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SAFETY INVESTIGATION REPORT

Serious incident to the PILATUS - PC12 - 47E registered F-HNFC on 19 July 2021 on La Môle aerodrome (Var)

Time	At 16:48[1]
Operator	Private
Type of flight	Site reconnaissance instruction flight (approval)
Persons on board	Pilot, instructor and two passengers
Consequences and damage	Propeller damaged
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.	

Hard landing, touchdown on nose wheel and propeller contact with ground, rejected landing, in instruction

1 HISTORY OF THE FLIGHT

Note: the following information is principally based on the aeroplane's Light Data Recorder LDR 1000 and the ACMS[2] data, statements, along with the analysis of the aerodrome's video-surveillance and radio communication recordings.

The pilot, who owned the aeroplane, was being given a site reconnaissance instruction flight[3]. He was accompanied by an instructor and two passengers who in turn, had each carried out a reconnaissance flight just before the occurrence flight.

The pilot took off a first time from runway 06 of La Môle aerodrome and then landed on runway 24. He took off from runway 06 again and planned to carry out an approach to runway 06. The pilot specified that the slope on final was steep and that he was late in lining up with the runway axis. Close to the ground, roughly 40 m before the threshold of runway 06, the pilot made a rough pitch-up input. The aeroplane briefly stayed level before abruptly pitching down. The propeller and nose gear came into contact with the ground. The pilot at the controls initiated a go-around and the instructor took the controls four seconds later when the aeroplane was established in climb.

The AFIS officer called the emergency services as a precautionary measure.

Aware that the propeller had touched the ground, the instructor decided to cut the flight short and to land on the reciprocal QFU of runway 24. The landing proceeded normally.

[1] Except where otherwise indicated, the times in this report are given in local time.
[2] Aircraft Condition and Monitoring System.
[3] Conditions described in paragraph 2.2.

2 ADDITIONAL INFORMATION

2.1 Meteorological information

Meteo-France estimated that in the area and at the time of the accident, there were low-pressure conditions, a southerly wind of 6 to 13 kt, visibility greater than 10 km, clear skies, a temperature of 30°C and a QNH of 1011 hPa.

The direction of the mean wind (two-minute mean wind) rotated at around 16:15: the wind changed from 060°/8 kt to 190°/7 kt at the time of the accident at 16:48 with gusts of 12 to 13 kt.

The AFIS officer reported a southerly wind of 7 kt at 16:46. A tailwind component was present during the landing on runway 06.

2.2 Aerodrome information

La Môle aerodrome (LFTZ) is a restricted use aerodrome situated in the river La Môle valley. It is bordered by high ground.

It can be used by aeroplanes under the conditions laid down by the modified order of 25 July 2019 approving La Môle aerodrome.

The AIP documents and the VAC chart specify the following for aeroplanes such as the PC12:
"Group 2 aircraft :
Within the six months prior to the first flight at La Môle as captain, the captain has performed an aerodrome reconnaissance flight as pilot on the type or class of aircraft concerned, with an instructor approved by the south east civil aviation safety director.

This aptitude is maintained if, within the last twenty-four months, the captain has taken [off] from and landed on the La Môle aerodrome as captain of an aircraft of the same class or type.

Group 2 ACFT instructors are approved by DSAC/SE. Approvals are valid for 3 years and extendible on request within the 3 months preceding the expiry date. A list of Group 2 ACFT instructors by type or class of ACFT is established and is available on request from DSAC/SE."

Runway 24 is equipped with a Precision Approach Path Indicator (PAPI) unlike runway 06.
The take-off and landing funnels are:

- landing RWY 06 / take-off RWY 24: slope at 5%;
- landing RWY 24 / take-off RWY 06: slope at 4%.

The final for runway 06 is offset due to the terrain.

