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

www.bea.aero
@BEA_Aero

INVESTIGATION REPORT

Accident to the SOCATA TBM700N registered N850GC
on 8 August 2013
at Vertaizon (Puy-de-Dôme)

Time	Around 07:40[1]
Operator	Private
Type of flight	Cross-country
Persons on board	Pilot and two passengers
Consequences and damage	Occupants fatally injured, plane destroyed

This is a courtesy translation by the BEA of the Final Report on the Safety Investigation published in June 2020. As accurate as the translation may be, the original text in French is the work of reference.

[1] Unless otherwise stated, all times in this report are in Coordinated Universal Time (UTC). Two hours must be added to this time to obtain the time in metropolitan France on the day of the occurrence.

Loss of control during go-around on precision approach

1 - HISTORY OF THE FLIGHT

The pilot, who was accompanied by two passengers, took off from Toussus le Noble airport (Yvelines) bound for Clermont-Ferrand Auvergne airport (Puy-de-Dôme) for a private flight on an IFR flight plan. Cruise was conducted at FL 230.

The path constructed from the radar data suggests that the autopilot was engaged. At 07:20:08, the pilot established radio contact with the Clermont-Ferrand approach controller. The controller asked him to descend to FL 90, direct to RIMOR IAF[2] under the ILS Z procedure for runway 26 in use. The pilot did not read back. When the controller contacted him again to find out if he had heard the instruction, the pilot read back with a flight level error. The controller corrected him, instructed him to descend to 6,000 feet and cleared him for the ILS Z approach to runway 26. The meteorological conditions at the time of the approach were IMC.

[2] Initial Approach Fix.

At 07:30:37, at a distance of 12 NM from CF[3], the pilot announced that he was established on the localizer for runway 26. The approach controller transferred him to the tower controller. Thirty seconds later, the pilot advised the tower controller that he was established on the localizer for runway 26, 10 NM from CF. The tower controller then cleared him to land on runway 26.

[3] DME of ILS 26.

