turbulence. He then flew through a zone with heavy precipitations for around ten minutes.

With respect to the two aeroplanes, he said that they had AP and were equipped to carry out a flight with no visibility without being approved for IFR flight. He considered that the engine of his aeroplane was less powerful than that of the D-EIOI which could furthermore, fly quicker and higher.

The D-EKPM pilot said that the D-EIOI pilot probably decided to track towards the mountain massif and climb rather than manoeuvre in the precipitations with the passing of the active front south east of the route. He added that on two occasions, the D-EIOI radio equipment had been damaged after getting wet following infiltrations during flights in precipitations.

3 - LESSONS LEARNED AND CONCLUSION

The investigation was unable to ascertain what the pilots had collected as weather information during their flight planning but the pilot of the second aeroplane said that they had concluded that the flight was possible under VFR.

On approaching Lake Geneva, the D-EIOI pilot continued the flight by tracking towards the Alp massif. The weather conditions, consistent with the weather forecasts available before take-off, were unstable with an active thunderstorm over the Alps. Due to the high ground, the cloud layers and the icing phenomena affecting the engine carburetion system, he then found himself having to manage a more difficult path than that chosen by the D-EKPM pilot. He did not formally ask for controller assistance and did not declare an emergency situation. At high altitude, the aeroplane manoeuvred in a moist, cold air mass with turbulence. The icing of the engine carburetion system for the third time caused a drop of manifold pressure when the aeroplane was banking right with a high angle and nose-down attitude. The pilot lost control of the aeroplane which dropped 4,600 ft in 35 s and then regained control a few seconds before the collision with the terrain.

The following factors may have contributed to the accident:

- An inadequate analysis when preparing the flight, of the available weather forecasts consistent with those observed and estimated during the accident flight and of the possible diversions according to the meteorological conditions encountered in flight;
- Continuing the flight by tracking towards the highest massifs of the Alps in unfavourable/incompatible weather conditions for a flight under VFR.

Decision-making is a complex process which depends on the person's judgement of the situation and assessment of possible solutions, and must comply with a time constraint. On the ground, the flight should be prepared using the meteorological and aeronautical information, with the least time pressure possible. In flight, at the first signs of unfavourable meteorological conditions, a diversion is an essential alternative to be taken into account.