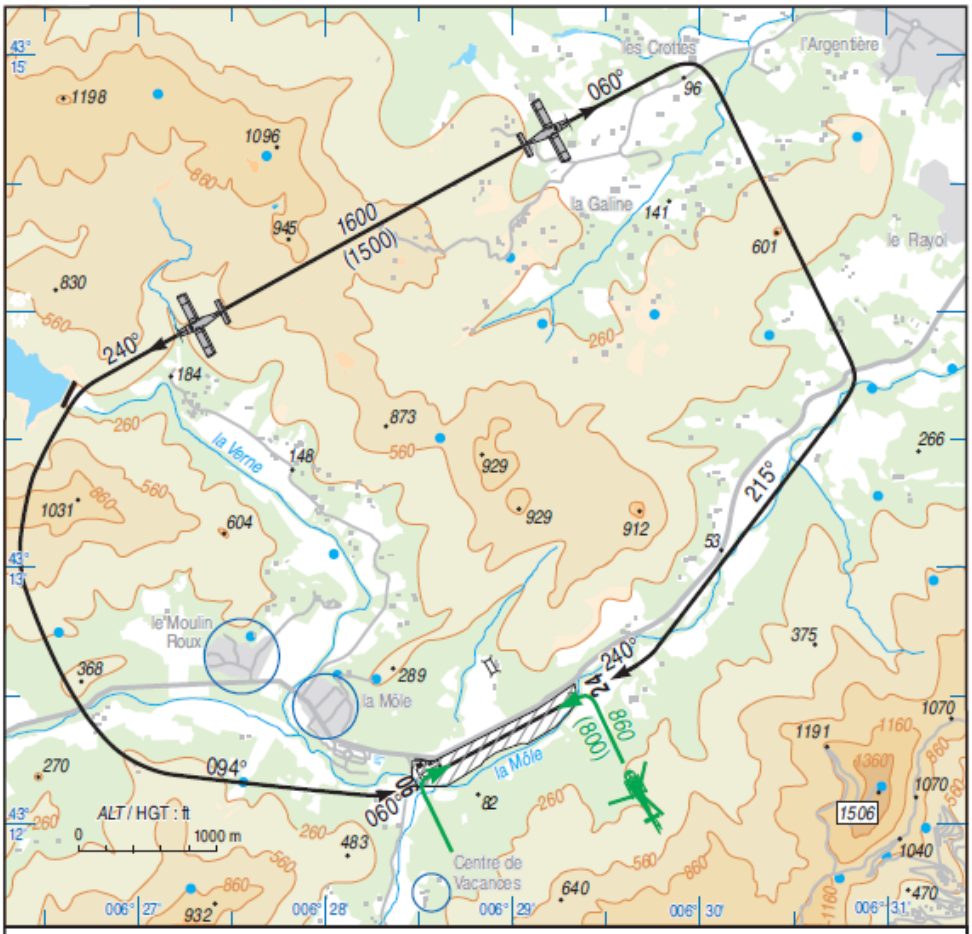
The instructor training programme (see paragraph 2.3) specifies that:

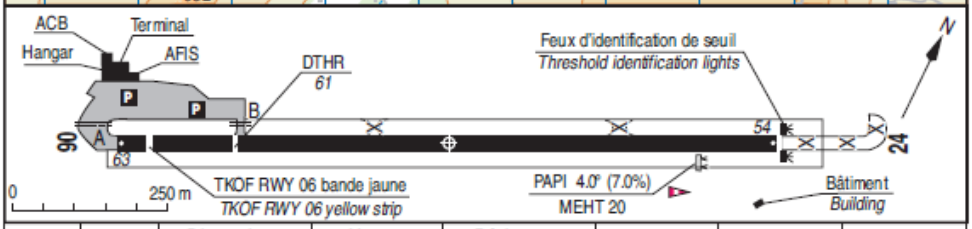
- the lining up on final for QFU 06 is a particularly short phase and requires the utmost rigour in holding both the speed and the aiming point;
- taking off and/or landing at La Môle aerodrome requires highly-developed situational analysis and decision-making skills.

LA MOLE **ATTERRISSAGE A VUE**

AD 2 LFTZ ATT 01 *Visual landing*

25 MAR 21





RWY	QFU	Dimensions *Dimension*	Nature *Surface*	Résistance *Strength*	TODA	ASDA	LDA
06 24	060 240	1071 x 30	Revêtue *Paved*	21 F/C/W/T	1131 961	1071 1071	931 1071

Aides lumineuses : RWY 24 : PAPI orientés au 231°.
Le franchissement du relief élevé situé dans l'axe de piste à environ 2200 m en amont du THR n'est pas assuré par le PAPI.
Feux d'identification de seuil RWY 24.
Le décollage doit se faire à partir de la bande jaune.
Bretelle B réservée aux ACFT dont l'envergure est < 24 m et dont la largeur hors tout du train principal est < 6 m
Portée du PAPI limitée à 7000 m.
PAPI 24 décalé de 9° vers le Nord

Lighting aids : *RWY 24 : PAPI lights are 231°orientated.*
Clearing of high mountains located in RWY axis at 2200 m from THR is not provided by PAPI.
Identification lights at threshold RWY 24.
Take-off must be done from the yellow strip.
TWY B reserved for ACFT which span is stricly less than 24 m and whose overall width of the main gear is stricly less than 6 m.
PAPI's range limited to 7000 m.
PAPI 24 offset 9° to the North.