RÉPUBLIQUE FRANÇAISE
Liberté Égalité Fraternité

n-gc130808.en/**November 2020**

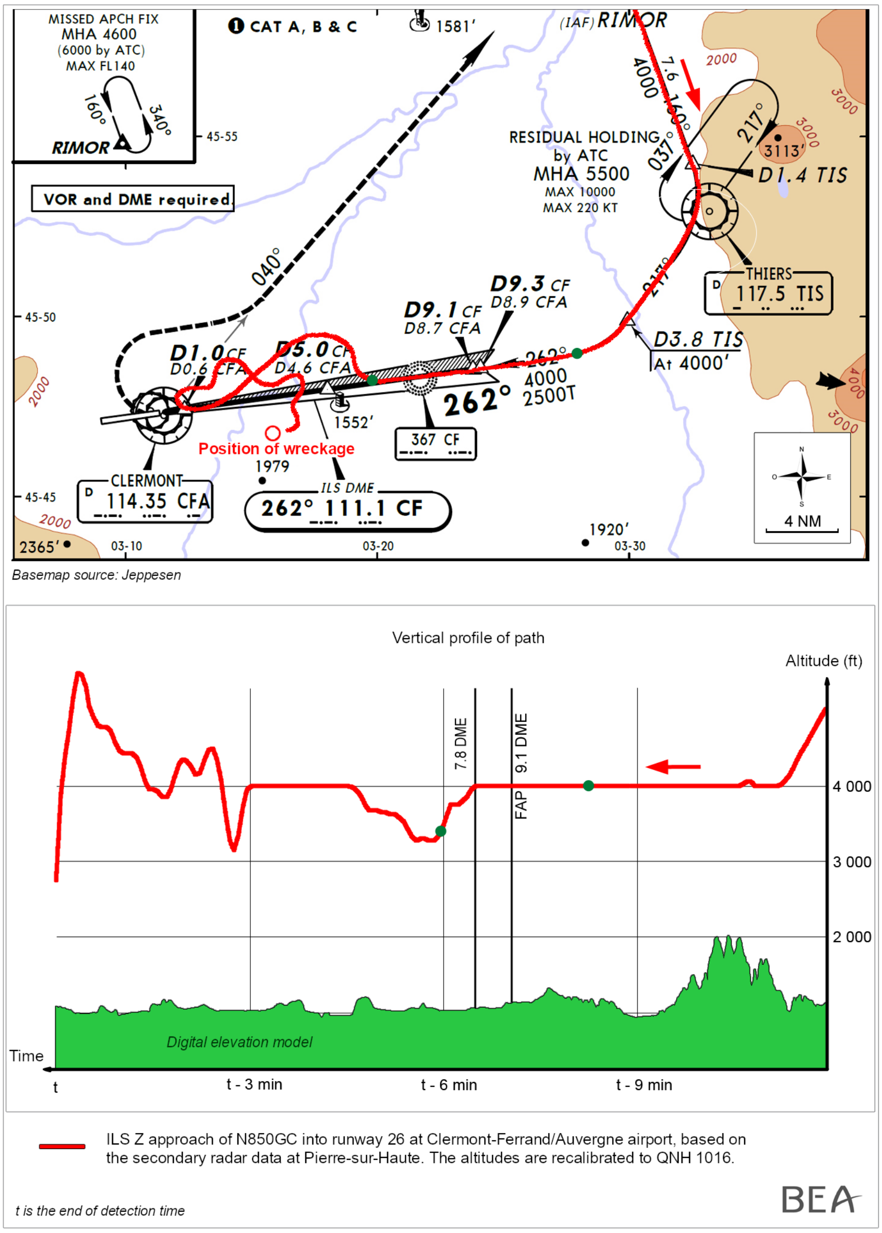

Figure 1: Vertical path as a function of time

The aeroplane remained in level flight at 4,000 feet beyond the final approach point (FAP) located 9.1 NM from CF. It remained aligned with the localizer until 6.4 NM from the runway threshold. The pilot probably disconnected the autopilot and attempted to rectify the glide slope from above. About two minutes later, the tower controller noticed a lateral deviation to the right of the runway centreline and contacted the pilot. The pilot informed him that he wished to "*go around and go back to resume the approach*" and announced that "*his autopilot had malfunctioned*".

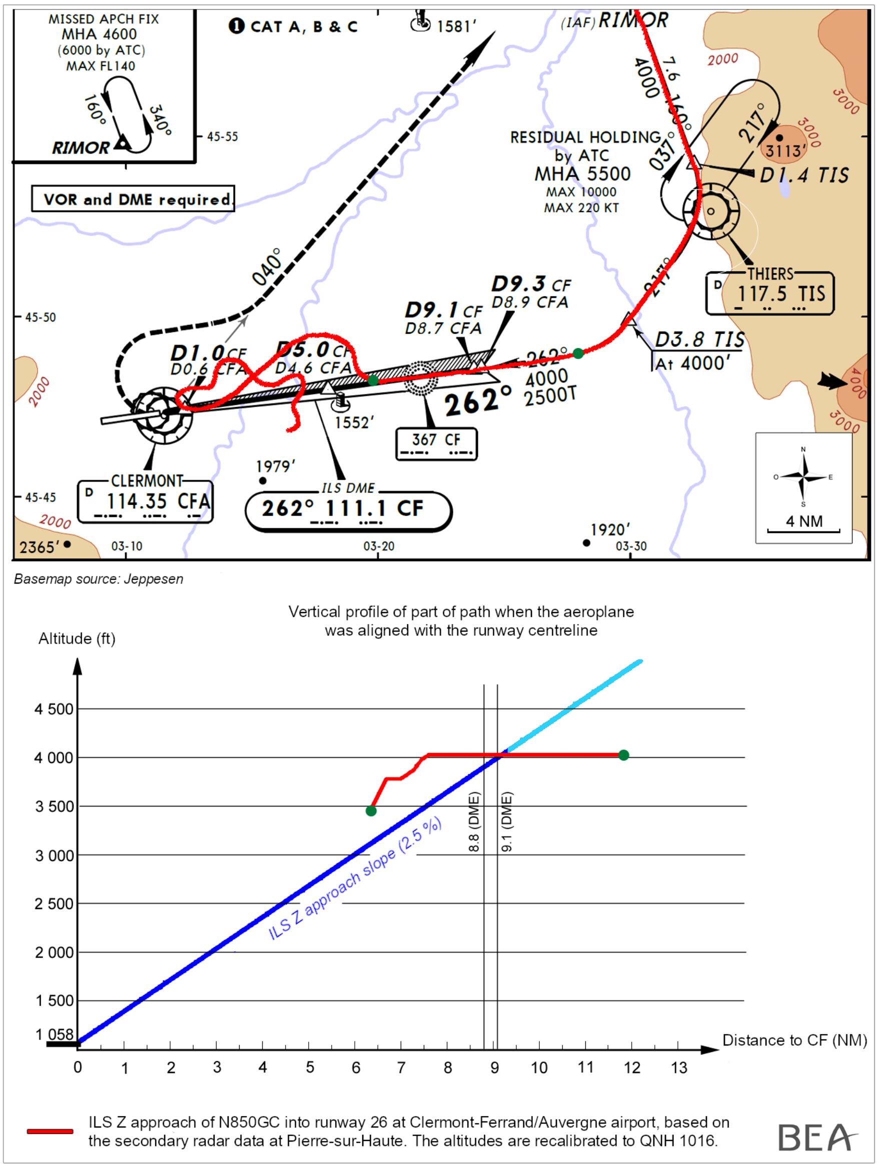

Figure 2: Vertical path as a function of distance compared with ILS glide slope

As the pilot was not following the published missed approach procedure, the controller suggested that he climb to the 6,000-foot safety altitude in the direction of the TIS VOR by making a right turn. The pilot read back, but first returned to the runway centreline in level flight at 4,000 ft. The controller then repeated his instruction to re-join the TIS VOR. The pilot replied that he was going to "*programme*" this point and then turned several times to the right and then to the left, first descending and then climbing. During this phase, the controller provided heading instructions to re-join the TIS VOR. The pilot read back with delays and sometimes with errors. The controller realised this and therefore limited his instructions to a climb to 6,000 ft. The aeroplane then started to climb to about 5,500 ft and then descended at a significant vertical speed south of the runway centreline. Witnesses saw the aeroplane collide with the ground on a steep slope with a wings-level attitude.

BEA

Figure 3: Aerial view of the site

Figure 4: Wreckage as seen from the ground

2.2 Description and use of the Garmin 1000 avionics suite

(4) Primary Flight Display.

(5) Multi Function Display.

(6) GPS is used to refer to the function of the avionics suite and refers to GNSS navigation as a whole.

(7) Flight Management System.

N850GC was a TBM850 equipped with a Garmin 1000 avionics suite, which includes two PFDs(4) and an MFD(5). Navigation can be performed using either satellite or conventional means (VOR, ADF) or a combination of these sources. The pilot can select the active source. The departure and en-route portion of the flight is usually conducted using a GPS source(6) and if an ILS is available on arrival, then the approach is performed using conventional radio navigation.

The flight plan is entered into the FMS(7) and sequenced: departure, en route, arrival, approach and missed approach. However, it is necessary to add to it depending on the clearances given by the controller. Most of the departure, arrival and approach procedures (SID, STAR and APP) are coded in the avionics suite database and can be inserted into this flight plan. When a flight plan containing an arrival procedure is entered into the FMS, then the system is able to perform the change from the GPS source (**Magenta GPS**) to the conventional source (**Green LOC**) automatically.

If the autopilot (AP) is active and the approach mode is enabled by the pilot, then the horizontal and vertical paths of the aeroplane will be flown automatically by the system. All the pilot has to do is manage the power.