SERVICE DE L'INFORMATION AERONAUTIQUE

AMDT 04/21 **CHG :** Emprise AD, orientations, QFU, ALT THR et DTHR, INFRA, restrictions PAPI. ©SIA

Figure 1: LFTZ VAC chart (source: AIS)

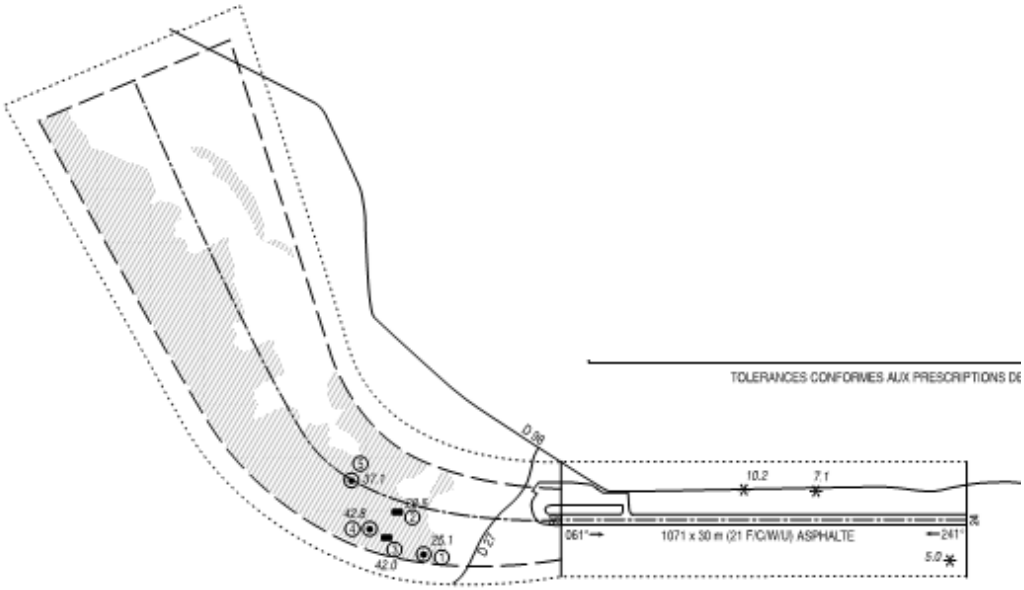


Figure 2: obstacle landing RWY 06 / Take-off RWY 24 funnel (source: AIS)

2.3 Training authorised instructors for issuing approval to use La Môle aerodrome

During the instructor training given by the DSAC/SE inspector pilot, a presentation is given on environmental, regulatory and operational aspects. The overflight ground references are described in detail, as well as the presence of windshear in identified zones near the thresholds.

During the training to approve a pilot to use La Môle aerodrome, instructors are expected to assess the students' piloting skills (holding parameters and following flight path, aiming point and touchdown point) and to carry out a briefing to check their knowledge of the aeroplane's performance.

The instructor did not assess the three pilots prior to the approval flight. However, he carried out a ground briefing.

2.4 Aeroplane and systems information

The examination of the flight file found that for the accident flight, the plane's weight and balance were within the operational limitations defined in the flight manual.

2.4.1 Airframe

Manufacturer	Pilatus
Type	PC12/47E
Serial number	1,277
Registration	F-HNFC
Entry into service	2012

2.4.2 Engine

Manufacturer	Pratt & Whitney Canada
Type	PT6A-67P
Serial number	PCE–RY0393
Date of installation	2012
Total operating time	1,791 hours and 1,322 cycles
Operating time since previous overhaul	92 hours and 71 cycles

2.4.3 Propeller

Manufacturer	Hartzell propeller Inc.
Propeller model	HC-E5A-3A
Blade model	NC10245B X 5 composite
Cone	105820(P)
Propeller diameter	105 in

2.4.4 Recording systems

European regulations do not require single-engine aeroplanes with a maximum take-off weight of less than 5,700 kg to carry a flight recorder.

However, the manufacturer Pilatus, chose to offer the possibility of installing a combined Cockpit Voice and Flight Data Recorder (CVFDR), called a Light Data Recorder (LDR) on the PC12/47E.

The Modular Avionics Unit (MAU) carries a double data bus to which different modules including the Aircraft Condition and Monitoring System (ACMS) are connected. The ACMS data is stored on a removable memory card. The ACMS records flight data and engine trend parameters.

The flight data from the LDR and the ACMS as well as the audio data was synchronized using the vertical acceleration and the noise caused by the plane striking the ground.