An automatic descent of the aeroplane under the AP is possible:

- only when the source that is compatible with the planned approach is active, which in this case was the conventional source (the GPS-conventional transition is performed either automatically or manually);
- only if the localizer (LOC) mode is active before the Glide Slope (GS) is intercepted.

The pilot controls the descent sequence using the same method, i.e., control of the actual source and control of the actual LOC before interception of the GS.

Although an automatic transition from a GPS source to a conventional source is possible, the pilot must either anticipate the change in status or initiate it manually. It is the latter method that is usually taught.

During an ILS approach, the manual transition from the GPS source to the conventional source at the appropriate time allows for efficient operation of the radio navigation equipment. The anticipation and attention required by this method provides better situational awareness and increased path monitoring, including in the event of an error in the approach procedure coded in the FMS.

The introduction of glass cockpit systems implies a change in working methods for pilots of light aeroplane flying under IFR. They must check the validity of the data contained in the FMS, in particular by checking the sequencing of the approach points and the distance between them.

2.3 Coding of ILS Z 26 approach to Clermont-Ferrand Auvergne airport in the G1000 suite

The final approach point (FAP), which indicates the start of descent on the 5.2% ILS slope, was 9.1 NM from CF. The decision altitude (DA) was 1,320 ft (decision height (DH) of 260 ft).

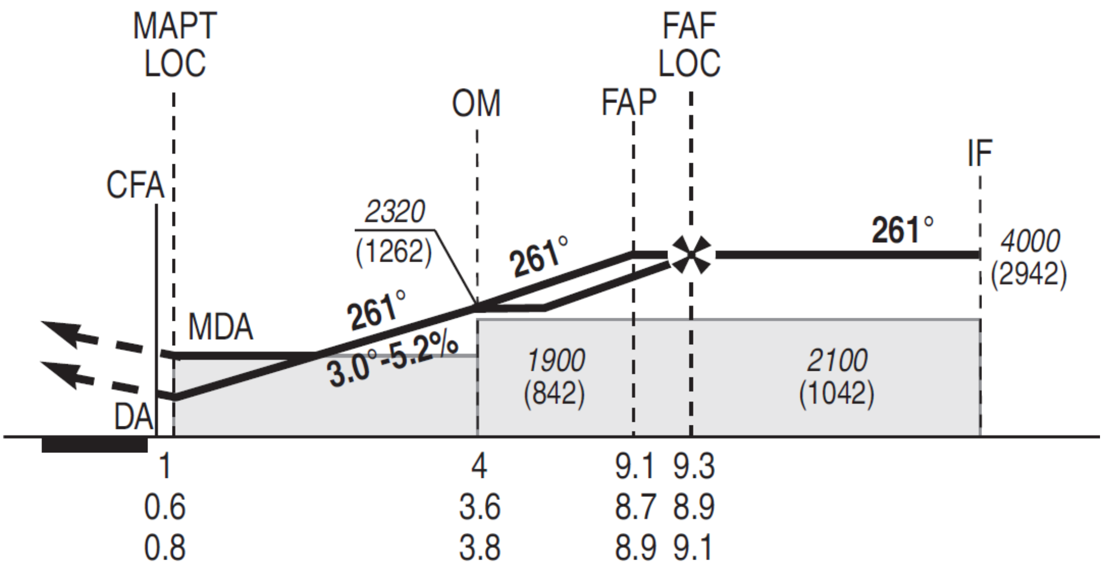

Figure 5: Vertical section of the ILS Z approach slope on the IAC[8].
The vertical profile of the Jeppesen chart is identical

[8] Instrument Approach Chart.

The coding of the Jeppesen database of the Garmin G1000 avionics suite differs from previous charts. The ILS approach is coded with an FAF[9] (Final Approach Fix) and an MAP (Missed Approach Point), which are characteristic of non-precision approaches:

[9] And not an FAP (Final Approach Point) as should be the case for a precision approach and as specified on the IAC.

- The RW26 map is located at the threshold of runway 26.
- The FI26 faf is located 5 NM from the MAP and must be flown over at an altitude of 4,000 ft.
- A point CI26Z located 8.9 NM from the MAP is also recorded and an altitude of 4,000 ft is associated with it. It is located just after the real FAP[10] through which the radio beam passes.

[10] In the direction of the approach.

Figure 6: G1000 cumulative distance between the points (APP - ILS Z 26)

Thus, the last active point is located after the actual descent point. These differences are shown in Figure 7.

The **red** FAP is the start of descent point for IAC and Jeppesen procedures.

The other points are the last points of the LFLC ILS Z 26 approach from the Jeppesen database in the G1000.

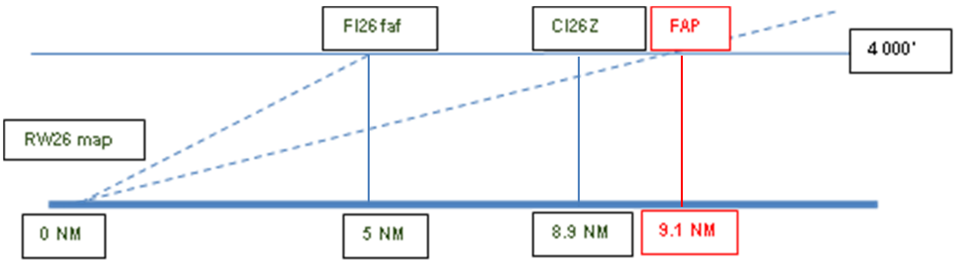

Figure 7: Differences between the approach charts and the coding in the G1000 avionics suite database - 0 NM corresponds to the threshold of runway 26

To perform the automatic transition from GPS to LOC, the avionics suite uses a defined distance from the start of descent point (FAP or FAF). If the position of this point is wrong in the database, then the automatic transition is not performed at the right place. If this transition occurs after the FAP, then the automatic flight control system is no longer able to capture the GS and ensure descent.

The error in the Garmin 1000 avionics suite database prevents full engagement of the approach mode for the following reasons according to the Garmin specifications:

1. The automatic transition from GPS mode to VLOC mode is only possible when the point FI26 faf is active, after passing point CI26Z, which is coded more than 0.2 NM after interception of the glide slope.
2. Interception of the glide slope could only be possible after passing the programmed point FI26 faf. However, by this point, the aeroplane is above the GS's actual beam. Capturing the glide slope from above is not possible with the AP engaged. Thus the aeroplane remains in level flight.

Figure 8: 9.8 NM DME CF: source GPS

Figure 9: 8.8 NM CF: transition GPS → LOC

This coding error and the transition were reproduced during a test flight with an aeroplane fitted with the same avionics suite. The following sequence was reproduced:

- The aeroplane was in AP in lateral navigation mode and with the GNSS source active (NAV GPS displayed). The appropriate ILS frequency was set.
- The approach mode, to follow the LOC and GS on precision approaches, was enabled by pressing on the APP button (LOC and GS modes displayed).
- During the CI26Z branch to FI26 faf, the automatic transition from the GPS source to the VLOC source occurred 0.3NM after the official FAP for the ILS approach to runway 26.
- The aeroplane continued in level flight and did not capture the ILS glide slope.

The screenshots in Figures 8 and 9 illustrate the transition from GPS mode to LOC mode during a test flight following the ILS 26 approach. In Figure 9, the automatic source change has just taken place (DME D8.8 CF) and the aeroplane is located above the GS. The LOC is still being activated when the point of interception with the glide slope is passed. The GS is armed but not active. The system does not descend the aeroplane and the aeroplane remains in level flight, which is consistent with the sequencing required to descend (see §2.2).

The inconsistency could have been detected by comparing the position of the FAF in the database with the position indicated on the approach chart, either during flight preparation or in flight after inserting the approach into the FMS. The distance between FI26 faf and RW26 map was 5 NM in the database whereas the distance between the FAP and the MAP is 9.1 NM in the aeronautical information publication.