2.4.5 Angle of Attack (AOA) protection system

Flight tests carried out during the initial certification of the PC12 showed that the natural behaviour of the aeroplane on stalling did not comply with certain certification requirements: in certain flight conditions, the roll rate, after stalling, could exceed the certification requirements.

Compliance with certification requirements was shown by the design and installation of a stall protection system (stick-pusher) which prevents the aeroplane from stalling by generating a pitch-down input before the AOA is too high.

In addition to this, the stick-shaker and the STALL message on the PFD inform the pilot that the AOA is approaching a stall situation. If the pilot takes no action and the AOA continues to increase, the stick-pusher engages to reduce the pitch angle before the aeroplane stalls.

The combination of the stick-shaker and the stick-pusher is called the Stall and Warning Protection System (SWPS).

This system is made up of the following components:

- two AOA sensors situated on the leading edge of the left and right wings;
- two independent computers; each computer receives the AOA information from each sensor and processes this data in order to determine if the aeroplane is approaching an excessive AOA;
- the stick-shaker which warns the pilot that the aeroplane is approaching a stall situation by simulating the vibrations felt during an aerodynamic stall. It is activated when one of the two computers detects the approach of an excessive AOA. It disconnects the autopilot;
- the stick-pusher which moves the stick forward in order to reduce the pitch attitude before the aeroplane enters a stall situation. It is only activated when both computers detect the approach of an excessive AOA.

It is possible to override the stick-pusher in the event of its untimely activation by applying sufficient force. A pushbutton on the stick, when pressed, disengages the actuator which pushes the stick.

The SWPS uses the Flight Alerting System (FAS) to warn the pilot of an imminent stall condition.

On the ground, the stick-pusher, stick-shaker and the stall aural and visual warnings are inhibited except when the test function is activated. As soon as the aeroplane takes off, and up to when it touches down, the stick-shaker and the stall aural and visual warnings are available. The stick-pusher is inhibited for five seconds after take-off in order to avoid its activation should the pilot rotate too early. It is then available until landing.

Stall detection is based on the measurement of the aeroplane's AOA. The SWPS calculates the AOA thresholds beyond which the various protection systems must intervene:

- an AOA threshold beyond which the stick-shaker and the aural and visual warnings are activated;
- an AOA threshold beyond which the stick-pusher is activated.

The AOA threshold for the activation of the aural and visual warnings and the stick-shaker is below that of the stick-pusher.

This means that the crew are first warned by an aural and visual warning and vibrations in the stick when the AOA is close to the stall AOA, and can reduce the aeroplane's pitch attitude if it gets too close to the stall AOA.

From a regulatory view point, today, as at the time of certification of the PC12, American certification requirement FAR 23.691[4] did not have any requisite regarding the deactivation of the stick-pusher close to the ground.

[4] There is no European requirement CS 23.691.

The manufacturer and certifier pointed out that a natural stall during the landing phase (full flaps and idle) can produce a whip stall (45° induced roll with an abrupt fall) which might be more dangerous for the person on board than an unwanted stick-pusher action, resulting mainly in material damage.

2.4.6 Read-out of flight data

At point 1 (see Figure 4), the aeroplane was aligned on final (20 s before the flare) in the landing configuration (flaps 40° and landing gear extended), its Calibrated AirSpeed (CAS) was 93 kt and decreasing and its height around 300 ft.

At 16:47:40, on passing a height of 180 ft, the pilot reduced power to flight idle, and the CAS stabilised at 87 kt[5].

At 16:47:49, the instructor called out four times for the pilot to watch the speed. No variation in the parameters was recorded. At this point the CAS was 79 kt.

At 16:47:51, the pilot flared by pulling hard on the stick, the pitch attitude increased to 11° and the CAS decreased to 73 kt.

At point 2, at 16:47:53, a first "STALL" warning[6] sounded. The AOA protections were activated and the stick-pusher brought the pitch attitude from +11° to -6°. The speed decreased to the minimum value of 68 kt. The nose gear and propeller struck the runway.

In the following second, the RH main landing gear followed by the LH main landing gear touched down on the runway. The pilot increased power and rejected the landing. The "STALL" warning sounded three times, at two second intervals.

Given the dynamics of the event, the actions of the stick-shaker and the stick-pusher and the "STALL" warning were simultaneous. No SWPS operating anomaly was observed.

[5] V_{APP} between 83 and 87 kt in the conditions of the day.

[6] The call was made 5 to 10 kt before the stall, at a CAS of between 68 and 63 kt in the conditions of the day.