However, this information was not very salient. The detection of such an inconsistency should, in principle, lead the pilot to invalidate the FMS procedure concerned and opt for a manual source selection with a view to piloting the aeroplane according to the conventional procedure.

The databases that are integrated into the avionics suites are not subject to point-to-point validation, but rather to certification based on general coding principles. It is the responsibility of the operator or the pilot in recreational aviation to ensure compliance with the applicable official documentation.

2.4 Pilot information

The 73-year-old pilot had held a PPL (A) licence since 2009. He had had it converted to an American licence in 2010 and held an IR rating in the United States. He had held a SET SOCATA TBM class rating since April 2013.

He had logged 615 flight hours, including 141 hours under IFR, 51 hours on TBM, including 7 hours under IFR and 30 hours in the last three months. His pilot logbook included the signatures of various safety pilots relating to 16 hours completed in dual control after obtaining the TBM class rating.

He also owned an SR22 equipped with a G1000 avionics suite on which he had logged approximately 134 flight hours under IFR before obtaining the TBM class rating. He was unfamiliar with IFR flights without external visual references.

The insurance chosen by the pilot had required him to have a safety pilot present for the first 25 hours of flight time on the TBM following completion of his class rating. This safety pilot had to be an instructor and have at least 200 flight hours of experience on the TBM. The safety pilots who were contacted indicated that the pilot regarded this requirement as a constraint and wanted to fly alone. They added that the pilot trusted the aeroplane's automated systems, the basic modes of which he could use without difficulty. As soon as his plan of action was disrupted or the workload increased significantly, his ability to manage the conduct of the flight diminished significantly. Furthermore, it would appear that he did not accept the criticism levelled at him by the safety pilots.

2.5 Training and rating on TBM

The European licence also requires a Socata TBM700 Single Engine Turbine (SET) class rating following a training programme completed in accordance with the EASA OEB[11] filed by Daher-Socata. According to this programme, the pilot must be able to demonstrate 200 hours of IFR flight time before beginning the training. This class rating training is mainly conducted under VFR. The class rating training programme ensures that the pilot is capable of handling the aeroplane under VFR, but it does not provide him with the skills to conduct a flight under IFR (even though the programme includes some IFR approaches) or to operate the aeroplane in upper controlled airspace, conventional navigation or GNSS. This is why Daher-Socata added additional clauses with insurers so that pilots can gain experience: 25 hours of dual-control flight time with a safety pilot with more than 200 hours of flight time on TBM. On the day of the accident, the pilot had not met this 25-hour requirement with a safety pilot.

[11] Operational Evaluation Board, which has since been replaced by the Operational Suitability Data (OSD).

The United States of America, for its part, does not require this training for the SET class rating. However, the pilot, who held a US licence, had completed this training offered by the manufacturer to its customers when they purchase a new aeroplane. This training was given by ATO Airways, which had a commercial agreement with Daher-Socata.

2.6 Human performance

From the time the approach was aborted, there are several indications that the pilot's cognitive faculties were impaired:

- ❐ The go-around path was not followed: it is likely that it was not properly prepared during the arrival briefing.
- ❐ The readback of the controller's messages and the failure to comply with the heading or altitude instructions show that the pilot's attention was distracted during the missed approach.
- ❐ It is likely that the numerous heading alterations and attitude changes, which were manually controlled by the pilot in this blind environment, led him to experience vestibular-type sensory illusions.