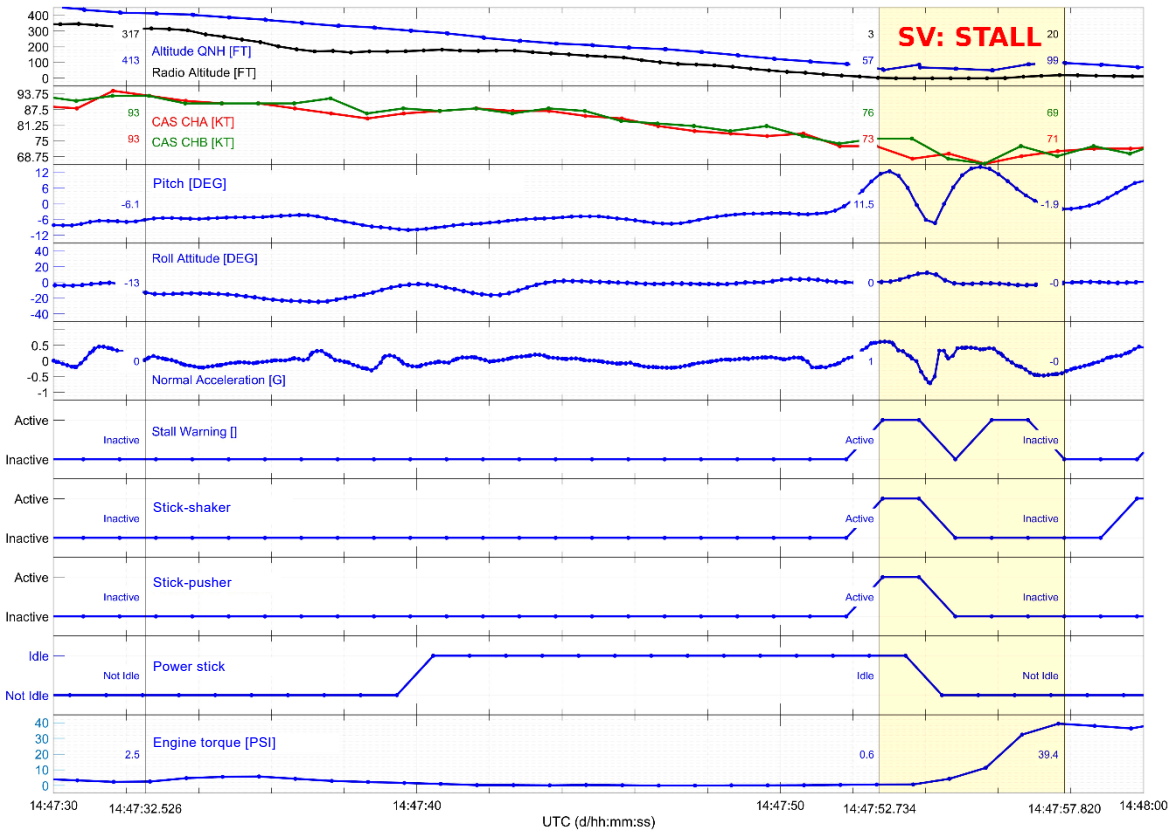


Figure 3: parameters of final approach up to touch-down (source: BEA)
(SV (Synthetic Voice generated in cockpit)

2.5 Analysis of data

2.5.1 Aerodrome video-surveillance

The examination of the video from the aerodrome's video-surveillance camera showed a sudden variation in the pitch attitude to pitch-up and then to pitch-down as described by the witnesses in the aeroplane and on the ground. The nose gear and propeller came into contact with the ground immediately after the threshold of runway 06, in the first few meters of the threshold stripes. The aeroplane bounced and then flew level a few metres from the ground. It then disappeared from the camera's field while slightly oscillating up and down.

2.5.2 Flight path

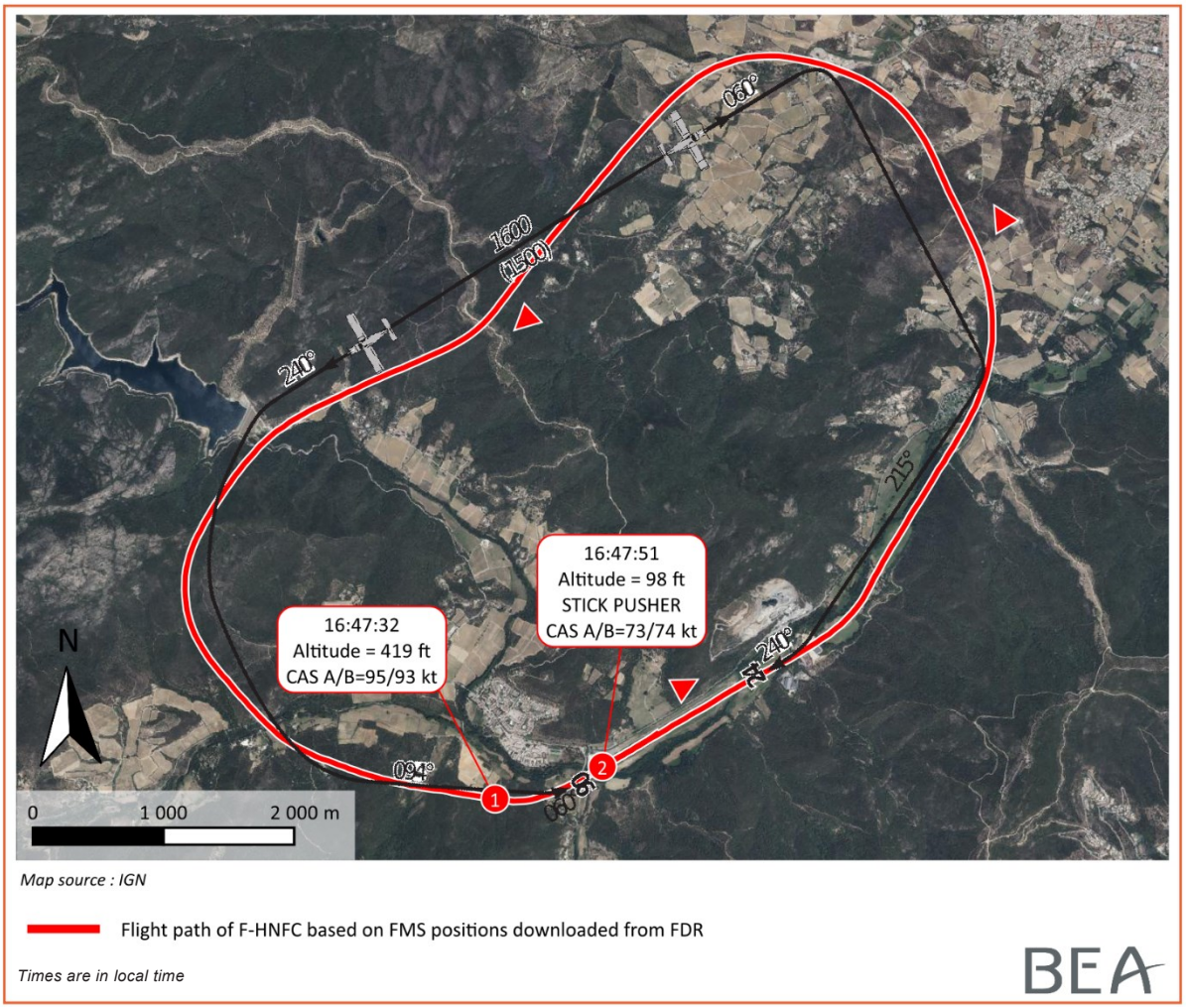


Figure 4: flight path of F-HNFC from take-off to rejection of landing

2.6 Personnel information

2.6.1 Instructor

The 46-year-old instructor held a CPL(A) licence obtained in 2018 with the Pilatus PC12 SET SPO and IR/PBN ratings. He held the class rating instructor (CRI(A)) and the instrument rating instructor (IRI(A)). He held a valid authorisation for checking the aptitude of pilots to use La Môle aerodrome awarded by the DSAC/SE in 2020. He had logged 5,814 flight hours, including 465 hours on type. In the previous three months he had logged 112 flight hours including 42 hours on type.

2.6.2 Pilot in training

The 56-year-old pilot held a PPL(A) licence obtained in 2008 with the Pilatus PC12 SET SPO and IR/PBN ratings. He had logged 381 flight hours, including 38 hours on type, 14 take-offs and 14 landings. In the previous three months, he had logged 9 flight hours on PC12s.

2.6.3 Rear-seat passengers

The first passenger, aged 56, held a CPL(A) obtained in 1997 with the Pilatus PC12 SET rating. He had logged 10,050 flight hours, including 2,200 hours on type.

The second passenger, aged 30, held a CPL(A) obtained in 2020 with the Pilatus PC12 SET rating. He had logged 400 flight hours, including 70 hours on type.

2.7 Analysis of human performance

2.7.1 Management of risks in instruction at La Môle aerodrome

In flight, instructors manage risks by anticipating threats with knowledge, skills and mental resources that are often greater than those of their students. Thus, the instructor must be continuously aware of both relevant information regarding the state of the aircraft, the surrounding traffic, the weather conditions, the airspace and the surrounding area, and what the pilot under instruction is doing and intends to do.