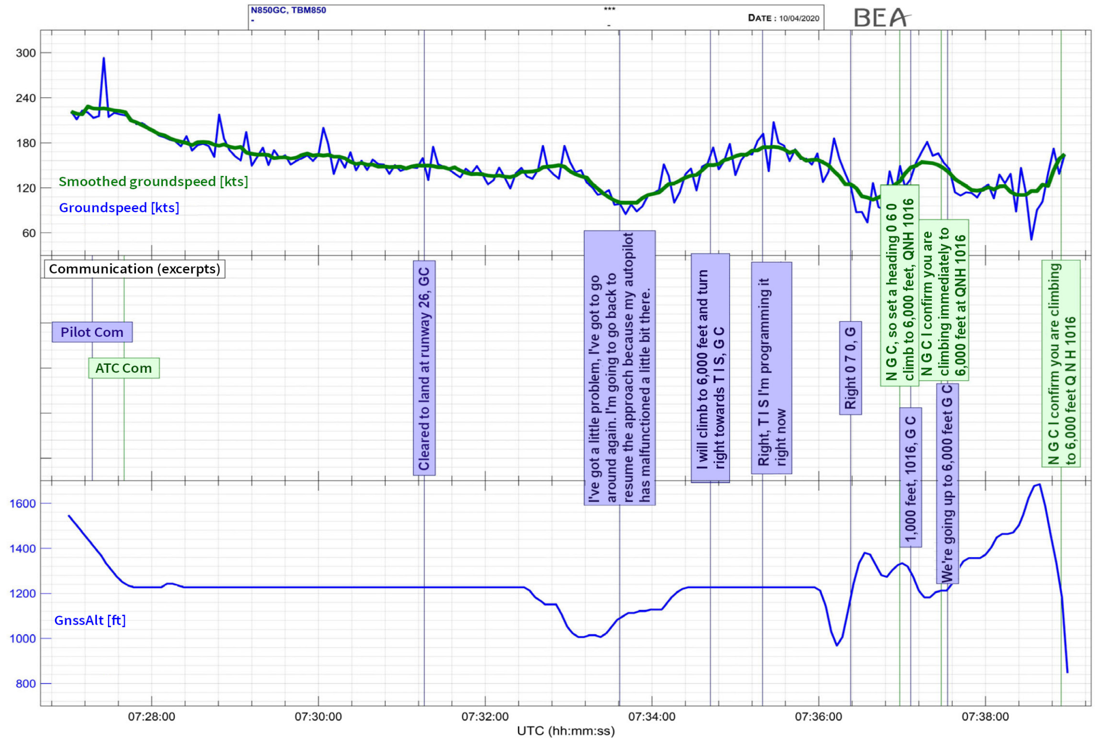

Figure 10: Vertical profile of the approach and speed indication

His overall experience, little recent experience under IFR flight without external visual references and failure to follow a structured work method prevented him from responding effectively to a high workload situation.

2.7 Meteorological information

A thundery front had moved away on the morning of 8 August towards Italy. However, an unstable air mass was still present over the Massif Central causing rain and showers, sometimes of a stormy nature

TAF - METAR

LFLC 080500Z 0806/0906 33006KT 9999 FEW006 SCT016 BKN033 TEMPO 0806/0809 3000 RA BKN015 SCT030TCU PROB30 TEMPO 0806/0809 1500 +RA BKN008 FEW030CB PROB40 TEMPO 0809/0812 5000 SHRA FEW035CB SCT040TCU PROB30 TEMPO 0812/0816 SHRA FEW035TCU PROB40 TEMPO 0900/0906 3000 BR OVC005 PROB30 TEMPO 0902/0905 0500 BCFG OVC003

LFLC 080600Z 34003KT 310V020 4500 RA BKN007 FEW030CB BKN036 15/14 Q1015 NOSIG=
LFLC 080630Z 33008KT 270V010 4500 RA BKN016 OVC036 15/14 Q1015 NOSIG=
LFLC 080700Z 34006KT 5000 RA BKN020 OVC033 15/14 Q1015 NOSIG=
LFLC 080730Z 35005KT 320V030 5000 RA SCT014 BKN030 OVC053 16/15 Q1016 NOSIG=

The meteorological conditions at Clermont-Ferrand Auvergne airport at the time of the accident were as follows:

- wind 350°, 5 kt;
- visibility 5,000 m;
- rain;
- SCT at 1,400 ft, BKN at 3,000 ft;
- temperature 16 °C, dew point temperature 15 °C;
- QNH 1 016.