Threats linked to the wide-range of skills of the pilots under instruction:
The population of approved pilots flying in and out of La Môle aerodrome is made up of professional pilots (scheduled flights) and private pilots (variable frequency). The same rigour in terms of piloting precision is expected of both populations.

The method inherent in professional pilot training can compensate for little experience on the aircraft.

Adaptation to the instantaneous situation, based on the basic knowledge acquired during their initial training, is more characteristic of the behaviour of private pilots. The experience of expert private pilots generally compensates for the lack of method.

For an instructor, having to train professional and private pilots, with different skills, during the same instruction session, can constitute a threat.

Threats linked to aircraft:
A flight to obtain the approval to use a restricted-use aerodrome requires that the instructor has perfect knowledge of the aircraft on which she/he will be giving the training, and its airworthiness. Taking into account this threat minimises the probability/severity of equipment failure.

Threats linked to piloting errors by the pilots under instruction:
The instructor must be prepared for errors to be made by the pilot under instruction or the student pilot. The threats associated with these errors can be mitigated by planning activities according to the actual conditions, allowing sufficient time and space for the pilot under instruction to train and for the instructor to take control of the aircraft before the situation deteriorates to the point where the instructor is no longer able to recover it.

Environmental threats:
The aerodrome is bordered by high ground. It is difficult to imagine that pilots could acquire both skills in flying the aeroplane used and knowledge of the particularities and environment of the aerodrome. The constraints imposed by La Môle aerodrome require the pilot to have a high level of piloting precision (compliance with speeds and aiming point) and to scrupulously follow the flight paths.

For his part, the instructor has to monitor the same piloting parameters, while providing the student with additional skills. He must also let the student act, and correct any unacceptable deviations.

Added to this, the student may have to join busy and varied air traffic.

To reduce the risks associated with this type of operation, many instructors assess their students' piloting skills at a known aerodrome before starting training at La Môle aerodrome.

2.7.2 Activity observed on the day of the occurrence

Hereafter in the report, the private pilot in the left seat and the two passengers (commercial pilots) occupying the rear seats at the time of the occurrence will be referred to as P2, P3 and P4 respectively. The analysis below is based on the readout of the LDR audio data.

Threats linked to the wide-range of skills of the pilots under instruction:
The three pilots tended to carry out the technical call outs (actions, checks, etc.). As the flight progressed, this rigour gradually disappeared.
There were a few differences between the pilots:

- P3 carried out a very thorough and concise initial before take-off briefing, mentioning the case of an engine failure at take-off and the division of tasks (CRM);
- P4 carried out a briefing at the start of the flight, but did not mention the possibility of a failure;
- after the instructor’s briefing about the path to follow, P2 did not carry out a specific briefing before taking off.

During the flights performed by P3 and P4, discussions can be heard at the rear, relating to the flight path, the external references for the runway circuit and the use of the PC12. For example, one of the pilots in the rear seat can be heard reminding the other pilot of the extension and retraction sequences for the flaps and gear.

Certain questions from the student seem to suggest difficulties in simultaneously managing the flight path and the configuration, and in assimilating the information provided by the instructor regarding the various reference points.

On the same day, the instructor carried out a connecting flight between Luc-en-Provence and La Môle aerodromes, followed by three instruction flights for P3, P4 and P2.

P3 and P4 indicated that they had informed the instructor that P2 had recently obtained his PC12 rating.

During the flight, P2, the less experienced of the three pilots, seemed to show that he did not have the same level of expertise on the PC12. These aspects did not seem to receive any particular attention from the instructor.

Threats linked to aircraft:
The PC12 was airworthy and its systems were functioning in accordance with the manufacturer's specifications.

The instructor had very good knowledge of the operation of the aeroplane's systems and of piloting it. These threats were controlled.

Threats linked to pilots:
Just before the flare, the instructor called out four times for the pilot to watch the speed. He did not intervene on the controls. P2 did not adjust the power and made a rough pitch-up input which further reduced the speed. The "STALL" call sounded four times. On the aeroplane's violent touchdown (activation of stick-pusher), P2 immediately asked what he should do. The instructor did not react. P2 increased power. A few seconds later, P3 (or P4) indicated that the propeller had touched the ground. The instructor verbalised this while P3 twice asked him to take the controls. The instructor replied that he had the controls and continued the flight, landing on runway 24.

This sequence shows that the instructor did not intervene although he was aware that the speed was low. He did, however, repeatedly call P2's attention to this. He was slow taking the controls after the contact with the ground although P2 was destabilised and asking for help. The input from P3 and P4 over the intercom system helped put him back into the piloting loop.

Environmental threats:
The instructor gave quite strict directions to the three pilots on the aspects regarding the flight path, configuration and speed management. He was in charge of radio communications.

When they started the circuit for runway 06, the instructor did not recall the tailwind threat for landing.

2.8 Statements

2.8.1 Instructor's statement

During the approach to runway 06, the pilot flying (student) carried out a relatively stabilised approach. He flared a little too early, and the airspeed decreased to around 76 kt on the left PFD, entering the amber section on the airspeed tape. The instructor called out to watch the airspeed to draw the student's attention to the decrease in speed. He perceived an increase in the landing pitch attitude followed by a sudden movement of the stick. The propeller came into contact with the runway. The student initiated a go-around and after take-off, the instructor took the controls. He considered that the environment of the La Môle runway made it impossible to abort the go-around after applying take-off power. The emergency services were alerted by the air traffic controller and during the climb, he confirmed they were in a MAYDAY situation. He then landed on runway 24.

The instructor declared that no engine instrument warnings were observed during the go-around. He added that performance had decreased due to the reduced effectiveness of the propeller, its

blade tips being missing. Vibrations were noticeable during the climb, but they were not excessive, probably due to the tips of the five blades having similar damage The quick pitch moment after wheel touchdown was consistent with the activation of the stick-pusher. He specified that he was aware that the PC-12 NG stick-pusher was not inhibited during the landing.

2.8.2 Statement from pilot

The pilot specified that he felt that the approach slope was a little steep and that he aligned late. He added that he performed a large flare and that the aeroplane then abruptly plunged.

2.8.3 Statements from passengers

One passenger seated in the rear indicated that it seemed to him that the final was not well stabilised on the yaw axis and that the pitch-down attitude was high. He perceived a sudden change in pitch attitude when the aeroplane pitched up before suddenly pitching down.

The two passengers indicated that they clearly perceived the nose gear's and propeller's violent contact with the ground and announced it out loud, but at that moment, they were not wearing headsets. Both were surprised to observe that the student was still at the controls at the start of the go-around and that the instructor had not taken the controls. They added that they thought that the instructor had not taken the measure of the situation and decided to inform him of the contact again, over the headset.

3 CONCLUSIONS

The conclusions are solely based on the information which came to the knowledge of the BEA during the investigation.

Scenario

During an instruction flight to obtain the approval to use La Môle aerodrome, the pilot under instruction carried out an approach to runway 06. On approaching the ground, the instructor warned him four times to watch the speed without the pilot correcting it. During the flare, the amplitude of the pitch-up was too great which resulted in the simultaneous triggering of the STALL warning and the activation of the AOA protection system (stick-pusher). This system induced an instantaneous pitch-down movement (-15.5 °/s). The propeller and nose gear made violent contact with the ground. The five blades of the propeller were damaged. The pilot increased power and asked for instructions from the instructor who was slow taking the controls. The landing on runway 24 proceeded normally.

Contributing factors

The following factors may have contributed to the hard landing:

- the pilot focalising on the management of the flight path to the detriment of monitoring the speed;
- an absence of stimulus from the instructor when the speed was decreasing;
- the instructor not making a prior assessment of the owner pilot's abilities to pilot with precision on a less demanding aerodrome;
- a possible reduction in vigilance on the part of the instructor, who had repeated several similar flights with professional and private pilots with different levels of proficiency.

Safety lessons

The PC12 is equipped with an AOA protection system complying with FAR/CS 23 standards. Unlike the FAR/CS 25 specification standards applicable to heavy aeroplanes, the FAR/CS 23 standards do not require the inhibition of the stick-pusher during the landing. There is, however, a control to inhibit this system, but only in the event of untimely activation.

The Pilatus flight safety representatives indicated that they had observed that certain pilots or instructors suggested disconnecting the stick-pusher during the landing to prevent the system from being activated close to the ground in the event of a low approach speed.

Pilatus condemns this practice as dangerous on the basis that stalling close to the ground, a possible consequence of the disconnection of the stick-pusher system, is more dangerous than the risk of contact with the ground produced by the variation in attitude induced by the activation of the stick-pusher.

Consequently, Pilatus' position regarding pilot activation of the stick-pusher switch during the final phase of the approach is as follows: *"Pilatus stresses the importance of adhering to the published procedures, and advises against intentionally disabling a protection function of the aircraft."*

The BEA investigations are conducted with the sole objective of improving aviation safety and are not intended to apportion blame or liabilities.