The entire approach was performed in clouds, with no external visual references.

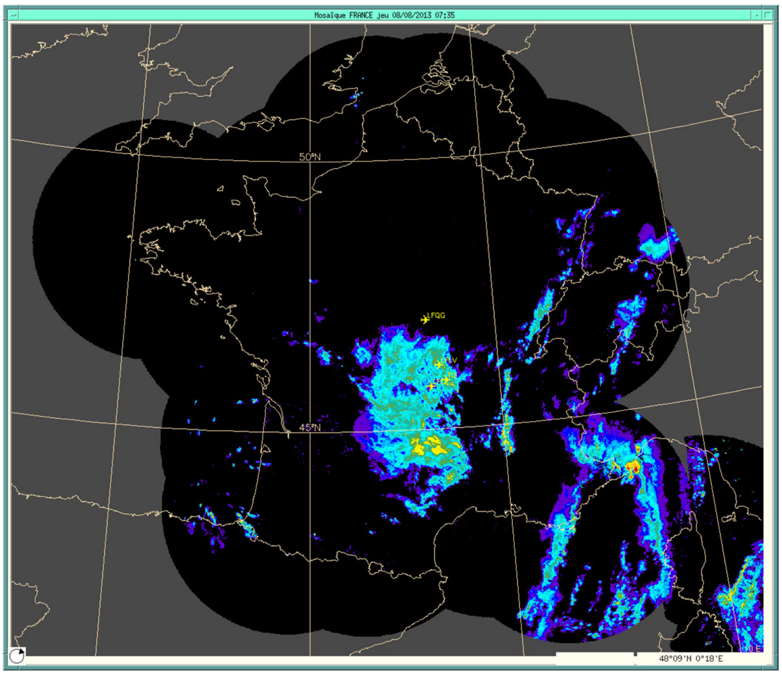

Figure 11: Mosaic radar image over France at 07:35 UTC

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

The plot from the radar data shows that the aeroplane followed the horizontal profile of the ILS Z 26 procedure up to about 6.4 NM from the runway threshold. This observation is consistent with the autopilot track for the ILS Z 26 procedure entered into the FMS, in GPS mode. The transition from GPS to LOC occurred after the FAP.

Although the autopilot mode was engaged, the aeroplane did not descend as the pilot expected. It continued aligned with the LOC but in level flight at 4,000 feet for more than 1 NM. The pilot attempted to rectify the glide slope from above. As he was unable to stabilise his path, he aborted the approach without following the prescribed go-around procedure or the heading and altitude instructions provided by the controller. He made a succession of left and right turns and climbs and descents.

The path and readbacks show that he lost situational awareness. The reduction in airspeed following the last climb caused the pilot to lose control of the aeroplane, which collided with the ground. The entire approach was flown without any external references.

Contributing factors

The following factors may have contributed to the loss of control:

- A coding error in the database of the Garmin 1000 avionics suite that prevented the automatic transition from GPS mode to LOC mode. As a result, the automatic interception of the glide slope did not occur, which probably surprised the pilot and led him to take manual control of the aeroplane and make excessive corrections.
- The pilot's overconfidence in the aeroplane's automatic systems.
- A lack of knowledge of the conditions required for the aeroplane's autopilot system to capture and follow the glide slope.
- The failure by the pilot to check the consistency of the procedure coded in the avionics suite with his own documentation.
- The pilot's limited total and recent instrument flight experience without external visual references may have contributed to his increased stress, distraction and spatial disorientation.
- Sensory illusions that the pilot may have been confronted with, given the numerous changes in aeroplane attitude without external visual references.
- Acquisition of additional experience and skills with safety pilots after obtaining the SET class rating that was ineffective and obtained outside the regulatory training framework, which can lead pilots to dispense with this guidance when it is regarded as a constraint.